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ELECTRONICS TODAY INTERNATIONAL

check
inside
Applied Technology's
EASY USE
Semiconductor Wall Chart

SLOT CAR CONTROLLERS

★
★
**WIN A
SYSTEM
80** ★

**2650
COMPUTER
on \$100 board**

**A look at
QUAD'S NEW
Electrostatics**

Particle Beam Fusion



The average hi-fi designer versus the human ear.

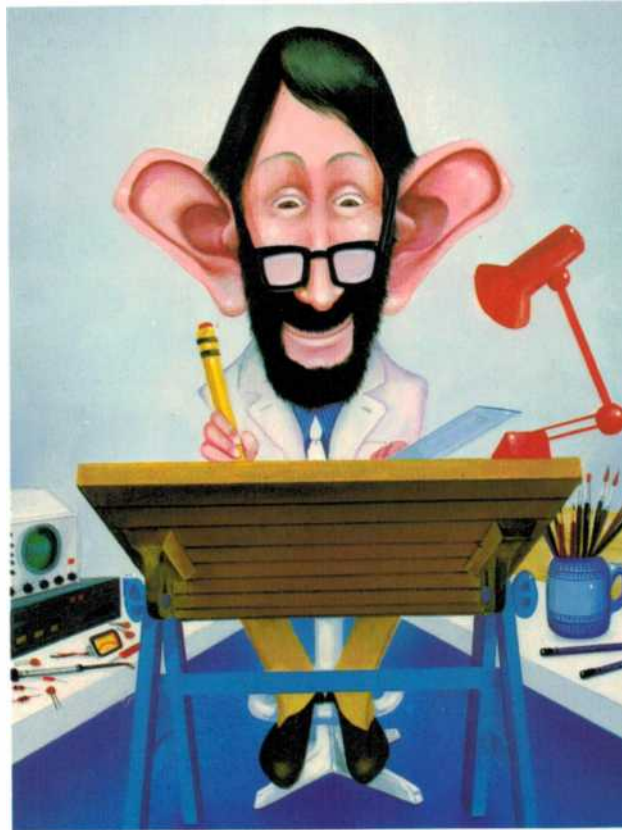
The human ear forms part of a sound receiving system that outperforms the best audio equipment known to science.

Capable of interpreting a dynamic range of 120db or 10 octaves, it has double the capability of any man made electronic equipment.

The ear can discern direction, coloration and musical detail within a complex rendition of a 50 piece orchestra in a manner no electronic equipment is able to do.

It is, in short, a sophisticated piece of equipment that should represent the most stimulating challenge to any designer of audio equipment.

Unfortunately it's a challenge that's largely ignored. Which is why in most stereo



were tired of compromise, Vector Research represents a new standard in high fidelity excellence.

Discussing the Vector VRX 9000, *Stereo Review* states "The receiver surpassed virtually every one of its performance specifications... it sounds as good as it looks, which is saying a lot..."

High Fidelity states "a receiver with such sophisticated performance and functions demands attention." *Popular Electronics* on the Vector VCX 600 cassette deck, "Lower Flutter readings than those of the VCX 600 are hard to find..."

while not cheap, it affords excellent value." *Hi-Fi Buyer's Review* sums up.

"Vector Research is a newcomer to the audio scene, but if the VCX 600 is any guide, this company should be very successful."

If then you are an audiophile whose interest goes beyond famous names and shiny knobs then you owe it to yourself to learn more about Vector Research.



systems handling power and volume are substituted for subtlety and frequency response. Vector Research however is one of the few exceptions. Developed by a team of highly experienced audio engineers who

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KO 404 ETI

Vector Research. A fraction better than excellent.



Well, it has been an eventful year for us here at ETI. We put our best foot forward — project wise — right at the start by commencing the Series 5000 hi-fi projects with the 100 W MOSFET stereo amplifier featuring performance unrivalled by *any* published project — or commercially available amp. In February we became the first magazine in the world to review loudspeakers using spectral decay analysis — thanks to the work of Louis Challis. Now we can measure those subtleties you can hear. In March we exposed the fallibility of police speed radars with a detailed examination of their workings never previously seen in the technical press.

April was our tenth birthday issue — and the biggest selling issue for many years! In May we featured a technical review of research work carried out on the Shroud of Turin following examination of it by an international scientific team in October 1978. It was the first such technical review published worldwide, and we gained an enormous amount of attention from the general media as a result.

In June we launched Hobby Electronics which, disappointingly, we had to discontinue as a monthly publication in November. We also launched COMDEC, a computer magazine for business people — which gained immediate success. You win some, you lose some.

In July we commenced the second stage of the Series 5000 projects with the introduction of the Stereo Control Preamp, since widely acclaimed. September saw the start of construction of the long-awaited Learners' Microcomputer — for the first time, a *truly* low-cost computer project aimed at those who want to get into microcomputing without boiling their brain cells or breaking the bank.

October stood out, not only because David Tilbrook appeared on the front cover, but for the ZX81 contest, which attracted what seems to be the greatest number of entries of any contest we've ever run! Results next issue. The November issue represented a 'first' for us — but maybe you didn't notice. The cover featured silver! That's *real silver* in the ink! Stash those precious copies away, there's about three cents worth on each cover — you might make a killing on the silver market when the price rises again!

This month we continue our support of the hobby computerist with another in our series of S100 computer projects — the ETI-685. And there's more to come.

Well, so much for the year in review. Next year? That would be telling. Suffice to say we not only plan to continue our high standard of projects, features and reviews but we'll introduce a few new things as well.

We extend to our readers and advertisers best wishes of the season and trust that you have a prosperous, exciting new year.

Roger Harrison
Editor



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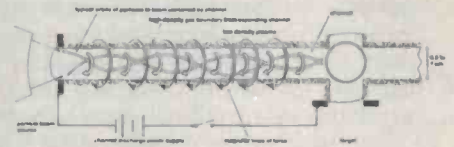
Slot cars are fun!... for kids of all ages. Jonathan Scott, together with Corey and Jamye Harrison, proved the point for our photographers by converting the studio into a miniature Le Mans (complete with sound effects from the side of the mouth and odd staff making crowd noises to egg them on). You too can join in the fun, commencing page 26.

*Recommended retail price only

news

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features



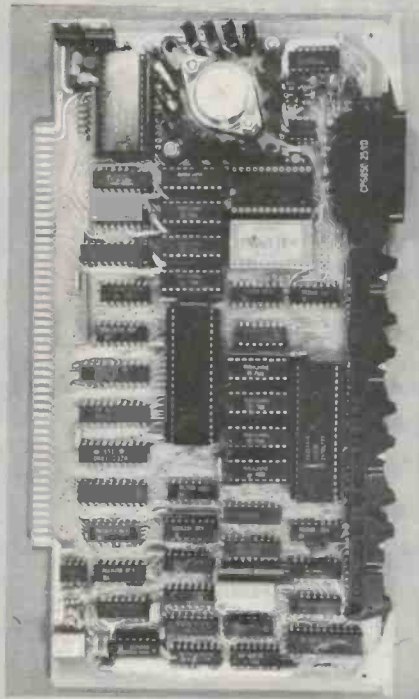
PARTICLE BEAM FUSION 14
Could particle beam fusion supersede the fission processes of present-day nuclear reactors to provide the answer to world energy requirements? Brian Dance investigates.



WIN A SYSTEM 80 — CONTEST 110
Complete a simple crossword and write a short essay, and a Dick Smith System 80 personal computer could be yours.

projects

824/825: SLOT CAR CONTROLLERS	26
Hours of fun for electronics enthusiasts and their families — Invest in a cheap slot car set and turn it into your version of Le Mans! For once your family won't moan about your hobby!	
159: EXPANDED SCALE VOLTMETER	37
This simple, low-cost instrument can be built into power supplies or used as a portable or fixed battery condition monitoring meter.	



685: 2650 SBC FOR \$100 91

This project continues ETI's series of projects supporting the popular S100 buss, and uses the 2650 microprocessor in a single-board computer design with many features not found elsewhere. It is compatible with the ETI-640 VDU and ETI-681 PCG, and will be followed by more associated projects and articles.

sight & sound

INSIDE QUAD'S LATEST ELECTROSTATIC SPEAKERS 140

No new loudspeaker development has been heralded by more rumour, speculation and comment than Quad's new electrostatic model. Brian Dance finds out what it's all about.



SANSUI SE-8 EQUALISER/ANALYSER 150

According to Louis Challis, this unit "comes closer to the amateur's expectation of a panacea than anything else . . . yet seen in the marketplace."

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computing

COMPUTING TODAY 73

IBM helps the deaf to speak and to listen; Cromemco sales up.

NEWTON'S COOL 86

Morbid-minded physicists should take delight in this unusual application of Newton's Law of Cooling — a computer game for those looking for something different.

KEYBOARD BEEPER FOR THE SORCERER 118

This ultra-simple circuit beeps to alert you when the machine is ready for your next entry. It uses only one IC and no software is required.

next month



SATURN UP CLOSE

Voyager 2's flyby of Saturn in late August/early September gave us our closest look yet at this fascinating planet. Passing 101 000 km from the cloud tops, Voyager 2 showed that Saturn's rings number in the thousands, rather than the few we thought existed — even though Voyager 1 picked up hundreds in its 1980 flyby.

January's science feature shows some of the spectacular detail obtained by Voyager 2's cameras and discusses the scientific achievements of the mission.

LASERS & HOLOGRAPHY

A major laser and holography exhibition will tour Australia next year. Called 'Space Light', it will spend all January in Sydney before touring major centres in the other states. Our article previews what it's all about.

INFRARED TRIP RELAY

A simple, low-cost project that operates a relay when a beam of infrared light is broken. Useful as a 'door minder' alarm or to trip a camera for wildlife photography, etc, this project is easy to get going and will only set the budget back by about \$25.

REVERSING ALARM

There are a number of accidents reported each year where a child or adult has been seriously injured by a vehicle being driven in reverse. There would be countless potentially serious near misses. A reversing alarm that operates when you select reverse gear would obviously help prevent the number of 'incidents'. The project is inexpensive, provides a loud, audible 'beep', and is easy to fit. A must for the safety conscious.

SPEEDY BASIC

How to improve your programming by writing programs that operate more efficiently. No matter which BASIC you're using . . .

DOLBY C EXPLAINED

The brilliant Ray Dolby has waged an indefatigable war against noise in audio systems, and with not a little success. His latest weapon is examined in detail.

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

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TYPING TUTOR: An interactive program that teaches you to touch type. Claimed to teach typing skills faster than any other method. X-3682 \$33.50.

SPEED READING: 4 programs, 2 cassettes, designed to help readers of all ages improve reading skills. Reading speed can be set as high as 0.1 seconds per line. X-3692 \$33.50.

SIMUTEK PACKAGE ONE: Five fantastic space fantasy games in one. Outstanding value! X-3685 \$29.95.

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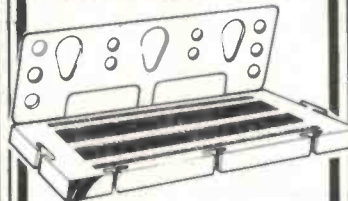
GRADUATED EDGE METER

32(W) X 10(H)mm. SNZ is ideal for fine level adjustments. X-498 \$4.98

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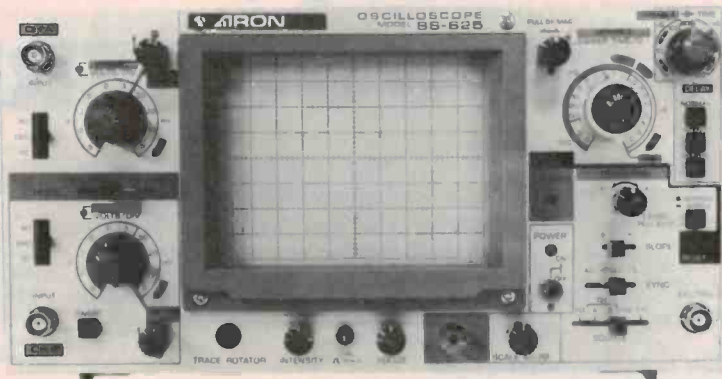
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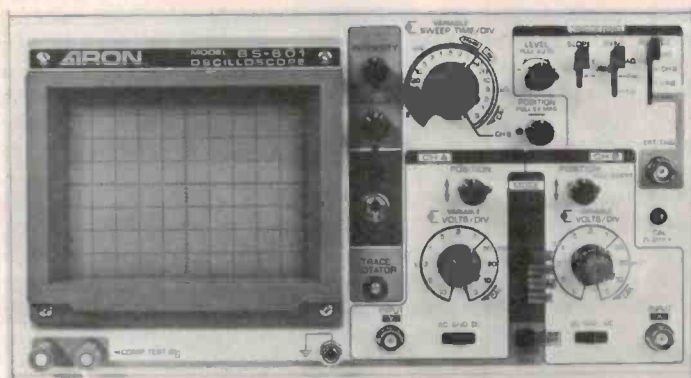
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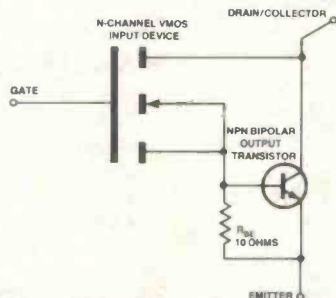
It's a chip, it's a what? — it's a SUPERFET!

A new monolithic device which allegedly has the advantages of VMOS devices combined with the high current handling capability and low saturation voltage of a bipolar transistor has been developed by Supertex Inc of California, and is claimed to offer considerably better switching performance than existing products.

The internal circuit of the SUPERFET, shown here, consists of a VMOS input device — which provides an extremely high input impedance, a current gain of perhaps a hundred million and a very fast switching capability — and a bipolar output transistor specially designed to preserve the fast switching ability.

A 10 ohm resistor is connected between the base and emitter of the bipolar output transistor to prevent the device from being turned on by spurious transient signals. In fact, this resistor consists of 32 separate resistors connected in parallel to preserve the fast switching capability, while the output transistor has many small emitter regions connected to two output pads. The input VMOS transistor occupies about 40% of the area of the 6.5 mm by 6.2 mm chip.

The Supertex XN01 was the first SUPERFET described in a



paper given at the US Powercon Conference recently. It consists of an n-channel enhancement mode DMOS power FET and an npn high current, high voltage power transistor.

It is a really high power device, available with voltage ratings from 350 V to 500 V, and can pass a continuous drain current of 20 A (40 A when pulsed) with a power dissipation that can reach 150 W.

A particular feature of this device is that a drain-emitter voltage of only 6 V can be used

Device Type	Max. Drain-to-Emitter Voltage BV_{DES}	Drain-to-emitter Voltage V_{DE}	Current when Conducting
XNO135N1	350 V	6 V	20 A
XNO140N1	400 V	6 V	20 A
XNO145N1	450 V	6 V	20 A
XNO150N1	500 V	6 V	20 A

Summary of XNO1 device categories; all are in TO-3 packages.

to produce the maximum current of 20 A. It is claimed that the saturation voltage of the SUPERFET is lower than that of any comparable power MOSFET device. Resistive switching speeds are comparable with those of power MOSFET devices and more than twice as fast as those of a comparable 450 V, 20 A power Darlington device.

Incidentally, it is not possible to make a circuit with the performance of a SUPERFET by connecting a VMOS device to a high-power bipolar transistor. The switching speeds of the available VMOS and bipolar devices are similar to or worse than that of the SUPERFET, while parasitic lead inductances in the connections to the two devices would drastically limit the operating speed.

Supertex has stated that even if devices with a faster switching capability should become available, it will not be possible

to use them to match the performance of the SUPERFET owing to the lead inductances.

As in the case of all enhancement VMOS devices, the SUPERFET will be non-conducting at zero gate voltage (maximum current 10 mA at 25°C or 100 mA at 125°C). A positive potential applied to the gate will turn the device to its conducting state.

Applications of the SUPERFET are expected to lie mainly in fields where fast switching is needed at high power levels (e.g. switch mode power supplies). This device is likely to be much used in switched mode power supply units for higher frequencies than can easily be handled by high-power bipolar discrete transistors. Devices which will operate at 200 kHz or more are required for this purpose. Another application is in the field of ac motor control.

Brian Dance

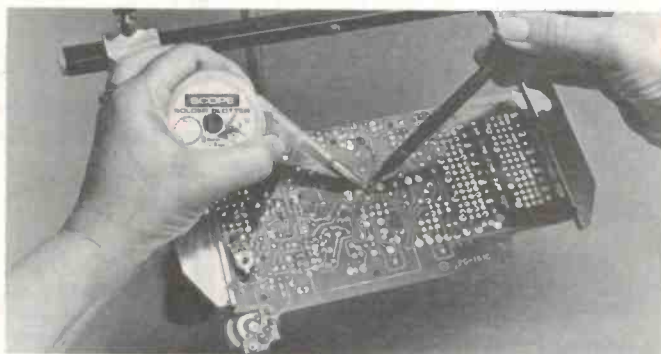
Don't solder your fingers

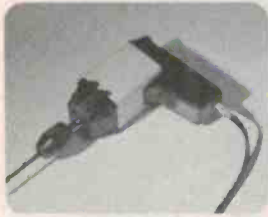
Scope Laboratories now have available a dispenser pack for desoldering braid which helps you avoid burnt fingertips — no longer do you have to hold the braid close to the working area and the hot iron.

The new pack is claimed to accurately position the braid, even in tight and awkward spots, and lets surplus braid be easily rewound. The dispenser, called the 'Scope Solder Blotter', also holds 30% more braid than most conventionally packed

braids, but the two-metre roll is said to be nevertheless competitively priced.

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





Cheaper housing!

Individually styled plastic housings for electronic and scientific instrumentation, computers, business machines, etc, can now be custom-designed and manufactured without the high tooling and die costs normally associated with conventional moulding processes.

A new service offered by Aegis Pty Ltd of Melbourne utilises vacuum forming and fabrication techniques, which afford the designer virtually all the facilities of conventional moulding, but tooling costs are in the order of only a few hundred dollars as compared to the several thousands of dollars normally incurred.

The process makes use of versatile ABS plastic sheet, which lends itself readily to forming into a myriad of shapes and styles and in the finished

state is lightweight, durable and highly impact resistant.

The service is expected to be of particular advantage to manufacturers of specialised equipment in the low to medium-volume field, where a professional presentation is required without high initial capital outlay.

For further information contact Sigea Australia (Marketing Division of Aegis Pty Ltd), 141 Christmas St, Fairfield Vic. 3078. (03)481-1422; telex: AA34225.

Natsemi changes distributors

National Semiconductor (Australia) has announced that it is switching all its distributor business from ICS Pty Ltd and RIFA Pty Ltd, retaining Semtech NSW Pty Ltd and appointing a new company, NSD Pty Ltd, to handle its product lines.

NSD is headed by two top salesmen from ICS and RIFA, both of whom have had wide experience with Natsemi products. Mr. Kerry Kelly from ICS will head NSW sales, and Mr. George Stockman from RIFA will look after Victorian distribution.

National Semiconductor explained the change: "In both New South Wales and Victoria the distributors were not only competing with one another but

also each carried their own competitive semiconductor lines. We were not content that ICS and RIFA were giving our product the level of exposure and thrust we wanted. The new arrangement gives us a much stronger marketing arm."

It is hoped to develop the design-in side of the business under the new arrangement, whereby NDS will design components to order for customers.

Hobbyist toolkit

A good set of workshop tools can make all the difference between a hassle and a pleasure when it comes to doing the mechanical construction work for electronic projects.

Good tools can also make the difference between 'just a job' and a 'professional finish' on that project.

Minitool Australia recently introduced a series of small-scale electrically operated tools and tool kits that are just right for the hobbyist — particularly beginners and youngsters.

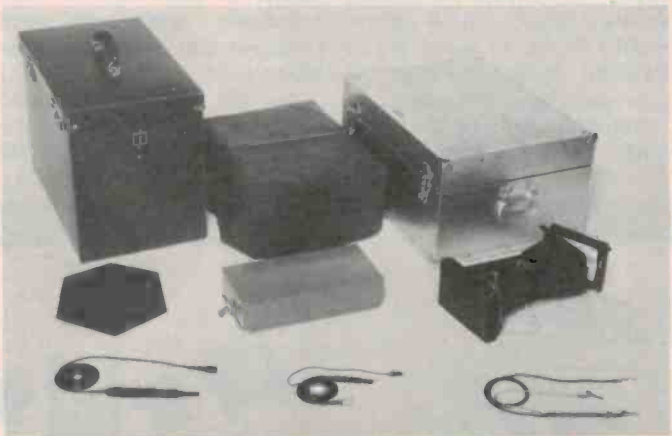
All the tools operate from a 12 Vdc source — battery or suitable plugback or dc power supply. Amongst the tools are: a pistol drill that takes drill bits from 0.8 mm to 6 mm diameter (just right for pc boards, jiffy boxes and small front panels); a jigsaw with a cutting depth to 7 mm (the saw has a blunt tip to protect against injury); an orbital sander and a drilling stand. In addition, you can attach a flexible shaft to the drill and a chuck on the opposite end to hold all sorts of accessory tool bits — like drills, milling cutters, grinding bits, wire brushes, etc, etc.

All in all, the Minitool range looks very comprehensive and would prove most useful to the hobbyist who wants to make his or her work less of a hassle and to produce more of a 'professional' job.

Two workshop 'kits' are available. The larger, Kit 000-62-90X, includes a power supply (12 Vdc plugpack), pistol drill, drill stand, orbital sander, flexible shaft unit, table clamp, platform table, jigsaw, spare blades and a very handy carry case — all for \$250 (rrp). The 000-62-90Y Kit does not include the flexible shaft unit and is priced at \$199 (rrp).

Look for the exciting competition with a Minitool Workshop kit and tools as prizes in a forthcoming issue of ETI.

More details on the tools can be had from Minitool Australia, 134A Ayr St, Doncaster Vic. 3108. (03)850-9887.



Range of accessories from BWD

Complementing the wide range of professional instruments manufactured by BWD Instruments Pty Ltd is an equally wide range of accessories to be used with BWD's oscilloscopes, power supplies, function generators, etc.

The range includes probes, covers, protective front covers and viewing hoods. Each product is manufactured for or by BWD to their own specifications, and considerable attention is said to be given to

convenience of use, safety and weight.

For further information contact BWD Instruments Pty Ltd, Miles St, Mulgrave Vic. 3170. (P.O. Box 325, Springvale Vic. 3171). (03)561-2888; telex: 35115.

Ideas for Christmas

Tandy Electronics has come up with a few answers to that age-old plaint: "Whatever can we buy so-and-so for Christmas?"

Tandy's gifts cover all ages, starting with a good idea for teaching young schoolchildren to calculate with Radio Shack's EC-351 Child's Learning Calculator. This comes with an easy-to-understand booklet and is supposed to make even arithmetic fun. It'll cost you \$12.95.

For kids to use as a 'lie detector' or adults who have trouble relaxing, Tandy's 'Bio-feedback Monitor' has two probes which clip to your fingers and measure your stress level by judging your skin resistance. The trick is to make the tone from the monitor's loudspeaker change by relaxing. Such a gadget will set you back \$18.95.

There are cuddly toys with AM radios inside them, priced upwards from the 'Cuddly Cat' at \$14.95, and for more advanced music lovers there is also the Stereo-Mate AM/FM radio with micro headset for use while walking, working, exercising, etc. It goes for \$64.95, while for \$99.95 you can get the mobile SCP-4 Personal Stereo Cassette Player and listen to your own choice of music.

You can get hours of fun, thrills and developing skills

driving one of Tandy's radio-controlled toy cars, which can be bought with a range of features; there are even tanks and motorcycles. Prices range from \$16.95 to \$89.95, depending on how sophisticated the remote control system is on the model chosen.

The Tandy 'Electronic Computerised Arcade' is twelve action-packed electronic games in one, costing only \$39.95. Children — and the rest of the family, no doubt — can compete at baseball, gamble on roulette, guess unknown colours, fire torpedoes to sink enemy ships, or shoot missiles to bring down alien spacecraft. It's even a twelve-note organ you can compose songs on as well! And if you're still having trouble deciding what to buy, have a go at Tandy's 'Executive Decision Maker' for \$14.95. You ask it a question and press a button, whereupon one of six randomly chosen replies will be indicated, ranging from 'definitely' to 'forget it'. Give one to your managing director or local politician and help make their lives easier!

As well as such toys and gadgets, the new Tandy catalogue contains almost 2500



other products ranging from microcomputers to security systems, stereo systems to clocks and radios, plus of course all the tools, hardware, electronic parts and accessories that the name of Tandy is automatically associated with. Don't miss your copy of the catalogue — it's free at any Tandy store.

LED catalogue from Philips

Available from Philips Electronic Components and Materials is a new short-form catalogue detailing more than sixty types of LED circuit board indicators. Highlighted are red, green and yellow LEDs, QUAD-LED four-element arrays, and bicolour.

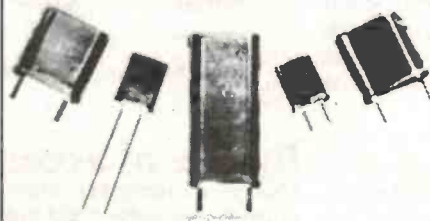
Illustrated with photographs and dimensional drawings, the catalogue provides complete product descriptions and specifications. Particularly handy is a product selector chart.

To receive this catalogue (75-CBI-8100), contact Sales Department, Philips Electronic Components and Materials, 67 Mars Road, Lane Cove NSW. (02)427-0888.

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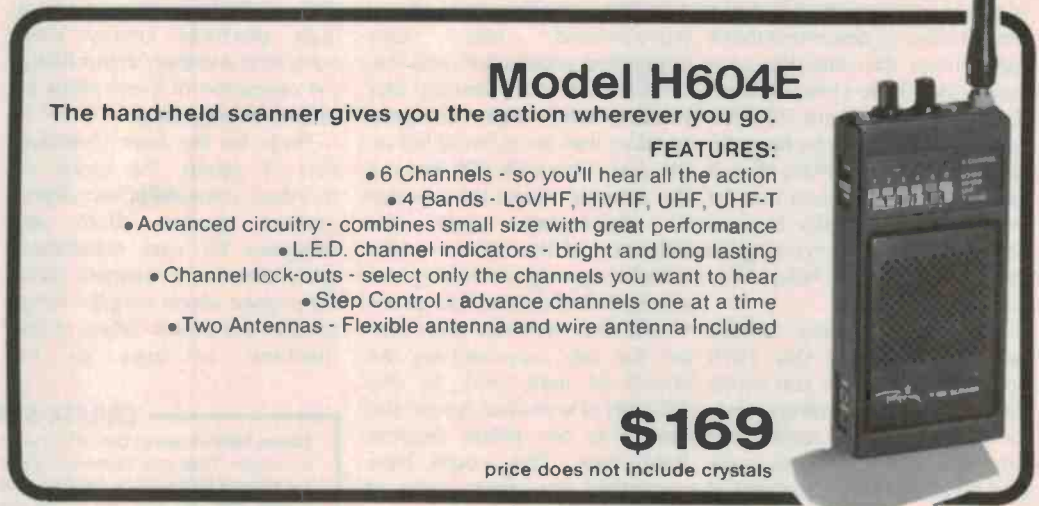
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- Priority
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- 30 programmable Channels
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- Programmable Search Increments
- Search and scan delay
- Manual, Search or Scan Control
- Custom frequency-synthesized circuitry
- AC supply and DC cord supplied
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- Nickel Cadmium memory battery included

- Attractive, durable case
- Top-mounted speaker
- Regency quality and reliability

\$449



Something terrible happened in outer space . . .

Astronomers have just discovered that something really terrible happened way out in space some time ago, but they don't know yet where it was, when it was, how terrible it was or even quite what it was.

Examination of a backlog of recordings made in Earth's orbit four years ago by the first high-energy astronomy observatory has revealed a burst of gamma rays, indicating a catastrophic event far out in space. The burst was followed by half a minute of 4.2 second reverberations, suggesting its probable association with a superdense neutron star rotating at that rate.

Only one other such reverberating gamma ray burst has been recorded, on March 5 1979. The newly discovered event was actually recorded on October 29 1977.

The 1979 burst was detected by nine spacecraft scattered about the solar system. By comparing precise arrival times of the burst at each of them, it was possible to determine that it came from the direction of a large Magellanic cloud, a small galaxy of stars about 200 000 light years away, not far from the outer fringes of the Milky Way. If the source was indeed that far away, within seconds it must have emitted as much energy as the stars of the Milky Way combined.

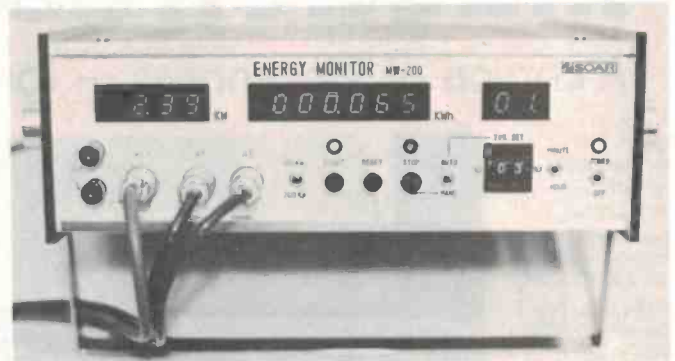
Many astronomers believe that the source of this 1979 burst was a neutron star within that star cloud. A neutron star is formed when a large star exhausts its nuclear fuel, cools and collapses into an object of extremely small size, high

density and rapid rotation.

The newly recognised 1977 event was recorded by X-ray detectors placed on the orbiting observatory by the American Naval Research Laboratory under Dr. Herbert Friedman. The detectors were able to record the burst because, although it was primarily in gamma rays, it overlapped the X-ray spectrum. The rays were too weak for recording by other spacecraft, and hence the direction of the source has not been determined.

The suddenness and violence of the 1979 event were difficult to explain. It soared to full power in only twelve hundredths of a second, then tapered off in the next three minutes, reverberating at an eight-second rate. One suggested explanation was that a comet fell on a neutron star rotating every eight seconds; another that an asteroid fell on the star. About 96 000 km out the asteroid would have begun to disintegrate under the influence of the neutron star's extreme gravity, stretching into a long trail of debris. This debris would have encircled and fallen on the star, approaching the speed of light, and, in one billionth of a second, becoming heated to two billion degrees Fahrenheit. This could have generated the sharp pulse of gamma rays.

However, the newly discovered 1977 burst does not fit this model, according to Dr. Friedman. The two-second time required for the pulse to reach full power is not compatible with an almost instantaneous impact. One possibility, he added, might be that material that had accumulated in orbit around the star had fallen on it when perturbed in some manner. Another explanation could be sudden contraction or some other form of extremely massive transformation within the star.



Energy monitors from Soar

GFS Electronic Imports now have stocks of two new Soar energy monitors, designated MW-200 and MW-200SD. According to GFS, these will allow accurate measurement of electrical consumption of individual machines on electrical circuits, enabling manufacturers to determine precisely running costs of the particular areas under measurement.

Using this facility, GFS claim that manufacturers will be able to price their products more competitively as well as increase their profits by isolating areas of high electrical energy consumption and then streamlining the operation of these areas to reduce energy usage.

Made by the Soar Corporation of Japan, the range of monitors consists of two digital readout models. Both are designed for easy installation and make use of magnetic pick-up probes which simply clamp around the power cables of the machine or area to be

monitored.

Top of the range is the MW-200, which features both an accumulated kilowatt/hour readout as well as a separate instantaneous kilowatt power readout. Both models incorporate an automatic timer which allows measurement to be taken over two ranges — 1 to 99 minutes or 1 to 99 hours — with a maximum reading of 100 000 kW/hr in two ranges.

For further information contact GFS Electronic Imports, 15 McKeon Rd, Mitcham Vic. 3132. (03) 873-3939; telex: 38053.

ERRATA & OMISSIONS

Series 5000 Preamp, Oct. '81. The 400 Hz oscillator procedure was omitted. It's simple. Take your multimeter, set to read ac volts, and connect it between the wiper of RV4 and 0 V. Set RV4 to obtain 1.2 Vac (RMS).

Note that R52 and R53 on the overlay are shown as 220R when they should be 220k as per the circuit and parts list.

ETI-660 Learner's Micro, Nov. '81. On Overlay Drawing #5, p.32, the link near IC8 is shown as LINK 2 when it should be LINK 3. On the circuit, pages 36-37, the designations for diodes D5 and D6 are reversed. The upper diode is D6. The note relating to D5, D6 is correct.

Programming in CHIP-8, Nov. '81. The procedure for loading on cassette (In box, p.116) has an omission. The load procedure should read:

```
'RESET  
'0'  
'STEP  
'0400'  
'06'  
'STEP  
'00'  
'STEP  
'07'  
'STEP  
'25'  
(or you could put FF here)  
'RESET  
'4'
```

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Allow \$4.00 post & packaging per item

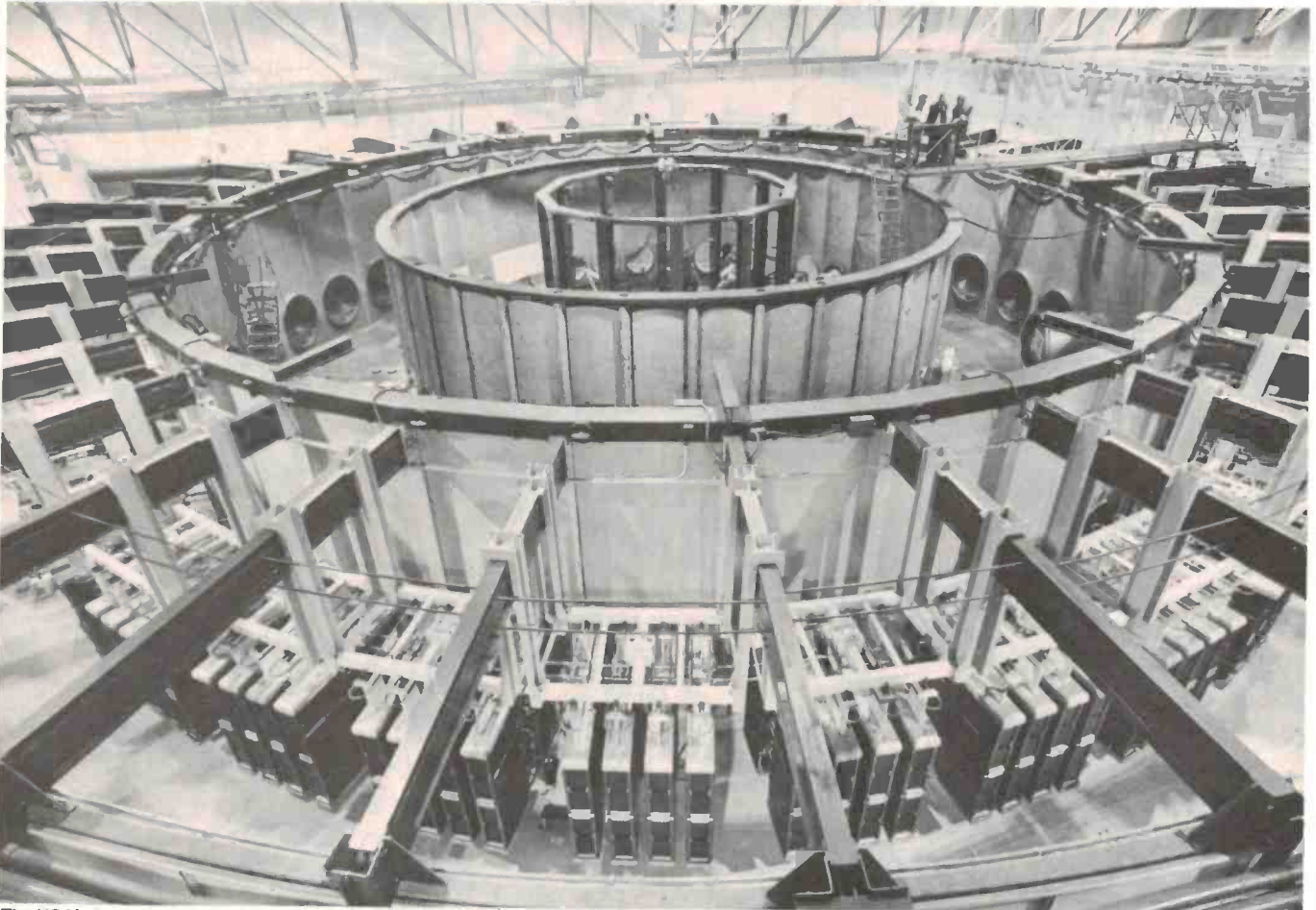
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Particle Beam Fusion



The USA's largest particle beam fusion accelerator (PBFA-1), completed in mid-1980, at Sandia Labs, Albuquerque. It is 30.5 m (100ft) in diameter and produces 36 ion beams, subjecting fuel pellets to a total power of 30 trillion watts.

There are two basic ways in which nuclear energy can be released from matter — by fission and by fusion. Will particle beam fusion supersede the fission process of our present-day nuclear reactors to provide the answer to world energy requirements?

Brian Dance

IN PRESENT-DAY nuclear reactors, heavy atoms (uranium and plutonium) divide into two parts to form lighter atoms together with neutrons and energy; the neutrons then cause more of the heavy atoms to divide. This is the fission process that was also used in the early nuclear weapons used at Hiroshima and Nagasaki. Unfortunately, as became tragically apparent, fission produces much highly radioactive waste.

Fusion

The second possible technique is the fusion process, in which light atoms (particularly hydrogen) fuse together to form heavier atoms. The main problem

in harnessing the fusion reactions to produce useful power is that these reactions will only occur at very high temperatures (hundreds of millions of degrees Celsius), since only at such temperatures do the nuclei of the atoms have enough energy to come together in spite of the mutual repulsion of their positive charges.

The sun and stars obtain their energy from fusion reactions. Hydrogen bombs also use fusion to liberate energy, but they require a fission bomb as a 'match' to heat up their nuclear fuel to a temperature at which the fusion reaction can commence. The fission bomb and the neutrons produced in the fusion reaction produce much radioactivity,

which appears as 'fallout', but in any case one certainly would not wish to try to use a hydrogen bomb as a source of useful energy!

During the past thirty years man has therefore undertaken intense research to try to 'tame' the hydrogen bomb so that controlled thermonuclear power could be obtained using cheap fuel without the production of much radioactive waste. Unfortunately this problem has proved to be one of the most difficult projects ever tackled, although the possibility of obtaining large amounts of energy at a relatively low price is enormously attractive.

In the 1950s the United States, the USSR and Britain were all carrying out

work using electrical discharges of very high currents through gases to try to produce the high temperatures required for thermonuclear fusion reactions to occur; the writer was involved in this work at that time. Initially the work was highly classified, owing to the importance of cheap power to a nation, but it was de-classified towards the end of the 1950s as it became clear that a very long time would pass before much useful power could be obtained from fusion reactions.

Basically the idea is to confine a plasma of ionised gas at a very high temperature in a 'magnetic bottle' so that it cannot touch any solid material which could take away much heat and reduce the reaction speed. All materials are gases at temperatures at which thermonuclear reactions can occur, so it was proposed that a magnetic field be used to keep the gases together whilst the reaction took place. Work on magnetic confinement is still being intensively continued in the United States, in the USSR and in Europe. The European efforts are now concentrated in the Joint European Torus (JET) project at Culham in England, since the cost is so high that it is best shared amongst the participating nations.

Thus in spite of thirty years of intensive research, man is still a very long way from being able to use fusion reactions to provide him with a convenient source of controlled and cheap energy. However, as our energy problems have become increasingly more severe during the last few years, work on controlled thermo-nuclear fusion has been intensified and a second technique has been evolved for attempting to keep the nuclear fuel together at a temperature of some 300 million degrees for long enough for it to react.

Inertial confinement

In the second technique, known as inertial confinement, the fuel is contained inside a small spherical pellet which has outer layers of metal or glass. The pellet is heated very rapidly by a laser beam or by a particle beam; the outer heated layers expand rapidly outwards and the force of reaction causes the remaining material to be rapidly radially accelerated inwards; the compression causes a temperature rise. If the temperature rises to about 300 million degrees whilst the fuel pellet is compressed to a density of hundreds of times that of a typical solid, a reaction with a duration of the order of 1 ns will occur and produce a very intense burst of thermonuclear energy in the form of neutrons, ions and X rays. Successive pellets would be irradiated to obtain more bursts of energy.

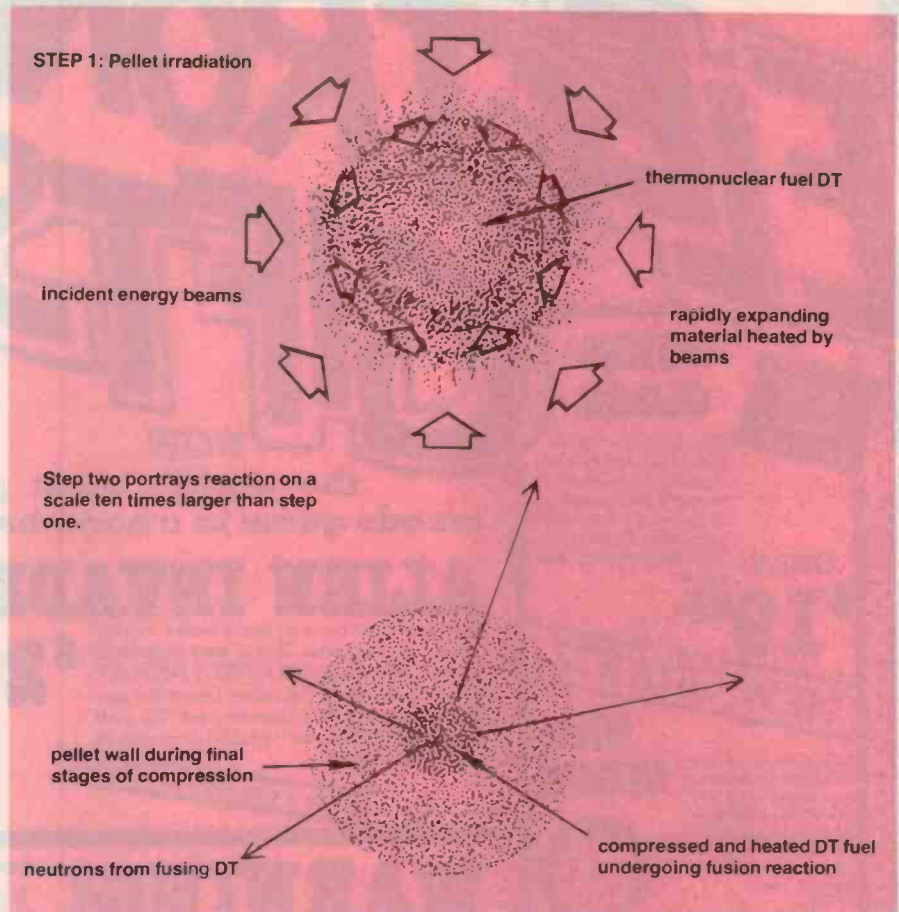


Figure 1. The thermonuclear fuel of the pellet imploded by external radiant energy.

The fuel pellets which it is proposed to employ in inertial confinement fusion work are a few millimetres in diameter. In order that the thermonuclear fuel containing deuterium and tritium at the centre of the pellet shall be adequately compressed and heated, as depicted in Figure 1, it is necessary to deliver a very intense pulse of energy to the outside layers of the pellet, this energy being delivered from all sides of the pellet simultaneously. Thus very powerful and specialised equipment is required. Let us look how work on nuclear weapons in the United States may contribute to the peaceful generation of thermonuclear power.

Sandia Laboratories

The Sandia Corporation, a subsidiary of Western Electric, operates the Sandia Laboratories at Albuquerque, New Mexico, on a non-profit basis for the United States Department of Energy. The primary work of the 7600 employees is in research and development for nuclear weapon systems, but about 120 people are working on inertial confinement — probably the largest group in the world in this field.

In the early 1960s Sandia Laboratories were engaged in the use of pulsed

intense radiation environments for the testing of the resistance of United States nuclear weapons to the radiation from any enemy nuclear bursts nearby. For this purpose a series of electron accelerators was constructed, ranging from a 300 kV Nereus accelerator to a huge 12 MV Hermes II in the later 1960s. Inertial confinement calculations indicated that the expertise available at the Albuquerque pulsed radiation facilities was especially suitable for investigating the possibility of developing a reactor using the inertial confinement principle.

An accelerator project costing some US\$14 million was completed in mid-1980. Originally named Electron Beam Fusion Accelerator (EBFA), since it was designed to produce intense pulsed beams of electrons, this accelerator has been renamed Particle Beam Fusion Accelerator (PBFA-1), since light ion beams are more attractive than electrons for inertial confinement work.

This accelerator is over 30 m in diameter and will produce 36 separate ion beams converging radially inwards towards a fuel pellet. It is the largest pulsed power accelerator in the world and will deliver about 30×10^{12} W or about 1 MJ (1 megajoule) to a pellet in ►

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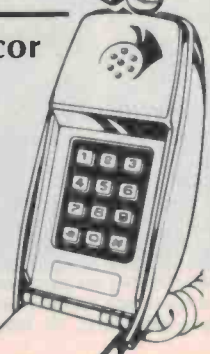
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DICK SMITH ELECTRONICS

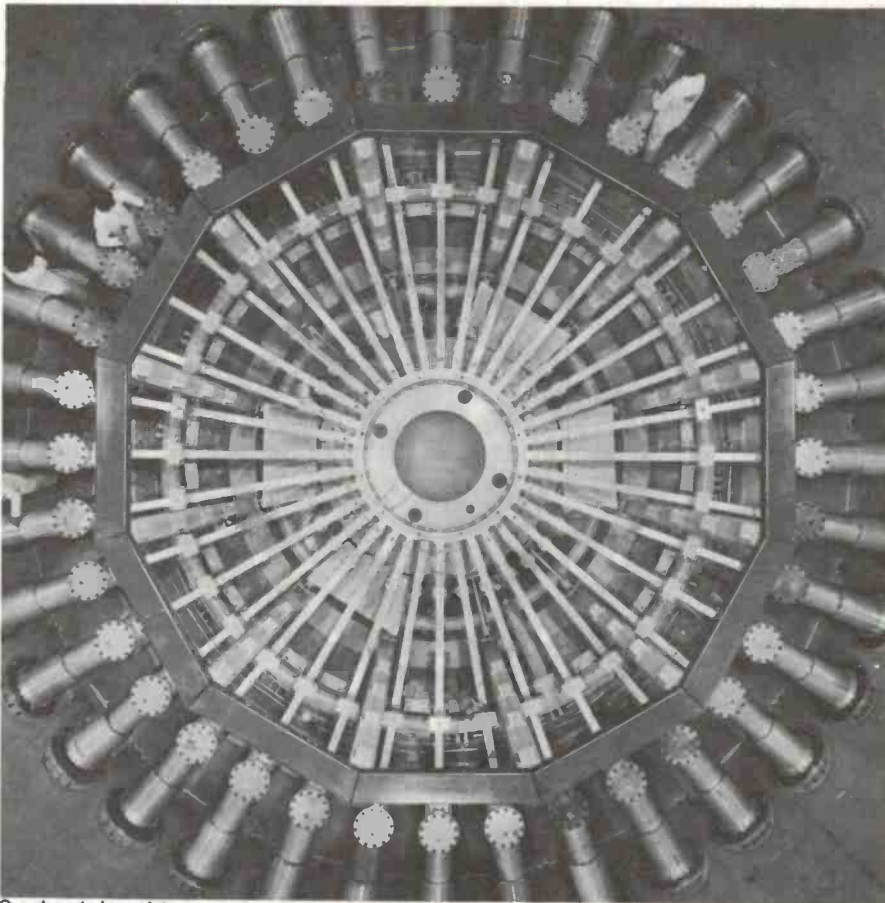
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Overhead view of the central section of Sandia's PBFA-1 accelerator, showing the 36 transmission lines converging on the diode area (diode not installed). This machine is now being tested in preparation for inertial confinement fusion experiments with ion beam pulses producing 30 trillion watts in 40 nanoseconds.

30 ns. It will be suitable for generating either electron or ion beams and will be used for weapon testing as well as for controlled thermonuclear research.

In 1983 to 1984 it is planned to upgrade the PBFA-1 to a more powerful PBFA-2. The upgrading will involve doubling the number of ion beams from 36 to 72 and operating from 4 MV instead of 2 MV. Each of the 72 modules of the upgraded machine will produce about 300 kA at 4 MV, so that the total power output will be about 100 TW ($= 10^{14}$ W). It should be ready for testing by 1985.

It is confidently expected by Sandia workers that the PBFA-2 will release as much energy from the fuel pellets as is required by the accelerator and that a net energy gain will be achieved soon after the testing of the upgraded machine. In a complete reactor system, the heat released would be used to power a turbogenerator.

It is intended that the fuel pellets will be injected into the reaction chamber at a rate of the order of ten pellets per second. They will be vapourised in miniature explosions which each release about as much energy as 3 kg of TNT. However, the PBFA is only an experimental reactor which will

irradiate single pellets. Nevertheless, it has been predicted that if the experiments are successful, they could lead to the construction of experimental power reactors which could be in operation within 20 years of the pellet ignition principles being established.

Which beam?

Which type of beam should one use for delivering intense pulses of energy to the fuel pellets? Laser beams, electron beams or ion beams? Scientists at Sandia Laboratories are strongly in favour of ion beams, but there are some important differences between the various methods.

The transport of the beam from its source to the target pellet is a vital consideration in inertial confinement systems. A distance of at least 1 m is required between the pellet and the reactor walls to absorb the energy of the microexplosions from each pellet. Laser beams must travel in nearly a complete vacuum to prevent gas breakdown at the very high intensities used, but particle beams can be transported at a gas pressure of 0.1 to 1 atmosphere. The gas present will moderate the intense pulses of X ray and debris energy from the fusion pellets and considerably

eases the design of the reaction vessel, since without the moderating effect of the gas, the intense bursts of radiation would damage the surfaces of the reactor wall.

Nevertheless laser work is being intensively carried out. The Shiva laser system at the Lawrence Livermore Laboratory equals the PBFA power of 30 TW and its updated version, Nova, has an output power of 120 to 300 TW. However, it is expected that the PBFA-2 will be constructed at a total cost of some \$40 million as against the \$188 million Nova laser system. Laser systems are said to be very inefficient in power (1% to 5%) when compared with the PBFA system (about 25%).

The Shiva laser system is used to irradiate targets consisting of hollow glass spheres of 322 μ m diameter and with walls 2 μ m thick. A mixture of deuterium and tritium gas (the nuclear fuel) is contained in the spheres. Twenty laser beams irradiate the spheres with 90 ps pulses, which deliver about 2 kJ. Thus the laser pulses are shorter in duration than the PBFA pulses and deliver less energy to the pellet.

When electron beams are compared with ion beams for inertial confinement fusion work, one of the main differences is the long range of electrons in matter. Electron beam interactions with the matter of the pellets must therefore be increased by the use of intense magnetic fields. The shorter range of an ion beam in matter is said to make it much more suitable for igniting thermonuclear fuel pellets, since the energy of the beam is more effectively deposited in a small mass of material on the outside of the pellet without the use of any magnetic field to enhance the beam interaction with the pellet.

A further advantage of the use of ion beams is that the X ray emission as the ions slow down in the pellet is much smaller than in the case of electron beams. The intense X rays present when electron beams are used can heat the pellet walls and severely degrade the quality of the compression required to ignite the fuel. In ion beam systems the designer can select the optimum pellet materials and ion beam properties to maximise the use of the beam energy in obtaining pellet ignition. Efficient methods for producing intense ion beams had not become well developed until the early 1970s, but rapid progress was then made. The same type of facilities are required for the generation of both pulsed ion beams and pulsed electron beams, so the PBFA accelerator can be used to produce beams of either type.

The PBFA equipment will use light ions such as carbon, oxygen, etc. which

can be accelerated much more readily than heavy ions. Ions have the further advantage that they can be bunched together at the target by increasing the accelerating voltage during the pulse so that the slower moving ions at the start of the pulse are overtaken by the faster moving ions later in the pulse. This can increase the pulse power by a factor of about five times. Calculations indicate that the use of ion beams is about three to ten times as effective as the use of electron beams of equal power. In the PBFA experiments the ion beams are used to irradiate gold or plastic shells a few mm in diameter with walls 0.02 to 0.4 mm in thickness.

Three fields

The work on ion fusion can be divided into three main fields. These are: (1) the ion source and accelerator; (ii) the fuel pellets and the physics of the pellet reactions; (iii) the reactor system itself.

1. Ion source

The ion source is essentially a high voltage pulse generator, which converts electrical energy into the energy of the particle beams, together with the system for transporting the ion beams to the target. The pulse generator consists of capacitors which are charged in parallel from fairly low voltage supplies and which are discharged in series to produce a high voltage for about $1 \mu\text{s}$. The pulse passes to an intermediate storage capacitor using water as the dielectric. A triggered gas switch switches the stored energy into the pulse forming section and is the main time synchronising element for the 36 beam lines of PBFA-1. The pulse is then shortened by a beam forming section to some 50 ns duration.

The pulse energy passes from the water-filled pulse lines into a vacuum transmission line which carries it some six metres to the particle beam source. In the latter, a high electric stress across the electrodes in a vacuum results in a layer of plasma forming on the negative electrode surface within a few ns. In electron beam sources, electrons from the plasma are drawn to the positive electrode (Figure 2), whereas in an ion source a magnetic field is applied which causes the electrons to travel in spiral paths so that they can no longer

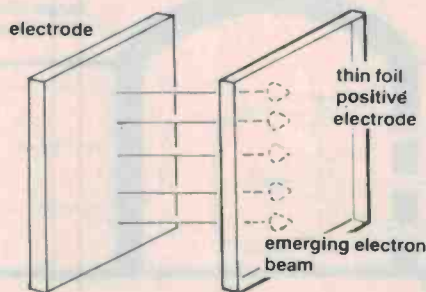


Figure 2. An electron beam source.

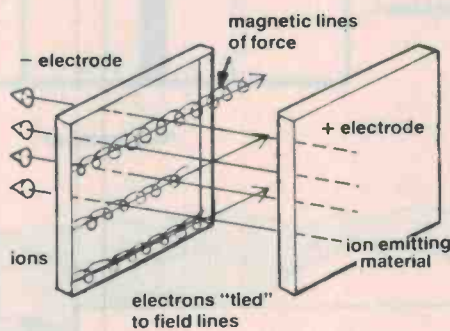


Figure 3. An ion beam source. A magnetic field removes the electrons.

cross the gap to the positive electrode (Figure 3). If positive ions are introduced from a plasma layer in the vicinity of the positive electrode, the electric field from negative electrons will accelerate the intense ion currents. The heavy ions can cross the gap between the electrodes almost undeflected by the magnetic field.

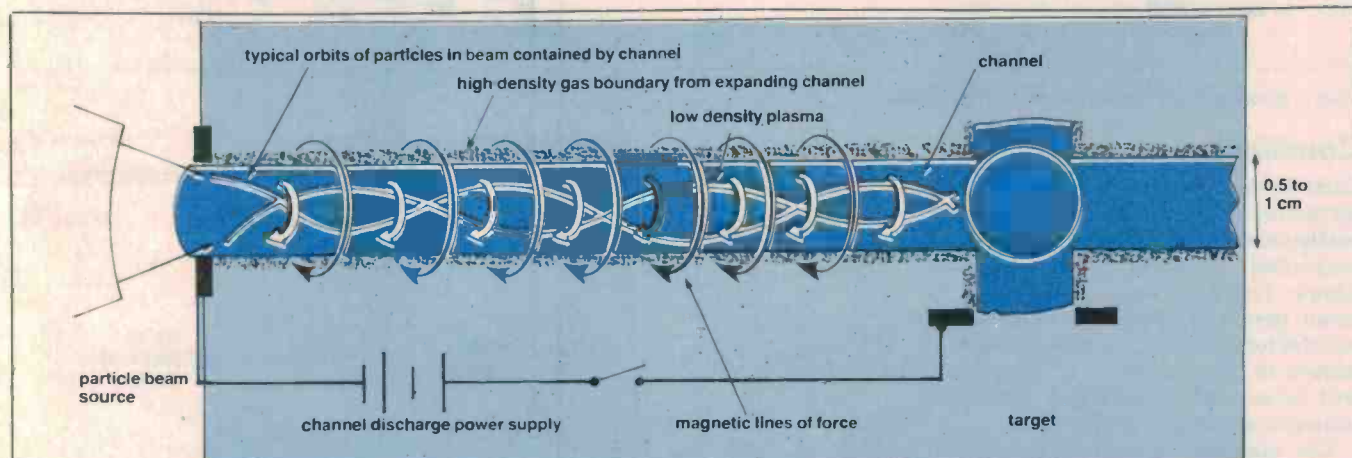
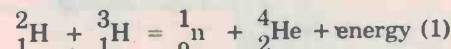
A channel may be formed by passing an intense electric discharge through gas; the discharge path may be initiated by a laser beam of moderate power (Figure 4). The ion particle beam is injected into one end of the channel when the channel current has reached about 50 kA and when the hot plasma channel has expanded to a diameter of 5 to 10 mm. The repulsive space charge effects in the ion beam are neutralised by the hot conducting plasma in the channel. The beam particles are confined by the presence of the magnetic field established by the channel forming discharge.

2. The pellet

The thermonuclear fuel pellets must be designed so that the fuel is compressed very uniformly. A flash X-ray diagnostic system has been developed to examine the inside of imploding spherical pellets for symmetry of implosion; effective exposure times of 3 ns have been used. High speed holography has also been used for examining the cylindrical implosions.

3. Reactor systems

The basic reactions for beam fusion systems are:



Step 1. Lightning bolt is originated, and current flowing in bolt heats gas, turning it into a conductor (plasma) which rapidly expands. The flowing current creates a magnetic field in the channel.

Step 2. After the hot plasma channel expands to a diameter of 0.5 to 1.0 centimetre and the channel current reaches levels of about 50 000 amperes, the particle beam is injected into one end.

Step 3. Repulsive space charge effects as well as current flow of the injected beam are neutralised by the hot conducting plasma in the channel. The magnetic field previously established by the channel-forming discharge confines the beam particles as they travel from the source to the target.

Figure 4. An ion channel formed by a moderate power laser beam.

The first reaction between the hydrogen isotopes deuterium and tritium produces a neutron and an alpha particle. In a practical reactor the neutrons emerging from the fuel pellet would be trapped by surrounding the pellet with a blanket of lithium where the second reaction would occur, producing tritium required for making more fuel pellets.

The heat produced by both reactions and by the X-ray and particle energy

absorbed by the walls of the reaction chamber is available for the production of steam for electricity generation. Although it is not expected that a particle beam fusion reactor will be constructed for a considerable time, work on possible designs is proceeding so that this type of reactor can become a reality at the earliest possible date.

Studies of fusion reactor systems have shown that such reactors, which

produce only a few hundred megawatts of electricity, may well be economically feasible. Larger plants could be constructed later. (For comparison, typical conventional generating stations range up to about 1000 MW.) The probable form and external appearance of a laser beam fusion power station of the future able to produce about 100 MW of electrical power is shown in Figure 5.

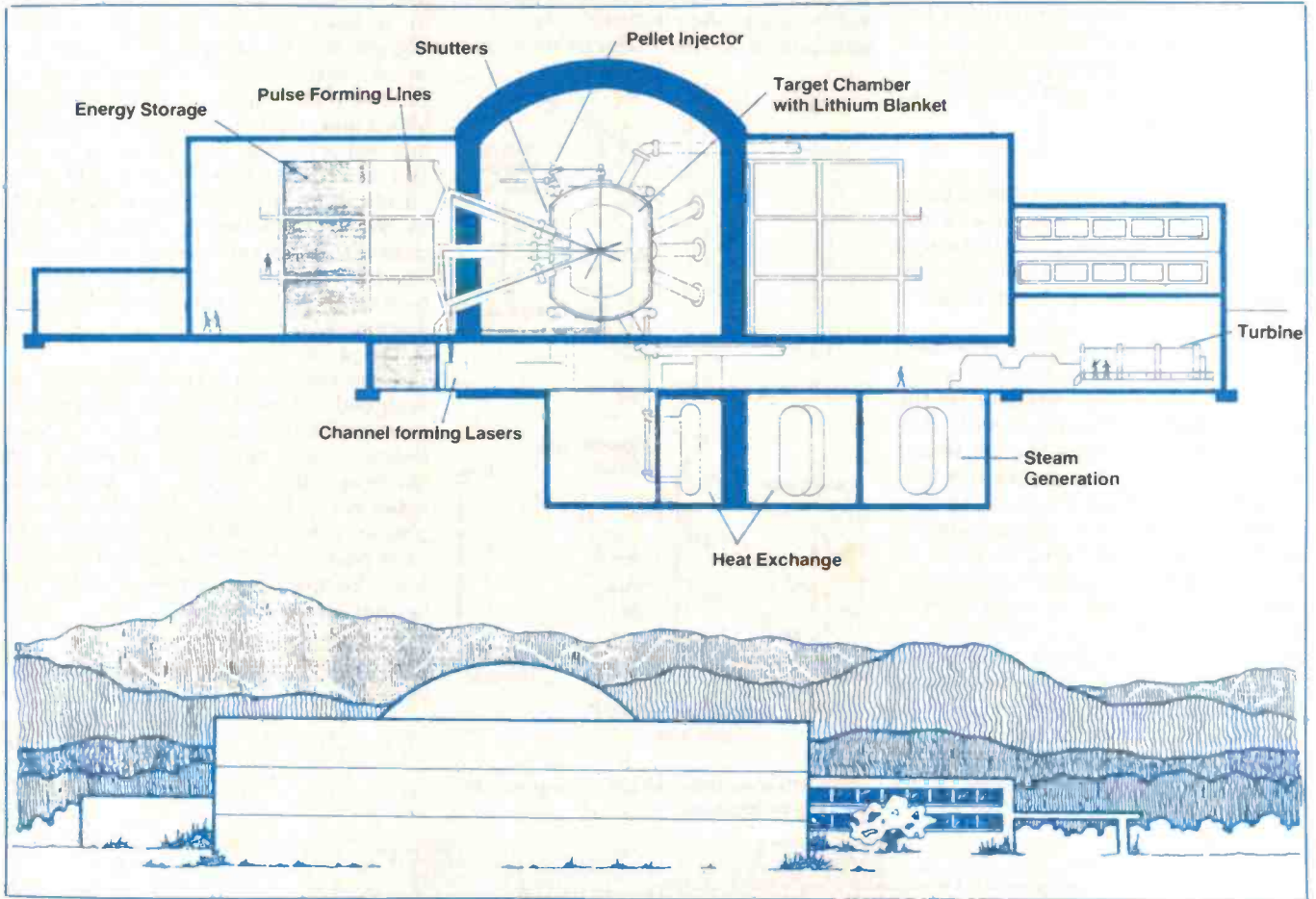


Figure 5. A compact 100 MW power station of the future.

Conclusions

Particle beam fusion offers a potentially attractive alternative to magnetic bottle technology for the development of controlled thermonuclear power reactors. However, even if the particle beam fusion principle is shown to be satisfactory, much depends on the economics of the reactor as to whether it will be a viable proposition. Projected timing is shown in Figure 6.

The apparatus required for particle beam fusion needs much heavy engineering work and is therefore very expensive. However, once such a reactor is set up and is properly operating, fuel costs will be extremely low. Deuterium is readily available from sea water at a cost which is currently less than US\$1

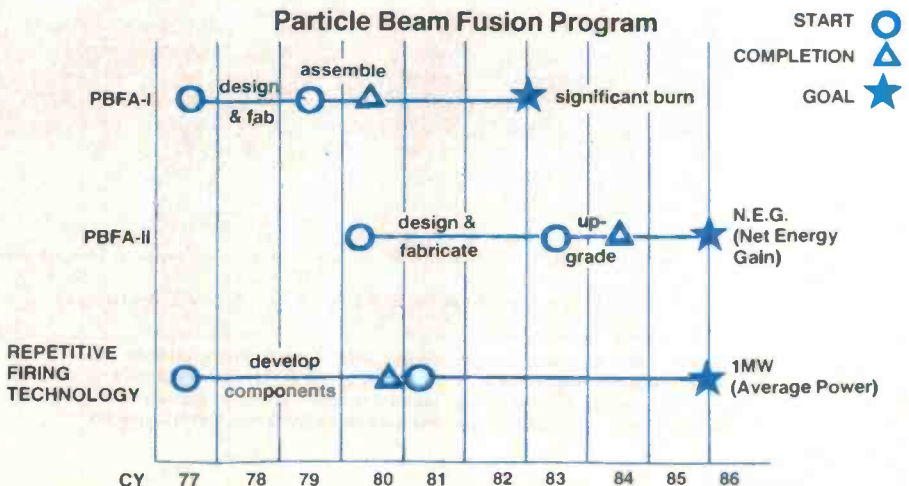


Figure 6. Project timing for particle beam fusion work in the next five years.

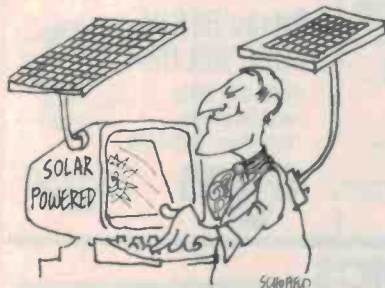
per gram. All the tritium required as fuel can be produced in the lithium blanket surrounding a beam fusion reactor, so there should be no great problem in obtaining this relatively expensive material. Indeed, it has been suggested that the pellet used in a particle beam fusion reactor should be surrounded with a blanket of natural uranium which would absorb neutrons and produce the enriched fuel required for conventional fission reactors. One of these fusion-fission reactors would produce enough enriched fuel for many conventional reactors. Ample supplies of lithium for the lithium blankets are available.

A fusion reactor must contain about 5×10^{18} individual nuclear reactions for each kilowatt-hour of electricity produced. Viewed in another way this means that the fusion of the small amount of deuterium contained in 1 gallon of ordinary water will produce a similar amount of energy to that obtained by burning about 350 gallons of petroleum spirit.

Fusion reactors (unlike conventional fission reactors) will produce only relatively small quantities of short-lived radioactive waste products, which are expected to impose no great disposal problems. Indeed, the operation of fusion reactors is expected to produce fewer environmental hazards than the burning of fossil fuels (coal, petrol and natural gas), which produces large amounts of carbon dioxide; the latter absorbs infra-red radiation and affects our climate.

Nevertheless it will certainly be a very considerable time before we have many fusion power stations in operation which provide us with a relatively cheap source of power from the deuterium contained in the sea.

The writer is indebted to Karen Shane, Sandia National Laboratories, Albuquerque, New Mexico 87185, for providing information and photographs for use in this article.



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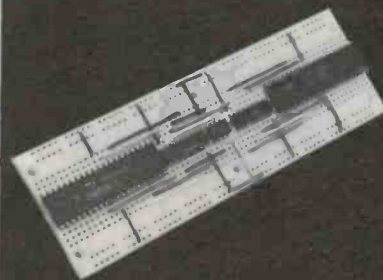
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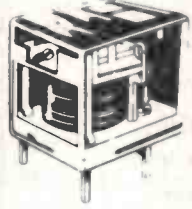
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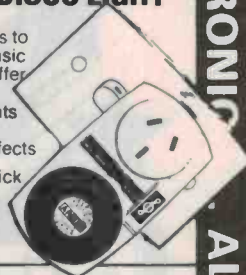
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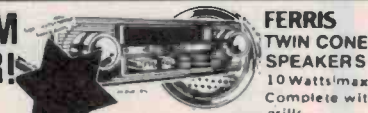
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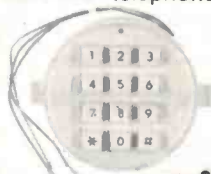
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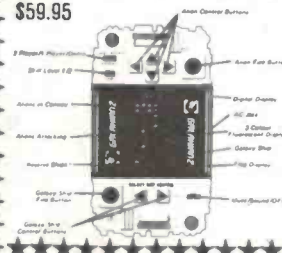
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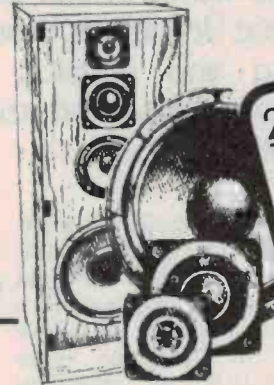
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These two slot car controllers will put more zap in their zip

Jonathan Scott

A spare \$15 and an idle Saturday afternoon led Jonathan and a few 'assistants' into the labyrinthine maze of the world of slot cars. Your basic slot car set is so basic that Jonathan thought the application of a few engineering and physics degrees, computers, components, electricity and trials would help. These two projects are the result!

WELL, let's not beat about the bush. Slot cars are fun. The genesis of this project was the purchase of a cheap set and the realisation that there was much room for improvement in the whole thing, especially the 'electronics'. Since then, we have built several controllers, purchased an alarming length of track, bought and modified too many controllers and cars, and generally had a load of fun! Here are the fruits of the labours, both in the form of electronic projects and in some discussion of what you can do to get the best performance from even a cheap set of slot cars.

Shortly after the infection set in, the author's household was to be found in a huddle with a couple of computer programmers, another engineer and a couple of PR people. A list was made of all the things that anybody could possibly want out of a given car set, and all the things that could possibly be desired in a controller. Argument ensued. The fearless editor of this magazine would argue for cost effectiveness; another for a no-holds-barred approach. Thursday nights were set aside for the various parties to meet and report... After preliminary models of controller had been made and *thoroughly* evaluated, it was conceded that all the aims could not be realised in the one type of controller. Hence, two lines were followed and we have the ETI-824 Slot Car Power Supply and the ETI-825 Slot Car Controller. We also have a lot of tips for optimising your set itself, and we trust that these are sufficient to turn a couple or three \$15 sets into a first-class slot car racing set-up.

We also present several suggested layouts, and suitable constructs and axioms for the optimisation of your own layouts.

In the course of this research use has been made of calculators, programmable calculators, desktop computers, plotters, engineering degrees, physics degrees, computer science degrees, a mound of components a lot of paper and a *hell* of a lot of electricity — so be warned that one can get pretty involved. Closet racers, prepare for exposure!

If you are not sure that you are a fanatic, the ETI-824 is probably what you require. It is relatively simple to construct, cheap, and easy to get going. It is basically a replacement for whatever you are using to power your set now. It offers operation from ac or dc, car battery, model train transformer, doorbell transformer or a range of typical project transformers or power supplies. It gives independent protected supplies for each lane, adjustable for most car set types available.

If you're after something really exciting, then the ETI-825 is *it*. This is not a project for beginners. It gives independent, protected supplies for each lane. It can operate in voltage and current modes. It has powered braking, controlled overshoot and fuel tank simulation. It has fault and fold warnings, does not load the hand controllers, and can handle a wide range of maximum torques on sets of 4.5 to 12 volt rating. If you are really enthusiastic or you have just blown \$100 to \$300 on a Scalextric set, this is the one for you.

Slot cars and tracks — a dissertation

In practice, the basic rheostat in series with the track (car) is not at all a bad compromise. For a given control setting the car accelerates fairly rapidly towards a final speed. This is because torque is proportional to current (in the permanent magnet motors used) and current is a maximum when the car is standing still; as the engine RPM increase so does the back emf, or rather the internal emf of the engine, which represents the mechanical power output in the mathematical model of the engine. As this rises, the voltage drop across the control resistance decreases, and so does the current, the torque and the acceleration. (Figure 1.) This gives a very car-like performance for a minimum of parts.

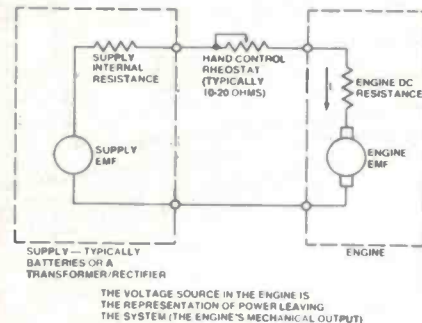


Figure 1. Circuit model, slot car set.

The final speed is fixed by the minimum dc path resistance, the available supply voltage and the amount of friction and other losses in the car. Overall performance includes cornering ability, which is affected by the car weighting and wheel



FUN!
FUN!
FUN!

type and condition. Attention to these factors will effectively 'tune' the car.

If you think you have a car set with one car better than the other, the chances are that checking the above things will reveal a silly fault in one car, and you will end up, after some tinkering, with two improved cars. Let us go through a typical tuning up of a small car, such as those in the \$14-\$15 sets. We will start at the car and end up at the controller.

Firstly, the wheels. It is important to check that these do not have some wobble or severe out-of-roundness. The tyres should be slightly rough, so that they grip, and fairly flat at the point of contact with the track, so that they do not bounce at all when the wheel rotates quickly. See that the tyre is fitted straight, if you have removable tyres, and that the wheels are squarely mounted on the axles.

Next it is worth opening the car up. Check that the axles and cogs are free of dust and carpet fluff. A very small touch of light machine oil on bearings and cogs is a good idea, though not entirely necessary. DON'T oil the tyres or any exposed bit of the car. See that the cogs mesh neatly and fairly silently. On an expensive car, such as Scalextric, these things should be in order already.

Now let's look at the brushes. These are, in our experience, the most vulnerable point in the car. Brush friction usually accounts for 90% of car performance problems. The brushes should be clean and dust free. There will be some unravelling of the braid. This is good. The ends of the brushes seem to benefit from a bit of 'combing'. This can be done with a small jeweller's screwdriver, a scribe or scalpel. About three to five millimetres of combed braid is nice. Finally, the shape of the brushes is important. There are several ways to bend the brush, and you should experiment to see which is better. We used the down-and-then-straight pattern. (See Figure 2.)

Next, the minimum rheostat resistance is important. Some controllers have such resistive leads that the series resistance never gets below an ohm or two. If you have a protected voltage source this is a disadvantage.

Finally, the supply potential is critical. If it is too high, the control becomes too critical and it is too hard to get just the right amount of power. It cannot be too low, of course, as you would not get anywhere near enough power to realise the maximum speed of which the car is capable without crashing — which takes out all the skill. As well, if the supply is

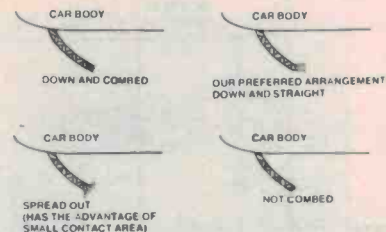


Figure 2. Arrangements for the contact brushes.

not regulated, one car can interact with the other; the extreme of this is seen when one car suddenly 'shutting down' causes such a surge that the other spins off the track. (It can happen!)

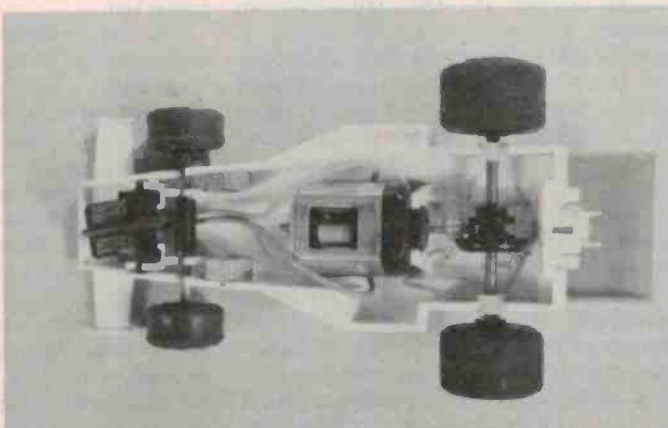
One further factor is worth discussing, with respect to the car: weighting. This is an area where you are going to have to experiment for yourselves. Most cars have spaces inside the plastic shells. Nuts or other pieces of metal can be secured in these spaces with a little Blutac, or similar poster adhesive, to add weight. Weight will reduce the acceleration for a given power, but it will increase wheel adhesion on the road. It will also change the handling, possibly making spinouts more likely, and reduce the period of time required between brush realignments. In our experience, a couple of 2 BA or similar nuts in a small car, near the middle and low down, are quite beneficial if you have adequate power, as with our controllers.

The 824 supply

As we have said, all that is necessary to achieve quite adequate performance is a voltage supply for each car. It needs to be the right voltage, and each car should not interact via the supply with the others. The ETI-824 is this. It is versatile in that it will operate from whatever source of voltage you have available; it simply needs to deliver at least three volts more than the cars need (average) and to be able to supply the maximum current, typically 1/2 to 1 amp per car. ▶

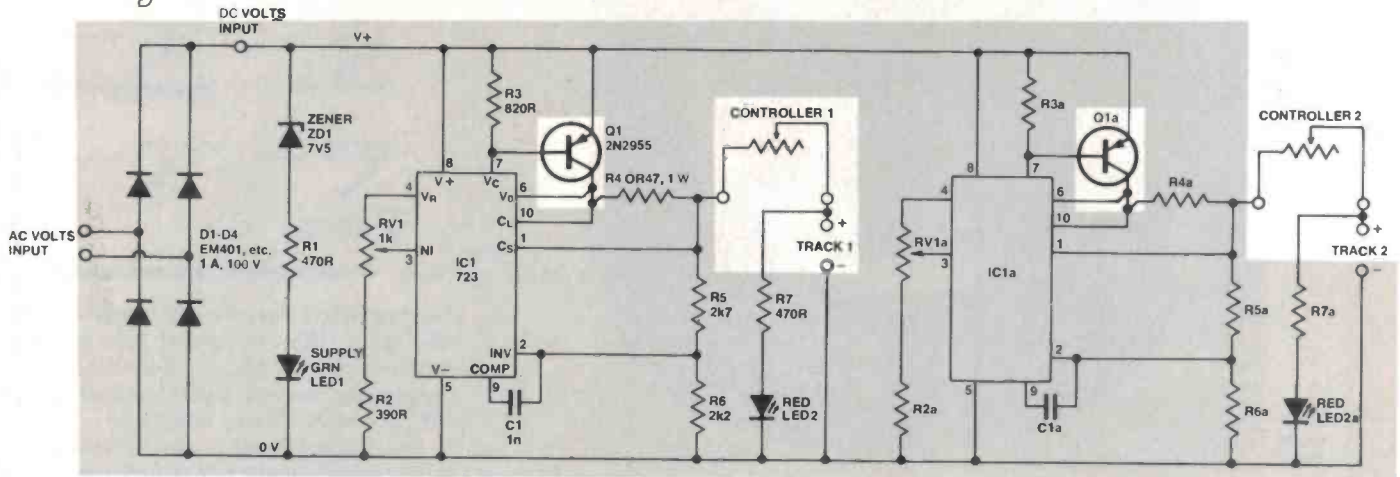


Plain and simple, the ETI-824 slot car supply.



Example of how to weight a car with two nuts stuck under the body.

Project 824/825



HOW IT WORKS — ETI 824

This is basically a crude series voltage regulator, based on the 723 variable regulator IC, that supplies power to the rheostat in the hand controller. The rheostat is in series with the motor in the car, via the track connections. The voltage supplied to the controller and car can be preset anywhere between about 3 V and about 12 V.

The circuit is designed to be powered from a variety of sources — bell transformer, car battery, plugpack, model train transformer or conventional 240 Vac to 15 V/1-2 A transformer — whatever is available. If the source is ac, such as that direct from a transformer secondary, the diode bridge rectifier formed by D1-D4 rectifies this, supplying unfiltered dc to the circuit. These four diodes may be deleted if the unit is run from a dc supply, or they may be left in, provided the dc supply you use exceeds the voltage required by the car by about four volts. Leaving D1-D4 in place has the advantage that the device can be run off ac at any time, and when running off a dc supply it can be connected either way

round as polarity doesn't matter and no possible damage can be occasioned by accidental reverse polarity connection.

To indicate that a supply of sufficient voltage is connected to the circuit, ZD1, R1 and LED1 make a simple indicator. When the supply voltage between the V+ and 0 V rails is high enough to overcome the zener voltage plus the voltage drop across LED1 and R1 at a current of a few millamps, LED1 will light. You need to produce a minimum of about 10 V between the V+ and 0 V rails. Note that while this is sufficient for the IC regulator circuit to operate, it may not be enough for some slot car sets. For those that require 12 Vdc, at least 14 V between the V+ and 0 V rails will be required. An ac input of up to 24 Vac (RMS) may be used.

Following the rectifier and indicator sections of the circuit is the regulator, which consists of IC1, Q1 and associated components. Each lane in the slot car set should be supplied with a separate regulator circuit to ensure that one lane does not interfere

with the operation of the other, especially in the event of a short circuit due to a crash or a fault, etc. Two regulator sections may be run from one rectifier section.

The 723, IC1, controls the base current of Q1 so as to deliver the required voltage to the hand controller, except when the external circuit (controller and car motor, via the track) attempts to draw current above about 1.2 A. In this case, the 723 reduces the voltage supplied to the external circuit to prevent possible damage.

The output voltage is set by RV1. By adjusting this preset control, the voltage delivered to the controller and external circuit may be varied anywhere between about 3 V and about 12 V maximum. This should be adjusted to suit the particular slot car set you are using by setting its position so as to deliver a suitable amount of acceleration to the car when the hand controller is set full on.

LED2 indicates that voltage is reaching the track. This is useful to check correct operation and for detecting shorts on the track.

The 825 controller

For superior performance, the controller can have several 'extras'. This is the ETI-825. Firstly, this gives you *fuel tank simulation*. This means that the control box has a meter which represents fuel in the car. A button 'refuels' the car, provided it is stationary. When it has petrol, you can go again. As the petrol is used up the car gets more acceleration, corresponding to the reduction in weight. The degree of the effect is presettable by a resistor (R107-R207 for the second car). It is rather exaggerated with the value given, but this is more fun. Of course, if you run out of fuel, the car slows down and finally coughs to a stop.

Next, the 825 offers *controlled overshoot*. If the output momentarily exceeds the level that your hand controller commands, the car responds more 'snappily'. This accelerates it a bit harder at first, corresponding to 'dropping the clutch', and brakes hard when it is slowing down corresponding to hard braking. You can even lock up, if you are too hasty!

The controller also informs you if it is folding, such as when the track is short-circuited. In the current mode, it warns of open circuit as well. It does not, in addition, load the hand controller rheostats, as they do not carry the car current. (In some sets the controller handsets get very warm.) It comes with an internal power supply as well. Both controllers are, of course, short-circuit protected.

The two modes, current and voltage, each offer their own advantages. Current mode gives torque proportional to control depression, as torque is proportional to current. It has slower take-off and generally sloppier, though perhaps more realistic, operation. It is also more immune to bad contact in the track and brushes, if you are having trouble in that direction. Voltage mode, which we prefer, gives a very tight control, with snappy response from the car; perhaps less realistic, but more fun. It seems to demand more from the drivers, though performance is considerably superior. You can actually get a car to lock up and slide sideways out of a long straight into

a corner, and accelerate out of the corner, the car's pin in the slot all the time, which is not a mean feat!

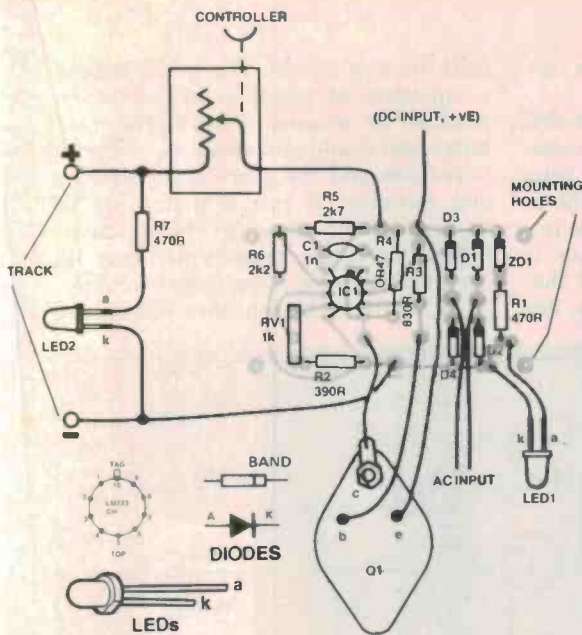
Having set forth the pros and cons, we will proceed into the construction of the two projects, and you may choose the one you feel is appropriate.

Construction ETI-824

Construction of the ETI-824 is relatively straightforward. You will require one pc board for each lane, though some components will not be required on all but the first board. If you have only two lanes, as is likely, you can follow our construction diagrams exactly. Further lanes will simply demand a larger box and a repeat of the wiring up of the first two boards, less ZD1, R1 and LED1.

The first step is to drill the box. We used a jiffy box, primarily because they are the cheapest form of conveniently workable container. If you want it to look particularly good, or it will have to withstand nasty knocks, a diecast aluminium or extruded type of box of sufficient size can be used, but is likely to

slot car controllers



PARTS LIST—ETI-824

Resistors		Miscellaneous	
R1, R7	470R	ETI-824 pc board; jiffy box to suit; terminal block; transformer (if necessary); nuts, bolts, wire etc.	
R2	390R		
R3	820R		
R4	0R47, 1W		
R5	2k7		
R6	2k2		
RV1	1k trimpot		
Capacitors		Price estimate	
C1	1n greencap	We estimate the cost of purchasing all the components for this project will be in the range:	
		\$15—\$18	
Semiconductors		Note that this is an estimate only and not a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used) etc — whether bought as separate components or made up as a kit.	
D1-D4	1N4001, EM401, etc. 1A, 100 V		
ZD1	7V5, 1 W zener		
LED1	TIL220G, green		
LED2	TIL220R, red		
IC1	723		
Q1	2N2955		

add 20-50% to the cost. Anyway, if you have our type of box, the front panel doubles as the heatsink.

Drill the 2N2955 mounting holes and the LED mounting holes first. The only other hardware preparation is the holes for the pc board mounting and the holes for the wires and the terminal block to which they lead.

After the drilling is done, assemble the boards. The first should have all components fitted. It is best to include D1 to D4 even if you have a dc supply, as the unit can then not be connected the wrong way around, and can still be used with ac later on if required. Only if the dc is too low to tolerate the diode drops should D1 to D4 be omitted — i.e.: below 12 volts average. (Omitting the diodes will let it run on around 10 volts.) It should also be noted that the supply will have to be a bit higher if the car set is a

12 volt type — around 15 volts at least. An 18 Vac transformer is ideal in that situation. Fit all the components on the boards as shown in the overlay, starting with resistors and finishing with the IC. Take care with the IC orientation.

Once the boards are assembled, connect the flying leads as shown in the assembly diagram. The current-limiting resistors for the track LEDs are mounted behind the LEDs themselves, as part of the flying leads. We used an ordinary plastic terminal block as these are cheap and wires will probably not have to be connected and disconnected repeatedly, so that more 'flashy' terminals are not justified.

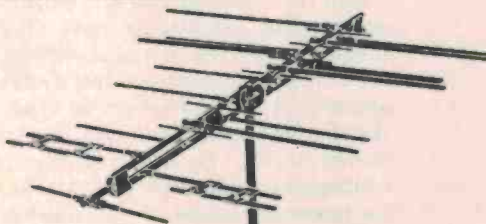
Once the assembly is complete, label the panel and connector appropriately. We used Dymo tape, again in the interests of cost. There is no reason why you should not use paint and Letraset on

the panel before assembly, or do a custom job with model paint after assembly, if you should be that way inclined. (Shades of certain panel vans we have seen! Probably more appropriate if your cars are hotrod types.)

Construction ETI-825

Construction of this unit is fairly flexible and will depend somewhat upon how you plan to house the unit. We built two prototypes — one very compactly in an extruded aluminium case from Amtex and one in a large plastic case from Vero (distributed by Warburton and Franki). It is advisable to use a fairly spacious housing as this demands less careful layout and allows easy access for adjustment or debugging. The only requirement for the case is that if you are using our pc board the meters must be spaced horizontally by the required amount, as ▶

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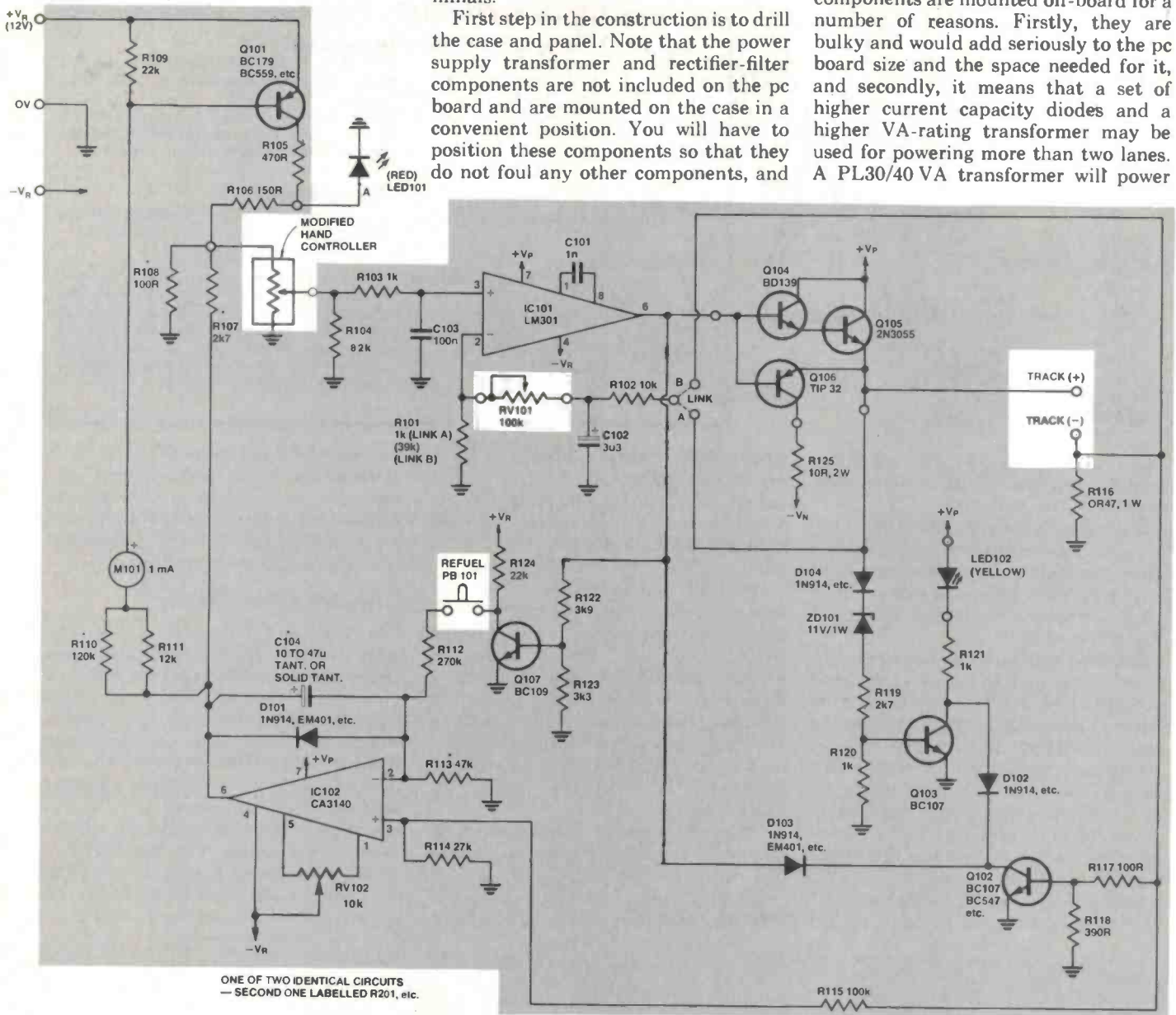
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Project 824/825

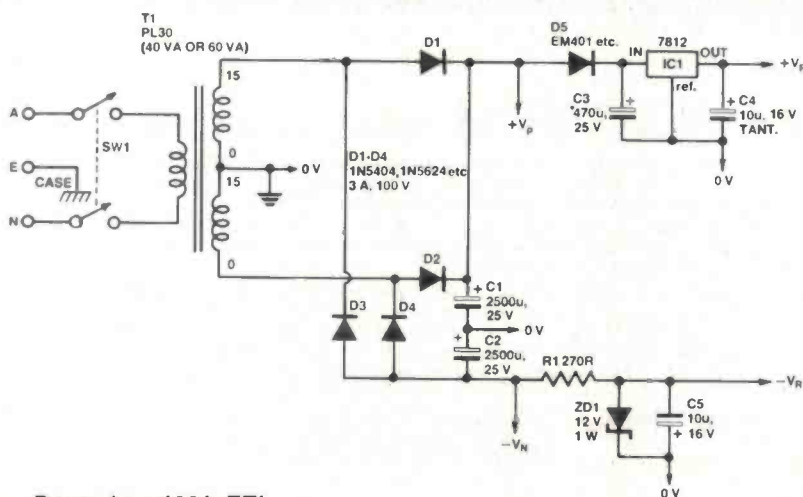
the board mounts on the meter terminals.

First step in the construction is to drill the case and panel. Note that the power supply transformer and rectifier-filter components are not included on the pc board and are mounted on the case in a convenient position. You will have to position these components so that they do not foul any other components, and

drill the case to suit. The power supply components are mounted off-board for a number of reasons. Firstly, they are bulky and would add seriously to the pc board size and the space needed for it, and secondly, it means that a set of higher current capacity diodes and a higher VA-rating transformer may be used for powering more than two lanes. A PL30/40 VA transformer will power



*ITEMS ASTERISKED MAY REQUIRE ALTERATION OF VALUE TO SUIT YOUR PARTICULAR REQUIREMENTS— SEE TEXT.



two lanes, a PL30/60 VA will power up to four lanes.

We found it convenient to mount the mains supply terminating block, cable clamp (or clamp-grommet), output terminals and presettable pots (RV101, RV201) on the rear panel of our box. We used ordinary potentiometers for RV101 and RV201, rather than preset types, cut the shafts short and cut a slot in the end of the shafts. To avoid fouling other components, mount the pots so that they are below the height of the transformer.

Next, prepare the front panel. Naturally, drill it first. Locate the meter holes carefully as the pc board determines their spacing (144 mm centre-to-

HOW IT WORKS — ETI-825

The unit comprises a power supply, a control section (involving IC101), a driver circuit (involving Q104, 5 and 6 and associated components), an overload protection and warning circuit (Q102, 3 etc), an 'electronic fuel tank' (Q101 plus IC102 and associated components) and a 'refuel' circuit (Q107 etc).

The circuit has two modes of operation — voltage and current. The mode to be employed is selected by means of a link on the pc board. In the voltage mode, the hand controller sets the voltage delivered to the track (and thus the slot car's motor). In the current mode the hand controller sets the current delivered to the car's motor via the track. In either mode, a potentiometer (RV101) sets the maximum value of the voltage or the current.

POWER SUPPLY

Transformer T1 has two 15V (RMS) secondaries, connected in series. There are two rectifier circuits — one to provide a positive supply rail, the other to provide a negative supply rail. The joining of the two secondaries provides a 0 V connection.

Diodes D1-D2 and capacitor C1 provide a nominal +21V supply rail (+V_p) while D1-D3 and C2 provide a nominal -21V supply rail (-V_N). From these two rails +12V and -12V regulated rails are derived. The +12V rail is achieved by IC1, a three-terminal positive supply regulator (a 7812 or 78L12). This rail is used as a reference for the hand controller and metering circuit. Capacitor C4 ensures high frequency stability for the three-terminal regulator and acts as a supply rail bypass. The -12V rail is derived by a simple zener circuit involving R1 and ZD1. C5 is a supply rail bypass. The negative rail is limited to 12 volts so that the maximum supply voltage limitation of the op-amps, which is about 36 volts, is not exceeded.

CONTROL SECTION

This centres on IC101. A certain current (which we will discuss in detail a little later) is passed through the hand controller resistance. This develops about 200 millivolts drop across it. Thus, when the hand controller is operated, a voltage ranging between 0 and 200 mV is applied to pin 3 of IC101, the precise voltage depending on how far the 'driver' has depressed the controller lever. Capacitor C103 smoothes out any variations — many hand controllers have momentary loss of contact between the wiper and the resistance as the wiper traverses the resistance element. You may need to vary the value of C103 according to how coarse the resistance variation happens to be in your controller. For the inexpensive controllers — which are really quite adequate despite the coarse variation they provide — a value of 470n to 1u (electro) is suitable.

Now, IC101 attempts to drive its output (pin 6) in such a fashion as to induce the same voltage on its inverting input (pin 2) as is on its non-inverting input (pin 3).

In the voltage mode, pin 2 of IC101 is connected via RV101, C102 and associated components to the positive track terminal so that the position of the wiper on the hand control resistance sets the output voltage. In the current mode, pin 2 of IC101 is connected to the end of the 'current sense' resistor (R116) so that current is defined by the position of the

wiper on the hand controller resistance.

In either mode, RV101 — which is in series with the negative feedback path — in conjunction with R101, sets the maximum voltage or current delivered to the car's motor via the track. Capacitor C102 induces some 'overshoot' in the feedback which enhances acceleration and braking according to controller movement.

DRIVER

The driver circuit comprises Q104, Q105 and Q106 plus R125. Its function is merely to amplify the current delivered from the output of IC101.

Transistors Q104 and Q105 are connected as a Darlington pair which provides considerable current gain (the Beta of Q105 is multiplied by the Beta of Q104). The output of IC101 (pin 6) swings positive during acceleration (depressing the hand controller lever) and Q104-5 amplify the current, the emitter of Q105 being connected to the track positive terminal. Q106 is reverse biased during this time. During braking, pin 6 of IC101 can go negative (particularly if you 'drop' the hand controller lever). This reverses the voltage delivered to the track or reverses the current flow (depending on which mode you're employing). When this occurs, Q104 and Q105 are reverse biased and Q106 is forward biased — and it amplifies the negative excursions from pin 6 of IC101.

The function of R125 is to protect Q106 against momentary current overload.

PROTECTION

The protection circuit involves Q102, Q103 and associated components. If the voltage output to the track exceeds about 13 volts, ZD101 and D104 conduct, forward biasing the base of Q103. When Q103 turns on, it draws collector current via LED102 and R121. LED102 lights, providing warning of a fault. If the output current exceeds about 1.5 amps the current through R116 (which is in series to the supply to the track) induces a voltage drop across it of about 0.7 volts or so and this forward biases the base of Q102 via R117 and R118. Q102 thus turns on and it draws collector current via D102, R121 and LED102. However, the collector voltage of Q102 will be around a few hundred millivolts and the output of IC101 (pin 6) will be shunted to the 0 V rail via D103 and the collector-emitter junction of Q102.

Thus, you receive a warning of supply overload and the supply, track etc., is protected against overcurrent damage.

FUEL TANK

The 'fuel tank' is simulated by IC102 and associated components. This op-amp is connected as an integrator. A 'full' tank corresponds to 0 V on the output of IC102 (pin 6), an 'empty' tank to about 12 volts. As current flows through the load (car motor), and hence via R116, a voltage is dropped across R116. This voltage is integrated by IC102 which has an RC network (R113-C104) in the feedback loop. As more load current is drawn, pin 6 of IC102 rises towards 12 volts.

The meter, M1, indicates the output voltage of IC102 and is marked like a fuel gauge. While the fuel tank is full or partially full, the current through M1 flows via the base of Q101, forward

blasing it. Thus, Q101 is held on while this current flows. The collector current of Q101 flows via LED101 (the hand controller and associated resistors). LED101 lights, indicating you have fuel in the tank. When the fuel 'runs out', pin 6 of IC102 is at 12 volts and no current flows through M1 and thus the base of Q101 receives no bias and it turns off. LED101 extinguishes at this stage and no voltage is delivered to the hand controller. IC101 interprets this as if you have the controller set to the rest or off position and no power is supplied to the track. Your car stops...

The 'capacity' of the fuel tank is defined by the values of C104 and R113. The values shown give a 'full tank' of about 60 amp-seconds — which corresponds to about 30 rapid laps of a 2½ metre long track in 1/64th scale. The values of C104 and R113 may be varied to suit your taste, as indicated in the table on page 33.

While there is fuel, LED101 is on and its terminal voltage is about 1.7 volts. This voltage permits about 10 mA to flow through the resistance of the hand controller via R105. (Recall we have yet to see what its current is). In addition, R107 permits some current to flow into the controller — generally between 0 and 5 mA — from pin 6 of IC102. This current increases as fuel is 'used up', corresponding to the car getting lighter, and you get more acceleration at any particular hand controller setting as you 'use up' fuel. Resistor R107 defines how much more acceleration is obtained when the car is 'lighter'.

When the fuel runs out and Q101 turns off, the current delivered through R105 to the hand controller plummets and only the 5 mA flowing via R107 is available. This gives a 'soft' end, allowing you to limp to the pits — if you aren't too far away on the track.

The parallel combination of R108 and the hand controller should be around 15 ohms. If your controller has a high resistance, or you want to substitute a 1k wirewound pot, for example, R108 should be derived from the following formula:

$$R108 = \frac{1}{\left(\frac{1}{15} - \frac{1}{R_{\text{controller}}}\right)}$$

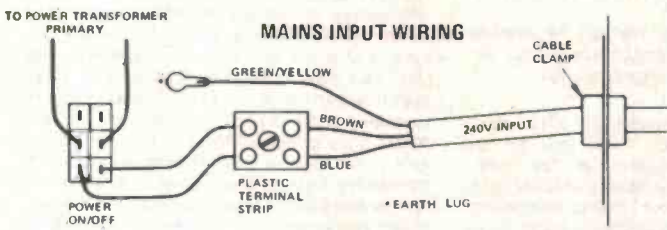
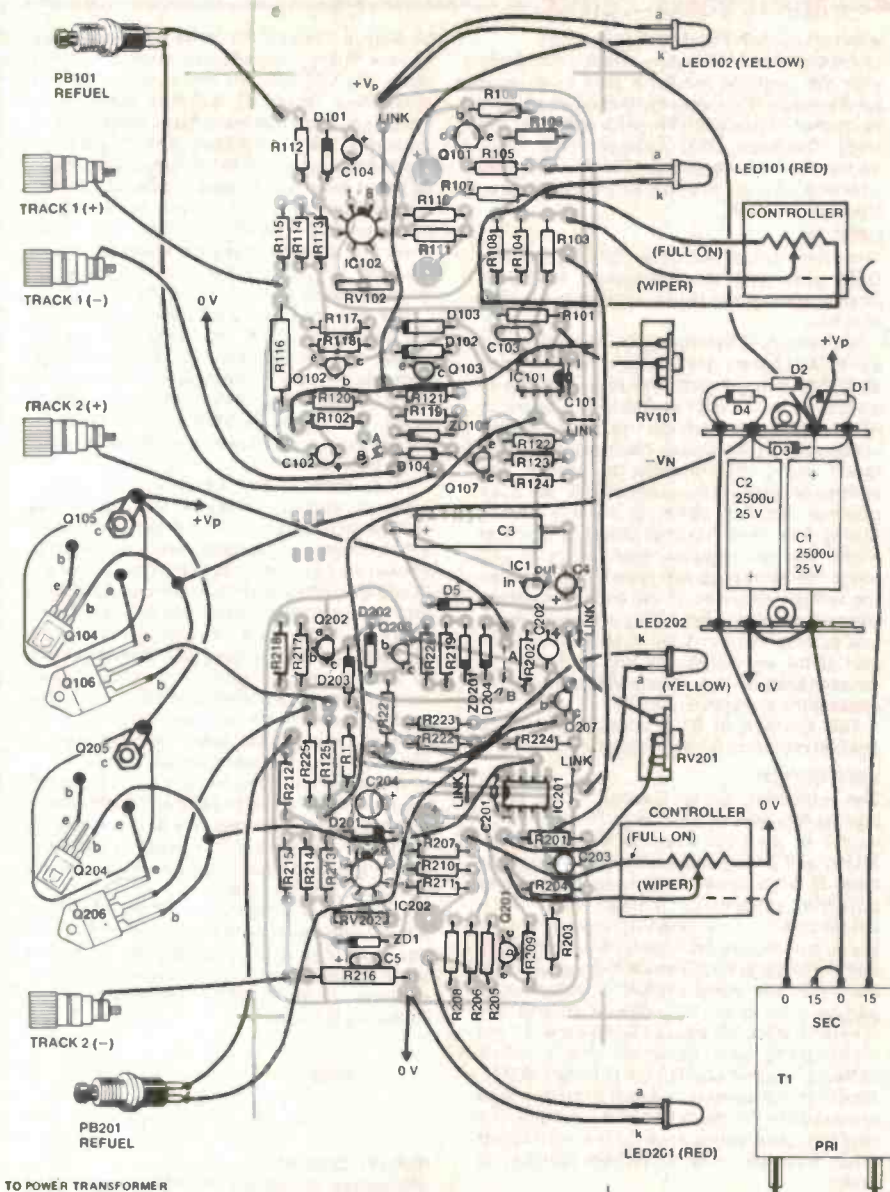
REFUEL CIRCUIT

'Refuelling' is effected by PB101 and Q107. When the car motor is not drawing power, the output of IC101 (pin 6) is low (less than one volt) and thus Q107, which derives its base bias from pin 6 of IC101, is off. Pressing PB101 connects R112 to the +12 V rail via R124 and IC102 will discharge C104. The output of IC102 (pin 6) will drop to 0 V (which is the 'tank full' condition). Q101 will turn on again and current will be supplied to the hand controller circuit. When you power the car again, the voltage on pin 6 of IC101 will rise, the base of Q107 will be biased on and its collector will draw current via R124. Thus, if you try to 'top up' while the car is in motion, R112 will be virtually connected to the 0 V rail via the collector-emitter junction of Q107 and you won't be able to drive the output of IC102 low. In addition, if you attempt to drive the car while refuelling, the refuelling action will be stopped by the same means.

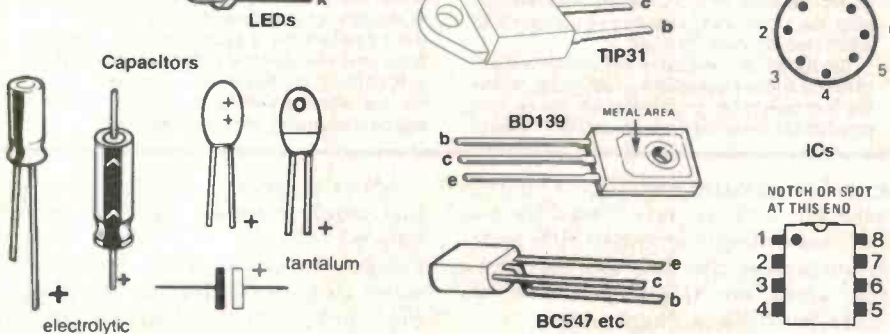
centre). For panel marking we used rub-down lettering on one panel (such as Letraset, Geotype, etc), put directly on the panel after cleaning it, and automotive 'touch-up' paint on the other. Both methods proved satisfac-

tory. In the interests of giving a Spartan, vehicular look we put '?' symbols near the overload/fold warning LEDs and '!' symbols near the fuel warning LEDs, but words are OK if you need the controller to be self-explanatory.

Apply a spray-on lacquer to protect the panel markings. With this job finished, fit the meters, LEDs, etc. Finally, drill the mounting holes for the power transistors, which are mounted off the board. These dissipate little heat so ▶



PIN-OUTS



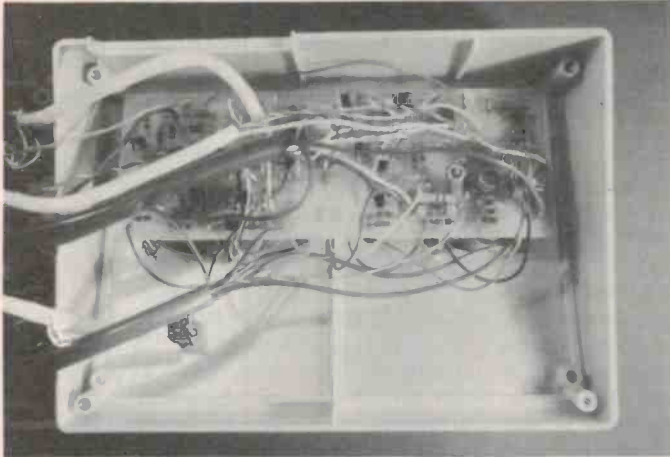
they merely need mechanical support.

The next step is to assemble the components to the pc board. As there are quite a few flying leads, it may pay to use pins for the termination of these to the pc board. Pay attention to all the usual details — orientation of tantalum and electrolytic capacitor, orientation of semiconductors, etc. Choose the components in Table 1 to suit your requirements, according to the instructions given with the Table. When all the components are soldered in place, fit the flying leads to the LEDs and pushbuttons which are mounted on the front panel, along with the meters. These can be secured and the pc board bolted to the meter terminals before the leads to the main case are fitted. Be sure that all flying leads are long enough to allow the box to be fitted together and dismantled without straining the connections. In the controller we assembled in the extruded aluminium case, very long wires were required as the panel has to be slid into position end-wise because it rides in a groove of the extrusion. Long leads can be kept neatly 'loomed' with plastic sleeving slipped over a bunch before one group of ends is terminated.

Assemble the transformer, power supply components and potentiometers in the case next and wire them up. Take particular care with the mains wiring. The rectifier components are supported on a tagstrip and we'll leave the wiring details to you for this one.

The final step before testing is to modify the handheld controllers from rheostats to true potentiometers. Open up the case of a controller. You will find that it consists of a short coil of resistance wire, wound on some sort of former, with a wiper contact which moves along the coil according to how far the thumb or finger control is depressed. When fully released, the wiper rests in a position where it does not touch the coil. There will be two wires coming from the hand controller — one leading to the wiper and one from an end of the resistance wire. It is necessary to have a third contact, connected to the other end of the coil (the end without a connection). Remove the existing wires (some of these have considerable resistance themselves) and fit the two new wires, then the third. These run to the controller unit. Make sure you have plenty of length to play with. Now re-assemble the hand controller, being careful to tie off the wires in the same way the original two were secured.

You should now be ready for a test run.



Inside the ETI-825. The board mounts on the meter terminals and the power supply and other components mount in the cabinet base.



Full frontal view of the ETI-825 'control' panel.

TABLE 1. Component value variations

Component	Nominal Value	Function	How to vary it
C104(C204)	10u	Sets fuel tank capacity, along with C104.	Increase its value to increase fuel tank capacity. E.g. 20u gives double capacity. RANGE: 10 to 47u
R113(R213)	47k	Sets fuel tank capacity, along with C104.	Increase its value to increase fuel tank capacity. RANGE: 10k to 100k
R110(R111)	120k in parallel with 12k	Calibrates M1 for full scale deflection at 'full tank' status; allows other meter fsd values to be used.	Reduce R110 to increase reading. Choose R110/R111 to give value according to $11.4/I_{fsd}$. This should not need much adjustment if a 1 mA meter is used.
R107	2k7	Sets the variation of engine power remaining fraction of fuel.	Reducing R107 gives a greater gain in power as the fuel 'runs out'. RANGE: 2k2 to 22k
R108	100R	Sets the effective controller resistance to about 15 ohms.	Choose R108 such that R108 in parallel with the controller resistance gives a combined resistance of 15 ohms.

PARTS LIST—ETI-825

Resistors all 1/2W, 5% unless noted

R1	270R
R101	1k (link A), 39k (link B)
R102	10k
R103,120,121	1k
R104	82k
R105	470R
R106	150R
R107	2k7*
R108	100R*
R109,124	22k
R110	120k*
R111	12k
R112	270k
R113	47k*
R114	27k
R115	100k
R116	0R47; 1W
R117	100R
R118	390R
R119	2k7
R122	3k9
R123	3k3
R125	10R, 2W
RV101	100k lin. pot.
RV102	10k

Capacitors

C1	2500u/25 V electro.
C2	2500u/25 V electro.
C3	470u/25 V electro.
C4, C5	10u/16 V tant.
C101	1n greencap
C102	3u3/10 V tant.
C103	100n greencap
C104	10 - 47 u/16 V tant. — preferably solid tant.

Semiconductors

D1-D4	1N5404, 1N5624 etc (3A, 100V)
D5, D101, D103	1N4001, EM401, (1A, 100V)
D102, D104	1N914, 1N4148
ZD1	12 V, 1 W zener
LED101	TIL220R, red
LED102	TIL220Y, yellow

Q101	BC179, BC559 etc
Q102, 103	BC107, BC547 etc
Q104	BD139
Q105	2N3055
Q106	TIP32
Q107	BC109, BC549
IC1	78L12 or 7812
IC101	LM301
IC102	CA3140

Miscellaneous

T1	PL30/40 VA (or 60 VA), Ferguson (2 x 15 V, 1A)
SW1	SPST, 240 Vac rated toggle switch
M101	1 mA meter, MU-45 or similar
PB101	momentary action pushbutton

ETI-825 pc board; case to suit; tagstrips; terminal block; mains cord and plug; clamp grommet; Scotchcal meter scales; nuts, bolts, wire etc.

NOTE: The controller circuit is duplicated for the second track and those parts marked R101, D101, C101, IC101 etc are duplicated, designated R201, D201, C201, IC201 etc for the second controller.

* Components marked with an asterisk may require alteration to suit your particular requirement (see text).

Price estimate

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

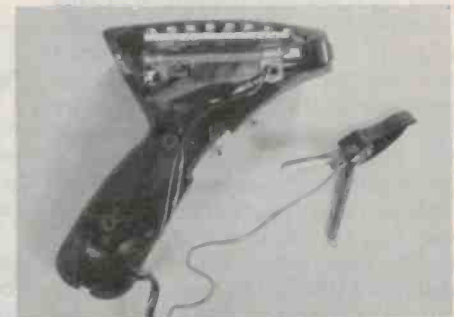
\$60—\$70

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

Test run

Make up a simple circle of track. On powering up, the car should work to some degree. If not, stop and recheck. Once it works it is necessary to adjust the presets and so forth. RV102/202 should be adjusted to minimise 'fuel tank' circuit drift in the absence of power being delivered. (These are the integrator offset adjustments.) At this stage it is probably worth assembling the unit and giving it a serious workout. You may find that you want to increase the fuel tank capacity (C104), change from one mode to the other (links A and B) or that the control is rough or jittery. If this latter is the case, then your controller is probably one with *relatively few* turns of resistance wire. This is causing sharp changes in level, to which the electronics respond with excessive overshoot. The cure is to increase C103/203 to, say, 1 μ F. This is especially prevalent with the cheap, 6 V operated sets. After you have had a while in the seat, remove the front panel and alter the appropriate components (marked with an asterisk) in order to produce the effects desired. To figure out what these are, consult Table 1.

A note should be included on the correct adjustment of the maximum torque presets, RV101/201. This is much a matter of preference. They should be ▶



Modified hand controller with connection to both ends of resistance wire.

adjusted so that the car does not get ridiculous amounts of power just prior to running out of fuel, but so that the car can just be crashed on full power with a full tank. It is probably also a good idea to set the two channels alike with a multimeter to ensure fairness. (Be sure to have equal amounts of fuel when doing this adjustment!)

The track

When it comes to track, there are three factors worth mentioning which may influence your choice if you have yet to purchase it, before we discuss actual layout. These factors are: range of pieces available, flexibility and width. If you are going to buy the cheap sets, and let's face it, that is the most cost-economical approach, you will have to accept that the track comes in fixed quantities, probably multiples of what it takes to make up one loop or a small figure-8. However, it is so cheap that you can get twelve 45° curves and four straights, not to mention two cars and controllers, and fences, etc, for under \$15 in some places in Sydney (e.g.: Paddy's markets, etc). For \$30, plus one of our controllers, you can get a really good set-up, and for \$45 you get a really *fantastic* set. There is no denying that an expensive brand is better in that you can buy three radii of curvature (for funny bends or up to six lanes) and several lengths of straight, but at \$150 or so for a basic figure-eight set, it is not a purchase to be taken lightly. Such sets also have the advantage that they have flexible track which can thus be banked on the curves, but they are on a larger scale and take up more room. The cheap stuff is usually about 102 mm (4") wide, but if you are lucky you can get it a bit wider, like 110 mm. This is a bit better, as the cars are less likely to interfere with each other on bends, and less likely to foul badly on fences.

In designing a layout, the main problem is not to find a shape which is particularly interesting, but one which is fair, or equal, for both lanes, as well as 'rational'. By rational we mean that the pieces of track fit together into a loop naturally and require no forcing. A layout which has to be pushed out a bit to meet up is not only unaesthetic to the perfectionist mind, but tends to rapidly separate in various places with a bit of use. If you are using the track pieces which come in the cheaper sets you are probably constrained to turn increments of 45°, and straight sections each equal to the centre radius of curvature of the curved sections. If, in addition, you want to use all or almost all of the track available, (and who doesn't?), you are probably constrained to some fixed ratio of curves-to-straights. Even if you are lucky enough to have a range of bits, it

is quite challenging to sort out a fair and rational track using all the bits. And besides, who rushes out and gets that quarter straight every time he devises a nice-looking layout that doesn't quite meet up squarely?

Method

If you are not seriously interested in layout analysis and design, you may skip this paragraph; it deals with our mathematical method of thinking out a track set-up. First, let us define some terms. A 'construct' is any group of track sections. It does not necessarily meet up to form a closed loop, but is usually a familiar shape which can be found in common layouts. A rational construct is one which replaces a basic subsection of an oval of track — either a right angle, a single straight section, or a combination of these — and thus, geometrically, introduces an integral multiple (or in some sets of track, a simple rational fraction) of the basic radius of curvature into each axis.

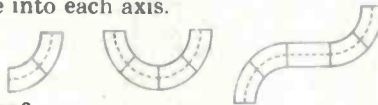


Figure 3.

To explain this, consider Figure 3. The right angle turn introduces a one-unit displacement down and one unit along. The U-bend introduces a two-unit shift down and no shift along. The S-bend introduces three down, and two along. These are all rational constructs in the system of track here — that is, one where straights are exactly one radius of curvature long, as is common. The constructs in Figure 4 are all equivalent to a right angle, and are thus rational.

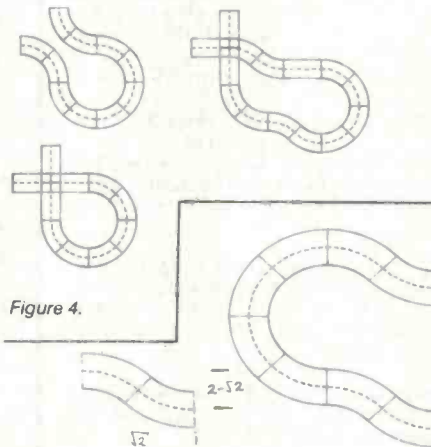


Figure 4.

Figure 5.

The zig-zag in Figure 5 is irrational, as it has displacements of $\sqrt{2}$ and $2 - \sqrt{2}$ respectively, but the construct next to it is rational, as the zig-zags clearly cancel out.

A layout is said to be *rational* if it fits together *exactly*. For this to happen, there must be no uncancelled irrational constructs. Some constructs favour one lane. For instance, in a plain 180° bend,

the outside lane is longer, and thus you might expect it to take longer to negotiate. If there are fences it may be faster, as the car can bounce off them and thus use them to allow greater speed without accident.

Experiment will determine how each construct favours lanes. In our experience, a zig-zag favours the lane first on the outside, especially with fencing. Once you have an idea of each construct and how it favours lanes, you can assemble them into a fair layout. Even though a completely flat layout will inevitably have one lane longer on the outside, it can be made fair by judicious addition of constructs to favour the worse lane — such as zig-zags at the ends of long straights.

It is desirable to avoid bridges, because they are easier to disrupt in moments of excitement as well as harder to achieve with rigid track. It is also a pain to quickly recover a crashed car from the underpass. Flat layouts can be fair, with some thought and understanding of the constructs used.

Finally, let us mention cleaning. Unless rust is rife, abrasive things such as emery paper should be avoided. Cloth soaked with methylated spirit is best for removing crud. After cleaning, light application of machine oil or Vaseline (the latter collects more hair but is better for storage) will reduce crudding and prevent corrosion. The plating on the tracks is sufficient protection until it fails, so just wiping should be enough. Occasionally, the small metal flanges which make contact from track to track should be bent slightly to improve friction and contact.

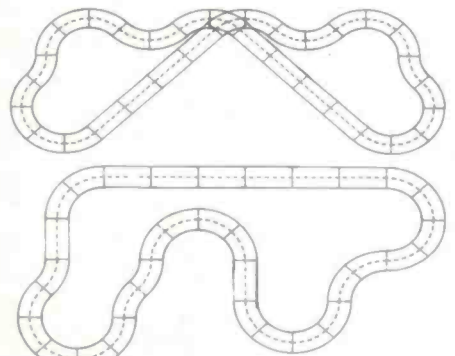


Figure 6.

If you are really getting into it, you can devise a catalogue of constructs. We developed a computer program for checking rationality and a layout plotting routine; we tender a couple of optimal layouts (Figure 6) which use all the track from two cheap figure-eight sets. The analysis and synthesis of track layouts becomes more complex when you have different and more varied pieces available — our examples are of the elementary type, as in cheaper sets. ●

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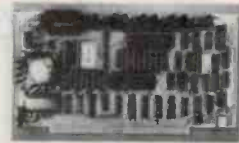
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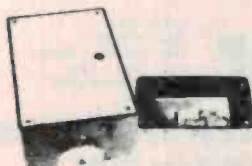


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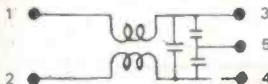
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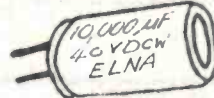


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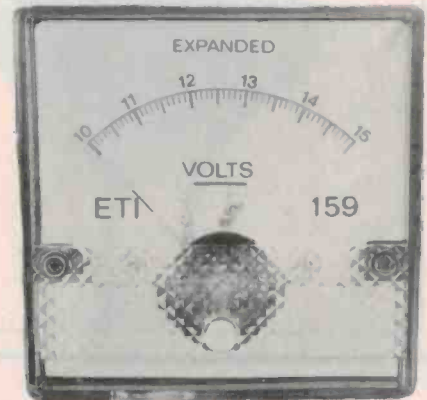
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Expanded scale voltmeter covering the 10 - 15 V range

A simple, low-cost instrument that can be built into power supplies or used as a portable or fixed 'battery condition' monitoring meter.

Simon Campbell
Roger Harrison



COMMON STORAGE BATTERIES to power nominal 12 Vdc electrical systems have a terminal voltage that ranges from a little over 10 volts when discharged to around 15 volts when fully charged, the operating voltage being somewhere in the range 11.5 V to 13.8 V. Lead-acid batteries, for example, may have a terminal voltage under rated discharge that commences at around 14.2 V and drops to about 11.8 V. A 12 V (nominal) nickel-cadmium battery may typically have a terminal voltage under rated discharge that starts at 13 volts, dropping to 11 volts when discharged.

Equipment designed to operate from a nominal 12 Vdc supply may only deliver its specified performance at a supply voltage of 13.8 V — mobile CB and amateur transceivers being a case in point. Other dc operated equipment may perform properly at 12.5 V but 'complain' when the supply reaches 14.5 V.

To monitor the state of charge/discharge of a battery, a battery-operated system or the output of power supplies, chargers, etc, a voltmeter which can be easily read to 100 mV over the range of interest, i.e: 10 to 15 volts, is an invaluable asset. This project does just that.

Some readers may note that our Expanded-scale LED Voltmeter, Project ETI-316, published in the September 1980 issue, does much the same job. However, the function of each is somewhat different. The ETI-316 has 10 LEDs indicating each half volt between 10.5 V and 15 V and is intended to be read 'at a glance', giving a general

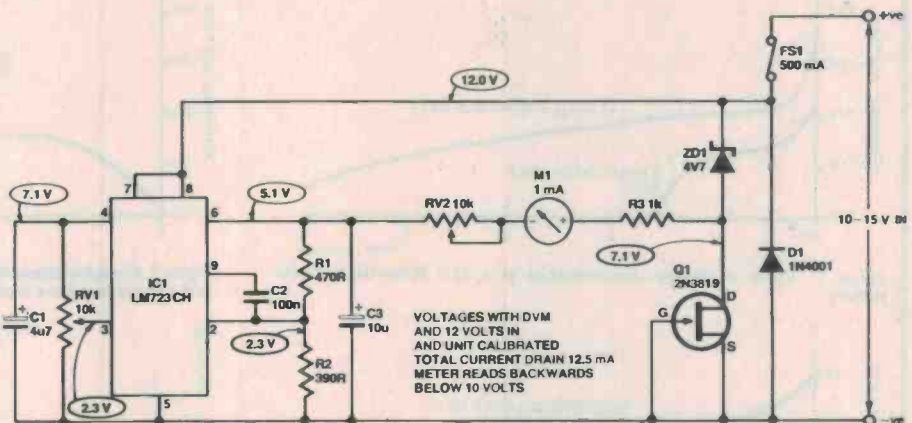
indication of battery condition or whatever. Its main application is in vehicles or other areas where operation is only checked periodically.

This instrument, being of the true analogue type, is intended for more exacting measurement and is better characterised as a test instrument.

The circuit

We originally came across this circuit in an article by Danny Apted (then VK7ZDA) published in 'QRM', the newsletter of the Northern Branch of the Wireless Institute of Australia, Tasmanian Division.

An LM723 variable voltage regulator IC is employed to set an accurate 'offset' voltage of 5 V, and the meter (M1) plus the trimpot RV2 and R3 make up a 5 V meter, with the trimpot allowing calibration. The negative terminal of the meter is connected to the output of the



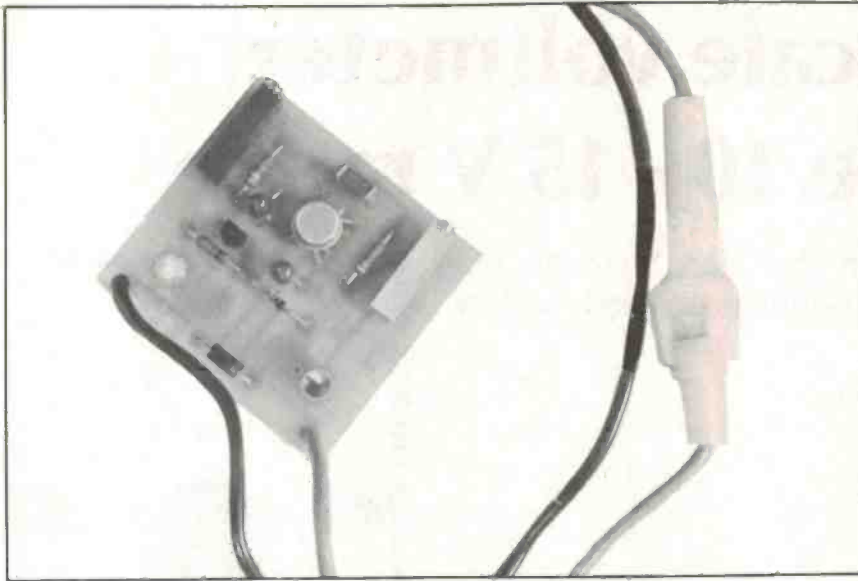
HOW IT WORKS — ETI 159

The meter, M1, is a 1 mA meter with series resistance — made up of R3 and RV2 — so that it becomes a 0-5 V voltmeter. The negative end of the meter is maintained at 5 V above the circuit negative line by the output of IC1, a 723 adjustable regulator. The positive end of the meter is connected to the circuit positive line via ZD1, a 4V7 zener diode. Thus, no 'forward' current will flow in the meter until the voltage between the circuit negative line and the circuit positive line is greater than 5 + 4.7 = 9.7 volts.

As current for the zener is provided by a FET, Q1, connected as a constant current source so that the zener current is accurately maintained over the range of circuit input voltage. This ensures the zener voltage remains essentially constant so that meter reading accuracy is maintained.

The trimpot RV1 sets the output voltage of the 723. This determines the lower scale voltage. Trimpot RV2 sets the meter scale range. More resistance increases the scale range, less resistance decreases it.

Diode D1 protects the circuit against damage from reverse connection.



723 so that it is always held at 5 V 'above' the circuit negative line. The positive end of the meter goes to a zener which will not conduct until more than 5 V appears between the circuit +ve and -ve lines. Thus the meter will not have forward current flowing through it until the voltage between the circuit +ve and -ve rails is greater than 10 V, and will read full scale when it reaches 15 V (after RV2 is set correctly).

The meter scale limits may be adjusted by setting the output of the 723 higher or lower (adjusted by RV1) and setting RV2 so that the meter has an increased or decreased full-scale deflection range.

A variety of meter makes and sizes may be used.

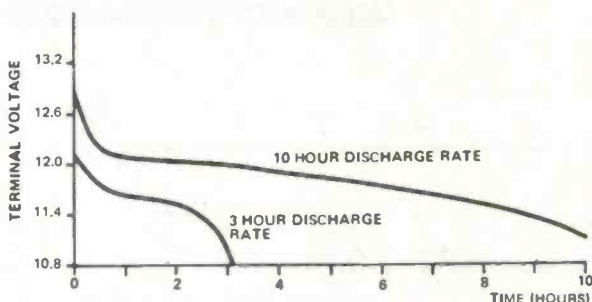


Figure 1. Typical discharge characteristics of a 12 V (nominal) lead-acid battery.

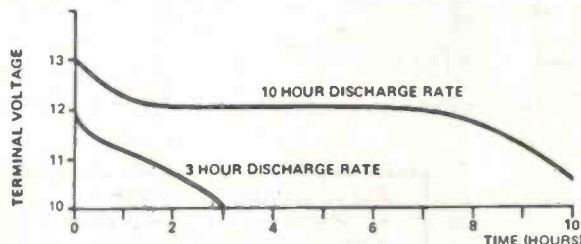


Figure 3. Typical discharge characteristics of a 12 V (nom.) nickel-cadmium battery (usually consisting of 10 cells in series).

Battery condition and terminal voltage

The 12V battery, in its many forms, is a pretty well universal source of mobile or portable electric power. There are lead-acid wet cell types, lead-acid gel electrolyte (sealed) types, sealed and vented nickel cadmium types, and so on. They are to be found in cars, trucks, tractors, portable lighting plants, receivers, transceivers, aircraft, electric fences and microwave relay stations — to name but a few areas.

No matter what the application, the occasion arises when you need to reliably determine the battery's condition — its state of charge, or discharge. With wet cell lead-acid types, the specific gravity of the electrolyte is one reliable indicator. However, it gets a bit confusing as the recommended electrolyte can have a different S.G. depending on the intended use. For example, a low duty lead-acid battery intended for lighting applications may have a recommended electrolyte S.G. of 1.210, while a heavy-duty truck or tractor battery may have a recommended electrolyte S.G. of 1.275. Car batteries generally have a recommended S.G. of 1.260.

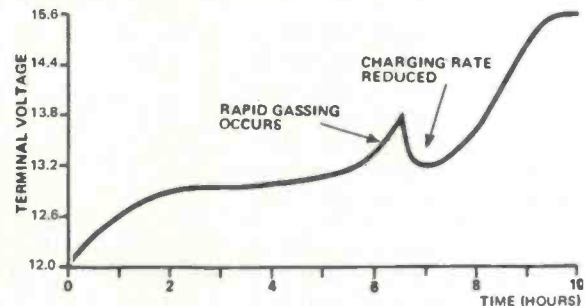


Figure 2. Charging characteristics of a 12 V (nom.) lead-acid battery. The 'kink' in the curve near 6 hrs is explained in the text.

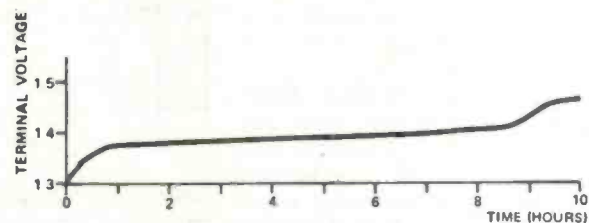


Figure 4. Typical charging characteristics of a 12 V NiCad battery (10 cells) charged with a constant current at one-tenth rated capacity (0.1C).

That's all very well for common wet cell batteries, but measuring the electrolyte S.G. of sealed lead-acid or nickel-cadmium batteries is out of the question.

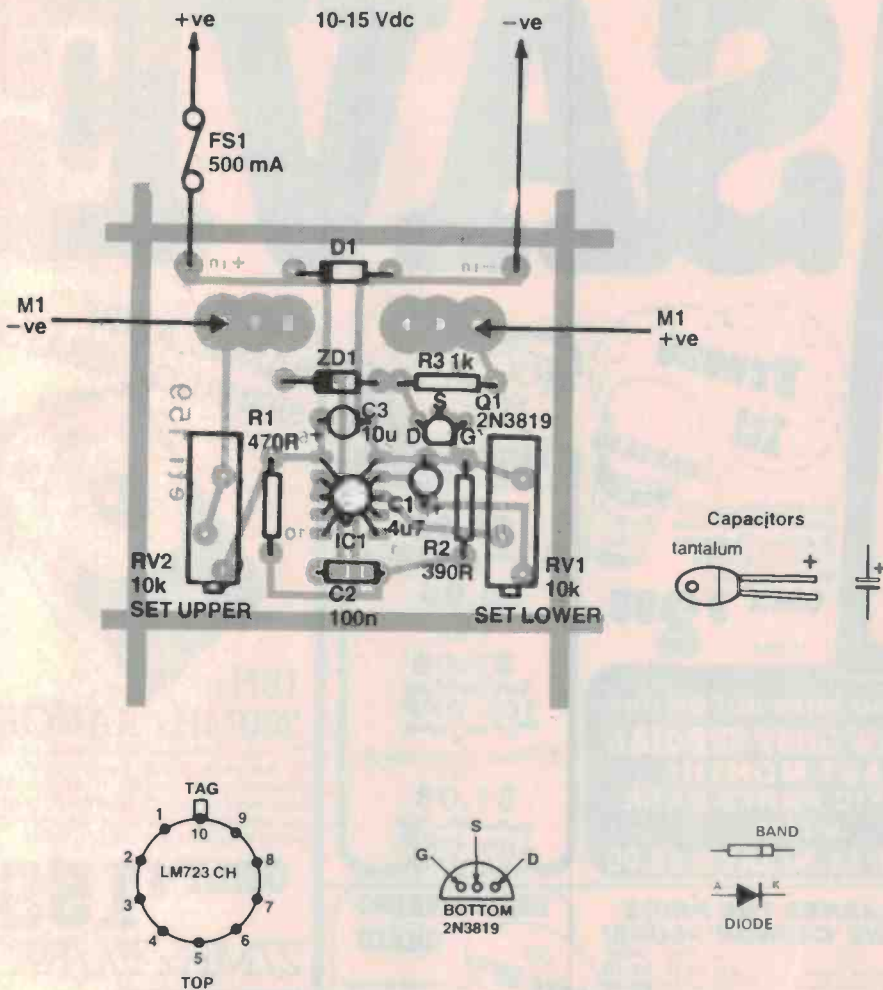
With NiCads, the electrolyte doesn't change during charge or discharge.

Fortunately, the terminal voltage is a good indicator of the state of charge or discharge. In general, the terminal voltage of a battery will be at a defined minimum when discharged (generally between 10 and 11 volts), and rise to a defined maximum when fully charged (generally around 15 volts). Under load, the terminal voltage will vary between these limits, depending on the battery's condition.

Hence a voltmeter having a scale 'spread' to read between these two extremes is a very good and useful indicator of battery condition. It's a lot less messy and more convenient than wielding a hydrometer to measure specific gravity of the electrolyte!

The charge and discharge characteristics of typical lead-acid and sealed NiCad batteries are given in the accompanying figures.

10-15 V meter



PARTS LIST — ETI 159

Resistors all 1/2W, 2% metal film
 R1 470R
 R2 390R
 R3 1k
 RV1, RV2 10k cermet multiturn horizontal trimpot

Capacitors

C1 4u7/10 V tant.
 C2 100n greencap or ceramic
 C3 10u/10 V tant.

Semiconductors

IC1 LM723CH
 ZD1 4V7, 400 mW or 1 W zener
 Q1 2N3819
 D1 1N4002 or similar

Miscellaneous

M1 1 mA meter (see text)
 FS1 500 mA fuse and in-line fuse holder

ETI-159 pc board; meter scale to suit meter; colour-coded (red & black) 'figure-8' cable, etc.

Price estimate

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

\$20—\$23

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

The pc board and meter scale artwork are on page 147.

Construction

Mechanical construction of this project has been arranged so that the pc board can be accommodated on the rear of any of the commonly available moving coil meter movements. We chose a meter with a 55 mm wide scale (overall panel width, 82mm). A meter movement with a large scale is an advantage as it is considerably easier, and more accurate, to read than meters with a smaller scale. It also pays to buy a 'Class 2' meter (2% fsd accuracy) for best accuracy.

Having chosen your meter, drill out the pc board to suit the meter terminal spacing first. The components may then be assembled to the board in any particular order that suits you. Watch the orientation of the 723, ZD1, the FET and particularly D1. The latter is an 'idiot diode'. That is, if you have a lapse of concentration or forethought and connect your project backwards across a battery, the fuse will blow and not the project. Fuses are generally found to be cheaper than this project!

Seat all the components right down on the pc board as the board may be positioned on the rear of the meter with the components facing the meter. The size of C2 may give you a little trouble. Greencaps are generally too large and therefore unsuitable. We used a 'Monobloc' type capacitor — as commonly used on computer pc boards as bypasses. Alternatively, a 100n tantalum capacitor (+ve to pin 2 of IC1) may be used. The actual value or type of capacitor is not all that critical.

We have used multiturn trimpots for RV1 and RV2 as they make the setting up a whole lot easier.

Note that the fuse (to protect the project) is inserted in an in-line holder in the external connecting leads. For these leads we used 'automotive' figure-8 cable, colour-coded red (for +ve) and black (for -ve).

Calibration

For this you will need a variable power supply covering 10 to 15 volts and a digital multimeter (borrow one for the

occasion).

First set the 10 V point. Connect the digital multimeter across the power supply output and adjust the power supply to obtain 10.00 volts. Set the mechanical zero on the meter movement to zero the meter's pointer. Connect the unit to the power supply output and adjust RV1 to zero the meter needle.

Next, set the power supply to obtain 15.00 V. Now adjust RV2 so that the meter needle sits on 15 V (full scale). Check the meter reading with the power supply output set at various voltages across the range. We were able to obtain readings across the full scale within \pm half a scale reading (\pm 50 mV). With a Class 2 meter the worst error may be about \pm one scale division.

When set up, our unit drew 12.5 mA maximum current drain, which is probably typical, but current drain may be around 20 mA or so maximum. Note that, when the input voltage is below 10 V, the meter needle will move in the reverse direction. ●

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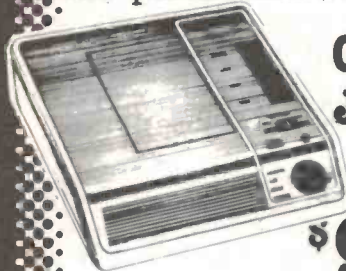
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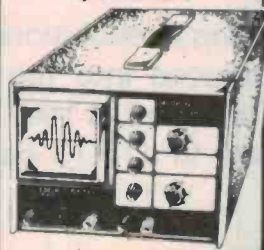
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Lab Notes



Using the LM 396 10A adjustable voltage regulator

Barry Davis

A new voltage regulator using a revolutionary IC fabrication technique has been introduced into the marketplace by National Semiconductor. It is the LM 196/396, a 10 ampere adjustable voltage regulator in a TO-3 package.

THIS NEW regulator has *all the protection features* that hobbyists have taken for granted in the lower power LM117/317 family. It is immune to blowout from excessive output current and all devices are 'burned-in' to guarantee the correct operation of the protection circuits under overload conditions.

The output voltage is adjustable over the range of 1.25 to 15 volts. The maximum input-output voltage differential ($V_{in} - V_{out}$) is 20 volts, and higher output voltages are possible providing that this parameter is not exceeded. A full load current of 10 amperes is available at all output voltages; however, the maximum power dissipation (70 watts) and the junction temperature must be watched closely. At a load current of 10 amperes, the maximum permissible $V_{in} - V_{out}$ differential is 7 volts. Under these conditions the power dissipated is —

$$V_{in} - V_{out} \times I_{max} \\ = 7 \times 10 = 70 \text{ watts.}$$

The features of the regulator are:

- 10 A guaranteed output current.
- 70 W maximum power dissipation.
- Adjustable output from 1.25 to 15 V.
- 100% burn-in thermal limit.
- Internal current power limiting.
- Input-output voltage differential is 20 V maximum.
- Dropout voltage is approximately 2.1 V.
- TO-3 Package.

The current limit and maximum power dissipation characteristics are shown in Figure 1a and 1b respectively.

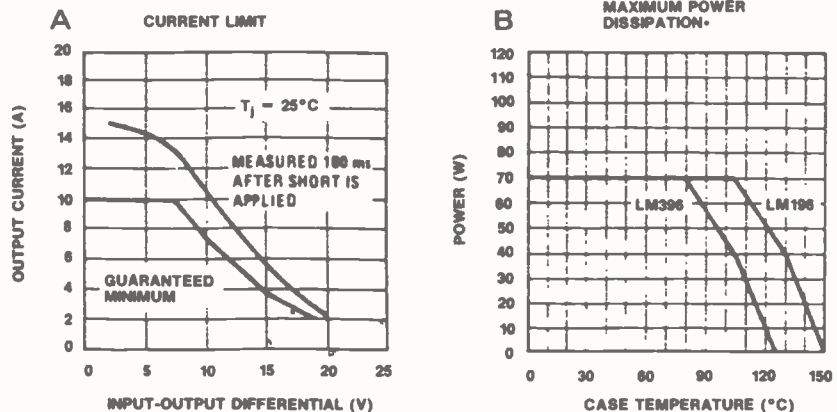


Figure 1. Current limit and power dissipation

Application precautions

1. Heatsinking

The major limitation in the output current capability of the regulator is heatsinking. The regulator has extremely high power dissipation, 70 watts continuously, providing that the maximum junction temperature limit is not exceeded. These limits are:

- LM 196 -55°C to +150°C
- LM 396 0°C to +125°C

Careful attention must be paid to *all* junction thermal resistances. A good heat-conductive paste *must* be used when mounting the regulator on the heatsink. The regulator must also be bolted down nice and tight. To ensure

ABOUT THE AUTHOR

Barry Davis is a lecturer with the Telecommunications Division of the Royal Melbourne Institute of Technology, engaged in teaching full-time technician students. He has worked in all facets of the electronics industry and is the author of a number of radio and television correspondence courses on fundamentals and servicing for Stotts.

Barry Davis is also the author of a text book called 'Understanding dc power supplies', published by Prentice-Hall earlier this year. This book mentions the development of National Semiconductor's 'Moose-process' LM196/396 regulator which very recently became available — hence this article.

the selection of the correct heatsink, the procedure is as follows.

Calculate the *worst case continuous average power dissipation* in the regulator from the formula:

$$P = (V_{in} - V_{out}) \times I_{out}$$

The voltage/current characteristics of the unregulated input must be accurate. A small change in input voltage can result in a large increase in the power dissipated by the regulator. For example, normal operating conditions are:

$$\begin{aligned} V_{out} &= 10 \text{ V} \\ V_{in} &= 14 \text{ V} \\ I_{out} &= 10 \text{ A} \\ P &= (14 - 10) \times 10 \\ &= 40 \text{ watts.} \end{aligned}$$

If the input voltage increases by 10% to 15.4 volts:

$$\begin{aligned} P &= (15.4 - 10) \times 10 \\ &= 54 \text{ watts} \end{aligned}$$

— an increase in power dissipation of 35%.

Therefore, the power supply circuit up to the regulator input (i.e: transformer, rectifier diodes, filter capacitor) plays an important role in the successful operation of the regulator itself. It should be built and tested to determine its average dc output voltage under full load with maximum input voltage. This circuit is shown in Figure 2.

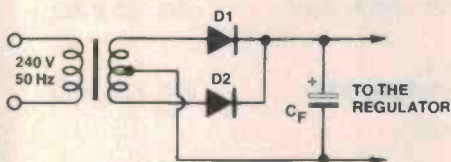


Figure 2. Circuit prior to the regulator.

The choice of C_F is also very important. At *high* current levels the capacitor ripple current (RMS) is two to three times the dc output current. If the capacitor has an equivalent series resistance (ESR) of 0.05 ohms, this can cause internal power dissipation (I^2R) of 20 to 45 watts at an output current of 10 amperes.

The life of the capacitor 'derates' with increase in operating temperature, and the choice of a small-value capacitor is asking for trouble (about 2000 μF is used for the LM 317 circuit). A value of some 2000 μF per ampere of load current is the minimum recommended value. Large values of capacitor will have longer life and will also reduce the ripple

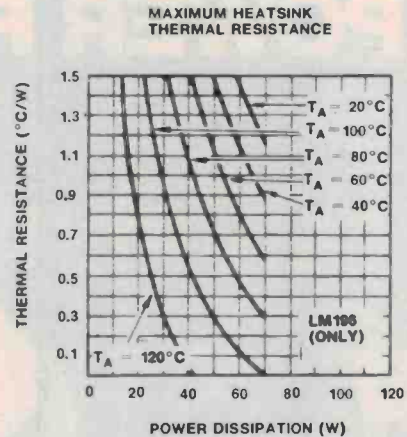
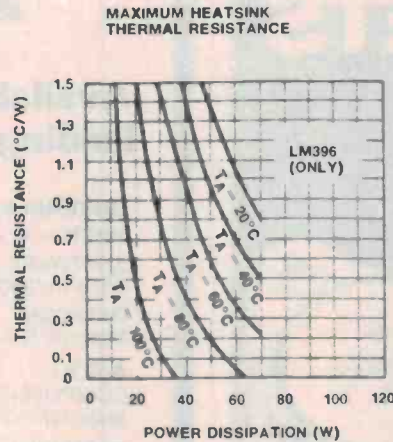


Figure 3. Heatsink thermal resistance graphs (T_A = Ambient temperature)

level. This allows a lower dc input voltage to the regulator, which will result in savings in transformer and heatsink costs.

A further idea is to place several capacitors in parallel. This increases the capacitance, reduces the net series resistance and increases the heat dissipating area (i.e: shares it among the capacitors). Once the circuit in Figure 2 has been finalised and the average dc output voltage determined, the thermal resistance of the heatsink can be determined from the graphs in Figure 3, in degrees centigrade per watt ($^{\circ}\text{C}/\text{W}$).

For conservative heatsinking it is recommended that you choose T_A to be 35°C higher than anticipated.

The heatsink resistance generally falls into the range of $0.2^{\circ}\text{C}/\text{W}$ - $1.5^{\circ}\text{C}/\text{W}$ at a $T_A = 60^{\circ}\text{C}$. These are *large* heatsinks such as the Philips 45D6CB, 55D6CB, and the large Minifin. These must be mounted for best convection cooling and could also be cooled by a fan.

2. Transformers

Correct transformer ratings are extremely important in high current supplies. If the secondary voltage is too high, power will be wasted and cause unnecessary power dissipation in the regulator. However, if the secondary voltage is too low it may cause loss of regulation if the input voltage (i.e: mains) fluctuates excessively.

The following formula can be used to calculate the secondary voltage required using the circuit in Figure 2 (full wave centre tap).

$$V_{(RMS)} = \frac{V_{out} + V_{reg} + V_{Rect} + V_{Ripple}}{\sqrt{2}} \times \frac{V_{Nom}}{V_{Low}} \times (1.1) \quad (1)$$

Where:

1.1 is the factor accounting for load regulation of the transformer.

V_{out} = dc regulated output voltage.

V_{Reg} = Minimum $V_{in} - V_{out}$

V_{Rect} = Voltage drop (forward) across the diode at $3 \times I_{out}$.

V_{Ripple} = Peak capacitor ripple voltage ($\frac{1}{2}$ p-p).

$$\text{i.e. } \frac{(5.3 \times 10^{-3}) I_{out}}{2C}$$

C is the capacitor value in farads.

V_{Nom} = Normal ac input (RMS).

V_{Low} = Minimum ac input (RMS).

The current rating required can be calculated from the formula:

$$I_{RMS} = I_{out} \times 1.2 \quad (2)$$

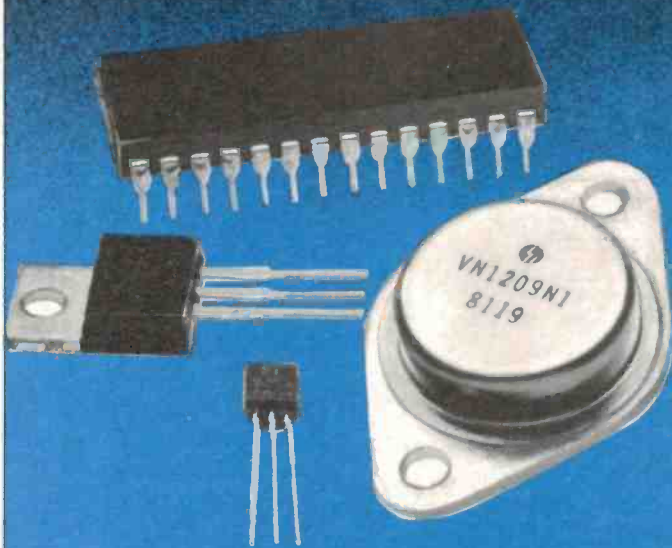
Where I_{out} = dc output current.

Transposing formula (2) we can calculate the value of filter capacitor required:

$$C = \frac{(5.3 \times 10^{-3}) I_{out}}{2 \times V_{Ripple}} \quad (3)$$

The best way to appreciate these formulas in use is to calculate the values required for a power supply circuit. If we design a good mobile radio power supply, 13.8 volts at 10 amperes: ▶

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ET 1

Lab Notes

$$V_{out} = 13.8 \text{ V}$$

$$I_{out} = 10 \text{ A}$$

$$\text{Assume } V_{Reg} = 2.2 \text{ V}, V_{Rect} = 1.2 \text{ V}$$

$$V_{Ripple} = 2 \text{ V p-p}, V_{Nom} = 240 \text{ V}$$

$$V_{Lrsw} = 220 \text{ V}$$

Using formula (1)

$$V_{(RMS)} = \left(\frac{13.8 + 2.2 + 1.2 + 1}{\sqrt{2}} \right) \left(\frac{240}{220} \right) 1.1$$

$$= \frac{18.2}{\sqrt{2}} \times 1.09 \times 1.1$$

$$= 12.869 \times 1.09 \times 1.1$$

$$= 15.4 \text{ volts (RMS)}$$

Using formula (2)

$$I_{(RMS)} = 10 \times 1.2$$

$$= 12 \text{ amperes (RMS)}$$

The transformer must therefore be 240:30 CT at 12 amperes. The centre tap (CT) will provide 15 volts secondary voltage for each diode.

The size of the filter capacitor required can be calculated using formula (3)

$$C = \frac{(5.3 \times 10^{-3}) 10}{2 \times 1}$$

$$= 26500 \mu\text{F}$$

The transformer, rectifier and filter circuit is now shown in Figure 4.

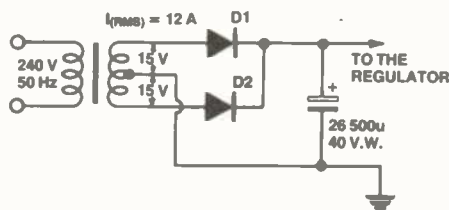


Figure 4. Rectifier and filter circuit

3. Diodes

The diodes used in the circuit must have a high dc current rating. The capacitor input filter draws high peak current pulses that are considerably higher than the average dc current. With a 10 amperes supply the average current is 5 amperes. The current pulse's duration and amplitude result in a long-term diode heating of approximately 10 amperes dc. Therefore the diodes should have a rating of at least 10-15 amperes. Also, the power supply may have to survive a short circuit and average current could rise to 15 amperes (see Figure 1a).

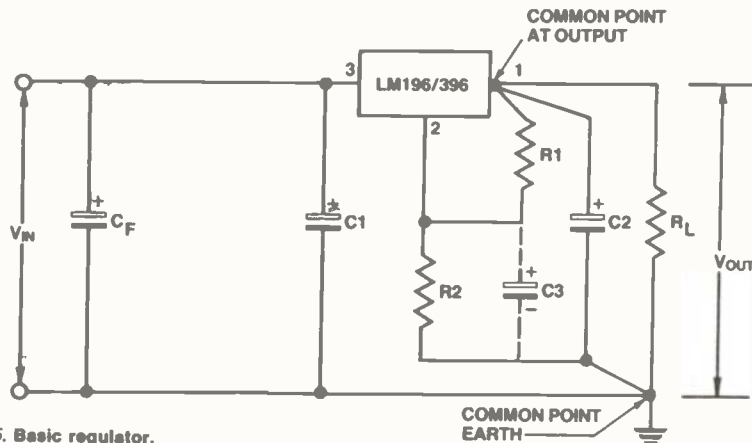


Figure 5. Basic regulator,
 $V_{out} = 1.25 \frac{(R1 + R2)}{R1}$

Another important factor in the choice of diode is the surge current at switch on. The peak surge current is about 10-20 times the dc output current (i.e. 100-200 A for a 10 A supply). (Note: smaller transformers and filter capacitors may be used in lower current supplies. This will reduce the surge current; unless you are sure of the worst case surges, do not economise on diodes.)

Stud-mounted diodes in a DO-4 or DO-5 package are recommended, such as IR 12F10B, IN3209 or 16F10 silicon rectifiers. Remember to choose the correct PIV for the type of transformer in use ($PIV = \sqrt{2} V_{Secondary}$).

4. Wiring

High load currents produce higher than normal voltage drops across the resistance of the wiring. It is suggested that 16-18 gauge wire is used for input and output connections, and the length is kept to a minimum.

The two resistors used to set the output voltage level are connected:

1. directly to a common point earth and
2. directly to the output of the regulator as shown in Figure 5.

Components in Figure 5.

$$C_F = \text{Main filter capacitor } 26500 \mu\text{F.}$$

$C_1 = 4 \mu\text{7}$ tantalum. It is only necessary if the main filter capacitor is more than 150 mm away from the regulator. Connecting wire is 18 gauge or larger.

$C_2 = 4 \mu\text{7}$ tantalum. It is not absolutely necessary, but is recommended to maintain low output impedance at high frequencies.

$C_3 = 25 \mu\text{F}$. Improves ripple rejection, output impedance, and noise. (Capacitor C2 should be close to the regulator if C3 is used).

$R_1 = 120$ ohms. It should be a wirewound or metal film resistor, tolerance 1% or better.

R_2 = calculated to set V_{out} ; the same type of resistor as R_1 .

The value of R_2 can be calculated from the formula:

$$R_2 = \left(\frac{V_{out}}{1.25} \right) \times R_1 - R_1$$

Example:

$$V_{out} = 13.8 \text{ V}$$

$$R_1 = 120 \text{ ohms}$$

$$R_2 = \left(\frac{13.8}{1.25} \right) \times 120 - 120$$

$$= (11.04 \times 120) - 120$$

$$= 1324.8 - 120$$

$$= 1204.8 \text{ ohms.}$$

As stated earlier, the package is a TO-3 and the connections are shown in Figure 6.

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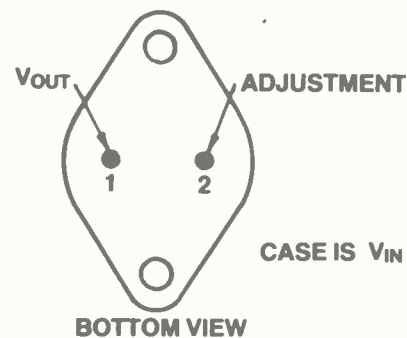


Figure 6. Connection diagram

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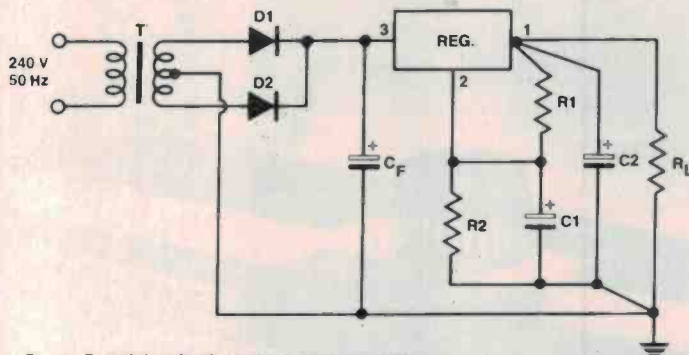


Figure 7. A 13.8 volt 10 ampere power supply.

The complete circuit can now be built, incorporating Figures 4 and 5. The circuit diagram of the final 13.8 V 10 A power supply is shown in Figure 7.

Component values for Figure 7.

- T = 240 : 30 CT at 12 amperes.
- D1 = 16F10 DO-4 case.
- D2 = 16F10 DO-4 case.
- CF = 26500 μ F 40 VW (ideally, capacitors in parallel).
- C1 = 25 μ F 16 VW.
- C2 = 4 μ 7 tantalum 16 VW.
- R1 = 120 ohms 1% metal film.
- R2 = 1k2 1% metal film.
- Reg = LM396 on a 6" 55 or 65D heatsink.

$$V_{out} = 1.25 \left(\frac{R1 + R2}{R1} \right)$$

$$= 1.25 \left(\frac{120 + 1200}{120} \right)$$

$$= 1.25 \times 11$$

$$= 13.75 \text{ volts}$$

A highly desirable situation would be to reduce the power dissipated by the regulator. This can be achieved by supplying part of the output current around the regulator as shown in Figure 8.

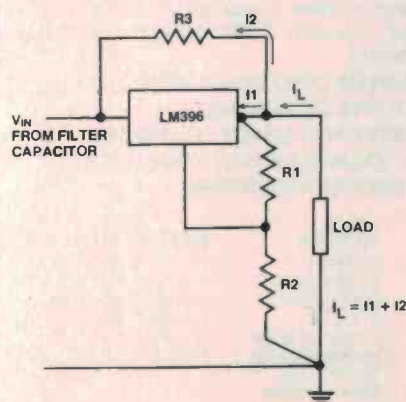


Figure 8. Reducing regulator power dissipation

Resistor R3 is selected to supply a portion of the load current. In this case a *minimum load must always be maintained*. This prevents the regulated output from rising uncontrolled. The value of R3 must be greater than:

$$\frac{V_{max} - V_{out}}{I_{min}} \text{ ohms}$$

Where: V_{max} is worst case high input voltage.
 I_{min} is the minimum load current.
 Power rating must also be considered and R3 must be rated at a minimum of:

$$\frac{(V_{in} - V_{out})^2 \text{ watts}}{R3}$$

This circuit configuration will reduce the regulator power dissipation by a factor of 2 to 3, if the minimum load current is about 50% of the full load current.

Precautions when using R3

1. The power rating of R3 must be increased to $\frac{(V_{max})^2}{R3}$ watts if continuous output short circuits are at all likely.
2. Under short circuit conditions the overall circuit power dissipation increases by $\frac{(V_{in})^2}{R3}$ watts.

The regulator and R3 will not be harmed (if R3 is the correct wattage), but the circuit components prior to the regulator (diodes, transformer) must be able to withstand the overload condition (i.e: the power rating is sufficient to handle the excess current).

The only problem with this technique

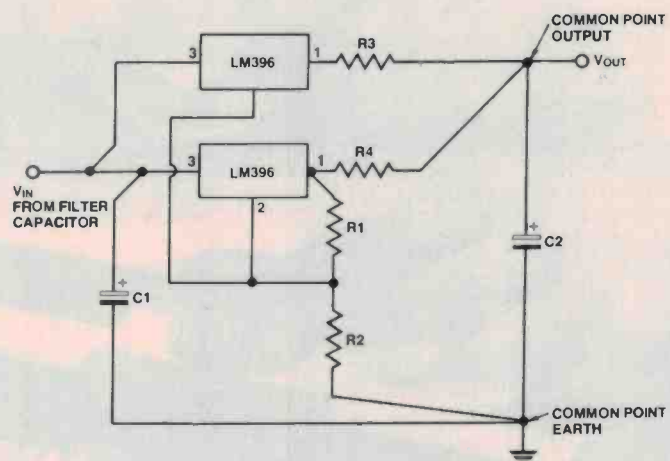


Figure 9. Quasi-parallel regulators

- R1 = 120 ohms
- R2 chosen to set V_{out}
- R3, R4 = 0.015 ohms
- C1 = 4 μ 7 tantalum
- C2 = 100 μ F

is the large power rating required for resistor R3. If $V_{in} - V_{out} = 7$ volts and $R3 = 2$ ohms, the power dissipated by the resistor is:

$$\frac{(7)^2}{2} = 24.5 \text{ watts}$$

with 3.5 A of current passing through it.

High Current Output

Placing regulators in parallel is not recommended because they may not share the current equally. The regulator with the highest reference voltage will handle the highest current up to the time it current limits. Therefore, one regulator may be flat out handling 16 A while the other is cool and calm passing only 2 A. Reliability cannot be guaranteed under these conditions because of the high junction temperature of regulator one.

However, if load regulation is not critical, the regulators may be connected quasi-parallel, as shown in Figure 9. This circuit will share current to within 1 ampere, and in the worst case 3 amperes. However, the payoff is in the load regulation. It is degraded by 150 mV at 20 ampere loads compared to about 20 mV with 10 ampere loads. This should not cause too much of a problem in higher voltage power supplies. ●

Acknowledgement

This article was made possible by the courtesy of National Semiconductor. Data and basic circuits were taken from their publication 'LM196/LM396 10 Amp Moose Adjustable Voltage Regulator'.



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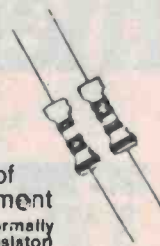
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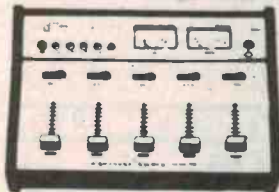
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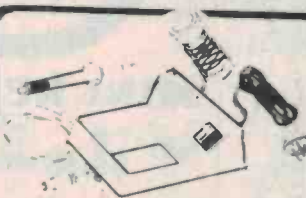
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BD438 45V4A 0.30

DECEMBER price reductions

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 - AM/FM BATTERY/ELECT. RADIO IN LEATHERETTE CARRY-CASE, \$19.00 **\$9.00**
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 - MICROPHONE FLOOR STANDS POPULAR TRI-STAND BASE, ADJUST \$35 **\$27.50**
 - SCOPE CORDLESS SOLDERING IRON RECHARGEABLE, 60 WATT \$55.00 **\$49.00**
 - SCOPE METAL ETCHING TOOL IDENTIFY OR LABEL TOOLS, ETC. \$21.50 **\$16.00**
 - EX-COMPUTER ELECTROS. G'TEED 1000's MICROFARADS AT 1/2 PRICE!
- | | |
|------------------------|-----------------------|
| 25,000uF .10v. \$2.00 | 50,000uF .30v. \$5.00 |
| 42,000uF .10v. \$2.50 | 3,150uF .40v. \$1.00 |
| 100,000uF .10v. \$3.00 | 21,000uF .40v. \$4.00 |
| 150,000uF .10v. \$4.00 | 33,000uF .40v. \$4.50 |
| 51,000uF .15v. \$4.00 | 31,000uF .50v. \$5.00 |
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VARIAC TRANSFORMERS

120V AC
2.5 Amps
\$10 EA

Buy 2 for use on 240V, wiring diagram incl. standard 10mm pot-hole mtg. open construction, ex-computer and g'teed. Others for 240V from \$40.00.

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\$49 COMPLETE IN SLOPING METAL BOXES

Top quality keyboards from famous makers. Limited quantity available. Standard typewriter layout with a few extra keys for your own use. They are assumed to be in good working order, however no warranty can be applied. The PCB includes all necessary electronics. Sorry, no data available.

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OUTPUT +50V 12A +24V 1A -24V 1A +5V 4A

THIS MONTH'S SPECIAL OFFER

CAR AERIALS WITH LEAD AND PLUG PERSONAL SHOPPERS ONLY! **\$1.50**

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Great value, worth over \$5 **\$2.50** huge purchase enables us to sell for less than HALF! Buy 10+ \$2.25

SPDT 8 to 15V DC, 225 OHMS, PCB MOUNTING

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RUNS FRIGDES, TV'S, RADIOS LIGHTS, ALMOST ANYTHING! REGULATED OUTPUT, 240V ± 5% RMS 50Hz ± 0.5% INPUT 11-15V DC **\$209** NORMALLY \$249. SAVE \$40 With reversal switch, use as a battery charger, 7A output from 240V mains.

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• ONLY 3 WIRES
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• LAST NUMBER MEMORY REDIAL

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U.S.A. Model **\$19.99**

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BOXES ONLY **\$44** SPECIAL PRICE!

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Do-it-yourself SPEAKER KITS
3 Way, 25W
8 OHMS, 55Hz-18KHz HI-FI sound, wood-grain finish with black grille cloth. Boxes are ready-made for easy finish in 2 hours.

1/2 PRICE HI FI SPEAKERS **PRY ONLY \$69**

Sounding GREAT with an 8" woofer, a 5" mid-range and a 3" tweeter with X'overs plus wire and Innerbond and screws.

Speakers

8" WOOFER 8Ω 25W RATING 55-5KHz **7.50**

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GREAT VALUE!

HiFi for Cars

AUTO REVERSE

ADJUSTABLE SHAFTS!

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This 15 watt/channel (in 4 ohms) AM/FM Stereo Radio/Cassette mounts in-dash and features AUTO-REVERSE and fast forward and rewind controls. Usually \$179.

5 BAND AM/SW/1B /FM/VHF RADIO BATTERY/ELECTRIC

\$59

WAS \$69, SAVE \$10

Healing WORLD-RANGE Radio with time-zone chart features SQUELCH control, Tone and Volume, Push-button Band-change Switch and large Slide-Rule Dial for easy frequency tuning

Covers AM 540-1600KHz, SW 4-12MHz, 1B 1.6-1.1MHz, FM 88-108 MHz, VHF 108-174MHz, Mains or Battery Operation.

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Under-Dash etc, LED bar-graph display, AUTO-STOP, mini size

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SAVE \$30 WAS \$79

BONUS: 2 HIGH QUALITY CASSETTE TAPES WITH CAR HI-FI PURCHASE!

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PROTECTED SPEAKER OUTPUTS!

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WITH **DOLBY** PUSH-BUTTON AND TUNING

ALSO LOCKING FAST FORWARD AND REWIND, SEPARATE BASS AND TREBLE CONTROLS PLUS 7 WATTS OUTPUT PER CHAN. IN 4 OHMS - UNIVERSAL IN-DASH INSTALLATION

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60 Watt \$85

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GRAPHIC GIVES 12dB + and - AT 80Hz, 250Hz, 500Hz, 1KHz, 4KHz, 8KHz, 15KHz, FREQ.

RADIOS BELOW HALF PRICE

PORTABLE AM

EACH **\$2.99**

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NOVELTY AM RADIOS

AS ABOVE, WERE \$5.99 **\$2.99**

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Lesson high quality with compression, LOW NOISE

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5 WATT HORN SPEAKER \$7.99

5" 80MM METAL WEATHER-PROOF HORN SPEAKER

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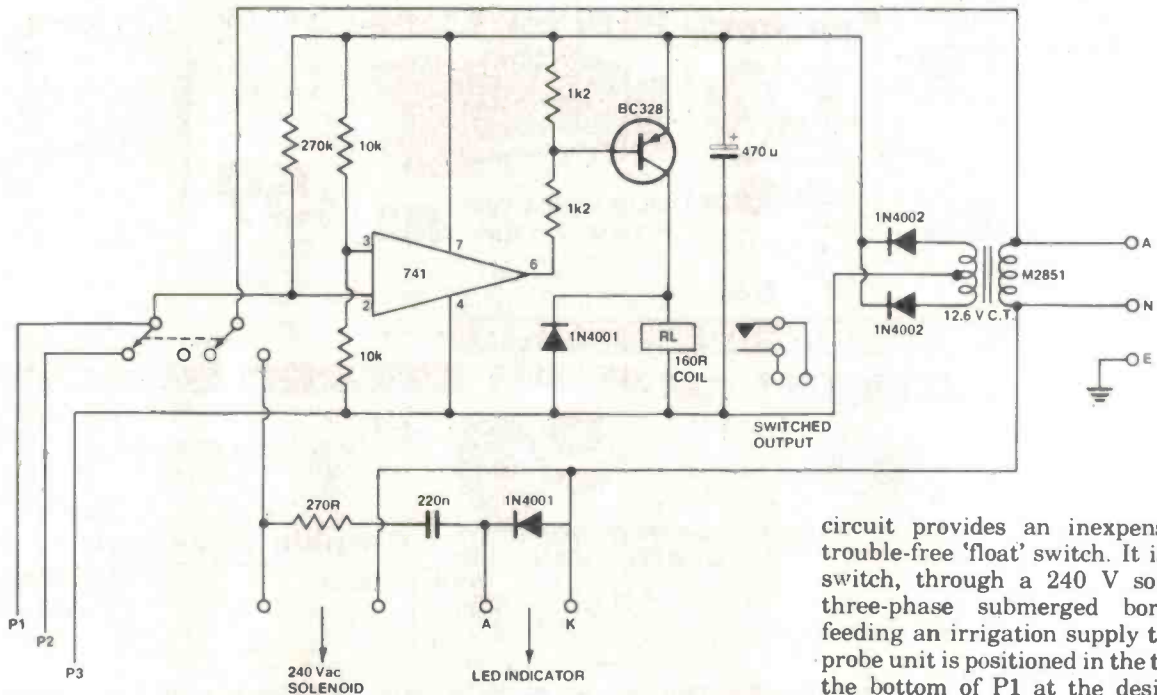
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Ideas for Experimenters

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



Water level sensor and switch

Here's a novel idea with a practical application, from F.L. Harrison of Ardross in West Australia.

It is a water level sensor that controls a pump which maintains the water level

in a tank. Three 'sensor' wires are employed: one at the 'high' water level (P1), one at the 'low' water level (P2), and one well below the latter (P3) so that it's permanently in the water. Here's what it's all about.

Using an inexpensive 741 IC and a relay with two sets of contacts, the

circuit provides an inexpensive and trouble-free 'float' switch. It is used to switch, through a 240 V solenoid, a three-phase submerged bore pump feeding an irrigation supply tank. The probe unit is positioned in the tank with the bottom of P1 at the desired 'full' level.

The bore pump does not start until the water level falls below P2 and is not switched off again until the water level reaches P1. This ensures that the supply tank always remains full. The LED, which is remotely mounted, gives a visual indication of when the pump is running.

ETI-606 tuning fork mods

With a few slight modifications to the ETI-606 Tuning Fork (Nov. 1979) it is possible to use the very cheap and plentiful TV colour crystal tuned to 4.43361875 MHz, according to M.L. Duncan of Greenford, UK.

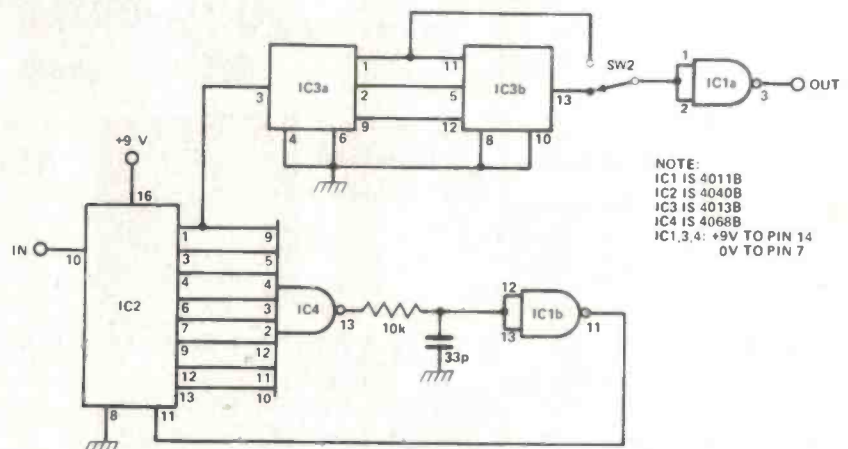
The oscillator circuit output is divided by 2519, giving a frequency of 1760 accurate to one part in 250 000. The division is done by a 4040 in place of the 4020 and the switching giving an alternate 'A' at 445 Hz is eliminated.

A 4013 dual flip-flop is added before the output buffer to give further division by two and four. These outputs are switched before the buffer to give a choice of 'A's at 880 and 440 Hz re-

spectively. The extra cpst of the 4013 is offset by eliminating one of the 4011s.

The diagram shows the altered parts

of the circuit. The oscillator is retained, using the changed crystal, as is the output circuit from R4 onwards.



HELLS APOPPIN' AT SHERIDAN'S



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THE WAR IS ON — JUST LOOK AT THESE PRICES!!

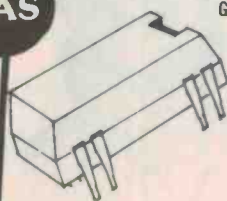
SAVE—SAVE

SEMICONDUCTORS AT WHOLESALE PRICES... JUST COMPARE

BC 547	NPN 45v 100mA 500mW	10+	9c	100+	7c
BC 557	PNP 45v 100mA 500mW		9c		7c
TIP29B	NPN Power 80v 1A 30W		35c		30c
2N3656	NPN 25v 50mA 200mW		10c		8c
5mm	Red LED's		8c		8c
BZX83C12V	12V 250mW Zener Diode		10c		7c
BZX96C4V7	4.7V 1.5W		30c		25c
ITTRO7B	7.1V 1.1W		25c		20c
NEC ZD	5.6V 200mW		10c		8c
ZX12	12V 15W Zener Diode		.95c		.80c
CD4001AE	CMOS I.C.		15c		12c
2114	450NS Static RAM		2.00		1.80
2114	200NS		2.50		2.30
4116	200NS Dynamic		2.00		1.80
2708	450NS Eprom		4.00		3.70
2716	450NS		4.80		4.30
2532	450NS		10.00		9.00

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ELECTROTHERMAL MINI-DIP DUAL-IN-LINE REED RELAYS TYPE GR108A2



Specs:
SPST 12vdc
Coil Resistance, 1100 ohms
Nom. Current, 11mA
Pull-in Voltage, 8Vdc
Contact rating, 500mA

ONLY \$1 each
10+, 90c
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CRAZY CRAZY CRAZY

CLEARANCE OF TOP GRADE & QUALITY MINI POT'S

Allen-Bradley 1Kohm Single Turn in a T05
Transistor Case **Five for \$2.00 or 10x 35c each**



BOURNES 50Kohms Single Turn Cermet Trimpots
Type 3386 .5W rating 1/4" sq.
Five for \$2.00 or 10+ 35c each.



CLEARANCE SPECIAL
DIPOT PCB or Solder Spill PUSH-BUTTON SWITCHES. Complete with RED KNOBS
AT A MAD PRICE OF ONLY 40c each
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WHERE ELSE BUT AT SHERIDAN'S

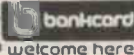
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Cap. Mfd.	Volts	Dia mm	Height mm	Price	P & P
4,700	100	35	85	\$8.50	1.00
10,000	25	50	110	\$8.00	1.25
9,100	50	50	110	\$8.50	1.25



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SOAR I.C.D. FULLY AUTORANGING D.V.M.'s.
Three types to choose from

	ME533	ME532	ME531	
DCV	1000	1000	1000	Max
ACV	600	600	600	Max
DCA	200mA	200mA	10A	Max
ACA	200mA	200mA	10A	Max
Res:	2Mohms	2Mohms	2Mohms	Max
In-built	Cont	Cont.	Buzzer	Diode
In-built	Buzzer	Buzzer	Diode	Test

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Size 28 x 12mm
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.027	160	13c	11c
.039	160	13c	11c
.039	400	16c	13c
.18	400	18c	15c
.33	160	18c	13c
.68	160	18c	13c
.82	160	18c	15c
RADIAL TYPES			
.01	630	Blue Cap	25c
.39	100	Red Cap	20c
.1	400	AEE Miniprint	30c
.01	500	Disc Ceramic	15c
4700pf	3kV	Disc Ceramic	25c
150µf	6V	Union Carbide	\$2
		Solid Tantalum	\$1.80
453pf	400V	1% Silver Mica (ITT)	18c

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PART NO.	DESCRIPTION	PRICE EACH
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B	5 PIN DIN PLUG TO PHONO SOCKET	.45
C	2x3.5 PLUGS TO PHONO SOCKET	.45
D	3.5MM PLUG TO 2 ALLIGATOR CLIPS	.70
E	5 PIN DIN PLUG TO 2 ALLIGATOR CLIPS	.80
F	5 PIN DIN PLUG TO 4x6.5MM PLUGS	.75
G	5 PIN DIN PLUG TO RCA SOCKET	.40
H	3.5MM PLUG TO 2x6.5MM SOCKETS	.50
I	6.5 PLUG TO 2x6.5MM SOCKETS	.25
J	3.5MM PLUG TO BARE ENDS	.50
K	3.5MM PLUG TO 3.5MM PLUG	\$1.00
L	5 PIN DIN PLUG TO 3.5MM PLUG	\$1.00
M	STEREO HEADPHONE COILED EXT. LEAD	.40
N	5 PIN DIN PLUG TO 4x RCA PLUGS	.40
O	5 PIN DIN PLUG TO 3.5MM PLUG	.20
P	3.5MM PLUG TO 2.5MM PLUG	.20
Q	ADAPTOR — 3.5MM PLUG TO 2.5MM PLUG	.20
R	ADAPTOR — 3.5MM SKT. TO RCA SKT.	.20

PLEASE ADD SUFFICIENT FOR POST & PKG.

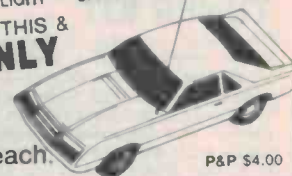
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your friends will
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PLAYMASTER STEREO MOSFET AMPLIFIER

This 'Top of the Line' amplifier with huge 50W per channel output, has everything you'll ever need in an amplifier. Features include: LED indicated input, Loudness control, Muting control, Full speaker switching facility, Stereo/Mono switching, Tape monitor switch. And with its professionally designed front panel, this amplifier looks as good as it sounds! Complete with comprehensive instructions.



Cat. K-3515

\$132

PLAYMASTER AM/FM TUNER KIT

This tuner combines a digital readout AM/FM stereo receiver with a quartz controlled digital clock. The kit comes with a fully built, tested and aligned tuner module. With the tuner off, the unit becomes a digital clock with an easy to read LED display. This same display indicates the received frequency in either AM or FM mode when the tuner is in use. Also included are Signal and Tuning



Why build from a kit?

For the best reason: you'll save a fortune! You supply the labour, instead of paying for a production line (and the Managing Director's Ferrari). You can save 50% and more by building it yourself.

Can I do it?

Let's answer that one by asking you a question: can you read and follow simple instructions? If the answer is yes, then you can build our kits: most come with our exclusive step-by-step instructions. You can't go wrong!

Dick Smith's money-back offer.

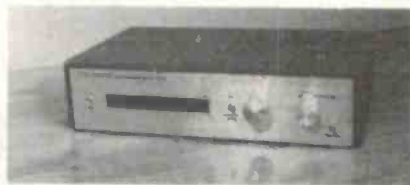
We're confident you'll be delighted with our kits. But if you're not (for any reason at all — even the fact that you might think construction is beyond you) you can return any kit to us in original condition and packaging (that is, before construction has commenced) and we'll refund your purchase price in full. What could be fairer than that?

Exclusive 'Sorry Dick It Doesn't Work' Guarantee.

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DON'T PAY \$350 BUILD IT YOURSELF

meters to help you pull-in those weak stations. FM stereo is indicated by an LED. The completed unit is designed to complement the Equaliser,

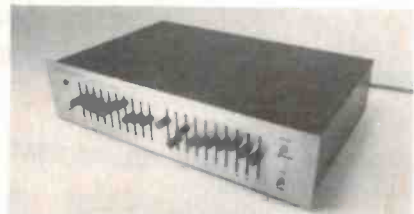


Cat. K-3494

\$145

PLAYMASTER STEREO GRAPHIC EQUALIZER

This unit gives you the tonal flexibility and control of a professional equalizer in a kit. With cut and boost of up to 13dB per section, you can use it to make up for audio deficiencies in your listening area, or even create special effects. Look at these specifications: Frequency Response: EQ OUT: flat, EQ IN, 10Hz to 10kHz; Distortion (wrt 1Vrms): @ 100Hz: 93dB, @ 1kHz: 74dB, @ 10kHz: 55dB. This equalizer is designed to complement the Playmaster Mk II Amplifier and the Playmaster Tuner with the same brushed aluminium front panel.



Cat. K-3500

\$99⁵⁰

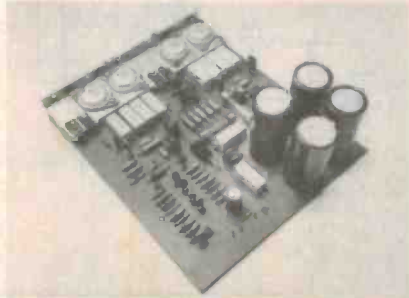
300 WATT AMPLIFIER MODULE

This kit has the scope for boosting the output of your existing sound system. One module produces 300W RMS into 4 ohms or two modules give you 600W RMS continuous power. These kits are easily suited for mounting in the standard rack mounting case either singly, or in pairs. You will require a transformer (Cat. M-0150) and one or two heatsinks, depending on light or heavy use (Cat. H-3426). Complete with all other components and instructions.

MORE QUALITY DICK SMITH KITS



Everything you
need is supplied
even nuts &
bolts



Cat. K-3444

\$72

100 WATT AMPLIFIER MODULE

The ultimate in simplicity, even the power transistors mount on the one printed circuit board. PCB heatsink bracket is supplied with the silkscreen overlay on our fibreglass heavy duty PCB. This design is based on the ETI 422 power amplifier but without the power transistor wiring hassles. Features on-board fuse protection and input sensitivity. To be used with power supply (Cat. K-3438).



Cat. K-3442

\$25

50 WATT AMPLIFIER MODULE

Same design, same simplicity as the 100W Amplifier Module with the added economy of two units able to be run from one power supply (Cat. K-3438). The compact design makes this module an obvious choice for a medium power, general purpose amplifier. Supplied with instruction booklet and fibreglass PCB with silkscreened component overlay for easy assembly. Heatsink bracket is supplied, heatsink is extra.



Cat. K-3440

\$19⁹⁵

POWER SUPPLY

Full PCB and component kit for one (K-3442) or two (K-3440) modules. Supplied complete with speaker de-thump relay and Zener regulated pre-amp rails. Assembly instructions supplied.

NOTE: Transformer extra.



Cat. K-3438

\$19⁹⁵

MIXER PREAMP

This is the ideal mixer, adaptable for your requirements. Designed to suit the 300W amplifier kit, this mixer preamp provides 4 inputs, the input amplifiers having an input of 100K which is suitable for most microphones, guitars, etc. It is also suitable for use with the 50W (K-3440) and 100W (K-3442) power amp modules. This unit also provides bass, treble and presence controls plus a master volume control. Comes complete with all components and instructions.

NOTE: Power transformer, case and mains wiring are not supplied so that the unit can be mounted to suit individual applications.

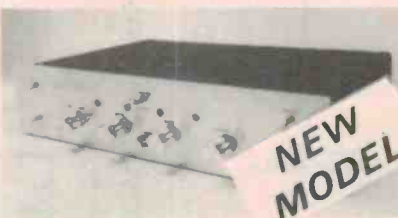


Cat. K-3035

\$29⁵⁰

MUSICOLOR IV

A new design that combines all the features of Musicolor III and Light Chaser plus much more. Chaser plus 4 chase patterns plus automatic and reverse modes for startling effects. 4 channel Musicolor adds a new dimension to sound — light! Built-in microphone allows any sound to trigger the Musicolor. Comes with sturdy chassis, and exclusive Dick Smith front panel with LED display. Detailed step by step instructions are supplied.



Cat. K-3143

\$91⁵⁰

LIGHT CHASER

This chaser design not only makes the lights chase each other, it can also invert the action and make the 'shadows' chase each other. Or it can reverse the direction. Or invert and reverse automatically, and you can vary the flash rate to suit the particular application.



Cat. K-3145

\$71⁵⁰

DISCO-STROBE

This includes a special printed circuit board, with provision for a second tube if required. Also includes a 180mm photographic type reflector, which is specially modified so that the perspex safety guard which is supplied, can easily be fitted. Special new instructions are also supplied. A timing control allows flash rate to be varied between one and twenty flashes per second.

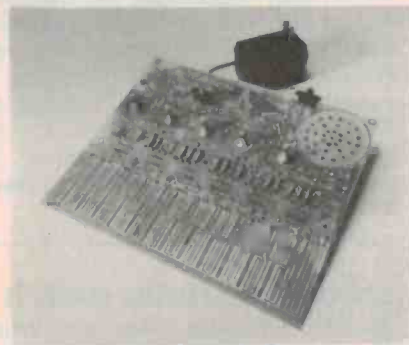


Cat. K-3152

\$26⁵⁰

ELECTROCHUNE

The Electrochune is a keyless monophonic organ and uses the circuitry of a synthesizer to give variable attack/decay times, tremolo and square/sine wave output mixing. It even has a built-in amplifier and speaker with separate volume control. Complete with plugpack and full instructions.



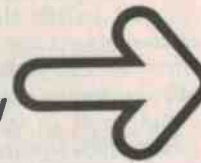
Cat. K-3506

\$69⁹⁰

TV MASTHEAD AMPLIFIER

Improve your TV reception with this easy-to-build kit. Cut out 'snow effect' in low signal areas and reduce 'ghosting' caused by multiple signals or signal pickup from feeder cabling. Also works well in picking up distant stations. This kit is powered by the 12V power

**MORE
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Ideas for Experimenters

Simple timer

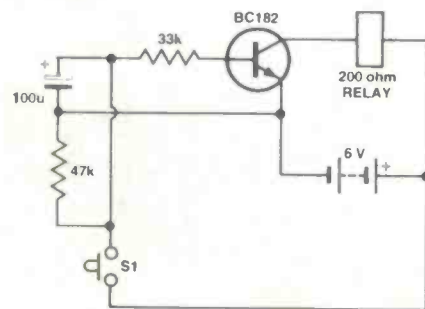
This simple little timer features a minimum of components, most of which can be found in any well-stocked hobbyist's junkbox, and you can fudge a variety of delays by trial and error substitution of components. The idea comes from **David Hughes of Howrah, Tasmania**.

It works as follows. When you press S1 (an ordinary pushbutton) the 100u electrolytic capacitor rapidly charges up. When it gets to about 0.7 V the transistor will be forward biased and collector current will flow, in turn operating the relay. When you release S1, the capacitor will begin to discharge

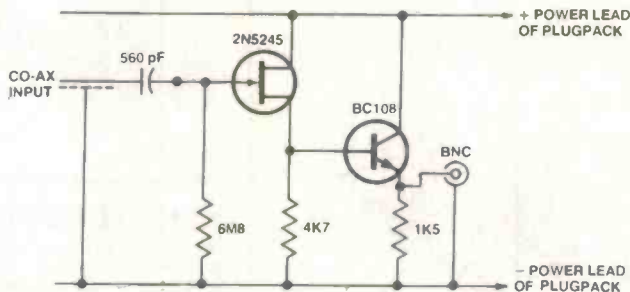
via the 33k resistor and the base of the transistor. When the voltage across the capacitor gets down to half a volt or so the transistor base will no longer be forward biased, collector current will cease and the relay will drop out. The capacitor will continue to discharge via the 47k resistor.

With the values shown, the relay will remain operated for about eight seconds or so. It is advisable to use either a tantalum or a low leakage (RBL) electrolytic capacitor.

You can fudge things a little to obtain increased times by simply increasing the value of the electrolytic capacitor. Decreasing the value will shorten the period.



You can get quite long times with lower values of capacitance by substituting a Darlington pair for the BC182. In this case you can increase the two resistor values into the megohm range.



Video buffer for the ZX80

When **J.L. Elkhorne of Chigwell, Tasmania**, became the proud possessor of a brand new ZX80, he didn't want to disturb the family's TV viewing by commandeering the TV set as the ZX80's VDU. Having a 230 mm (9") monochrome monitor on hand, the circuit here was developed to press it into service.

Nothing critical exists in the circuit; all values were determined empirically. Transistor type substitutions could probably be made without problems. The bias for the BC108 is provided by the dc coupling to the source of the 2N5245. In the prototype, the drop across the 4k7 resistor was about two volts.

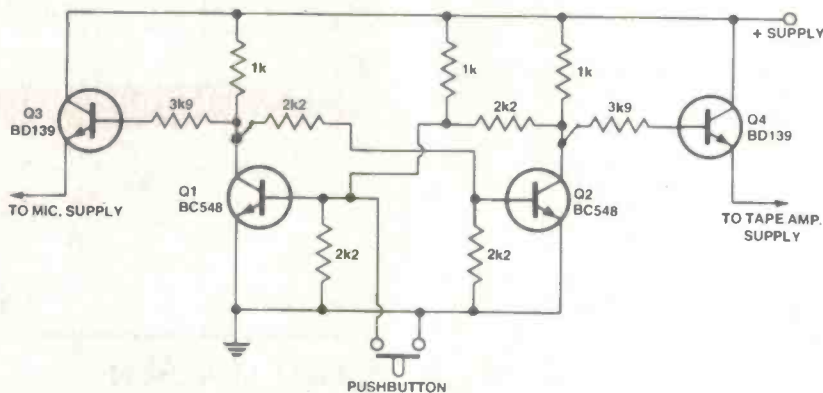
The circuit was built on a tiny piece of Veroboard and put in a small plastic box on hand. The plugpack used with the ZX80 supplied the power. In keeping with a personal policy of minimal changes to commercial hardware, the only internal change to the ZX80 itself was tacking the 560 pF capacitor on the video lead into the on-board modulator. The free end was protected with sleeving and protrudes out the back slot by the card edge connector.

The centre conductor of a length of miniature coax clips onto the capacitor. The flex of the plugpack was cut and the buffer board used to reconnect it, thus deriving power for nothing. A BNC connector mounted on the plastic box completed this small project.

Solid state audio switch

The purpose of this circuit is to switch off a music source (from a tape amp in this case) and turn on a microphone. **G.B. Wolfe of Bombala, NSW**, wanted to do it electronically, without messy, intervening cables, and this is how he did it.

The pushbutton on the microphone stand is pressed into service to operate the solid-state switch. When operated (i.e. when you want to switch the music off and switch the mic in), the pushbutton shorts the base of Q1 to 0 V. Q1 turns off and Q2 turns on. This turns Q4 off, and as it is in series with the positive supply rail to the music source (tape amp), then the music source turns off. At the same time, Q3 turns on and



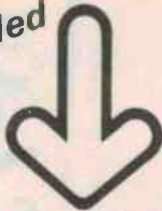
provides positive supply to the mic preamp.

When the pushbutton is open, Q1 is biased on and Q2/Q3 biased off. Thus only Q4 will be biased on and the music

source will be operating.

This way, there is no need to alter the signal circuits and the only change required is to the supply rails; control is by a single-pair lead.

Kit includes detailed instructions



supply, which is included. Also ideal as an FM radio booster too. Instructions included.

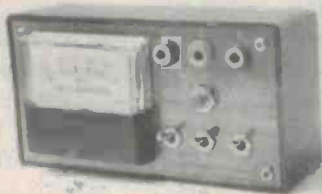


Cat. K-3232

\$33⁵⁰

TRANSISTOR TESTER

Not just another Transistor Tester! This one tests bipolar transistors, F.E.T.s, diodes and even S.C.R.s and P.U.T.s. This practical, low cost test instrument is simple enough to be built by a beginner and then provide him with a valuable piece of test equipment. Ideal for the beginner and serviceman alike. Battery operated and supplied with one of our large 50mm meters in a 'Zippy' box with a deluxe front panel.



Cat. K-3052

\$19⁷⁵

TV CRO ADAPTOR

This TV CRO Adaptor is an economical alternative to a conventional CRO. It converts any standard TV set into a large screen oscilloscope with a frequency response from 10Hz to 300kHz with a sensitivity of 100mV RMS for full screen deflection. Gives a good display at low frequencies which makes it ideal for all audio and Hi-Fi applications. This adaptor could also be used as a dramatic display for large audiences such as universities, schools, etc., or even a monitor for stereo systems.



Cat. K-3060

\$23⁹⁵

DUAL TRACE CRO SWITCH

Convert your single trace oscilloscope to a dual trace with this money saver. Dual trace CROs have uses in almost every application. In fact, whenever

you need to compare two waveforms, the dual trace CRO is the best answer. Bandwidth is DC to 1MHz, AC 10Hz to 1MHz and Input Impedance is 100k shunted with 30pF.

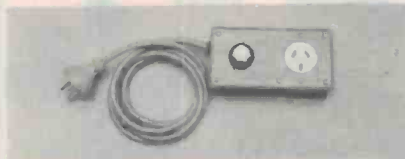


Cat. K-3065

\$59⁵⁰

DRILL SPEED CONTROL

This unit enables your drill to be slowed down to drill large holes in metal or even to be used as a screwdriver. Circuitry gives good torque at very low speeds. Suitable for most 240V 'universal' brush-type motors, up to 3A rating. The kit is supplied complete, down to the last nut and bolt, and that includes the mains cord/plug and output socket. Assembly instructions provided.



Cat. K-3080

\$13⁹⁵

METAL DETECTOR

An induction balance detector which is the equivalent of detectors that cost hundreds of dollars. All electronic components, meter, box, coil wire etc. is supplied, all you supply is some dowel for the shaft and a former for the coil and you're ready to find your fortune!

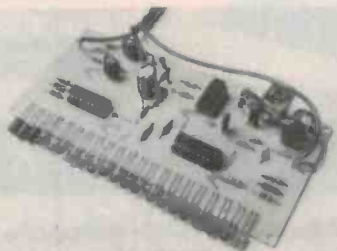


Cat. K-3100

\$36⁵⁰

LED TACHOMETER KIT

This kit enables you to get the best from your car's engine. Displays engine speed in analogue form in an illuminated row of LEDs. This form of display indicates your engines performance at a glance. Used with 12V positive or negative earthed systems and only 3 connections are required for installation. Complete instructions supplied.

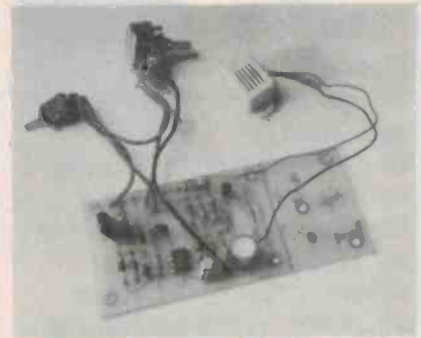


Cat. K-3240

\$24⁵⁰

SPEED SENTRY

Speed Sentry is an aid to better driving. An alarm will sound (or switch a warning light) when a preset speed is reached. Trigger speed is set by the driver, or at the flick of a switch, a pre-set speed may be monitored.



Cat. K-3245

\$12⁷⁵

CAR ALARM

This alarm works on the principle of detecting voltage drop anywhere in the vehicle's electrical system caused, for example, by the interior light coming on when a door is opened, the brake pedal pressing to energise the stop lights, starting the engine, turning the headlights on, etc. It is very easy to install as it simply connects to a point which is normally 'live' at all times e.g. clock or starter solenoid. Facility is also provided for the alarm to be triggered if an external triggering point is earthed, such as the bonnet or boot opening, detection by way of a mercury tilt switch. This alarm includes an LED which flashes once per second when the alarm is set.



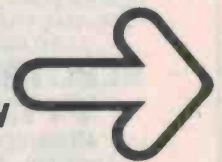
Cat. K-3253

\$28⁵⁰

CAPACITOR DISCHARGE IGNITION KIT

All cars with conventional 'Kettering' ignition systems can be fitted with this simple, easy-to-build kit. The kind of results you can expect from using this kit are: Plugs and points last up to 10 times longer, engine stays in tune much longer, vehicle is much easier to start, even on cold, wet mornings. It also simply disconnects back to your standard ignition.

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KITS**





PRICE REDUCTIONS

Because of economies of production and favourable exchange rates, Electromark has been able to reduce prices by 15% to 30% over the whole range of amplifier modules. Write enclosing 45¢ postage for data sheets and new price list.



BIPOLAR		Standard with Heatsinks Without Heatsinks (P)		
MODEL NUMBER	OUTPUT POWER WATTS RMS	DISTORTION		SUPPLY VOLTAGE TYP/MAX
		TNB TYP at 1kHz	IMD 60Hz/7kHz 4:1	
HY30	15w/4.8Ω	0.015%	<0.006%	± 18 ± 20
HY60	30w/4.8Ω	0.015%	<0.006%	± 25 ± 30
HY120	60w/4.8Ω	0.01%	<0.006%	± 35 ± 40
HY120P				± 45
HY200	120w/4.8Ω	0.01%	<0.006%	± 50
HY200P				± 45
HY400	240w/4. Ω	0.01%	<0.006%	± 45
HY400P				± 50
HEAVY DUTY				
HD120	60w/4.8Ω	0.01%	0.006%	± 35 ± 40
HD120P				± 45
HD200	120w/4.8Ω	0.01%	0.006%	± 50
HD200P				± 45
HD400	240w/4. Ω	0.01%	0.006%	± 45 ± 50
HD400P				
MOSFET				
MOS120	60w/4.8Ω	0.005%	0.006%	± 45 ± 50
MOS120P				± 55
MOS200	120w/4.8Ω	0.005%	0.006%	± 50 ± 55
MOS200P				± 55
MOS400	240w/4. Ω	0.005%	0.006%	± 55 ± 60
MOS400P				

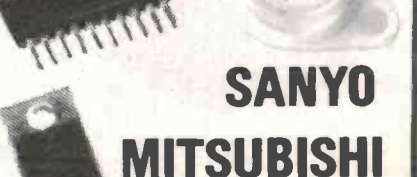
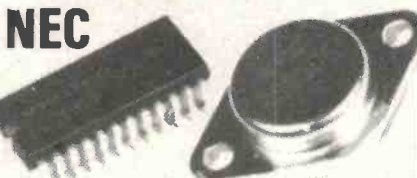
FP480. BRIDGING UNIT FOR DOUBLING POWER

Designed specially by I.L.P. for use with any two power amplifiers of the same type to double the power output obtained and will function with any I.L.P. power supply in totally sealed case, size 45 X 50 X 20 mm with edge connector. It thus becomes possible to obtain 480 watts rms (single channel) into 8 ohm. Contributory distortion less than 0.005%.

POWER SUPPLY UNITS AND TOROIDAL TRANSFORMERS ALSO AVAILABLE

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Mortdale, NSW 2223

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PTY. LTD.
167 Roden St., West Melbourne,
Victoria 3003
Phone: (03) 329 5433 Telex AA37753

A MERRY CHRISTMAS



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Electrocraft wish their many customers — and readers — a "Happy Christmas" and a peaceful "New Year". We provide an aerial supply service second to none, with the largest range of antenna accessories in Australia. Our range of aerials, amplifiers and fittings is both comprehensive and unique. Aerials from \$14.00 to \$198.00.

When recording video or sound tapes (FM-AM or TV), the performance is largely dependant on the level and quality of the signal being fed into the tuner or video cassette. You could be plagued with the same bugs, (ghosting-snow-poor sound) that you encounter with TV reception. Regardless of how much you spend on your video cassette or FM and AM tuner, your equipment will only perform as well as your aerial system will allow. However, a good antenna installation will rectify these problems and let the tuner or video cassette prove how good they can be.

We at Electrocraft are specialist with 30 years in the antenna business.

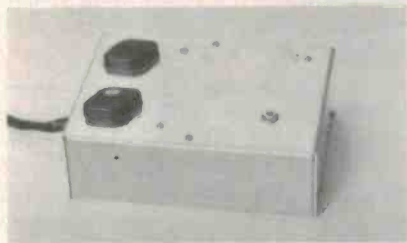
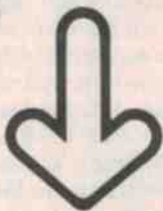
FREE VERBAL advice given.

Phone: (02) 438 4308
(02) 438 3266

Hours
8 am to 5 pm Monday — Friday.

ELECTROCRAFT
68 WHITING ST. ARTARMON 2064

Only top quality
components
used



Cat. K-3280

\$33⁵⁰

CORE BALANCE RELAY

This kit could save your life and protect your equipment. The Core Balance Relay electronically detects earth fault currents and then trips a relay which cuts the power. The relay cannot be reset until the fault has been corrected. Designed to run to 240V, this unit is portable and built into a tough moulded plastic case. Comes complete with special front label.



Cat. K-3315

\$52

NEGATIVE ION GENERATOR

You've heard about Negative Ion Generators and their benefits, now you can buy the kit and build one yourself. This kit runs on 12V which means that it may be used in your car, as well as making it safer to use. Also includes exclusive Dick Smith emitter head, power pack and tough moulded plastic case. Full instructions supplied.



Cat. K-3335

\$38⁵⁰

LED LEVEL METER

This unit will display the sum of the peak channel output voltages (power), or use two for separate stereo readouts. Readout power level is displayed by 10 green light emitting diodes, one yellow indicating maximum power and red for overload. Full solid-state circuitry, all components mount on a small printed circuit board with the display conveniently attached at right angles for easy mounting

of the finished unit. Simple power supply requirement of 10V-16V or DC at 50mA.

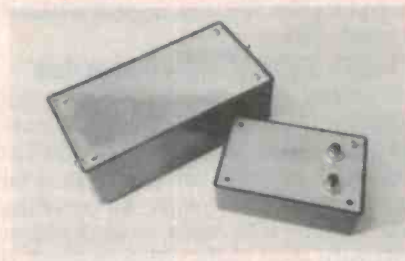


Cat. K-3370

\$14⁹⁵

INFRARED LIGHT BEAM RELAY

This light beam trigger uses an invisible beam of light which makes it ideal for burglar alarms, photographic triggering, etc. Depending on conditions, this unit has a range of up to 5m and there are no lenses to adjust. Battery power gives the unit around 50 hours of continuous operation.

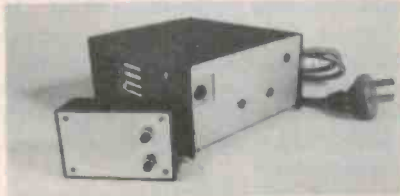


Cat. K-3375

\$38⁵⁰

2 CHANNEL INFRARED REMOTE CONTROL

An inexpensive 2 channel remote control with a range of 20m and will control 2 appliances independently. Use it to control your alarms, stereo, radio, in fact just about anything you can think of. The transmitter is battery powered and enclosed in a small 'zippy' box whilst the receiver is mains powered and housed in a handsome metal instrument case (undrilled).

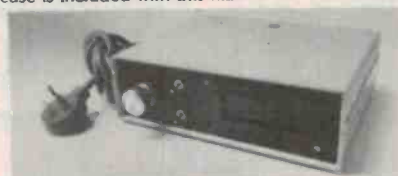


Cat. K-3380

\$65⁹⁵

DIGITAL CLOCK/THERMOMETER

This kit gives you all the features of a digital alarm clock as well as a digital thermometer. The thermometer will display in either Fahrenheit or Celsius and the clock will even turn your radio on for you. Fitted with an alarm (speaker included) and snooze button, the clock is mains powered with battery back-up. No case is included with this kit.



Cat. K-3436

\$49⁵⁰

LEDS AND LADDERS

Based on the old 'Snakes and Ladders' game, we've replaced snakes with LEDs! This kit has been updated with new circuitry and simplified controls so the whole family can enjoy playing. Complete kit includes front panel sticker and 'zippy' box.

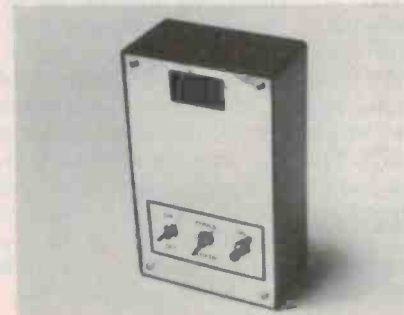


Cat. K-3390

\$16⁵⁰

LOTTO/POOLS SELECTOR

This miniature electronic marvel could help you to your first million! Push button, with large LED display makes it easy. Supplied with an attractive front label. Good luck!



Cat. K-3392

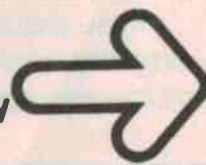
\$19⁹⁵

DIGITAL FREQUENCY/PERIOD COUNTER

(500MHz with optional prescaler) Not only a frequency meter, but also a period counter for accurate high resolution, low frequency measurements. Based on a design by Electronics Australia DEC 81, this professional class instrument rivals the features of fully built up units many times the price.



**MORE
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Shoparound

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

ETI-824/825 slot car controllers

As these units use common components in general, you should experience little difficulty in obtaining parts. The 723 regulator used in the ETI-824 is a stock item almost everywhere. The same goes for the semiconductors in the ETI-825. We have not produced panel artwork for either project as we expect most constructors will house the projects to suit their own requirements, thus Scotchcal panels will not be available.

We used different cases on the two ETI-825 prototypes. That shown on the front cover employs an Amtex case, type Amtex 20. These are distributed by Amtex, P.O. Box 285 Chatswood 2067, (02)411-1323. According to Amtex, Radio Despatch Service and David Reid Electronics in Sydney have stocked this case, so check them if you can't find it locally. The other case we used is a Vero case having a sloping front panel and measuring 220 mm wide by 155 mm deep by 100 mm high. It comes in two parts — one light grey, the other dark grey. These are available from Warburton Franki outlets.

Slot cars? See your local toy store, department store, newsagent or hobby shop! You can even find them at the local markets (we bought several \$15 sets from a stall at Paddy's Market in Sydney).

So far as we are aware, All Electronic Components and Rod Irving Electronics in Melbourne will be stocking kits.

ETI-159 10-15 V meter

This project also uses commonly-available components and constructors should have little difficulty obtaining parts. The pc board has been designed so that it can be secured to the connecting terminals on the rear of any of the common panel meters so you can use a meter of your choice.

Multiturn trim pots are reasonably common, so you should be able to locate the right ones for this project without too much difficulty.

ETI-685 2650 S100 computer

This project is stocked as a complete kit by Applied Technology (\$209). They are also able to supply the pc board, 82S123 ROM and a manual for \$80. This is for those constructors with an existing 2650 system who wish to go S100 or those with most of the chips on hand. If you want to make your own pc board (which we don't recommend) patterns are available from us as detailed in the article — but you'll have to work out your own ROM software. Multibug and Binbug monitor ROMs are also available through Applied Technology.

ETI-158 Low Ohms Meter

Constructors looking for kit suppliers of this project, published last month, should try the following firms: In Melbourne, All Electronic Components and Rod Irving Electronics. In Sydney, Electronic Agencies. Note that Radio Despatch Service is able to supply all the parts, including the Scotchcal panel and meter scale.

ETI-660 Learners' Micro

This already popular project is stocked in kit form by the following firms (so far as we can determine at time of going to press): In Sydney, Electronic Agencies and J.R. Components (mail order — P.O. Box 128 Eastwood NSW 2122); All Electronic Components and Rod Irving Electronics in Melbourne plus Kit Parts (Aust) mail order (Private Bag, Noosa Heads Qld 4567).

LM394s

This dual-transistor IC has been specified for the ETI-329 Vehicle Ammeter (Feb.), ETI-330 Car Alarm (July) and ETI-478MC preamp (Sept.) from our Series 5000 Stereo Control Preamp. Earlier in the year, supplies were plentiful. Wouldn't you know it — LM394s are now scarcer than the proverbial hen's teeth. National Semiconductor in the US advise they currently have a manufacturing problem and are quoting lead times in excess of three months. Sorry folks, but this is a problem over which we have no control, nor could we reasonably force it. We are investigating possible alternatives and will keep you posted.

If you're in desperate straits, try Dick Smith's store at Coburg in Melbourne or Altronics in Perth. Then again, you could try LM194s — the mil-spec. version... at around ten times the price, and you may have to buy a minimum quantity. Ask a National Semiconductors distributor.

LM396 regulators

These aren't your 'bog standard' regulator... yet, but the following shops should be able to sell you the odd one:

Radio Despatch Service
869 George St
Sydney NSW 2000

Radio Parts
1103 Dandenong Rd
East Malvern Vic. 3145

Tasman Electronics
12 Victoria St
Coburg Vic. 3058

FAIRLIGHT IS EXPANDING exciting career opportunities available

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Our kits look so good your friends won't believe you built them.



Cat. K-3439

\$99⁵⁰

Case extra. **\$19⁹⁵** Cat. H-2505

UNIVERSAL TIMER/ STOPWATCH

All-purpose counter that can be used as a stopwatch, countdown timer or event timer. Large, bright 4 digit LED display and selectable timing rates between 0.01 and 1.0 secs make this timer ideal for sporting events or even darkrooms, wherever keeping accurate time is important. Wiring the unit for any of seven different functions is also possible.



Cat. K-3435

\$39⁵⁰

STEREO BOOSTER AMP

An easy-to-build kit which can economically upgrade the power of your car's stereo radio or cassette to 12.5W RMS per channel. Fitted with a bypass switch for comparison purposes and works with all negative earth electrical systems.



Cat. K-3493

\$29⁵⁰

13.8V 6 AMP PEAK POWER SUPPLY

5 Amps continuous and 6 Amps peak (depending on heatsinks used). This kit includes the M-2000 heavy duty transformer, circuit board and electronic components. This kit does not include case or heatsinks.

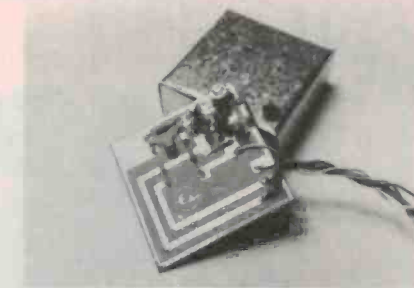
Not Illustrated

Cat. K-3449

\$35⁵⁰

VIDEO MODULATOR KIT

This RF Modulator Kit uses only one transistor. The unit is enclosed in a small tinplate box to minimise radiation and all components are mounted on a small printed circuit board. A simple and very useful kit.



Cat. K-3462

\$4⁷⁵

LOW DISTORTION AUDIO OSCILLATOR

This Audio Oscillator uses the characteristic low noise of a VMOS device to give an ultra-low distortion output. All the components mount on a single printed circuit board and construction is very straightforward. This kit comes in a sturdy chassis with black perspex front panel, silkscreened with white lettering. LED power indicator also acts as a dial marker.



Cat. K-3467

\$6⁷

SHORT WAVE ANTENNA KIT

Get the best possible reception from your shortwave receiver with this kit. Specially designed for Dick Smith by an expert in short wave receivers. This kit comes complete and ready to build and needs no soldering.

Not Illustrated

Cat. K-3490

\$9⁹⁵

SOUND LEVEL METER

This unit will measure noise in its many forms. Measures levels of less than 20dB to levels greater than 120dB with fast or slow response times. This allows you to measure peak or average levels. A large VU meter gives easy readings and the meter range is selectable in 9 steps. The kit is mounted in a 'zippy' box and is battery powered.



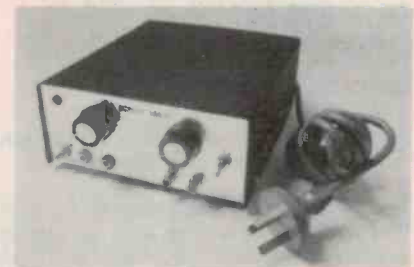
Cat. K-3476

\$35⁵⁰

BENCHMARK

A handy piece of equipment for the test bench. The Benchmark is a regulated power supply, variable between 1.25V and 16V at currents of up to 1A. It also doubles as a audio amplifier capable of deliver-

ing a little over 1W rms. The kit comes complete with a sturdy metal instrument case (undrilled), transformer and all the parts and instructions you need, plus a self-adhesive front label for that professional finishing touch.



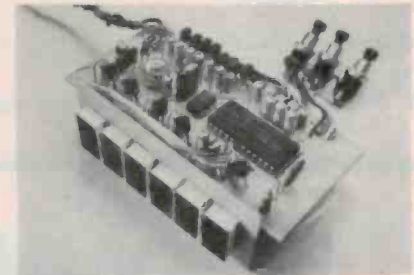
Cat. K-3478

\$46

6 DIGIT 12V CLOCK

This extremely easy-to-build clock kit ideal for cars, boats, aircraft, etc. Bright red LED digital readout, large 8mm high, and chronometer accuracy, quartz crystal controlled, this is the only clock kit with seconds display. This kit operates from any 9-19V DC source; use a simple power supply or plug pack for 240V DC operation. Highly detailed instructions included.

Power supply to suit (Cat. M-9514)



Cat. K-3495

\$19⁷⁵

AUTOCHIME

Autochime is an electronic door chime kit based on the latest microprocessor technology. An exclusive design, this unit plays one of 24 different tunes every time you press the front door button. Perhaps you like one tune in particular, this is also possible. This kit contains all parts necessary to build the project.

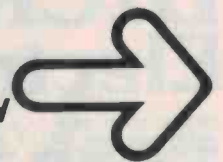
NOTE: Front panel is supplied undrilled.



Cat. K-3502

\$31

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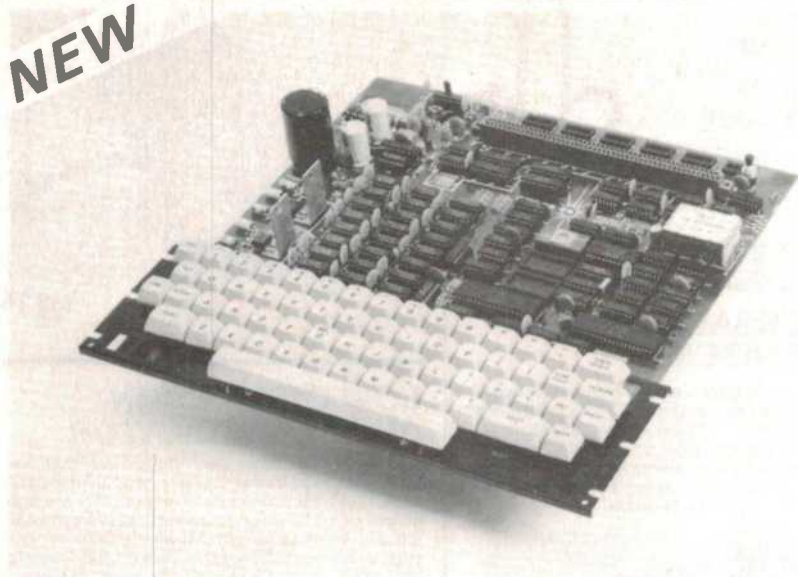
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 BASIC in Eprom K-3604 \$99.50

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Written by the world-renowned author, George Grammer, this book is recommended reading for anyone studying for their amateur licence, be it Novice, Limited or Full. In fact, it's a very good reference text for any enthusiastic hobbyist. The book contains 26 chapters, covering a considerable amount of basic theory from electric and magnetic fields to ac and dc circuits, resistance, reactance, transformers, RF circuits, filters, etc, to vacuum tubes and transistors, amplification, feedback and amplifier circuits. A chapter on practical experiments is included and each chapter has associated problems to work out (answers given).

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This is a modified equidistant azimuthal projection map showing all areas of the world with political boundaries, call areas, IARU continental subdivisions, ITU regional boundaries, world time zones and cities. A valuable addition to any shack.

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An invaluable book for the beginner or newcomer to digital circuitry. In nine chapters Jerry Hall and Charles Watts take you through the basics of commonly used linear and digital ICs, binary arithmetic and counting, frequency counters and digital voltmeters — and show you how to build a frequency counter/DVM as you go along! Written in a clear, easy-to-follow style; complete construction details, pc board artwork, etc, are included.

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This book is a compilation of the best of recent HF antenna articles and theory presentations published in QST magazine. Its five chapters cover Vertical Antennas, Yagi Antennas, Quad Antennas, Miscellaneous Antenna Types and Antenna Theory and Test Methods. Construction of more than 30 antennas is described along with a range of matching networks and systems.

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A basic reference text that should be in every enthusiast's and amateur's library. In 18 chapters, this book covers such topics as Wave Propagation, Transmission Lines, Long-Wire Antennas, Multiband Antennas, VHF/UHF Antennas, Rotatable Antennas, Specialised Antennas and Antenna Measurements. It is a comprehensive text chock-full of tables, charts and construction information.

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A must for every electronics enthusiast's or radio amateur's bookshelf. Its 10 chapters cover Math Aids and Tables, Time and Frequency, RF Circuit Data, LCR Networks, Transformers, Filter Design, Antennas and Feed Systems, Catalogue of Solid State Circuits, Constructions and Testing Data, Data Potpourri. How could you do without it?

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SOLID STATE DESIGN FOR THE RADIO AMATEUR

Written as a series for QST, this book is an anthology of the work of Wes Hayward and Doug DeMaw — two world-renowned technical authors. The Collins Radio Division of Rockwell regard this book as recommended reading for their junior engineers. Considered generally as a landmark text, it is just the thing for those interested in actually building high performance equipment, as it contains practical information not found elsewhere in sources available to the professional or non-professional. In nine chapters, the book covers Semiconductors and the Amateur, Basics of Transmitter Design, Power Amplifiers and Matching Networks, Receiver Design, Test Equipment, Modulation Methods and Portable Gear, etc. An extensive and very handy bibliography is included.

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COMMUNICATIONS



OSCAR 9 flies!

The long-awaited, oft delayed UOSAT spacecraft was launched from the US Vandenberg Air Force Base at 1127Z October 6 in what was described as a 'perfect launch'.

The orbit is circular, the craft being at an altitude of around 545 km above ground. Orbital period is close to 95 minutes and the path moves westward at about 24 degrees each successive orbit.

A command problem, involving the 145.825 MHz beacon, arose shortly after launch but was resolved apparently later in October.

The English-built craft is a 'hobbyist and educational' satellite carrying a variety of equipment including a camera for transmission of earth pictures that can be readily received on simple equipment. In

addition, it carries a number of phase-referenced HF beacons operating in the 7, 14, 21 and 28 MHz bands for propagation studies and two microwave beacons in the 2.4 and 10 GHz bands. UOSAT also carries a magnetometer and two particle radiation counters.

Oscar 9 has a general data beacon on 145.825 MHz and an engineering data beacon on 435.025 MHz, both of which have been reported received at good strength on simple equipment (handheld and a rubber ducky antenna!).

Radio-induced changes in ionosphere to be studied

How radio transmissions may alter the ionosphere and thereby disturb long-range communications is being investigated by scientists at the Lockheed Palo Alto Laboratories.

Under a contract with the Office of Naval Research, Lockheed has designed and built a satellite-borne experiment to determine if radio transmissions at very low frequencies will induce electron precipitation from the earth's magnetosphere into its ionosphere.

Such precipitation causes irregularities in the ionosphere, which in turn can interrupt or degrade extremely low frequency (ELF) and very low frequency (VLF) communications.

This phenomenon is of significant interest to the US Navy because of the number of existing and proposed communication systems they operate in these frequency ranges.

Called the Stimulated Emission of Energetic Particles (SEEP) experiment, the programme is a joint effort of Lockheed's Space Sciences Laboratory and the Radio Sciences Laboratory of Stanford University. It follows earlier research conducted by Lockheed for the Office of Naval Research (ONR).

It is known that energetic electrons from the magnetosphere (the region of space in which such particles are controlled by the earth's magnetic field) are naturally injected into the ionosphere near the polar regions.

When the energetic electrons

penetrate the ionosphere they give up their energy by ionising its neutral constituents. This ionisation and ionisation ebbs and flows by natural processes. However, when it increases markedly (for example, when solar activity is high), it degrades or destroys the 'reflecting' properties of the ionosphere and adversely affects radio propagation — notably at long wavelengths.

Lockheed scientists now suspect that this energetic electron precipitation may be caused by specific ground-based radio transmitters.

The SEEP instrumentation system will operate aboard a satellite. The system's detectors will observe electron precipitation while several high-powered, ground-based transmitters at different locations are keyed in an on/off duty cycle that will provide a unique 'signature' in the particles, enabling researchers to establish positively a cause-effect relationship.

Among radio transmissions to be monitored during the experiment are those of the OMEGA network, the US Navy communications system, and the Stanford University research transmitter at Siple, Antarctica. All operate in the VLF range (3 to 30 kHz), which resonates with the natural frequencies of the trapped electrons in the magnetosphere.

Amateur regulations handbook

You can now obtain the Department of Communications' Amateur Operator's Handbook through Dick Smith Stores — an item you'll need now if you're going for the exam early next year.

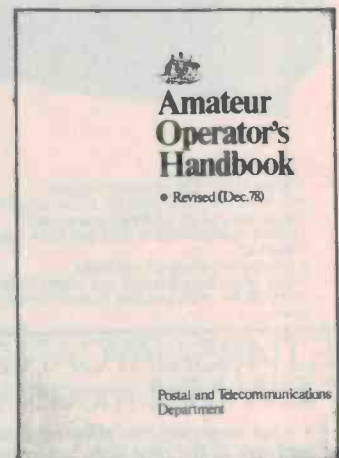
The Amateur Operator's Handbook, Cat.No. B 5042, outlines the regulations and conditions for the operating of Amateur Radio.

About one third of the exam for Amateur Operators' Certificates of Proficiency (AOCP) is based on regulations, and so the B 5042 is essential reading for anyone interested in becoming an amateur operator.

This handbook is the all-new

updated version, including changes in the service since the previous version.

The handbook was previously only available from Government Publications, but Dick Smith has made a special purchase as a service to amateurs and aspiring amateurs. Now the Amateur Operator's Handbook is available for \$3.60 from all Dick Smith Electronics stores.



SEEP instrumentation consists of high-sensitivity electron spectrometers, a mapping X-ray spectrometer, and an airglow photometer.

The electron spectrometers will directly sample energetic particles which strike them. The mapping X-ray spectrometer will view a much broader area, detecting the particles by the X-radiation they emit as they penetrate the atmosphere and interact with other particle nuclei. The photometer responds to light (airglow) emitted by the atmospheric atoms when they are struck by the precipitating electrons.

AEA agent for coaxial cable

Antenna Engineering Australia Pty Ltd has been appointed agent in Australia for the West German manufactured range of coaxial cables and wave-guides by Kabelmetal.

Low-loss foam dielectric coaxial cables cover 6 mm to 41 mm diameter, and air dielectric cables available are from 9.5 mm to 230 mm diameter. AEA is currently stocking 13 mm and 22 mm low-loss foam coaxial cable and matching connectors.

Kabelmetal products are manufactured in Hannover, West Germany, and by associated companies in the USA and Brazil. Kabelmetal also produce a wide range of elliptical wave guides and components and rectangular wave guide components.

Radiating RF cables for restricted communication systems are available, together with all necessary installation components.

Kabelmetal products are manufactured in Hannover, West Germany, and by associated companies in the USA and Brazil.

For further information contact Antenna Engineering Australia Pty Ltd, P.O. Box 191, Croydon Vic. 3136.

ELEGANT SIMPLICITY → MOSFET TECHNOLOGY

Advances in technology should make life simpler. A cluttered power amplifier board may well perform superbly, but its busy elaboration is an indication that its design is pushing the limit of its component technology.

There are many first class bipolar amps on the market. All of them are complex and consequently expensive. Any additional improvements in the areas where they are weak (i.e. H.F. distortion) can only be obtained with yet further complexity and cost. Only new technology can provide the sort of "quantum jump" in component performance necessary to reduce the clutter on the board, reduce the cost and make the Highest Fidelity a reality.

So far 29 semiconductor manufacturers have invested in MOSFET technology. Clearly power MOSFETs are something special. The enormous power gain of the MOSFET helps eliminate conventional drive circuitry permitting delightfully simple designs viz. the 5000. Their freedom from secondary breakdown and tendency to shutdown when thermally overstressed results in inherently destruction-proof output stages, not needing protection circuitry. Remember if your bipolar amp is D.C. coupled the only thing between your speaker and lethal supply rails is that bipolar power transistor! Back to MOSFETs.

Perhaps best of all, the MOSFETs lack of charge storage makes them FAST, FAST, FAST and RESPONSIVE. MOSFET transistors produce amps, that have wide bandwidth, low distortion even at high frequencies and – very important – high slew rate. If you are a perfectionist or are just not happy with what you have got now this system could be for you. You owe it to yourself once in a lifetime to bestow upon yourself "the best". In the case of amplifiers, this is it.

A CHRISTMAS PRESENT PERHAPS?

5000 POWER AMPLIFIER PERHAPS THE PERFECT REALISATION OF THE CLASSIC POWERFET AMP DESIGN.

The Jaycar kit of this project is being continuously updated in quality so that the constructor will benefit. We now supply metal film 1% 50ppm resistors in place of carbon film types. All Aluminium hardware (including heatsink bracket) is now anodised in black. (Incidentally there has never been a problem with instability with Jaycar kits. We have ALWAYS used high quality capacitors).

The original square-section chassis bars are used. And then there is the Superfinish frontpanel!

Specifications: Power Output – 100 watts r.m.s. into 8 ohms x2
Frequency Response – 8Hz to 20kHz, +0 –0.4dB. Noise – 116dB below full output. Input Sensitivity – 1V r.m.s. for 100 watt output. For full specifications see magazine article on this amplifier.

Ref: ET1 Jan – April 1981



- EXCLUSIVE!!!**
- Metal film 1% resistors used
 - All Aluminium panels now anodised
 - Original design chassis bars used
 - Heavy gauge extruded section heatsink bracket
 - prewound output chokes
 - Flux shorting straps on transformers
 - And then there's the Superfinish heatsink

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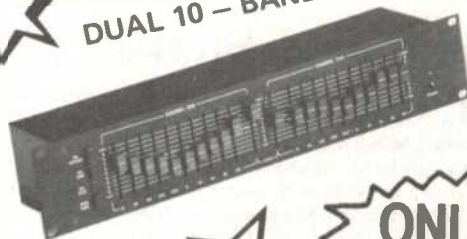
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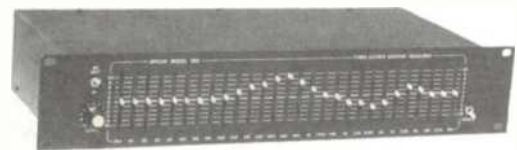
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LETTERS

Dear Sir,

I was one of the first to rush out and buy one of the ETI 466 300 watt amps. Since the first day I built it I've started losing hair!

Having made over 20 kits of numerous things, done repairs on my friends' amps and repaired computer cards, (the latter for a living) I thought I'd be up to building this amp.

I was on holidays at the time and I had the amp built in next to no time. When it came to set up the current through the output transistors, I found I could get only 1.5 V across the 10 ohm resistors replacing the fuses and then it quickly increased till the 10 ohm resistors exploded. Thus ended the first lot of power transistors.

Next time I earthed the input the same thing happened, but not so quickly. After I had spent about \$80 on output trannies and the complete replacement of all transistors (twice!!) the manager of Dick Smith's at Buranda, Brisbane enquired as to what was going wrong. I explained what was happening and that I'd even gone to the extent of checking each component to see that it was within tolerance. I was in luck! There was a chap up from Dick's head office and he sent it down (the amp) to be fixed by the experts down south. About three weeks later it returned. I managed to get hold of the same gentleman (I forget his name) and he informed me it was going wild at about 2 MHz and that the chaps replaced one of the feedback caps and moved my heatsink earth strap (the amp wasn't mounted in a box yet) and replaced the output transistors again. It was working!

I might add all those repairs were done for free and I was very grateful for their assistance. The amp ran perfectly for about six months without fault until it received a short on the output which promptly killed it. I replaced the faulty parts and she was away again!

About two months ago the amp once again failed and I might add at this point the amp does get used for disc jockey work into 4 ohms. My speakers will only handle 100 watts each so I have a power meter set for 200 watts (it was calibrated on a professional amp). The heatsink is a sheet of aluminium 13 x 7 inches with 14 7" x 3" fins fixed to it. This keeps things really cool. Anyway — I carry a 120 watt Auditec amp (these

are indestructible!) as back-up so I used it till I had time to look at the 466.

I bought four new output transistors, checked all surrounding BD140s and 139s, and it set up OK. Plugged her in — no worries, away she went, flat chat into distortion, no worries. The next time I had to use it whilst DJ-ing, I ran it for half an hour at about 3 - 5 watts and then I decreased the level (due to the party noise) and bang!, dead again. Back to the back-up amp.

I then took the 466 into work where I have a full workshop except for a CRO. I checked all transistors and replaced the faulty ones. I even replaced some of the suspect resistors and diodes. It set up OK so I added two more output transistors (total of 6). I increased the current a little to cover the addition of these and it set up perfectly. I took it home and plugged in one 8 ohm speaker and it promptly blew up. I took it back to work again and practically stripped the board. I replaced every transistor standing. I checked all voltage levels. It set up perfectly again (only four output transistors as replacing six each time is very expensive). I even gave it a short test run on a small speaker at work. I took it home and it self destructed again! I then picked up the case which housed both the 300 W and the 120 W Auditec and threw it down the stairs at the front of my house!



Crushed and mangled, I took the remains upstairs and realised the Auditec was also in the mess somewhere. I plugged it in and away went the Auditec as if nothing had happened!

I won't say what I think about the chap who designed this 'novel paperweight' but I have never been so disgusted with anything in all my years. I defy all attempts to reverse it. The only satisfaction I ever got from building it was destroying it.

I know of many other amps which have also met the same fate, because I'm at Dick Smith's store so often I've seen many a frustrated hobbyist bewildered by the 466. All I could tell them is 'pull it apart before it gets you'. If you want to keep hair on the heads of Australian men DON'T GIVE US ANY MORE KITS OR PROJECTS LIKE THIS, EVER!!!

Yours sincerely,
A. Stewart
Gumdale, Qld.

Well, well. You certainly seem to have had the rounds of Murphy's Law, Mother Nature and mayhem on this one! You should have called us the first time. We built three of these projects prior to publication without experiencing the difficulties you report.

The problem, as you found out, stems from high frequency instability. This is not a fault inherent in either the electronic design or the physical construction, as we described in the article (Feb. '80). Let us make that point abundantly clear at the outset. The instability is brought about by components which have different characteristics to those employed in the units we constructed. This is something over which we have no control, nor was it something we were aware of until after the project was published and kits became available.

Prime offender was the capacitors supplied for C15. The network on the output consisting of C15 and R47 is there to provide a low impedance load to the amplifier at frequencies beyond the audio range — where speakers and crossover networks look like strange reactances. For this network to do its job, C15 must look like a 'real' capacitor. If, owing to its particular internal construction, it looks like an inductor at the frequencies concerned (above 25kHz) then that little network will have entirely the opposite effect to that desired. Which is what happened in your case — and many others.

The next culprit (or culprits) we discovered turned out to be the emitter ballast resistors for the output devices. As is evident from the photographs of the pc board included in the article, we used 'Noble' brand resistors. Unbeknown to us, these just happen to be the types having the lowest inductance available. Types supplied with some kits had up to four times the inductance of the ones we used. Result, instability! ▶

LETTERS

When problems became evident following publication we quickly researched what might be causing the problem. We had discussions with Gary Crapp, Service Manager at Dick Smith Electronics, about reported problems with kits supplied by Dick Smith. Following our investigations, we made certain recommendations which we understand were followed and common problems, much of the nature you experienced, rapidly cleared up. Details of our recommendations were circulated to other kit and component suppliers.

In addition, some people were using output devices (MJ15003/MJ15004) which had differing specifications to the Motorola-manufactured devices we used. We recommend the Motorola devices as the protection circuitry was designed around the published Motorola specifications for these devices.

A very large number of these amplifiers have been built and appear to work satisfactorily. It is apparent that you are the victim of circumstances beyond our control. We are indebted to Gary Crapp of Dick Smith Electronics

for his cooperation in respect of this project.

To our certain knowledge, other firms supplying this kit have not reported customers experiencing difficulties as you did. Components which do not behave as one would reasonably expect can catch out anyone and the only consolation you, the Dick Smith organisation and anybody else has, is that we have all been in the same boat.

When difficulties like this arise, constructors should make **absolutely certain** that the components used are as we specify in the project article. We can take no responsibility for substitutions. In any event, you can phone us (after 4.30 pm please) and check with technical staff.

A similar problem arose with the ETI-477 MOSFET amplifier, published earlier this year. The capacitor in the HF load network on the output, C9, was a source of trouble in some kits, as were the source ballast resistors for the output devices. A note to this effect was published on page 11 of the August '81 issue.

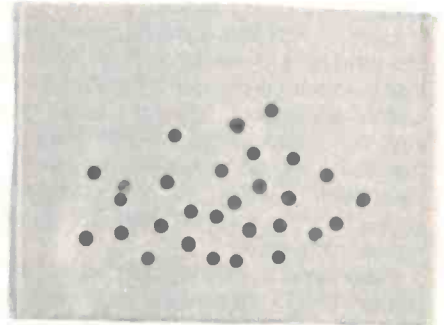
Roger Harrison, Editor

Dear Sir,

Many thanks for solving the big problem with my mini-drill which, until now, has been frustrating to use. I constructed the ETI-258 on Veroboard around a 7805, using a scratch-built 0R22, and deleting the rectifier diodes and zener. By substituting a 1000 μ F capacitor I was able to get the project into Dick Smith's smallest Zippy box, using the cover as a heatsink. I find 9 volts from my LM317 power supply quite sufficient for most jobs, as the increased torque from the drill is truly remarkable.

I am enclosing an electronic tea-strainer for Roger, as a token of appreciation for publishing Graeme's circuit.

F. Hawkins, Townsville Qld.



Many thanks, Mr. Hawkins, all donations gratefully accepted and usefully applied ... except I rarely drink teal (R.H.)

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COMPUTING TODAY

IBM helps the deaf to speak

Researchers at IBM France are developing visual feedback techniques that help deaf people to modulate their voices normally.

People with normal hearing continually vary the pitch and intensity of their voices as they speak, but those with impaired hearing find it very difficult to do this. Children born deaf, in particular, have never heard a human voice and therefore have no concept of stress or pitch. Without extensive speech training, their voices may become loud or shrill.

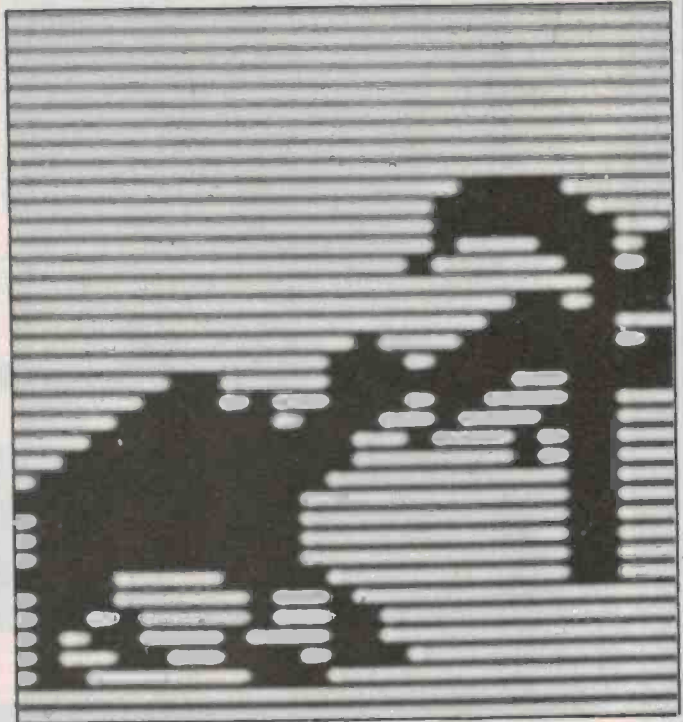
At the IBM Scientific Centre in Paris, experimenters have developed a set of games that give deaf children visual feedback about the sound of their voices. A typical game presents a stylised image of a camel on a VDU screen. The camel moves jerkily across the screen according to the sounds made by a child speaking into a microphone. If the child's voice is well-modulated, the camel proceeds smoothly towards an oasis, otherwise it wanders off course and blunders into palm trees.

As well as these 'hit the target' games, the system also allows a

teacher to divide the screen horizontally, so that the upper half displays a graph of the teacher's voice and the lower half displays the child's. The child can then see how closely the pitch of his or her voice matches the teacher's.

The system is based on two co-operating microprocessors, one of which analyses the speech while the other controls the input and output devices. An analogue-to-digital converter translates the sounds spoken into a digital code, from which the analysing microprocessor generates signals representing pitch and intensity. These signals are sent to the second microprocessor, which uses them to generate control signals for the VDU.

The researchers are naturally cautious about the results, but they are encouraged by their experiences to date. In one case, for example, a boy with a high-pitched voice succeeded in lowering its pitch after ten sessions with the equipment.



... and to listen

Another project at the same Centre aims to help severely deaf people by applying data processing techniques to lip-reading.

For many purposes, simple lip-reading is not accurate enough, because different sounds often appear the same on the lips. The problem can be overcome by a technique known as cued speech, in which the speaker uses a set of hand signals to indicate vowels or consonants. By moving his hands as he speaks, the speaker clarifies ambiguities for the lip-reader.

The disadvantage of cued speech is that the hand signals must be learned by the speaker. IBM's researchers are trying to eliminate this problem by using a computer to translate the speaker's sounds directly into visual cues. These cues could be displayed, for example, by a set of lights on the frame of a pair of spectacles.

Experiments are now being conducted, using an IBM System



370 Model 145 computer, to improve the accuracy of speech recognition techniques. They hope to train the computer to discriminate reliably between different phonemes (the basic elements of speech). If they succeed, their work could bring a dramatic improvement in communication with deaf people.

Cromemco sales up

Informative Systems Pty Ltd, a Cromemco distributor, has announced a 150% growth in sales for the 1980-81 trading year. Managing Director Dr. Simon Rosenbaum said it was the third successive year in which sales had exceeded 100% growth rate.

The increase was not in any one market area, sales to the education and small business areas being only slightly ahead of purchases for industrial and scientific applications.

To handle increased demand, Informative Systems recently moved to larger premises and more than doubled its systems and support staff. It is at present seeking more staff in the software and technical area, as well as for its new Victorian sales consultancy.

A new Cromemco business accounting system offering multi-terminal, multi-tasking capability has just become available from Informative Systems, and is claimed to be the only Unix-based micro-computer in Australia offering six-terminal capability.

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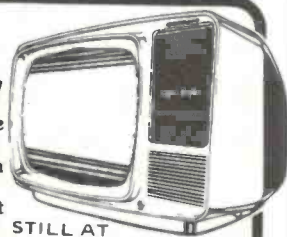
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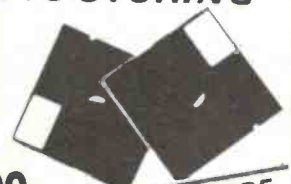
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Fluke microsystem troubleshooter

With the population explosion of microprocessor-based circuits in terminals, business machines, minicomputers, peripherals and electronic instruments of all types, a rapidly growing need for a simple and efficient digital service tool has been created. The new Fluke 9010A Microsystem Troubleshooter is said to fulfil that need exactly.

According to Elmeasco Instruments, Fluke's Australian agents, the 9010A will, without writing any test program and regardless of the complexity of the microsystem, troubleshoot the entire 'kernel' (power supply, clock, buss, RAM, ROM, I/O) of the microsystem automatically. Operating through the microprocessor socket, results are posted on a 32-character alphanumeric display.

The design of the 9010A includes an algorithm which automatically examines and defines all signal locations and functions of the microsystem kernel from a working board using its 'learn' mode, storing this data in its own memory for the day's work or on minicassette for permanent storage. Thus the toughest and most time consuming failures to troubleshoot, namely failures occurring in buss-

connected devices outside the micro itself, may be found by a fast and totally self-contained test program, put to work literally the same day as the instrument is received in a production or service facility.

The 9010A has other testing algorithms for working outside the 'kernel' where peripheral devices such as character generators, keyboards, readouts, print heads, relays and other mechanical or electronic controls reside.

The 9010A's keyboard includes grouped troubleshooting key functions for automatic patterns and digital exercises which are selected directly at the keyboard in an interactive, on-line manner by the operator. No computer expertise or knowledge of programming language is said to be required. High-level software works to provide a few simple keystrokes for the most complex testing functions.



The 9010A also includes a highly versatile troubleshooting probe, which not only counts events, takes signatures and shows logic states, but also injects signals at either a 1 kHz rate or synchronised to the system clock. The probe may be synchronised to data, address or free-run, while an oscilloscope trigger output synchronised with the probe is another convenience item not found in other microsystem testers.

Compact, lightweight and rugged, the 9010A works through a calculator-sized interface 'pod', which in turn connects to the microprocessor socket via a tough

ribbon cable. The pod is protected from such common operator abuses as plugging into the microprocessor socket backwards. Several pods are available to match the popular microprocessors, with future capability for a 32-bit device.

The 9010A, including the pod, is priced at no more than the cost of a good scope. Elmeasco anticipate that the 9010A could easily replace the scope as preferred instrument for front-line microprocessor system troubleshooting.

Further information is available from Elmeasco Instruments Pty Ltd, P.O. Box 30, Concord NSW 2137. (02)736-2888.



Spectrum moves into Winchesters

The Australian computer designer and manufacturer D.D. Webster Electronics Pty Ltd has introduced a range of Winchester disk machines at the top end of its large family of Spectrum-II minicomputers.

D.D. Webster Electronics has a product range of over 50 model configurations available, with installation sites now approaching 300.

Two new systems have been released, Spectrum models HC and GC, with a formatted storage capacity of 8.5 M and 30 M respectively. The new models use high performance eight-inch DEC RK07 software-compatible Winchester disks and can comfortably support between ten and fourteen terminals, including a parallel line printer interface. Prices for the new range start at \$12 000.

Complete specialised applications currently available with the two larger Spectrums include software

packages for accounting, production planning, purchasing, word processing, educational administration and student education.

Since its establishment in 1970, D.D. Webster Electronics has established sales branches in Brisbane and New York, and recently received a \$50 000 order to supply three Spectrum-IIs to the People's Republic of China, for installation at the Beijing (Peking) Institute of Technology, where they will be used in educational applications.

For further information on the Spectrum range contact D.D. Webster Electronics Pty Ltd, 17 Malvern St, Bayswater Vic. 3153. (03)729-8444.

ComputerLand on the Gold Coast

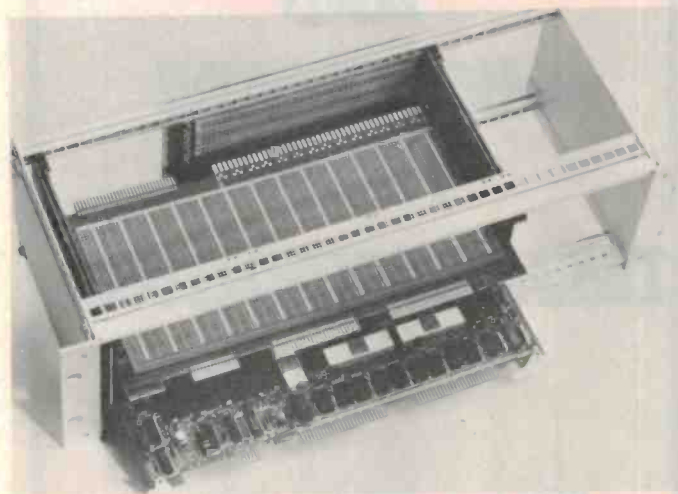
ComputerLand started in the USA only six years ago, and now has stores opening around the world at the rate of six every month. The ComputerLand store opening on the Gold Coast could well be the two hundredth, and will be owned and managed by 30-year-old Paul Rees, who brought the ComputerLand idea to Brisbane 2½ years ago.

Paul's Brisbane store is one of only twelve internationally which has topped sales of \$200 000 in one month, and the new Gold Coast store is planned to be even bigger and better, with 2500 square feet for a giant service and repair depot where equipment can be assembled, tested and repaired. There will also be a well-stocked retail showroom where customers can browse.

Paul expects the new ComputerLand store to satisfy the requirements of the many thriving small businesses on the Gold Coast. "Over the last 2½ years we have become familiar with the huge range of microcomputer products, and we know which products are best for each particular application. We have also become very familiar with what the market in Queensland needs," he said.

Computerland started out by catering to the computer hobbyist, providing a wide range of small, inexpensive computers, programming manuals and lots of friendly advice and assistance. However, they now find that businessmen come into the stores with specific problems which they need to solve on a tight budget, without becoming involved in the technical details of computers. ComputerLand has therefore developed a wide range of hardware and software packaging expertise to cater for the requirements of most small businessmen. The idea of a computer supermarket for both hobbyist and businessman has become a reality.

The new Gold Coast ComputerLand store may be found at 126 Scarborough St, Southport Qld. 4215. (075)32-8300.



Vero boards for microprocessors

Vero have increased their range of Eurocard Microboards by introducing prototyping boards compatible with common microprocessor systems.

The systems they have chosen are the S100, Intel Multibus, Exorciser and Apple systems, because these are the commonest throughout the world.

In conjunction with the Exorciser and Multibus microboards, they have also introduced KM6-compatible dedicated motherboards. Used

with their KM6 Horizontal Mounting Kit, the whole system can be mounted in a 3U x KM6 open card frame or case frame.

More information may be obtained from the distributors, Warburton Franki, 199 Parramatta Road, Auburn NSW 2144. (02) 648-1711.



Applied Technology now selling complete systems

NSW manufacturers Applied Technology, well known for their range of computer boards for hobbyists, have put together a range of complete personal computer systems.

All these systems are built around the DGZ80 single board S100/Z80 computer, which was originally incarnated as the ETI-680 in this magazine. Applied Technology's kits for this computer have found wide acceptance in industry, education and government departments.

The basic system is the Super Instructor 80, which includes the DGZ80, an MW640 VDU and a keyboard. The VDU is memory mapped, with a 16-line by 64-

character format, and displays both upper and lower case. Because it is already S100, expansion requires no special interface. The system can be improved by adding the 'BASIC 80' pack, which includes Microworld BASIC in ROM and 16K of RAM.

Price of the Super Instructor 80 is \$399, and the 'BASIC 80' costs a further \$269. For more details contact Applied Technology Pty Ltd, 1a Pattison Avenue, Waitara NSW 2077. (02)487-2711.

New circuits stay cool at high speeds

An experimental new circuit technology developed by two IBM engineers promises faster signal speeds with low power consumption.

The circuits, developed by Richard Konian and James Walsh, are reported to be faster than ECL (emitter-coupled logic) circuits, but can be packed just as densely as TTL (transistor-transistor logic). They also use much less power than ECL.

The speed and power consumption of the new Konian-Walsh circuitry depends on its density on the chip. If the designer of an IC wants high speed, a few thousand

K-W circuits might be configured on a chip that uses around 2.5 milliwatts of power. If he wants high density, at least twice as many circuits might be connected on a chip with a power consumption of 0.5 to 0.7 milliwatts.

Konian-Walsh circuits are therefore the first to give designers the option of integrating both low and high-performance circuits on the same chip.

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The system includes the necessary hardware to interface to your amplifier and three tunes. \$54.95

PIANO PLAYER — This program is an option for the above music system and adds delightful graphical animation of a high resolution piano player tinkling the ivories. The little man's arms move in synchronization with the beat of the music. A large keyboard is displayed upon which four cursors jump around on the keys to the four notes being played. Piano player comes with a Christmas medley to brighten the coming season. \$15.95.

EZYFILE — A Super-fast Z-80 code database program that is easy to use for filing information of any type. Ideal for mailing lists, club membership records, record collections etc. which require rapid retrieval of individual items. Up to 750 records may be included in a file and these may be edited, sorted, listed, deleted or added to as well as printed out in a user-defined format can be used on cassette or disk. \$35.95.

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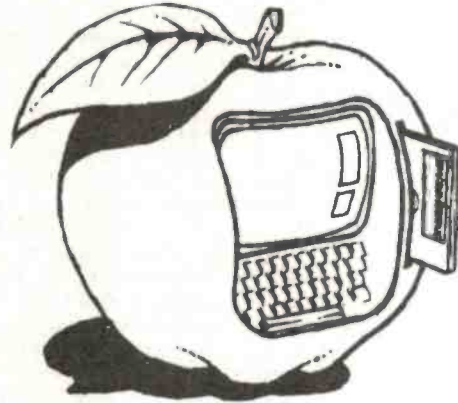
VISTA SINGLE DRIVE V200E-10: With the Vista's there is no need for an S100 unit — they plug straight in to the Sorcerer and allow you to use Rom Pacs. The Vista's come with CP/M, Basic E, full documentation and disks. Capacity on this drive is 200K. \$1010.00

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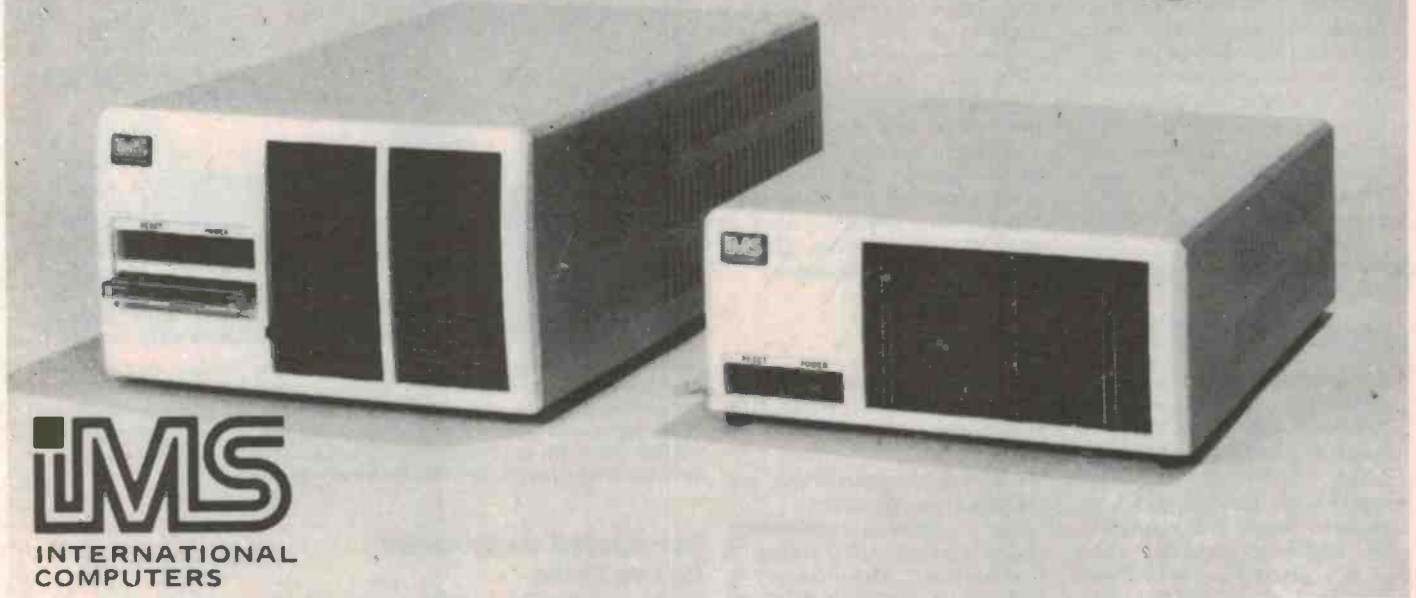
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EXTRAS: You'll be glad you have them. The 5000SX comes standard with lots of extras, starting with a fully terminated 12-slot S-100 Motherboard, (on which there are 7 spare slots for your use!). Add to that, 64K Dynamic RAM modules with parity of course, and receptacles for your CRT and Printer that turn on with the main power switch. Plus a convenient up-front reset switch, built-in mains line filter and more.

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TRS-80 Hotline

Users of TRS-80 who have problems can now get expert advice from Tandy via their newly established 'Computer Hotline'.

By dialling 008-22-6366 from anywhere in Australia (outside the Sydney Metropolitan area), they can get skilled help with all their hardware and software problems for the price of a local call. Callers in the Sydney area should ring 638-6633 and ask for the 'Computer Hotline'. Trained staff man the hotline 'phones from 9 am to 5 pm Eastern Standard Time, Monday to Friday.

For quickest service, hotline callers should be ready with information about their model

number, memory size, number of disk drives and disk operating system, as well as any error messages connected with their problem.

Tandy would like callers to use the hotline only for calls about operating problems. Enquiries about prices, availability, and specifications of TRS-80 hardware and software should be made to local TRS-80 Computer Centres, Tandy stores or Tandy dealers.

New USART available

Standard Microsystems Corporation has released the COM 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART). The COM 8251A is a pin-for-pin replacement for the industry standard 8251A.

The COM 8251A USART provides the serial-to-parallel and parallel-to-serial data conversions for interfacing a parallel microprocessor bus to a serial bit stream. In addition, it provides the various 'handshakes' and controls required

for both asynchronous and synchronous communication.

For additional information, please contact AJF Systems & Components, 310 Queen St, Melbourne Vic. 3000. (03)67-9306.



Memory upgrade for Commodore Computers

MicroPro Design now have available a memory upgrade module for Commodore computers which is said to allow the memory capacity of the 8K and 16K Commodore CBM microcomputers to be economically expanded to the full 32K bytes.

The module requires no tools for fitting or modifications to be made to the standard computer, and is plugged directly onto the memory expansion connectors inside the computer.

The unit was designed and

manufactured in Australia and is supplied as a fully tested and assembled unit.

For further information contact A.J. Mowat, MicroPro Design Pty Ltd, Suite 205, 6 Clarke St, Crows Nest NSW 2065. (02)438-1220.



Tektronix now operates a fleet of vans in the Sydney and Melbourne metropolitan areas, to give faster service to users of its computer graphics equipment. Each van carries all the most commonly needed boards and other spare parts necessary for maintenance and repairs, and most repairs are carried out on the spot by trained technicians. Tektronix plans to extend the service later to its other service centres in Australia.

The Apple II Users' Guide By Lon Poole

Osborne-McGraw-Hill, approx \$17.

As its name suggests, this is not a beginner's book for Apple programming and operation. It is a guidebook for those who own an Apple II and would like the information contained in the manuals in one easy reference book. This book answers, in one reference, many of the most-asked questions of first-time Apple users.

The first chapter covers actual setting-up and describes the various pieces of hardware that typically accompany an Apple system.

The book goes on to explain some of the more commonly used keyboard commands of the Apple, including the loading and saving of cassette tape programs as well as the use of the more common disk commands. At this point it stresses correct handling of disk media and correct operation of the drives themselves. Setting-up is then discussed, although unfortunately no mention is made of the PAL colour card, which is necessary on Australian Apples.

Both Integer and Applesoft BASICs are covered, although this is not a complete instructional course in BASIC programming. Editing on the Apple is covered in this section, as is the operation of BASIC in immediate and deferred modes.

The chapter on the disk system describes each of the disk commands available in the Apple DOS. It does not attempt to be a complete 'teach-yourself' on the use of disk commands within a program and is basically little more than a short description of these commands. I was glad to see a chapter devoted to an area where

the Apple has a great deal to offer the budding programmer.

Such topics as creating sound from machine language, the generation of shape tables and high-resolution graphics access from Integer BASIC are also covered, as is the saving of pictures and shape tables to both disk and tape.

What I considered to be the best feature of the whole book were the appendices, in which is contained a wealth of information on the various peeks, pokes and calls which are available. Also covered are the editing commands and error messages, while for the more advanced user, the Apple's memory map and disk format are also discussed.

This book strikes me as a reference manual containing much of the information which is spread over many Apple manuals, rather than a book for the teaching of new Apple users. The title pretty well sums up the contents as a guide to present Apple users, containing much useful information which otherwise would mean tedious searching through manuals to locate.

David Hanney
Computerland, Sydney

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Vector's new system has 8-inch Winchester

32 megabytes of mass storage are available on the new Vector 3032 system, thanks to the inclusion of an eight-inch Winchester hard disk drive.

Vector say they opted for Winchester rather than cartridge-type hard disks, because they are cheaper, more reliable, faster and need no preventive maintenance. The 32 megabytes of disk storage allows software to make full use of the maximum size files (8 megabytes) allowed by the CP/M 2 operating system.

Like other members of the Vector 3 family, the 3035 uses a Z80B microprocessor and a 4K ROM. However, the microprocessor is clocked at 6 MHz, a 50% increase in speed, which should lead to a significant increase in system performance.

As well as the Winchester, the 3032 also includes a 680K mini-floppy disk drive, which can be used to back up critical data files. Both the hard disks and the floppies are controlled by a version of the Vector's DualMode disk controller and the accuracy of the data stored on them is protected by Vector's Automatic Error Detection and Correction system. Floppy and hard disk drives are both contained in a single unit that can sit on top of or underneath a desk.

More details from the distributors, Dicker Data Projects Pty Ltd, 24 Woodfield Blvd, Caringbah NSW 2229. (02)524-5639.

Sanyo screen is easy on the eyes

Sanyo's DM 8112CX data display monitor incorporates several features aimed at improving the eye comfort of its operators.

Its non-reflective P31 green screen has a resolution of 850 lines at the centre, and its almost flat surface reduces distortion at the edges. This is particularly important in word processing applications with 80 columns of characters on the screen.

Designed to meet the needs of OEM computer and data processing companies, the monitor's conservative styling should enable it to be matched with most of the related hardware currently being produced.

For further information contact Sanyo Office Machines Pty Ltd, 127 Walker St, North Sydney NSW 2060. (02)929-4644.



Real time multitasking software

A new software package from Motorola includes all the basic task control algorithms necessary for complex real time multitasking functions.

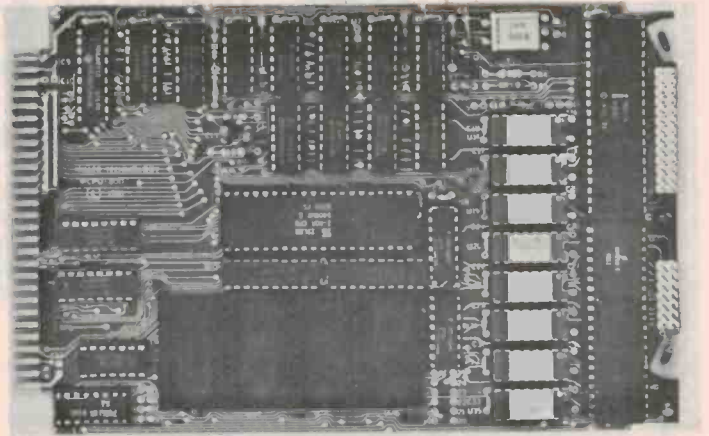
Real time systems respond to external events as they occur. Unlike batch systems, where each operation is completed before the next is begun, real time systems can delay the completion of one operation so that another operation can be started, continued or completed. Keeping two or more operations in progress at one time is called concurrent processing or multitasking. Although a single MPU can only be working on one operation at a time, multitasking gives the illusion of several operations executing simultaneously.

The new Motorola software is called RMS68K. It includes a task controller, an inter-task communication facility, an initialisation

facility and an optional memory management facility. It can be used in customer-designed hardware incorporating the Motorola MC68000 microprocessor, or in systems built around the Motorola VERSAmodule monoboard micro-computer.

RMS68K is also compatible with the EXORmacs development system and the VERSAdos operating system. This means that programs designed to execute under the control of RMS68K will also execute under the control of VERSAdos on the EXORmacs system.

For information contact David Ednie of Rank Electronics on (03)541-8444.



Single-board micro has up to 64K RAM and 32K ROM

The MCPUI-800 single board microcomputer from Memory Electronics is claimed to have more computing power, memory and I/O capability than any comparable product.

The STD compatible board, which is configured around a Z-80A clocked at 4 MHz, measures only 175 mm x 115 mm x 12 mm. Four 24-pin sockets accept 2K, 4K or 8K ROM and EPROM chips, and on-board jumpers allow different density chips to be mixed on the same board. RAMs may be single-supply 16K, 32K or 64K dynamics, or triple-supply 16K. A memory map port allows use of both RAM and ROM in the same address space.

Many applications can be served by the MCPUI-800 card alone, eliminating the need for a card cage and motherboard, but addition of an STD Disk Controller board enables it to be used in a full Z80 computer system with up to four disk drives, with many slots still available for special purpose cards like analogue or digital I/O.

For more details, contact Memory Electronics, 70 Patterson Road, Moorabbin Vic. 3189. (03) 557-7992 or 557-5394

Queensland Commodore User's Group

The Commodore Users' Group of Queensland meets on the first Tuesday of every month at Construction House, 130 Petrie Terrace, Brisbane at 7.00 pm. Business begins at 7.30 pm.

For more information call Bill Brown during business hours on (07)397-0888, or Mrs. Dillon after hours on (07)349-6612.

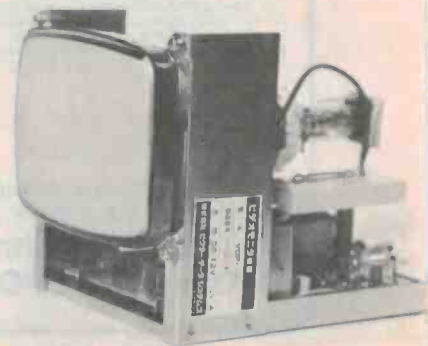
Victor mini monitor

The latest CRT monitor from Victor is a compact high-resolution model designed for use in industrial and commercial environments.

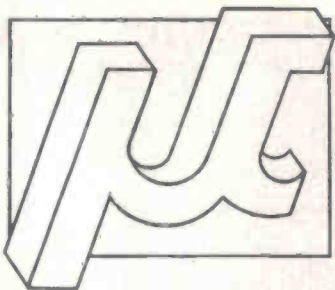
The VDP-582S offers 500-line resolution on a P31 green phosphor screen measuring 95 mm x 70 mm. The circuitry includes a spot killer to ensure long life for the phosphor coating. It requires only a 12 volt dc supply, which makes it suitable for mobile operations.

Rear-mounted controls are provided for adjustment of brightness, vertical hold, horizontal hold, vertical height and vertical linearity.

For more information, contact Alfatron Pty Ltd, 1761 Ferntree Gully Road, Ferntree Gully Vic. 3156. (03)758-9551.



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THE BASIS

As the motherboard is the link between all system components, it deserves special attention. We incorporated state-of-the-art design features like true active termination, and microstrip interconnecting lines. Crosstalk between adjacent lines and signal reflections have been largely eliminated for reliable data transfer, even at the high operating speeds of the new microprocessors.

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BUT WHAT'S INSIDE?

The heart of the system is the SBC200 by S.D. Systems, a Z-80 based CPU running at 4 MHz. An RS232 I/O port allows connection to a terminal, and a parallel port to a printer. Automatic baud rate selection is provided by virtue of a counter/timer circuit, three channels of which can be used for other functions. Up to 16K of EPROM can be stored on the CPU card, making for a compact system.

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Price for a complete system with 64K memory, 2.5 Megabytes of disc storage, CP/M 2.2 disc operating system, and a Hazeltine Esprit green screen terminal, is just \$5195.

SYSTEM PRODUCTS

S100 CARD CAGE

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In a matching cabinet to our card cage, complete with twin double-headed Remex or YE Data drives. Fully assembled & tested with cable. \$1850

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A range of software is available to suit the above system, as are other peripherals such as dot matrix and daisy wheel printers. Please send for a complete catalogue.

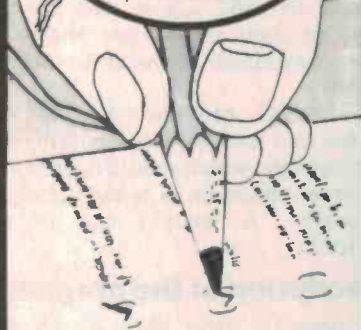
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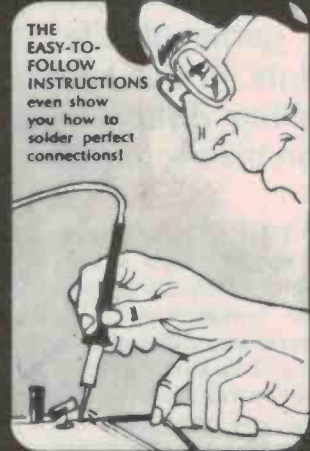
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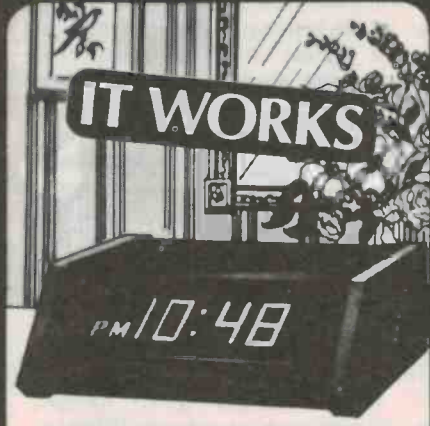


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Newton's cool

This program can be looked upon as a macabre twist of the game of Life. Morbid-minded physicists will take delight in this unusual application of Newton's Law of Cooling. Botanists, biologists and other lay people are let in on the secret first so that they too can play the game.

J.D. Lee
and
T.D. Lee

NEWTON'S Law of Cooling states that the rate at which a body cools in a draught is directly proportional to the excess temperature — that is, the temperature difference between the body and its surroundings. Whilst this should be well known by physicists, who regard any object as a body, it is less frequently known by others.

To illustrate this law an example is chosen which is likely to be remembered by a wide variety of morbid users. The example deals with bodies — dead bodies! The way in which the time of death of a body may be established from temperature readings will be described. This will be immensely useful to potential pathologists and aspiring assassins, and a computer program is provided for the benefit of non-physicists.

Background

When alive, a human body is closely regulated to maintain a temperature of 98.4°F (approximately 37°C) except during illness such as a fever. When a person dies, their body is no longer maintained at this temperature and consequently it gradually cools towards room temperature. For a physicist's type of body, for example a bar of metal, the rate at which the heat is conducted along the bar is given by:

$$-\frac{dQ}{dt} = K A \frac{\Delta\theta}{\Delta x} \quad (1)$$

where — dQ/dt is the rate of heat loss with time,
K is the thermal conductivity of the metal,
A is the (cross sectional) area through which heat travels,
 $\Delta\theta$ is the temperature difference between the two ends,
 Δx is the distance between the two ends.

For a human body, the heat is conducted from the centre of the body, through the skin and clothes to the air. In a strong draught the warmer air is immediately blown away. The constant K in equation (1) represents the thermal conductivity of skin and clothes combined, A is the surface area of the body and Δx is the thickness of skin and clothes. Not only are these three terms unknown, they also vary depending on the physique and state of dress of the particular body.

Nevertheless, they are constant for any one body. Thus:

$$-\frac{dQ}{dt} \text{ is proportional to } \Delta\theta \quad (2)$$

Moreover the heat content, Q, of a body is its heat capacity multiplied by its absolute temperature θ . Thus: Q is proportional to θ , hence

$$-\frac{dQ}{dt} \text{ is proportional to } -\frac{d\theta}{dt} \quad (3)$$

Combining equations (2) and (3) shows that the rate of cooling, $-d\theta/dt$, of the body is proportional to the excess temperature, $\Delta\theta$. Newton arrived at the same conclusion about three hundred years ago!

Programming the macabre!

Mathematically it can be shown that the body temperature falls exponentially towards the air temperature. If a body temperature reading is taken at an unknown time after death, it is not possible to calculate when the body was at 98.4°F since the proportionality constant is not known. However, if two temperature readings are taken with a known time interval between them, then the time of death may be calculated.

$$\text{Time of death} = \frac{\ln \left[\frac{\text{first body temperature} - \text{air temperature}}{\text{body temperature} - \text{air temperature}} \right]}{\ln \left[\frac{\text{second body temperature} - \text{air temperature}}{\text{body temperature} - \text{air temperature}} \right]} \times \text{time between readings}$$

The time of death thus calculated is given as the time before the first temperature reading was taken. Unfortunately Newton's Law of Cooling only applies in a strong constant draught, which would be the case in an exposed windy location, or in an air conditioned building. In still air, the air warms up and natural convection occurs. The rate of cooling $-d\theta/dt$ is given by

$$-\frac{d\theta}{dt} \text{ is proportional to } \Delta\theta^{1.4}$$

rather than

$$-\frac{d\theta}{dt} \text{ is proportional to } \Delta\theta$$

as given by Newton's Law of Cooling. The time of death may be calculated.

$$\text{Time of death} = \frac{\ln \left[\frac{\text{first body temperature} - \text{air temperature}}{\text{body temperature} - \text{air temperature}} \right]}{\ln \left[\frac{\text{second body temperature} - \text{air temperature}}{\text{body temperature} - \text{air temperature}} \right]} \times \text{time between readings}$$

The Five-Fourths Law of Cooling was determined empirically by Dulong and Petit, and justified theoretically by Lorentz in 1881. Users who are surprised at their results are referred to those mentioned above or to Newton himself!

A BASIC program is provided, written in a most elementary sub-set of the language, which should facilitate its implementation on a wide variety of computers. A sample run is also provided.

Description of the program

The program first asks if the user requires full instructions. An answer of YES or NO is expected and all other responses are rejected. Depending on the answer explicit or shortened messages are printed during the first run. Regardless of the answer, short messages are always given on the second and subsequent runs.

The user is invited to choose whether to use the Celsius or Fahrenheit temperature scales. The reply is checked and only C or F are allowed.

In turn the air temperature, the first body temperature and the second body temperature are requested. Checks are performed to ensure that the numbers entered are reasonable. Warning messages are printed if the values are out of range and the user has to re-type an acceptable value. Finally the user is asked for the time of the interval between the temperature readings. This too is checked, and must be positive and less than five hours.

The time of death is calculated using Newton's Law of Cooling (in a draught), and the Five-Fourths Law.

An explanation of the methods is pro-

vided on request and finally the user is asked if he would like another run.

List of variables

The strings Q\$ and I\$ are used for the replies to questions and whether full instructions are required respectively.

These are DIMensioned in line 10 so that I\$ may contain up to three characters and Q\$ up to ten characters. For a number of versions of BASIC strings are handled in a different way and DIM I\$(3) reserves space for four strings I\$(0), I\$(1), I\$(2) and I\$(3). For

such implementations of BASIC line 10 should be omitted.

- A Air temperature surroundings
- B Body temperature (when alive)
- D Death time in minutes before first reading
- F First temperature reading made on corpse
- S Second temperature reading made on corpse
- T Time in minutes between the two readings

Program Listing

```

10 DIM I$(3), Q$(10)
20 PRINT TAB(30); "Time of Death"
30 PRINT TAB(30); "=====
40 PRINT
50 PRINT "Would you like FULL instructions"
60 GOSUB 940
70 LET I$ = Q$
80 IF I$ = "NO" THEN 160
90 PRINT
100 PRINT "This program calculates how long a person has been dead"
110 PRINT "from two body temperature readings, the time between the"
120 PRINT "readings and the surrounding air temperature. Newton's"
130 PRINT "Law of Cooling is assumed if the body is in a draught"
140 PRINT "otherwise the Five Fourths Law of Natural Convection is used"
150 PRINT
160 PRINT "Would you like to work in degrees Celcius or Fahrenheit"
170 IF I$ = "NO" THEN 190
180 PRINT "Type C or F and press RETURN"
190 INPUT Q$
200 REM *** SET NORMAL BODY TEMPERATURE B
210 LET B = 98.6
220 IF Q$ = "F" THEN 270
230 LET B = 37
240 IF Q$ = "C" THEN 270
250 PRINT "Reply '"; Q$; "' not understood. Re-";
260 GOTO 180
270 PRINT "Type the air temperature"
280 INPUT A
290 IF (A + 40) * (A - B) < 0 THEN 330
300 PRINT "The air temperature must be between -40 degrees"
310 PRINT "and"; B; " degrees. Re-";
320 GOTO 270
330 PRINT "Type the first body temperature"
340 INPUT F
350 IF (F - B) * (F - A) < 0 THEN 390
360 PRINT "The first body temperature must be between"; B; " and"; A;
370 PRINT "degrees. Re-";
380 GOTO 330
390 PRINT "Type the second body temperature"
400 INPUT S
410 IF (S - F) * (S - A) < 0 THEN 450
420 PRINT "The second body temperature must be between"; F; " and"; A;
430 PRINT "degrees. Re-";
440 GOTO 390
450 LET S = S - A
460 LET F = F - A
470 LET B = B - A
480 PRINT "Type the time in minutes between temperature readings"
490 IF I$ = "NO" THEN 510
500 PRINT "Then press RETURN"
510 INPUT T
520 IF T * (T - 300) < 0 THEN 570
530 PRINT "The time must be between 0 and 300 minutes (five hours)"
540 PRINT "Re-";
550 GOTO 480
560 REM *** CALCULATE TIME OF DEATH USING NEWTON'S LAW OF COOLING
570 LET D = INT((LOG(F / B) * T / LOG(S / F) + 0.5))
580 PRINT "Assuming that the body was in a strong constant wind,"
590 PRINT "the person died";
600 IF D < 60 THEN 620
610 PRINT INT(D / 60); " hours and";
620 PRINT D - 60 * INT(D / 60); " minutes before the first reading."
630 PRINT
640 REM CALCULATE TIME OF DEATH USING FIVE FOURTHS LAW
650 LET D = INT((B^(-.25) - F^(-.25)) * T / (F^(-.25) - S^(-.25)) + 0.5)
660 PRINT "If the body was in still air then a better estimate is"
670 IF D < 60 THEN 690
680 PRINT INT(D / 60); " hours and";
690 PRINT D - 60 * INT(D / 60); " minutes before the first reading."
700 PRINT
710 PRINT "Would you like an explanation of the methods"
720 GOSUB 930
730 IF Q$ = "NO" THEN 850
740 PRINT
750 PRINT "The first method uses Newton's Law of Cooling which assumes"
760 PRINT "that the rate of cooling of a body is proportional to the"

```

```

770 PRINT "temperature difference between the body and the atmosphere."
780 PRINT "Newton's Law applies if the body is in a strong constant"
790 PRINT "draught eg. an air conditioned room. Such cooling is called"
800 PRINT "FORCED convection. If the atmosphere is still Newton's Law"
810 PRINT "does not apply and the heat loss is proportional to the"
820 PRINT "excess temperature to the power 1.25. This is called the"
830 PRINT "Five Fourths Law for NATURAL convection and gives rise to"
840 PRINT "the second result."
850 PRINT
860 PRINT "Would you like another run"
870 GOSUB 930
880 LET I$ = "NO"
890 IF Q$ = "YES" THEN 150
900 PRINT "You are finished - Rigor Mortis has set in"
910 STOP
920 REM *** SUBROUTINE TO SORT OUT YES / NO ANSWERS
930 IF I$ = "NO" THEN 950
940 PRINT "Type YES or NO and press RETURN"
950 INPUT Q$
960 IF Q$ = "YES" THEN 1000
970 IF Q$ = "NO" THEN 1000
980 PRINT "Reply '"; Q$; "' not understood. Re-";
990 GOTO 940
1000 RETURN
1010 END

```

Sample run

```

Time of Death
=====
Would you like FULL instructions
Type YES or NO and press RETURN
? YES

This program calculates how long a person has been dead
from two body temperature readings, the time between the
readings and the surrounding air temperature. Newton's
Law of Cooling is assumed if the body is in a draught
otherwise the Five Fourths Law of Natural Convection is used

Would you like to work in degrees Celcius or Fahrenheit
Type C or F and press RETURN
? C
Type the air temperature
? 6
Type the first body temperature
? 25
Type the second body temperature
? 14
Type the time in minutes between temperature readings
Then press RETURN
? 45
Assuming that the body was in a strong constant wind,
the person died 25 minutes before the first reading.

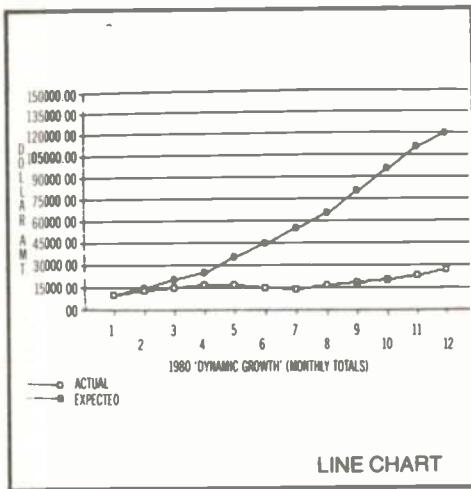
If the body was in still air then a better estimate is
21 minutes before the first reading.

Would you like an explanation of the methods
Type YES or NO and press RETURN
? YES

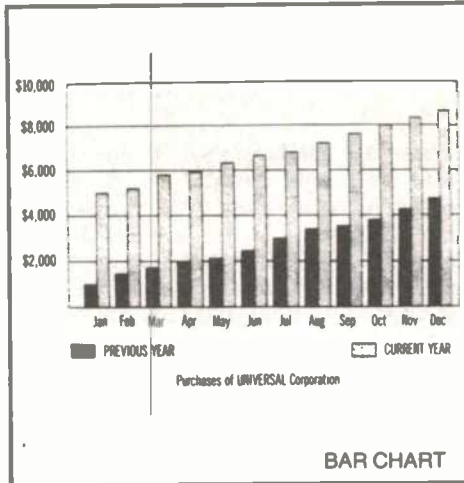
The first method uses Newton's Law of Cooling which assumes
that the rate of cooling of a body is proportional to the
temperature difference between the body and the atmosphere.
Newton's Law applies if the body is in a strong constant
draught eg. an air conditioned room. Such cooling is called
FORCED convection. If the atmosphere is still Newton's Law
does not apply and the heat loss is proportional to the
excess temperature to the power 1.25. This is called the
Five Fourths Law for NATURAL convection and gives rise to
the second result.

Would you like another run
Type YES or NO and press RETURN
? NO
You are finished - Rigor Mortis has set in
OK,

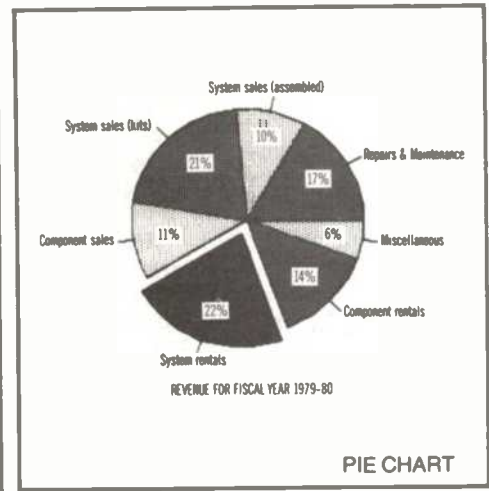
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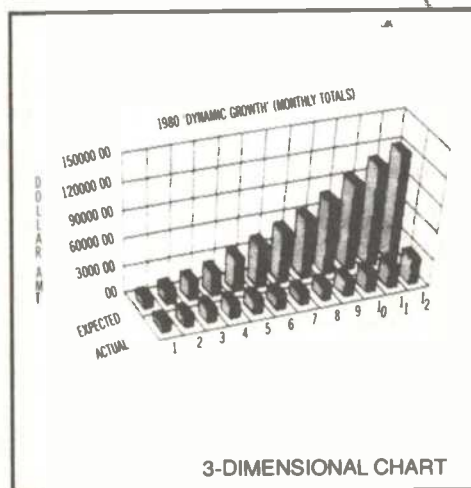
LINE CHART



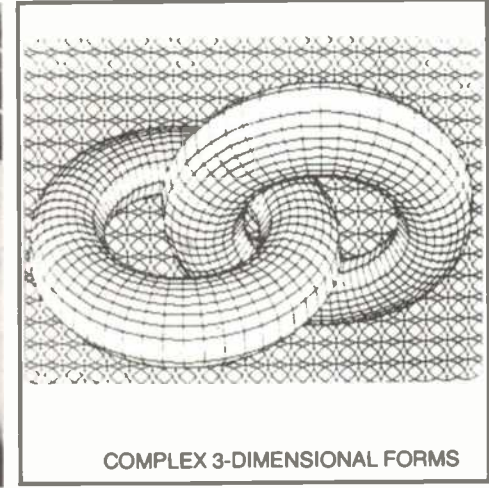
BAR CHART



PIE CHART



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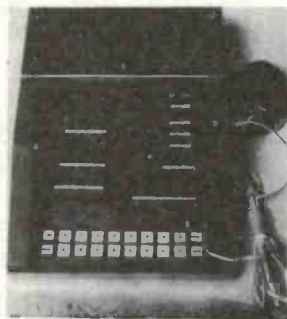
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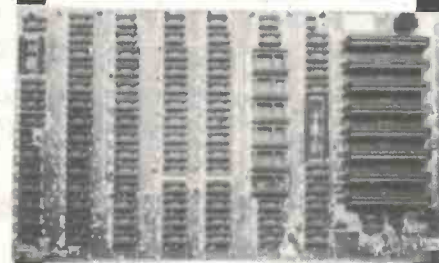
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A single-board computer using the 2650 on an S100 card

The S100 buss has become one of the most successful buss standards for both hobbyist and professional applications. Most past ETI computer projects have supported this buss. This project continues the line of succession and uses the popular 2650 microprocessor in a single-board computer design with many features not found elsewhere. It is compatible with our previous S100 projects (e.g: the 640 VDU and 681 PCG) and follow-up projects and articles are to come.

Ron Koenig

THE INTRODUCTION of the microprocessor to the electronics scene has brought with it many great possibilities and many new challenges for both the hobbyist and professional system builder. While the microprocessor is extremely flexible and is capable of excelling in most applications over 'discrete' circuit assemblies, it is unable to operate by itself. The microprocessor is only a system component and must be supported by a variety of additional components to be capable of performing any given task.

The basic microcomputer system is composed of three main units, or modules. These are: the Central Processing Unit (CPU), the Memory Unit and the Input/Output (I/O) Port Units. The CPU with its associated control circuitry performs all the processing and system control operations. The Memory Unit usually consists of several blocks of memory, each with its own address decoding circuitry. The memory blocks can consist of either non-volatile Read Only Memory (ROM) in which is stored permanent programs (or data), or Random Access Memory (RAM) in which is stored variable data that is subject to change during program execution. The Input/Output Units and the associated control circuitry provide the primary means by which the 'external world' can communicate with the CPU. All these units may be located simultaneously on one board or on separate boards, and are normally interconnected by a standardised system buss. (A 'buss' is a system or group of interconnections common to an assembly of different devices).

In many applications the microcomputer system is custom designed for the application required, but this is generally very expensive and quite inflexible to the needs of future expansion. Instead of designing individual cards which are dedicated to one application, it is often more cost effective to design small general purpose cards which can be used as building blocks for larger systems. This individual tailoring allows the finished system to suit any given application and, by its very nature of

construction, is more flexible to the needs of future expansion.

Fortunately, the microprocessor lends itself naturally to the modular system approach. The concept of the bus-structured system can therefore be utilised to its maximum and provide the system designer with a means by which he can buy and develop small general purpose cards and interconnect them via the microprocessor buss.

The microprocessor buss forms the backbone to the microcomputer system. ▶

GENERAL SPECIFICATIONS — ETI 685

- Accommodates 2650A (1 MHz) or high speed 2650A-1 (2 MHz) CPUs.
- On-board 4 MHz crystal oscillator supplying the CPU and buss clocks.
- 4K of on-board RAM memory switchable to any 4K address boundary.
- 4K of on-board EPROM memory configured as:
 - 1K, 2K or 4K of EPROM memory commencing at '0000' hex.
 - Supports multirail and single rail 2708 and 2716 EPROMs.
 - Selected on-board EPROM has priority over RAM Memory.
 - ROM memory can be enabled and disabled by software.
- The PHANTOM signal is generated when on-board RAM or EPROM is selected to disable any 'secondary' memory on the buss at the same address.
- One SERIAL PORT supported as EIA RS-232C and current loop.
- One latched 8-bit PARALLEL-IN 'keyboard' PORT.
- One Programmable Peripheral Interface (PPI) providing THREE PROGRAMMABLE PORTS. This PPI can provide combinations of static or strobed I/O, strobed bi-directional or serial I/O and 16-bit timer operations.
- One Programmable Interrupt Controller (PIC) providing eight levels of programmable vectored interrupts.
- Non-vectored Interrupts using pINT and sINTA.
- Full S100 processor and status signal generation:-
 - pWR, pDBIN, sMEMR, sMWRT, sWO, sINP and sOUT for memory and I/O data interchange.
 - pSTVAL, pSYNC, \emptyset (1 MHz) and CLOCK (2 MHz) for buss timing.
 - POC for system initialisation.
- Fully buffered status, address and data lines.
- Direct Memory Address (DMA) capability using pHOLD and pH LDA.
- CPU can address up to 512K of memory using a full 16-bit S100 address buss and the on-board bank select logic.

Project 685

It provides the communication 'high-way' between the CPU and the systems memory and input/output modules. A great many microcomputer standard busses exist today. Some of these have thrived because of the *de facto* acceptance by large user groups, some by their ability to support a wide variety of regular devices, and others by their technical excellence. I have chosen to interface with the S100 buss as this is currently recognised as one of the industry leaders.

The S100 buss

This originated in the USA early in 1975 in a microcomputer system manufactured by MITS. The system was called the Altair 8800 and it used a 100-pin pc board connector (50 pins a side) to provide a communications buss for an Intel 8080 CPU. The Altair Buss later became known as the 'Standard 100 Pin Buss', or S100 buss.

Recently the S100 buss has attracted the attention of the Institute of Electrical and Electronic Engineers in the USA. They have now drafted the IEEE-696 Specification for the buss, which defines the electrical and buss timing specifications for the current generation of 16-bit microprocessors. Some changes include a 16-bit bi-directional data buss and an extended 24-bit address buss. Special signals have been designated to permit the combined operation of 8-bit and 16-bit hardware. These improvements will increase the useful life of the S100 buss well into the 1990s.

The S100 buss has become one of the most commercially successful buss standards ever produced, and the multitude of S100-compatible boards has attracted the interest of both the professional and hobby computerist. Several Australian companies are currently manufacturing S100 boards and several 'kit' projects have been published in ETI.

The S100 RAM Card (Project 642 from Feb. 1979) and the S100 PROM Board (Project 682 from March 1981) are compatible with this project. The S100 VDU Board (Project 640 from April 1978) and the S100 Programmable Character Generator (Project 681 from June 1980) are compatible video interface units. A suitable keyboard and cassette tape interface will be published at a later date.

The project

The ETI-685 has been designed as a very flexible general purpose single-board computer incorporating the Signetics 2650 8-bit microprocessor. This 2650 CPU board has been designed to interface with the well-established S100 buss structure, and this enables the user to easily expand his system's input/output and memory capabilities. This easy-to-use single-board system is a very cost-effective CPU board for OEM

IEEE-696 S100 BUSS STANDARD PINOUTS

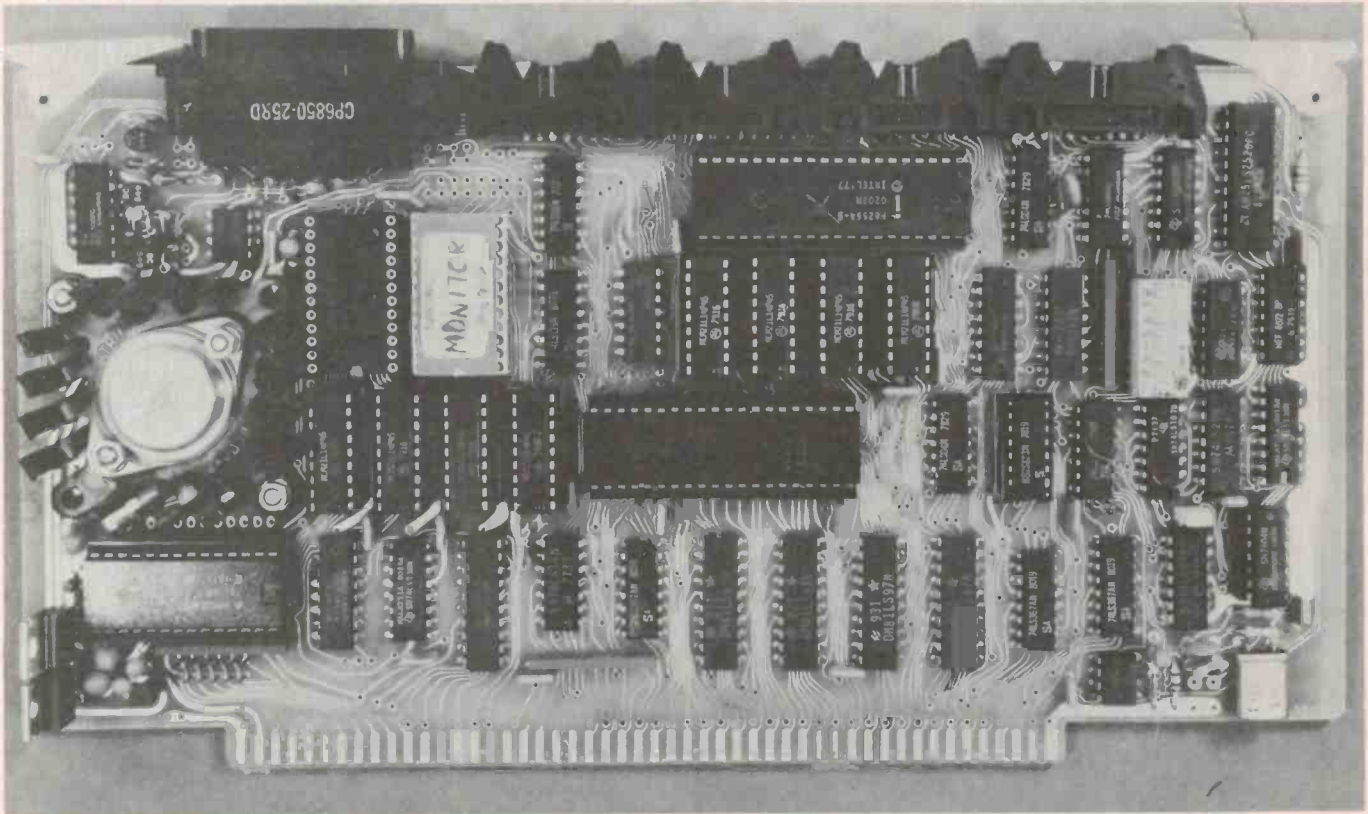
NOTE:

H = Active high signal. L = Active low signal.

(O/C) = signal driven by open collector device

PIN	NAME	LEVEL	FUNCTION
1	+8 V	-	Positive system power supply
2	+16 V	-	+16 V power supply
3	XRDY	H	Buss ready; use with pin 72
4	VI0	L(O/C)	Vectored interrupt line 0
5	VI1	L(O/C)	Ditto
6	VI2	L(O/C)	Ditto
7	VI3	L(O/C)	Ditto
8	VI4	L(O/C)	Ditto
9	VI5	L(O/C)	Ditto
10	VI6	L(O/C)	Ditto
11	VI7	L(O/C)	Ditto
12	NMI	L	Non-maskable interrupt
13	PWRFAIL	L	Indicates power failure
14	DMA3	L(O/C)	Priority bit 3
15	A18	H	Extended address bit 18
16	A16	H	Extended address bit 16
17	A17	H	Extended address bit 17
18	SDSB	L(O/C)	Disable 8 status lines
19	CDSB	L(O/C)	Disable 5 control lines
20	GND	-	Common with pin 100
21	NDEF	-	Manufacturer specification
22	ADSB	L(O/C)	Disable 16 address lines
23	DODSB	L(O/C)	Disable 8 data lines
24	PH2	H	Master buss timing signal
25	PSTVAL	L	Status valid strobe
26	PHLDA	H	Use with pin 74 to buss
27	RFU	-	Reserved
28	RFU	-	Reserved
29	A5	H	Address bit 5
30	A4	H	Address bit 4
31	A3	H	Address bit 3
32	A15	H	Address bit 15
33	A12	H	Address bit 12
34	A9	H	Address bit 9
35	DO1	H	Data out bit 1 (bidirectional bit 1)
36	DO0	H	Data out bit 0 (bidirectional bit 0)
37	A10	H	Address bit 10
38	DO4	H	Data out bit 4 (bidirectional bit 4)
39	DO5	H	Data out bit 5 (bidirectional bit 5)
40	DO6	H	Data out bit 6 (bidirectional bit 6)
41	DI2	H	Data in bit 2 (bidirectional bit 10)
42	DI3	H	Data in bit 3 (bidirectional bit 11)
43	DI7	H	Data in bit 7 (bidirectional bit 15)
44	SMI	H	Status signal (op-code fetch)
45	SOUT	H	Status signal (data to output device)
46	SINP	H	Status signal (data to input device)
47	SMEMR	H	Status signal (data from memory to buss)
48	SHLTA	H	Status signal (halt executed)
49	CLOCK	-	2 MHz signal
50	GND	-	Common with pin 100
51	+8 V	-	Common with pin 1
52	-16 V	-	Negative 16 V supply
53	GND	-	Common with pin 100
54	SCLR	L(O/C)	Reset buss slaves
55	DMA0	L(O/C)	Priority bit 0
56	DMA1	L(O/C)	Priority bit 1
57	DMA2	L(O/C)	Priority bit 2
58	SXTRQ	L	Status signal (slave request)
59	A19	H	Extended address bit 19
60	SIXTN	L	Response by slaves to pin 58
61	A20	H	Extended address bit 20
62	A21	H	Extended address bit 21
63	A22	H	Extended address bit 22
64	A23	H	Extended address bit 23
65	NDEF	-	NDEF
66	NDEF	-	NDEF
67	PHANT	L(O/C)	Phantom to disable slave devices
68	MWRT	H	With PWR for write operation
69	RFU	-	Reserved
70	GND	-	Common with pin 100
71	RFU	-	Reserved
72	RDY	H(O/C)	With pin 3
73	INT	L(O/C)	Interrupt request
74	HOLD	L(O/C)	Used with pHLDA
75	RESET	L(O/C)	Master reset
76	PSYNC	H	Control buss cycle 1
77	PWR	L	Valid data on DO buss
78	PDBIN	H	Control signal data from DI buss
79	A0	H	Address bit 0
80	A1	H	Address bit 1
81	A2	H	Address bit 2
82	A6	H	Address bit 6
83	A7	H	Address bit 7
84	A8	H	Address bit 8
85	A13	H	Address bit 13
86	A14	H	Address bit 14
87	A11	H	Address bit 11
88	DO2	H	Data out bit 2 (bidirectional bit 2)
89	DO3	H	Data out bit 3 (bidirectional bit 3)
90	DO7	H	Data out bit 7 (bidirectional bit 7)
91	DI4	H	Data in bit 4 (bidirectional bit 12)
92	DI5	H	Data in bit 5 (bidirectional bit 13)
93	DI6	H	Data in bit 6 (bidirectional bit 14)
94	DI1	H	Data in bit 1 (bidirectional bit 9)
95	DI0	H	Data in bit 0 (bidirectional bit 8)
96	SINTA	H	Status after interrupt request (pin 73)
97	SWO	L	Status signal data (transfer master to slave)
98	ERROR	L(O/C)	Status signal error (in current cycle)
99	POC	L(O/C)	Power-on-clear signal
100	GND	-	System ground

2650 sbc for S100



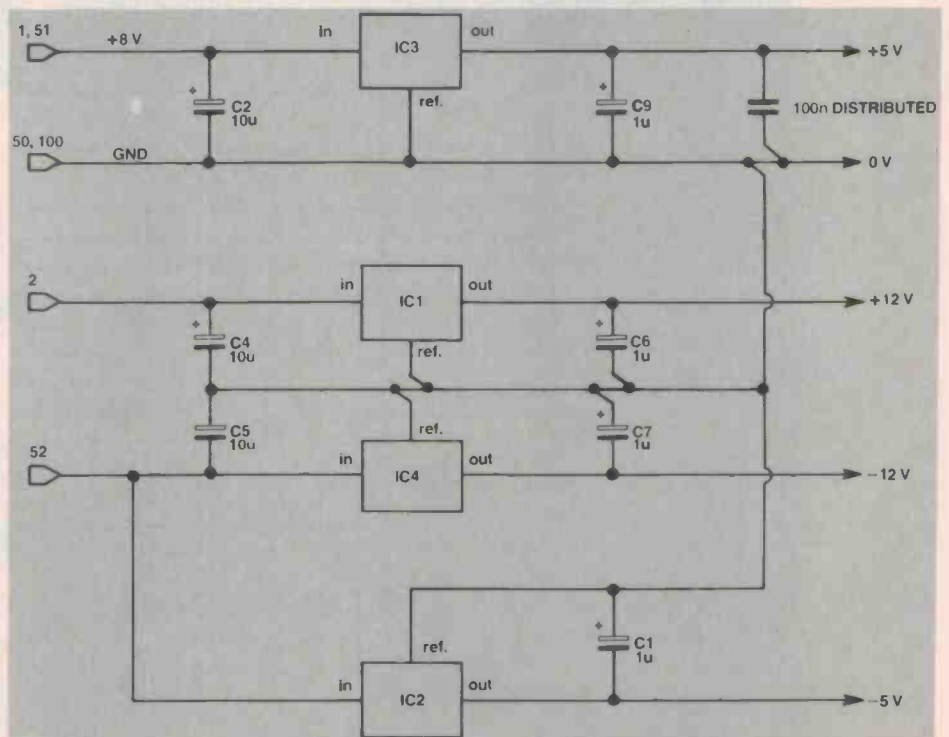
applications, 2650 enthusiasts, micro-processor students or the computer hobbyist after a powerful, expandable system well supported with projects and software.

The ETI-685 is an ideal microprocessor for the student or hobbyist who is just starting out in the world of microcomputing. Well-known author Adam Osborne describes the 2650 as "a very mini-computer-like device ... rich in memory-addressing modes and memory reference instructions". Memory addressing combinations available include absolute or relative direct addressing with optional indexing and auto-increment or decrement, and indirect addressing with optional post-indexing and auto-increment or decrement.

It may be seen from examination of the 2650 instruction set that there are many powerful instructions which are all easily understood and are typical of larger computers. This project has been designed to fully complement the capabilities of this very able microprocessor as every mode of memory or I/O addressing has been utilised.

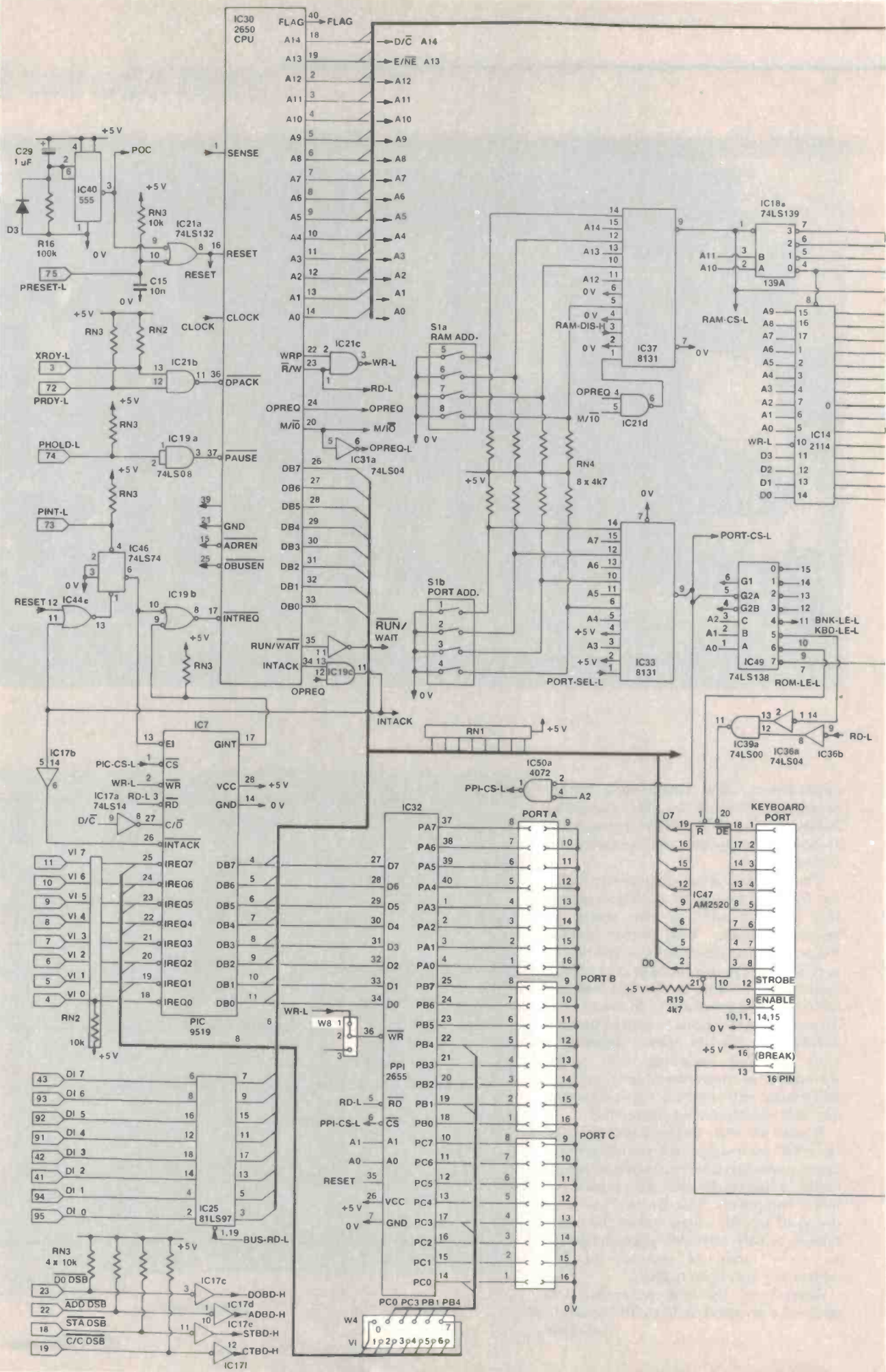
Several of the 256 extended I/O addresses are used on the CPU board to

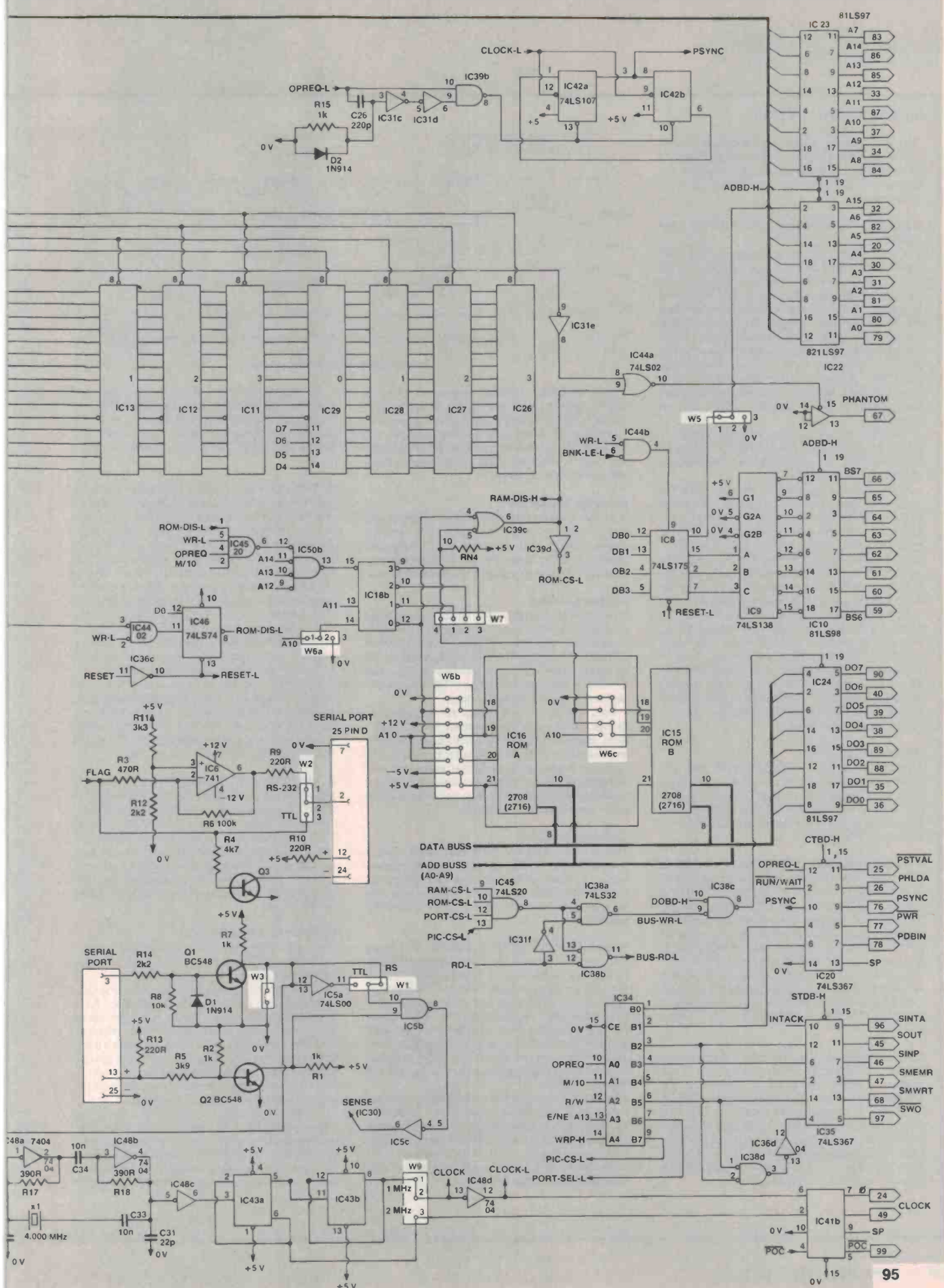
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NOTE: IC2 IS NOT REQUIRED IF 2708 EPROMS ARE NOT USED.

POWER SUPPLY





HOW IT WORKS — ETI 685

This is a detailed functional description of the project and not a 'pulse-by-pulse' description of its operation. Reference to data books for relevant ICs (especially the 2650) is recommended.

CENTRAL PROCESSOR UNIT (CPU) AND CLOCK

The CPU used is the Signetics single-chip 8-bit NMOS microprocessor, the 2650A. This processor has been designed to closely resemble conventional binary computers and executes variable length instructions of from one to three bytes in length. This CPU contains a total of eight general purpose registers, each eight bits long. Any register may be used as the source or destination for arithmetic operations, as index registers, and for I/O data transfers. The 2650 has a 15-bit parallel address buss and can address up to 32768 bytes (32K) of memory.

The 2650 includes a very versatile set of I/O instructions which provide it with 256 extended I/O addresses, two non-extended ports and a special single-bit I/O facility.

The project comprises an internal 8-bit bi-directional data buss, 15-bit address buss and several control signals which interconnect the 2650 CPU to the on-board RAM and ROM memory, ports and the S100 buss buffers. A programmed 32 x 8 fuse-link PROM is used to generate the S100 buss control signals from the 2650's control signals, required for external S100 memory and I/O data interchange.

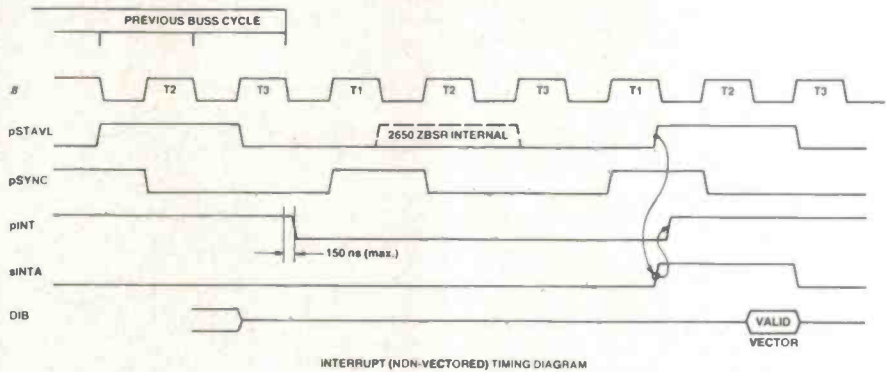
A 4 MHz quartz crystal oscillator formed by IC48a, b and c provides the basic timing element for the CPU and the entire S100 buss computer. This frequency is divided by IC43 to produce the 2 MHz and 1 MHz clocks required for the CPU and the S100 buss CLOCK (pin 49) and ϕ (pin 24) signals. The wire link, W9, is used to change the CPU clock to 2 MHz for the high-speed 2650A-1 processor.

ON-BOARD MEMORY

The Signetics 2650 microprocessor can address directly 32K of memory via its 15 address lines and, following a 'reset', reads its first instruction from address '0000'H. It is therefore customary to locate the system EPROM monitor to start at this address.

1. EPROM MEMORY: Provision has been made on the board for the use of either single (+5 V) or multitrail (+5, +12, -5 Volt) type EPROMs in either 1K (2708/2758) or 2K (2716) increments. Two EPROM sockets have been provided, so the board can accommodate 1K, 2K or 4K of EPROM memory, with the first EPROM (IC16) addressed to '0000'H. The wire link set, W7, selects the location of the second EPROM, and W6 adjusts the pin configuration for the EPROM family in use. These links are preset for a single 2708-type EPROM, which will carry the monitor program.

2. RAM MEMORY: The ETI-685 has provision for 4K of on-board RAM using eight 2114 memory chips. This block of RAM can be addressed to any 4K boundary within the 32K 2650 memory map by switches 5, 6 and 7 of SW1, or it can be disabled completely by switch 8. These four switches work in conjunction with the octal comparator (IC37) to select the RAM block address, and the 1-of-4 decoder (IC18a) generates the RAM chip-select signals.



The on-board EPROM has been given a higher priority than the RAM, and the gate IC39b inhibits the 'reading' of all RAM switched to occupy the same address. For example, if a 1K EPROM (i.e. monitor) and the RAM are both switched to start at '0000'H, the usable RAM will commence at '0400' H.

MEMORY PHANTOM

Both the on-board EPROM and RAM exercise a higher priority over the remaining system memory map and generate the PHANTOM signal on S100 buss pin 67 to deselect any external memory occupying the same address.

EPROM DISABLE

A facility has been provided where the selected on-board EPROM may be disabled, providing continuous RAM from '0000'H. The EPROM is disabled by writing '01'H to the applicable I/O address, which sets the flip-flop IC46b. The EPROM is returned by writing a '00'H to the I/O address or by a processor reset.

This feature is very useful for testing programs which have been written for operation from address '0000'H. It should be noted that even with the EPROM enabled it is possible to load (i.e. Write or Block Move) programs into the RAM, which is co-resident with the EPROM; however, you can only read (or run) the program when the EPROM is disabled.

ON-BOARD PORTS

The ETI-685 has been provided with five ports to give the user a wide variety of Interface Input-output devices without the need for additional I/O boards. Three ports are programmable, one port is serial and the fifth is a latched 8-bit parallel port.

1. THE PROGRAMMABLE PORTS: The three programmable ports (A, B and C) are provided by way of a single 40-pin LSI device (IC32) called the PPI (Programmable Peripheral Interface). This IC is addressed as four consecutive extended port addresses. The first three addresses access the A, B and C port registers and the fourth address is the Control Register. The PPI has three modes of operation, selected by writing the appropriate control word into the Control Register.

In MODE 0 the PPI provides simple input and output for the three 8-bit ports. MODE 1 provides for strobed input and output data transfer from ports A and B with 'handshaking' signals supplied by port C. In MODE 2 the A port is structured as an 8-bit bi-directional port with handshaking supplied by port C.

The Signetics 2655 PPI provides two additional features over the standard 8255 PPI. The B port may be configured for 8-bit serial-to-parallel or parallel-to-serial communications and, in the 2655, the B port contains a 16-bit timer.

2. THE SERIAL PORT: The serial port is supported by the 2650's single bit I/O facility via the Flag and Sense pins. These two CPU pins are connected directly to the processor's Program Status Word register and can be processed by software to provide a variety of serial communication formats. The monitor (Multibug) uses this port for 300 Baud ASCII serial communications, for keyboard input and CRT output, and for 300 Baud binary serial communications to the cassette tape interface. With suitable software, the port can be used to perform any form of data communication including *music and Morse code generation!*

The Flag and Sense pins of the CPU are buffered on the board and are made available at the serial port at EIA RS-232C voltage levels and as a current loop. The EIA RS-232C voltage levels can optionally be converted to TTL levels by rewiring the wire links W1 and W2.

3. THE PARALLEL PORT: The parallel port is supported by a single TTL octal latch which is similar in operation to the standard 74LS373. The latch used, however, is the AM25LS2520 (IC47) which features an additional asynchronous 'clear input' signal. This port is read and reset by addressing the appropriate 2650 extended port. The monitor uses this port as the keyboard input when the 'memory-mapped VDU' monitor is being used.

INTERRUPT CONTROLLER

The project uses the powerful AM9519 Universal Interrupt Controller (IC7) to process eight maskable interrupt inputs. This controller has been designed as a general purpose interface and can be used by most popular 8-bit microprocessors. The AM9519 manages up to eight maskable interrupt inputs, resolves priorities and issues an 'Interrupt request' to the CPU. When the CPU responds with an 'Interrupt acknowledge' the controller outputs a one-to-four byte response associated with the highest priority unmasked interrupt request.

For the 2650 CPU the AM9519 should be programmed for only one response byte, and the eight response bytes are pre-loaded into only eight locations within the 8 x 32 internal read/write response memory. All communication with the Interrupt Controller is by way of

the 2650's non-extended C and D ports. The C port addresses the Control Input for loading the Command Register and reading the Status Register, and the Data read or write transfers to or from the selected internal registers or memory locations are performed via the D port.

NON-VECTORED INTERRUPTS

The S100 non-vectored Interrupt Request (pINT) on buss-pin 73 is also supported on the board. This input, when pulled low, sets the flip-flop IC46a and generates a 2650 INTREQ. When this interrupt occurs, the 2650 will complete its current instruction, set the Interrupt Inhibit bit in the PSW and generate an S100 sINTA ('interrupt acknowledge') signal on buss pin 96. On receipt of sINTA the interrupting device must output the 8-bit vector onto the data-in buss. The flip-flop IC46a is reset automatically when the CPU generates sINTA.

This interrupt request (pINT) has been allotted a higher priority than the eight vectored interrupts managed by the PIC.

MONITOR

A 2716 2K, single-rail EPROM containing two 1K monitor programs is available for use with this project. The EPROM has been written to support either serial communications or memory-mapped video terminals by selecting the appropriate 1K monitor. The EPROM-type link field is set up for a 2758 single-rail 1K EPROM, and the A10 address pin is wired to either 0 V or +5 V to select the required 1K monitor.

Both monitor programs have been styled on the BINBUG monitor and their commands are compatible to BINBUG and the Signetics PIPBUG monitors. The SERIAL MONITOR communicates at 300 Baud via the 2650 Flag and Sense pins and contains a few new subroutines to erase the VDU screen and print a sign-on message. The MEMORY-MAPPED MONITOR differs only from BINBUG in the keyboard-in subroutine, which now utilises the SBC 8-bit parallel port.

BANK SELECT

The ETI-685 incorporates a bank select facility to extend the 2650's maximum address range to 512K of memory. This is accomplished by first generating a sixteenth address bit to

provide an address range of 64K, and then providing a one-of-eight bank (of 64K) select. A quad latch, addressed as one of the on-board decoded extended addresses, is used to store four bits of data. The least significant bit is used as the sixteenth S100 address bit (A15), and the other three bits are presented to a 74LS138 one-of-eight decoder. The eight outputs of the decoder are buffered and appear on the S100 buss on pins 59 to 66 inclusive. If the bank select feature is not required the 74LS138 and the tri-state buffer can be omitted.

S100 SIGNAL GENERATION AND TIMING

An 82S123 fuse-link PROM (IC34) is used to synthesise seven of the eleven S100 control and status signals generated on the board. This PROM has as its inputs the five 2650 control signals — OPREQ, WRP, \bar{R}/\bar{W} , M/ \bar{T} O and E/ \bar{N} E.

The 2650 'operation request' (OPREQ) output signal is the coordinating signal for all external CPU operations. As this signal validates (or qualifies) all data, address and control lines from the 2650 it is 'ANDed' in the PROM with the other four CPU control signals. The OPREQ signal is used to generate the S100 control signal pSTVAL (Processor Status Valid).

The Write Pulse (WRP) output is a timing signal from the CPU that provides a positive-going pulse in the middle of each memory or I/O write operation. It is designed to be used as a timed Write Strobe generated after the address and data lines have stabilised. In the fuse-link PROM this signal is used to generate the S100 control signal, PWR.

The processor Read/Write (\bar{R}/\bar{W}) output defines whether the external operation is a read or a write, and the Memory I/O (M/ \bar{T} O) output defines whether the operation is for memory or I/O. These signals are gated in the PROM to produce the S100 sMEMR, sINP, sMWRT and sOUT signals. As \bar{R}/\bar{W} also indicates in which direction the data flow is, it is also used to generate pDBIN and to control the on-board data-buss transceivers.

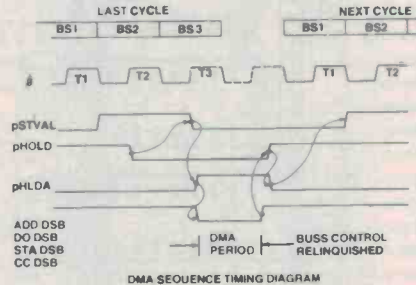
The Extended/Non-Extended (E/ \bar{N} E) 2650 output is the operation control signal that is used to discriminate between the two-byte extended and the one-byte non-extended I/O operation. On the ETI-685 the C and D non-extended I/O addresses are used for communicating with the on-board Interrupt Controller and they are not presented to the S100 buss. The extended signal is used in the PROM to

qualify the S100 I/O status signals sINP, sOUT and sWO.

The S100 control signal pSYNC is defined as indicating the start of a new buss cycle and was initially used to strobe the status latches of external circuitry. These latches stored the 8080's status information which was present on its data lines at this time. As several modern memory boards use pSYNC pulses (e.g. to generate 'wait states') this S100 control signal has been synthesised on the ETI-685. A modulo-3 counter synchronised by OPREQ is used to generate a pulse every three CPU clock cycles. This pulse is one clock period long, and is timed to rise midway through the first buss cycle.

The S100 CLOCK signal is a 2 MHz clock, and the phi (ϕ) signal is the same frequency as the CPU clock (as selected by W9). A Power-On-Clear (POC) signal is generated onboard and can be used to reset 'slave' devices. The Status signal sINTA is the 2650 INTACK, and the pHLDA is the 'WAIT' CPU signal.

Refer to the S100 buss timing diagram for a graphical representation of the timing of these Status and Control signals.



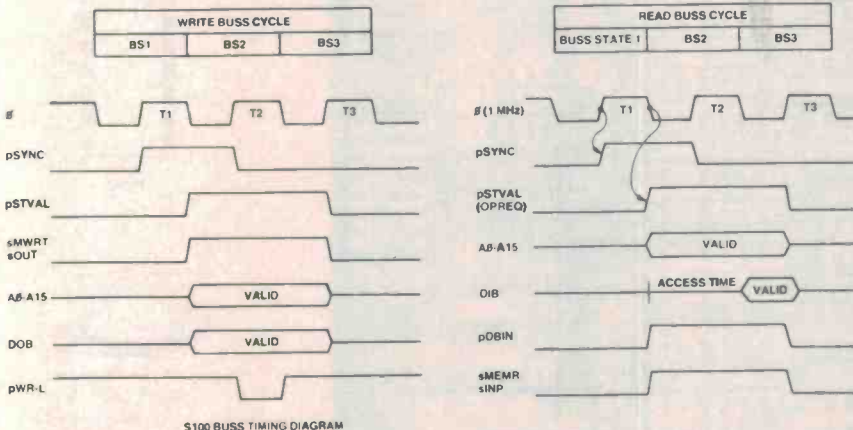
DIRECT MEMORY ACCESS (DMA)

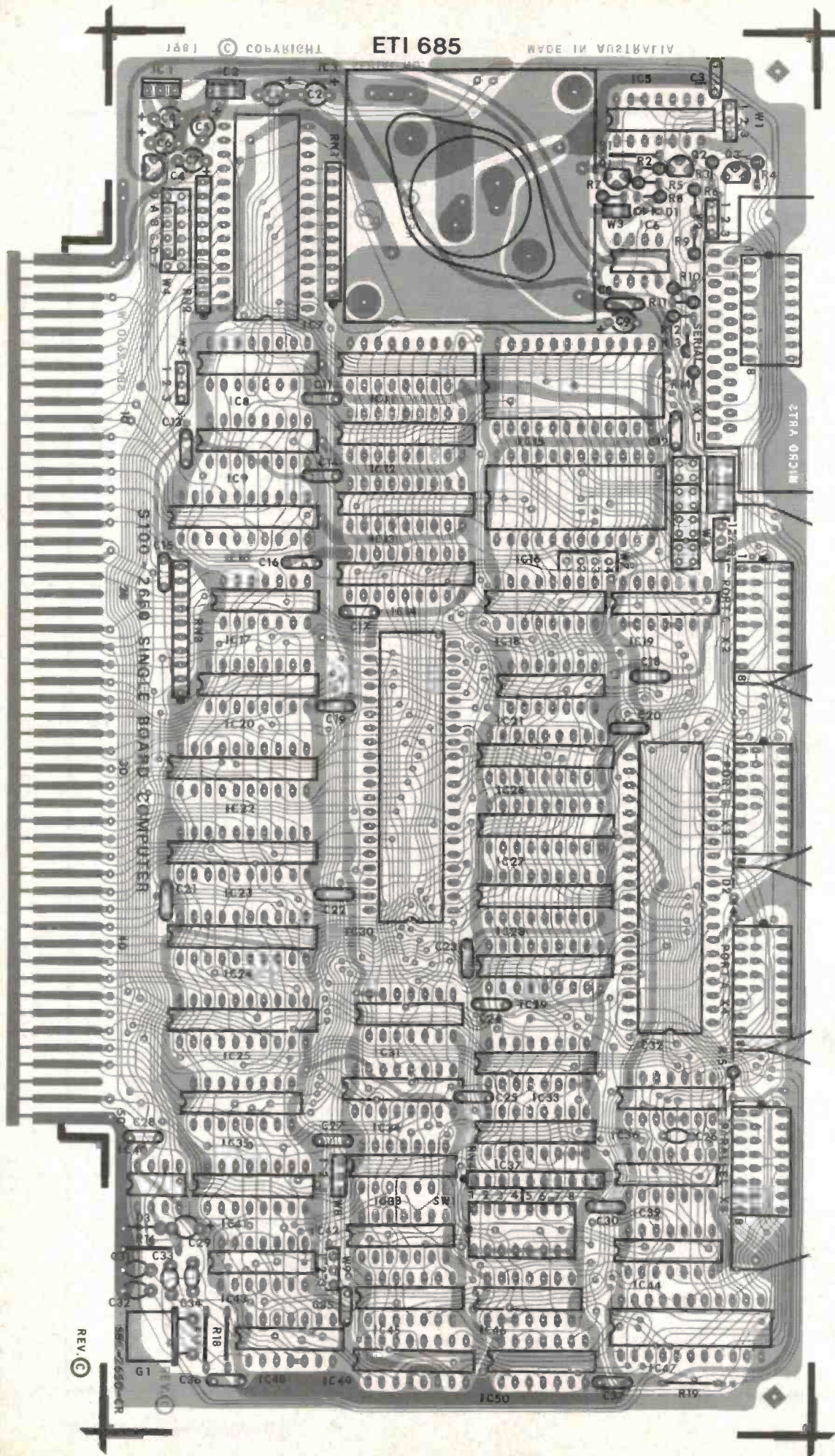
The temporary transfer of buss control from the Buss Master to a Temporary Buss Master for that device to execute a direct memory read or write is referred to as 'Direct Memory Access'. In order to avoid conflict during this transfer of buss control, a predetermined sequence of events exists which is called the DMA Cycle. The exchange of buss control to the DMA device and the subsequent return of control to the CPU (Buss Master) is accomplished by the S100 pHOLD and pHLDA signals.

On the ETI-685 board the pHOLD S100 signal (pin 74) is connected to the 2650 Pause line. When this signal is active the CPU completes its current instruction and enters the WAIT state. It indicates when this condition exists by sending the RUN/WATT status output 'low', and this action generates the S100 pHLDA signal (pin 26). The receipt of pHLDA by the DMA device indicates that it may assert ADDB, DODSB and SDSB, which disables (tri-states) the CPU address, data-out and status buss-buffers. The final transfer of buss control is effected with the assertion of CDSB, which disables the CPU control buss-buffer.

The Temporary Buss Master is now in full control of the buss, and will maintain this condition to the end of its DMA cycle. Return of control to the Buss Master is almost the 'mirror image' of events, with the final transfer of control accomplished with the removal of the pHOLD signal by the DMA device.

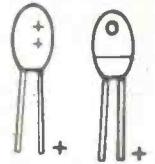
Refer to DMA sequence timing diagram for a graphical representation of a DMA Cycle.



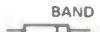


COMPONENT PINOUTS

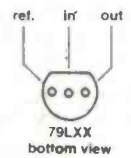
Capacitors



tantalum

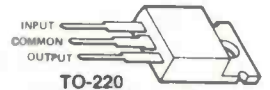


DIODES

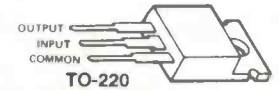


TO-92

79LXX bottom view



TO-220
78xx +ve voltage reg.



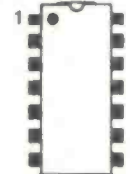
TO-220
79xx -ve voltage reg.



TO-92

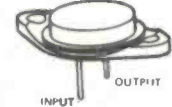
BC548, BC108

NOTCH OR SPOT AT THIS END



ICs

COMMON (INTERNALLY CONNECTED TO CASE)



INPUT

LEADS ARE CLOSER TO THIS END OF THE PACKAGE

TO-3

+ve voltage reg.

From page 93

access the on-board programmable ports, and the control and data non-extended I/O instructions are used to communicate with the programmable Interrupt Controller. This Interrupt Controller will provide the user with a full understanding of interrupt handling procedures.

Construction

The pc board designed for this project is a double-sided type with plated-through holes. We recommend you use a commercially made board for no other reason than that it goes a long way towards ensuring success with the project. If you have access to the appropriate equipment and have enough experience to feel confident in making your own double-sided board, then prints of the pc board pattern are available from us — with the usual proviso that you will only be making one for your own use and not for resale. Note that breach of copyright is now a criminal offence. The board design is copyright to the author, who has licensed Applied Technology to manufacture them. Apart from selling them retail, we understand Applied Technology will wholesale boards to other suppliers.

If you want to make your own board, then send a large (at least 250 x 300 mm) stamped, addressed envelope to:

ETI-685 PCB
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011

We will return a same-size positive print of the front and rear pc board patterns.

With the pc board and all the components in your possession, the first step is to install all the IC sockets in their correct positions. It is recommended that you use sockets for the two EPROM positions (ICs 15 and 16), the 2650 CPU (IC30), all the RAM chips (ICs 11, 12, 13 and 14 plus ICs 26, 27, 28 and 29), IC7 (the PIC), IC32 (the 8255 PPI), IC43 (though one is not shown in our picture) and IC48. These are all located on the component side ('front'). Take care to orient them correctly. On those oriented 'vertically', pin 1 faces 'down' (toward the S100 connector). Those oriented 'horizontally' face the right hand side of the board, when viewed from the component side with the S100 connector facing down.

For the ports — marked X1, X2, X3, X4 and X5 — you have the option of installing dual-in-line sockets or the appropriate right-angle connectors (as shown in the photograph of the prototype).

A little tip — when installing IC sockets, solder one pin on each end of the socket and check that the socket is flat against the board. If necessary, reheat the solder and push the socket against the board. When all sockets are 'tacked' in flat, finish soldering all the other pins.

Install all the resistors next. Pre-bend the leads of each resistor using a pair of long-nosed pliers before inserting them into the board. Note that R2 to R15 are mounted vertically.

Install the four resistor networks (RN1, 2, 3 and 4). Note that pin 1, identified by a 'dot' on the resistor network, is located as indicated on the component overlay.

Now install all the capacitors. Take note of the polarity of the tantalum capacitors.

Follow with diodes D1, D2 and D3; D1 and D2 are mounted vertically. Take note of their polarity, also.

Next comes the crystal. Carefully preform the leads with a pair of long-nosed pliers and apply an 8 mm-square piece of double-sided tape to the back of the crystal before installing it on the board.

When soldering, do not apply excessive heat.

At this stage, check with a multimeter that there is not a short circuit between any voltage rail and 0 V. Measure at the regulators IC1, 2, 3 and 4 between the input and output to ground for any short circuits. Locate and rectify any 'shorts' found before proceeding any further.

Now you can install the voltage regulators IC1, IC2, IC3 and IC4. IC3 is mounted on a large, finned heatsink which must be spaced above the board. Mount four M3 10 mm screws onto the pc board, with four nuts on the top of the board acting as spacers. Fit the heatsink onto the four screws and, after checking that the IC holes are the right way, secure the heatsink with two nuts to the outside screws. Apply heat conductive silicon paste to the underside of IC3 and mount it onto the heatsink. Secure with two nuts and solder the two pins.

Now it is prudent to check power supply operation. Apply power and verify with your multimeter that the outputs of the voltage regulators are within $\pm 5\%$ (e.g. 5.2 to 4.8 V for IC3). ▶

PARTS LIST—ETI-685

Resistors	all $\frac{1}{2}$ W5%	IC30	2650A (CPU)
R1, 2, 7, 15	1k	IC31, 36	74LS04
R3	470R	IC32	2655:8255A (PPI)
R4, 19	4k7	IC33, 37	8131
R5	3k9	IC34	82S123
R6, 16	100k	IC38	74LS32
R8	10k	IC40	555
R9, 10, 13	220R	IC42	74LS107
R11	3k3	IC43, 46	74LS74
R12, 14	2k2	IC44	74LS02
R17, 18	390R	IC45	74LS20
RN1, 2, 3, 4	4k7 x 9 SIP resistor networks	IC47	AM25LS2520
Capacitors		IC48	7404
C1, 6, 7, 9, 29	1u/6 V tant.	IC50	4072
C2, 4, 5	10u/6 V tant.	Miscellaneous	
C3, 8, 10-25, 27, 28, 30, 35-37	100n ceramic	X1	4.000 MHz crystal
C26	220p ceramic	SW1	8-way SPST DIP switch
C31, 32	22p (see text)	ETI-685 pc board (see text); pc-mount T0-3 heat- sink — Thermalloy type THM6051B or 6001B-2 or similar; DIP sockets — 2 x 8-pin, 15 x 14-pin, 15 x 16-pin; 8 x 18-pin, 5 x 20-pin, 1 x 22-pin, 2 x 24-pin, 1 x 28-pin, 2 x 40-pin; nuts, bolts etc.; two pc board ejectors — e.g. Cambion No. 415 7036 01 00 20 or similar.	
C33, 34	10n ceramic	Optional connectors: The following connectors may be used in lieu of 16-pin DIP sockets: 1 x 25-pin 90° pc-mount 'D' connector (CP6850- 25RD); 3 x 10-pin 90° headers (e.g. Hirose HIF3- 10P-2.54DS or sim.); 1 x 16-pin 90° header (e.g. Hirose HIF3-16P-2.54DS or sim.).	
Semiconductors		Price estimate	
D1, 2, 3	1N914A, 1N4148A	We estimate the cost of purchasing all the com- ponents for this project will be in the range:	
Q1, 2, 3	BC108, BC548	\$200—\$230	
IC1	7812	Note that this is an estimate only and not a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreg- lass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.	
IC2	7905		
IC3	LM323K		
IC4	79L12		
IC5, 39	74LS00		
IC6	741		
IC7	AM9519PC (PIC)		
IC8	74LS175		
IC9, 49	74LS138		
IC10	81LS98		
IC11-14, 26-29	2114L-4		
IC15, 16	2708/2716 (one monitor, one spare)		
IC17	74LS14		
IC18	74LS139		
IC19	74LS08		
IC20, 35, 41	74LS367		
IC21	74LS132		
IC22-25	81LS97		

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If all is well, remove power and clean the flux off the rear of the board with flux cleaner or methylated spirits.

Before proceeding with installation of the ICs onto the board it is advisable to check the data and address buss lines for shorts. Any shorts on these lines will prevent the board from operating and can make fault finding very difficult. An ohmmeter or small buzzer can be used to check for shorts. Place one probe on the first data or address line at the CPU socket (IC30) and touch the other probe across the remaining lines in turn. No continuity should be found. Move the fixed probe to the next line and repeat the process until all lines have been checked.

Install IC43 and 48 into their respective sockets. Apply power to the board and, with the aid of a logic probe or CRO, verify that the 1 MHz clock appears at pin 38 of IC30 and pin 6 of IC41.

Install the following ICs: 5, 13, 17, 18, 19, 21, 28, 30, 33, 36, 37, 40, 44, 45, 46, 49 and 50. The board now contains sufficient components to operate as a 'minimum component system' with 1K of user RAM available from '0400'H to '07FF'H. The board can be operated and tested using a serial VDU with communications via the current loop. A serial VDU monitor in 2708 EPROM must be installed at IC16. If the 2716 dual SBC monitor is to be used, the W6 wire link field must be rewired, as illustrated in the wire-link diagrams. The SBC Monitor requires the keyboard to be wired to the parallel port at socket X5.

The successful operation of the project at this point will indicate that all the internal data, address and control busses are without fault and you may proceed to install the on-board ports, extra RAM and the S100 buss buffers.

If a serial VDU is not available, this intermediate test cannot be performed, so proceed to the next step.

Install the following ICs: 6, 11, 12, 14, 20, 22, 23, 24, 25, 26, 27, 29, 31, 34, 35, 38, 39, 41, 42 and 47. The board is now complete and can be installed onto an S100 buss mother board.

A 'BINGUG' 2708 Monitor can be inserted into IC16 to enable the use of the 640 VDU. If the dual SBC monitor or any other program in 2716 EPROM is to be used, ensure that the W6 link field has been rewired accordingly.

The ETI-685 can now be tested on the S100 buss with additional RAM memory. To verify that the system is fully operational, load and execute the RAM-TEST program given on page 104.

Next, you can install the PPI (IC32) and the PIC (IC7 — optional). Verify that the PPI is operational by loading and executing the PPI-TEST Program on page 104. Note that external hardware (an octal DIP switch and pull-up resistors) will be required to connect to the port under test.

The Multibug Monitor

The Monitor is a peripheral interface program, resident in non-volatile ROM or EPROM, which provides the user with a basic set of operating commands. This program is resident at address '0000'H, and is executed by a CPU 'reset'.

The ETI-685 can be operated with any monitor program which commences at address '0000'H. In most cases one of three monitors will be used. Firstly, there is the Signetics' PIPBUG monitor (transferred into EPROM) for serial VDUs, then there is the range of BINBUG monitors (produced by MicroByte) for S100 memory-mapped VDUs and thirdly, the SBCBUG monitor.

The SBCBUG is a 2716 2K single-rail EPROM containing two 1K monitor programs. The EPROM has been written to support either serial communications or memory-mapped video terminals by selecting the appropriate 1K monitor. The EPROM-type link field is set up for a 2758 single-rail 1K EPROM, and the A10 address pin is wired to either 0 V or +5 V to select the required 1K monitor (see later).

Both monitor programs have been styled on the BINBUG monitor and their commands are compatible to the BINBUG and PIPBUG monitors. The original PIPBUG monitor supported seven basic commands, each selected by a single alpha character, and these have been retained. The SERIAL MONITOR communicates with the VDU at 300 Baud via the 2650 Flag and Sense pins, and contains a few new subroutines to erase the VDU screen and print a sign-on message. The MEMORY-MAPPED MONITOR differs only from BINBUG in the keyboard-in subroutine, which now utilises the on-board 8-bit parallel port.

Monitor commands

Following are the commands and their respective functions:

- A — Examine and Alter memory contents.
- B — Set a program Breakpoint.
- C — Clear a set breakpoint.
- D — Dump a block of memory to tape (300 Baud binary).
- G — Execute a program at a specified 'Go' address.
- L — Load a tape file into memory.
- S — Examine (See) and modify the CPU registers.

Now let us look in detail at each command and what they do.

Examine and alter memory: This command provides the user with a means of *displaying* the contents of a specified memory location and *altering* ▶

MONITOR SUBROUTINE SUMMARY

The monitor is included in the microcomputer system to provide the user with a basic set of operating peripheral interface commands. Many of the program subroutines contained in the monitor can be incorporated into user programs, and their use will greatly simplify interface programming requirements.

The following subroutine descriptions have been compiled to give the programmer a brief explanation of the function of each subroutine, details of the CPU registers affected and the maximum level of subroutine nesting achieved by each subroutine. The subroutines are listed in 'name' alphabetical order. The subroutines are only available in either the Serial or Memory-Mapped VDU Monitors.

Name	Address	Nest	Description
AGAP	027D	3	Outputs 'the number in Register 3' spaces ('H'20').
BIN	0224	3	Inputs two hexadecimal characters from the keyboard and forms as one 8-bit byte in register R1. Serial monitor only.
BOUT	0269	3	The byte in R1 is output in binary as two hexadecimal characters.
CHIN	0286	3	An ASCII character is input to R0 from the keyboard.
COUT	02B4	2	The byte in R0 is output as an ASCII character.
CRLF	008A	3	Outputs a carriage return and line feed to VDU.
DLAY	039B	1	Produces a 1-bit delay at 300 Baud (approx. 3.3 ms).
DLY	039F	1	Produces a half-bit delay at 300 Baud (approx. 1.6 ms).
FORM	027B	3	Outputs three spaces ('H'20') to the VDU.
GNUM	02DB	2	Places the next entry in the line buffer into R1 and R2. It ignores leading zeros and correctly interprets a 1, 2, 3 or 4-character entry.
INCT	00AB	1	Adds the two-byte number stored at TEMP and TEMP + 1 to R1 and R2 (with carry) and stores the two-byte result back in TEMP and TEMP + 1.
LINE	005B	3	Inputs up to 20 characters from the keyboard into the Line buffer. 'Delete' is used for entry corrections and CR or LF terminates the routine.
LKUP	028C	1	Converts an ASCII character in R0 into a hex value in R3. Generates an error message if a character is not hexadecimal.
STRT	00A4	1	Stores the number in R1 and R2 in TEMP and TEMP + 1.

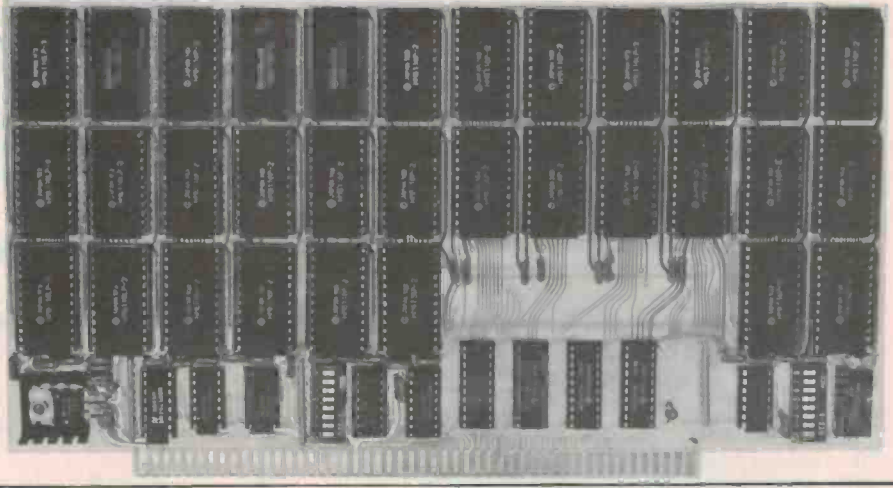


APPLIED TECHNOLOGY

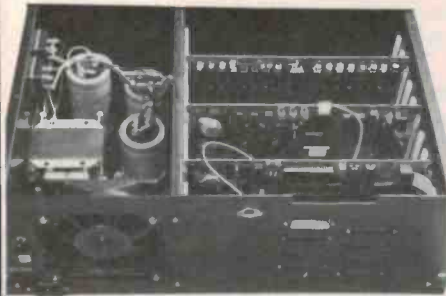
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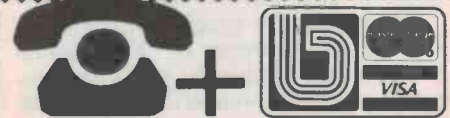
How can we offer professional S100 products at such low prices and stay in business? We can do this by keeping overheads low. We only have one outlet. We operate largely by mail order and we design and build our products here in Australia. As a result you get some of the finest S100 products in the world at truly bargain prices.

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the current contents if necessary. It contains an automatic address increment facility and may be used to load a program into consecutive memory locations.

This command is also used to *examine* the contents of memory following a program execution or breakpoint. The automatic address increment feature can be used to display the contents of consecutive memory locations.

Command format: **Axxxx<**

xxxx is the hexadecimal address of the memory location for display. Address leading zeros may be omitted.

Following the execution of this command by the entry of the 'carriage return' key (shown thus '<'), the memory address and its contents will be displayed in the following format:

xxxx . . . zz . . . []

zz is the current contents and **[]** represents the cursor location. To *alter* the memory contents, key in (in hex.) the required data. Leading zeros may be omitted. If no data is entered before a carriage return (CR) or line feed (LF) the contents will remain unaltered.

To *examine* the next memory location (auto address increment) enter a line feed. To exit from this command enter a carriage return.

Set breakpoint: A program *breakpoint* is primarily used during *program fault finding (debugging)* to terminate the execution of a program at a predetermined location. When the breakpoint is encountered, control is returned to the user, who is then able to use the other monitor commands to examine the microprocessor's internal registers or the program's memory locations.

Only one program breakpoint can be set at a time.

Command format: **Bxxxx<**

xxxx is the hexadecimal address of the first byte of the program instruction at which the program 'break' is required. Leading zeros may be omitted.

The breakpoint program operates by altering the contents of the program memory and cannot be used on programs which reside in ROM or EPROM. Two bytes of program data are replaced with '9B'H and the previous data is saved in reserved locations in the monitor's scratchpad RAM memory. When the breakpoint is encountered the original data is returned (auto-clear) to the program and the contents of the microprocessor's internal registers are saved in the monitor's scratchpad RAM.

Clear breakpoint: This command is used to erase a pending program breakpoint. The previous program data

is returned and the breakpoint flag reset. If no breakpoint exists the monitor's error message is displayed.

Command format: **C<**

The user should note that the monitor's RAM memory is cleared following a processor reset and any program data stored there due to a pending breakpoint will be lost.

Dump to tape: The *DUMP* command provides the user with a means of saving programs on audio-quality magnetic tape. The SBC monitor outputs binary data at 300 Baud in the same format as the popular BINBUG monitor. This format is approximately six times faster

than the original Signetics PIPBUG routine and represents the best compromise of speed and reliability. A suitable frequency shift keyed cassette tape interface must be connected to the serial port on-board.

Command format: **Dssss-ffff-eeee<**

ssss is the start address of the block of data to be saved.

ffff is the finish address of the block of data.

eeee is the optional auto-start program entry address.

The output format consists of a leader of 32 nulls, a ':' header, a four-byte start address, a two-byte block length, a two-

2650 MEMORY ADDRESS ASSIGNMENT TABLE

Memory Sector (K)	Starting Address	Ending Address
1	0000	03FF
2	0400	07FF
3	0800	0BFF
4	0C00	0FFF
5	1000	13FF
6	1400	17FF
7	1800	1BFF
8	1C00	1FFF

9	2000	23FF
10	2400	27FF
11	2800	2BFF
12	2C00	2FFF
13	3000	33FF
14	3400	37FF
15	3800	3BFF
16	3C00	3FFF

17	4000	43FF
18	4400	47FF
19	4800	4BFF
20	4C00	4FFF
21	5000	53FF
22	5400	57FF
23	5800	5BFF
24	5C00	5FFF

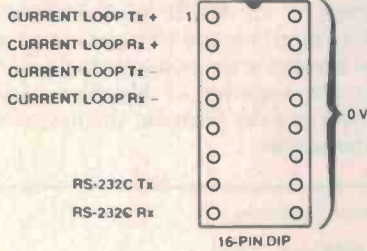
25	6000	63FF
26	6400	67FF
27	6800	6BFF
28	6C00	6FFF
29	7000	73FF
30	7400	77FF
31	7800	7BFF
32	7C00	7FFF

NOTES:

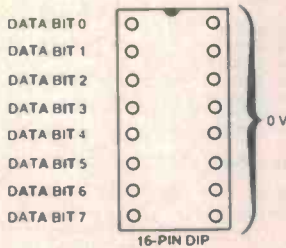
1. Caution should be exercised when attempting program flow across page boundaries (shown thus '- - -'). Refer to the Signetics 2650 Microprocessor Data Manual.
2. The 2650 Monitor resides in the first 1K sector (0000-03FF) and uses the next 64 bytes of RAM (0400-043F). User RAM commences at 0400.
3. The ETI-640 VDU resides in the 2K address sector 7800-7FFF.
4. The 2650 Disk Operating System (DOS) resides in the 2K address range 6800-6FFF and uses 2K of RAM at 7000-77FF.

PORT CONNECTOR PINOUT DIAGRAMS

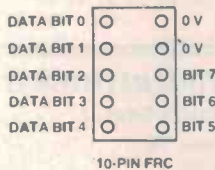
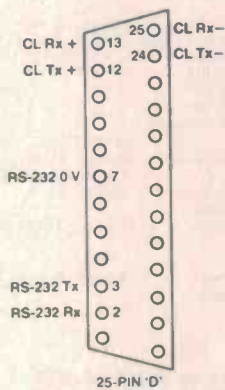
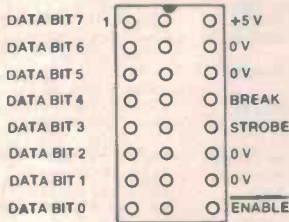
SERIAL PORT



PPI PORT A, B AND C



PARALLEL PORT (KEYBOARD)



PORT CONNECTOR PINOUT DIAGRAMS

byte SOT checksum, the data block and the block checksum. As the data block has a maximum length of 256 characters, the above process is repeated as often as necessary until the end address is reached.

GOTO (and execute): The *GOTO* command instructs the processor to execute the program at a specified hexadecimal address.

Command format: **Gaaaa <**

aaaa is the hexadecimal program execution address. Leading zeros can be omitted.

This command utilizes the monitor 'line' subroutine to input a line of up to 20 characters into the 'line buffer'. As only five characters are used by the command, a further 14 characters may be entered (following a delimiting 'space') to pass additional parameters to the executing program.

Load from tape: The *LOAD* command is used to read back a binary data file from tape which has been recorded using the *DUMP* command, or an identical output format. The program extracts the start address from the data file and performs CRC checking. The tape load will be aborted and the monitor's error

message displayed if a CRC error is detected.

Command format: **L <**

At the completion of an error-free load the program checks the end of the data file for an auto-start address. If an address is found the program will direct the processor to execute the program at that address. If no address is found the monitor will respond with the '*' prompt message.

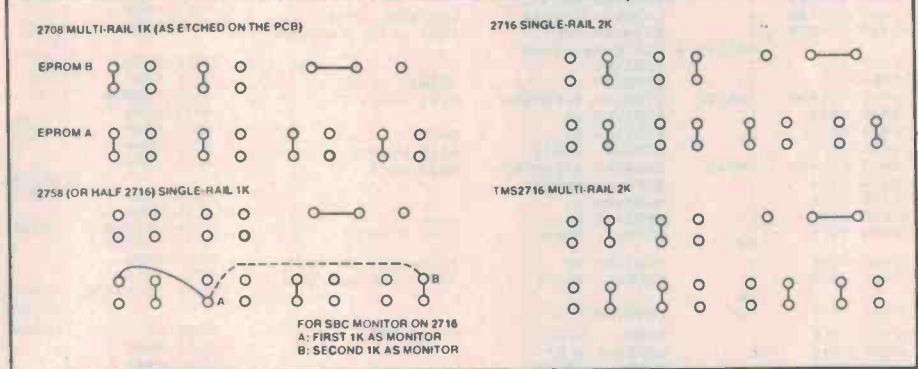
Examine (See and alter) CPU registers: This command is primarily used in conjunction with program breakpoints during program fault finding. Program breakpoints can be used to obtain a 'snapshot' of the program and the microprocessor's status immediately prior to the execution of the instruction at the breakpoint address.

This command is used to display the contents of any of the CPU's seven internal registers and two program status words following the execution of a program breakpoint. It also permits the user to alter the contents of any of these registers and resume program execution using the G command.

Command format: **Sn <**

The number 'n' (valid in the range 0 to 8) is used to select the particular register for display. ▶

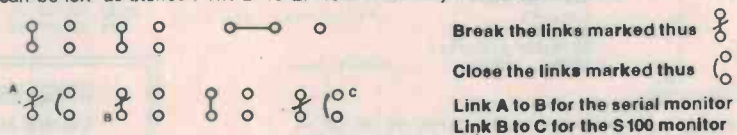
EPROM TYPE SELECTION FIELD (W6)



LINKING FOR THE MULTIBUG MONITOR ROM (V1.1)

The Multibug monitor EPROM is a single +5 V EPROM containing two 1K monitor programs which have been developed for the ETI-685 from the popular BINBUG monitor. This EPROM contains in the first 1K a monitor to interface with 300 Baud serial video terminals and in the second 1K a monitor to interface with S100 buss memory-mapped VDUs (such as the ETI-640). The required monitor program is selected by setting the EPROM's A10 address line to either 0 V (for the serial monitor) or +5 V (for the S100 monitor).

To use the 2716 EPROM the W6 link field must be rewired from its 'etched' linking, which has been preset for multi-rail 2708 EPROMs. Three links must be broken and the adjacent links closed; all other links can be left 'as etched'. The 2716 EPROM must only be inserted at IC16.



THE S100 MONITOR FOR ETI-640 TYPE VDUs.

The S100 Monitor uses the X5 parallel-in-port connection to interface to a standard parallel keyboard which produces a positive strobe. The port 'enable' line can be tied direct to 0 V and the keyboard should not draw more than 50 mA from the +5 V supply. A 'Break' function using the CPU Sense line can be used if the top half of the W2 link set is rewired (break 1-2 and close 2-3).

- 0 = register 0
- 1 = register 1 bank 0
- 2 = register 2 bank 0
- 3 = register 3 bank 0
- 4 = register 1 bank 1
- 5 = register 2 bank 1
- 6 = register 3 bank 1
- 7 = Program Status Word Upper
- 8 = Program Status Word Lower

The user may alter the displayed register's contents by entering a two-character hexadecimal number before entering a CR or LF. To display the next register (auto increment) enter a LF. To exit from this command, enter a CR.

Follow up

Plans are well advanced to follow up this project with a number of related articles

and projects. First up, we have an article coming on the subject of interfacing, using the 8255 programmable peripheral interface (PPI). Work is currently in progress on an ASCII keyboard and a cassette interface and we hope to present these as early in the new year as possible, given the vagaries of Murphy's Law, mayhem and the fairies at the bottom of the darkroom . . .

```

** MEMORY TEST PROGRAMME
**
** Execute by kevincs B440_S888_EEEE
**
:EBUG EQU H'001D'
:MBUG EQU H'0022'
:CRLF EQU H'0025'
:ZOUT EQU H'002A'
:GAST EQU H'00A1'
:BDOUT EQU H'0269'
:FDOUT EQU H'0279'
:GNUM EQU H'02DB'
**
:TEMP EQU H'040D' Start Address pointer
:TEMQ EQU H'040F' End Address pointer
**
: DRG H'0440'
**
0440 0402 :INIT LODI,R0 02 Arith. compare
0442 93 : LPBL Clear Carry, R81 0500 0480
0443 7640 : PPSU FLAG 0502 D403
0445 3F00A1 : BSTA,UN GAST Set flag 0504 20
0448 E504 : COMI,R1 04 Fetch Start Add. 0505 93
044A 9805 : BCFR,EQ CNT Not 0400-4FF block 0506 C809
044C 0505 : LODI,R1 05 then start at 0500 0508 C809
044E CD040D : STRA,R1 TEMP Start Add. in TEMP
0451 3F02DB :CONT BSTA,UN GNUM Fetch End Add.
0454 CD040F : STRA,R1 TEMQ End Add. in TEMQ
0457 20 : EDZR,R0 Hex '00' 050A 0400
0458 CC040E : STRA,R0 TEMP+1 Only 256 byte blocks 050C 0708
045B CC0410 : STRA,R0 TEMQ+1 050E 0580
**
045E BBA5 :Print Address block to test
:BLOCK ZBSR SCRLF New line 0510 D500
0460 0D040D : LODA,R1 TEMP High Add. byte 0512 5400
0463 3F0269 : BSTA,UN BOUT 0514 E1
0466 0D040E : LODA,R1 TEMP+1 Low Add. byte 0515 9829
0469 3F0279 : BSTA,UN FOUT BOUT with 3 spaces 0517 51
**
046C 20 : EDZR,R0 0518 FR76
046D C2 : STRZ,R2 Clear index 051A FA70
046E CEE40D :WRITE STRA,R0 *TEMP,R2 Fill block 051C 0973
0471 8401 : ADDI,R0 01 051E F501
0473 8601 : ADDI,R2 01 next 0520 1D052B
0475 9877 : BCFR,Z WRITE till H'00' 0523 8501
0477 FEE40D :READ COMA,R0 *TEMP,R2 Read back 0525 C96A
047A 9826 : BCFR,EQ ERROR 0527 C96A
047C 8401 : ADDI,R0 01 next 0529 185F
047E 8601 : ADDI,R2 01 till H'00'
0480 9875 : BCFR,Z READ
**
0482 8401 : ADDI,R0 01 Increment for all
0484 9868 : BCFR,Z WRITE data combinations
**
0486 044F :OK LODI,R0 A'D'
0488 BBAA : ZBSR *ZOUT Print '0'
048A 044B : LODI,R0 A'K'
048C BAAA : ZBSR *ZOUT Print 'K'
**Test for End Address
048E 0D040D : LODA,R1 TEMP
0491 ED040F : COMA,R1 TEMQ
0494 1C0022 : BCTA,EQ MBUG End of test
0497 1D001D : BCTA,GT EBUG Address wrong
049A 8501 : ADDI,R1 01 Next block
049C CD040D : STRA,R1 TEMP
049F 1F045E : BCTA,UN BLOCK
**Report error and Address
04A2 C3 :ERROR STRZ,R3 Save fail data byte
04A3 0D040D : LODA,R1 TEMP High Add. byte
04A6 3F0269 :IBOUT BSTA,UN BOUT Low Add. byte
04A9 02 : LODZ,R2
04AA C1 : STRZ,R1
04AB 3F0279 : BSTA,UN FOUT Print written value
04AE 03 : LODZ,R3
04AF C1 : STRZ,R1 Print fail data byte
04B0 3BF5 : BSTR,UN *IBOUT+1
04B2 9822 : ZBRM MBUG Abort test.
**
00 ERRORS DETECTED

** B255 PPI TEST PROGRAMME
**
**Execute by entering 'G500'
**
:PORTA EQU H'00'
:PORTB EQU H'01'
:PORTC EQU H'02'
:CNTRL EQU H'03'
**
:EBUG EQU H'001D'
:MBUG EQU H'0022'
:ZOUT EQU H'002A'
:BDOUT EQU H'0269'
:FORM EQU H'027B'
:FDOUT EQU H'0279'
:CDOUT EQU H'02B4'
**
: DRG H'0500'
**
:INIT LODI,R0 H'80' All port output
:WRITE,R0 CNTRL 0500 0480
:EDZR,R0 0502 D403
: LPBL Arith. compare, clear
0505 93 : carry and R81.
0506 C809 : STRR,R0 WRITE+1
0508 C809 : STRR,R0 READ+1
**Test port by writing a bit pattern and then
: read it back and compare
:START LODI,R2 H'00' Loop counter
:TEST LODI,R3 H'08' Byte counter
: LODI,R1 H'80' Bit 8 set
:WRITE WRITE,R1 PORTA Output data pattern
:READ REDE,R0 PORTA Read data back
: then compare
: COMZ,R1
: BCFR,EQ ERROR
: RRR,R1 Shift set bit
: BDRR,R3 WRITE eight times then
: BDRR,R2 TEST loop 256 times
**
: LODR,R1 WRITE+1 Fetch current port
: COMI,R1 PORTC-1 At port C set
: BCTA,GT END Yes, all ports OK
: ADDI,R1 01 No, next port number
: STRR,R1 WRITE+1 loaded
: STRR,R1 READ+1
: BCTR,UN START Continue test
**Print the PPI OK message
:END PPSU FLAG
: LODI,R3 0 Init. loop cnt.
:PRINT LODA,R0 TEXT-1,R3 Fetch byte
: BCTA,Z MBUG Last byte is zero
: ZBSR *ZOUT Print byte
: BCTR,UN PRINT loop
:TEXT DATA A'PPI OK'.0
**Print the error message
:ERROR STRZ,R2 Save found value in R2
: LODR,R0 START+1 Fetch port value
: ADDI,R0 H'41' Convert to Alpha
: ZBSR *ZOUT Print port
: BSTA,UN FORM Print written value
: BSTA,UN FOUT
: LODZ,R2
: STRZ,R1
: BSTA,UN BOUT Print found value
: ZBRM EBUG
**
00 ERRORS DETECTED

0500 04 80 D4 03 20 93 C8 09 06 00 07 08 05 80
0510 D5 00 54 00 E1 98 29 S1 FB 76 FA 70 09 73 E5 01
0520 1D 05 2B 85 01 C9 6A C9 6A 1B 5F 76 00 07 00 0F
0530 25 38 1C 00 22 BB AA 1B 76 50 49 20 4F 4B 00
0540 C2 08 48 84 41 BB AA 3F 02 7B 3F 02 79 02 C1 3F
0550 02 69 9B 1D

```

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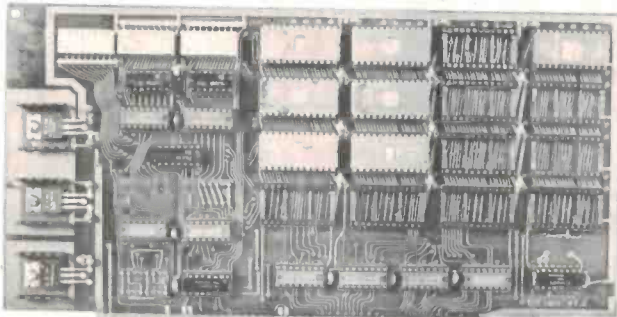
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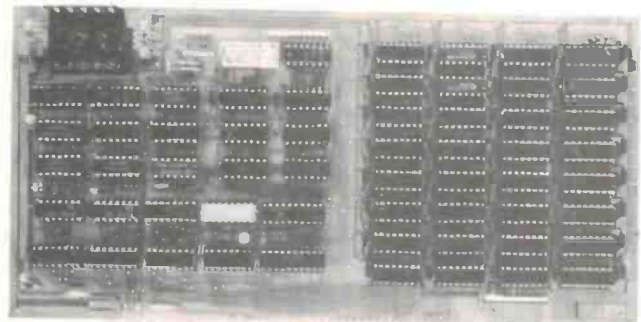
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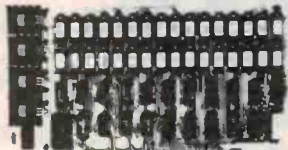
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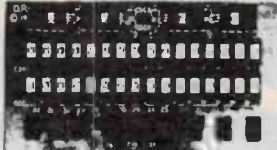
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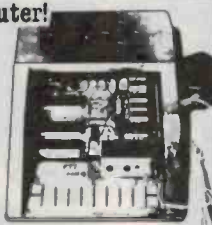
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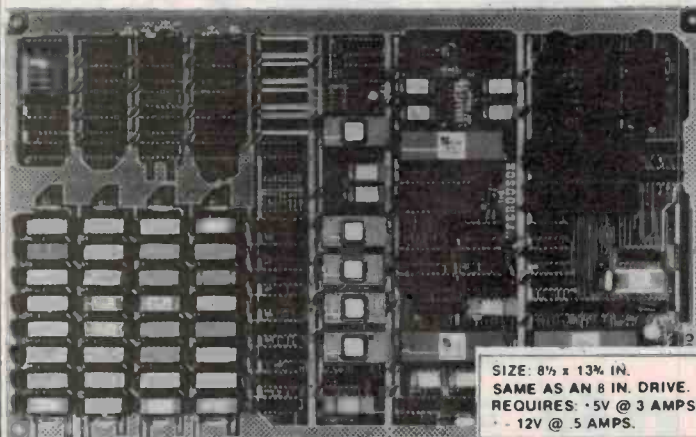
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Sorcerer Competition

We are running a programming competition and encourage anyone with time and enthusiasm to enter. Prizes will total over \$2,500.00! One prize of \$500.00 will be awarded to each winning entry in all 5 sections with the chance of more than one winning entry per section if the standard is particularly high.

SECTION 1: Games — Any type of game will be accepted although we recommend the arcade styles such as Asteroids or Adventure games.

SECTION 2: Utilities — Here a wide range of options is available including Graphics, Plotting, Assemblers, Mini Compilers, Printer Drivers and Disk Utilities.

SECTION 3: Educational — Anything from child education in Maths and Spelling to computing such as the Machine Code tutorials.

SECTION 4: Serious Applications — This may include Data Base programs, Accounting Systems (both cassette and disk based), Maths and Scientific packages, Astronomy and other special purpose applications.

SECTION 5: Miscellaneous — Anything not covered above such as Novelty Programs, Hardware/Software combinations, Sound Generation and Wordprocessor programs would come under this section.

CONDITIONS OF ENTRY

All applications must be lodged at System Software on or before the 31st December, 1981.

Entries should be submitted on cassette at both 1200 and 300 baud twice each. If the software is to be run on disk, instructions should be included on uploading.

No entry will be returned unless specifically requested and return postage forwarded.

Entries will be judged according to: (1) Programming technique, (2) Reliability, (3) Usefulness, (4) Creativity, (5) Originality, (6) Marketability and (7) Documentation.

At least one (1) winning entry will be taken from each section.

The Judges' decisions will be final and no correspondence will be entered into.

A prize of \$500.00 will be awarded to each winning entry.

Only winning entries will become the property of System Software.

The names of all programmers submitting winning entries will be published in a subsequent catalogue unless otherwise requested.

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The object is to guide a small space ship across the screen avoiding but shooting asteroids as they glide past. When an asteroid is hit, it will break up into many smaller pieces. By repeatedly hitting the pieces they will soon disintegrate and disappear. If you crash your ship into an asteroid it will break into pieces and splinter across the screen in a shower of sparks! However, if you manage to stay in one piece, chances are you'll soon be pursued by a flying saucer that shoots balls of fire! Best that you treat him with care, else you may make his friends VERY aggressive.

Apollo has used a novel but ingenious method of continually reprogramming graphics characters and has obtained stunning results! All movement is done pixel by pixel but without speed loss. Numbers of asteroids, directions, speeds and such like are all totally unpredictable. If you can show us a piece of software that has finer, smoother and faster graphics than SUPER ASTEROIDS, we guarantee to refund your money in full!

Cassette \$29.95

ZAP80 by Ian Robinson

'Secret Code Disassembler'

This is far from your average run-of-the-mill disassembler! Other than being a mere 4K long, able to disassemble at the speed of light and packed with options, ZAP80 will display before your very eyes all those unknown instructions ZILG never talk about! Ian has been doing extensive research into the actions of the Z80 processor when confronted with the 700 or so undocumented (and so called 'illegal') code sequences. Over 100 of these are VERY useful! Did you know you have extra 8 bit registers and a complete set of instructions to manipulate them? Did you know about extra rotate instructions?

ZAP80 will disassemble ANY code sequence. Nothing is illegal! It will allow you to program with codes that no other disassembler can decipher! Think about that

ZAP80 comes with documentation and explanation of all new mnemonics used. Three versions are supplied that reside in low, mid and high memory. Options include ASCII output, screen pause and customised printer control.

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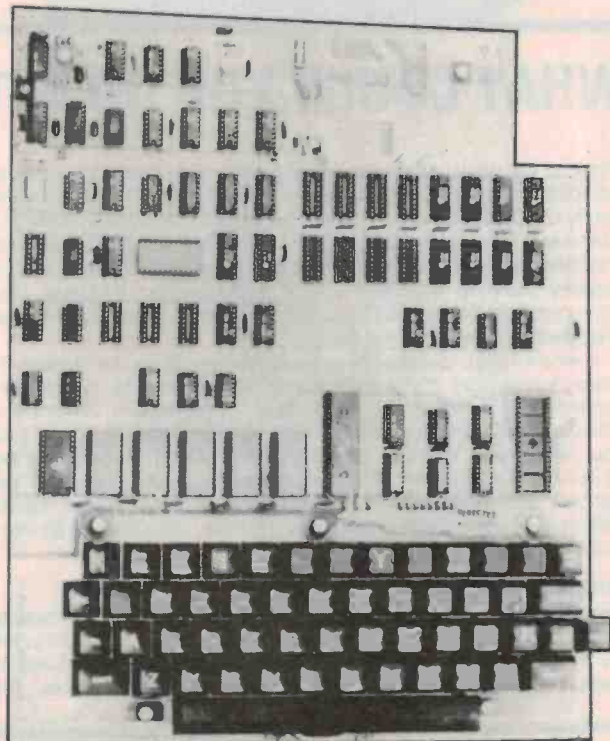
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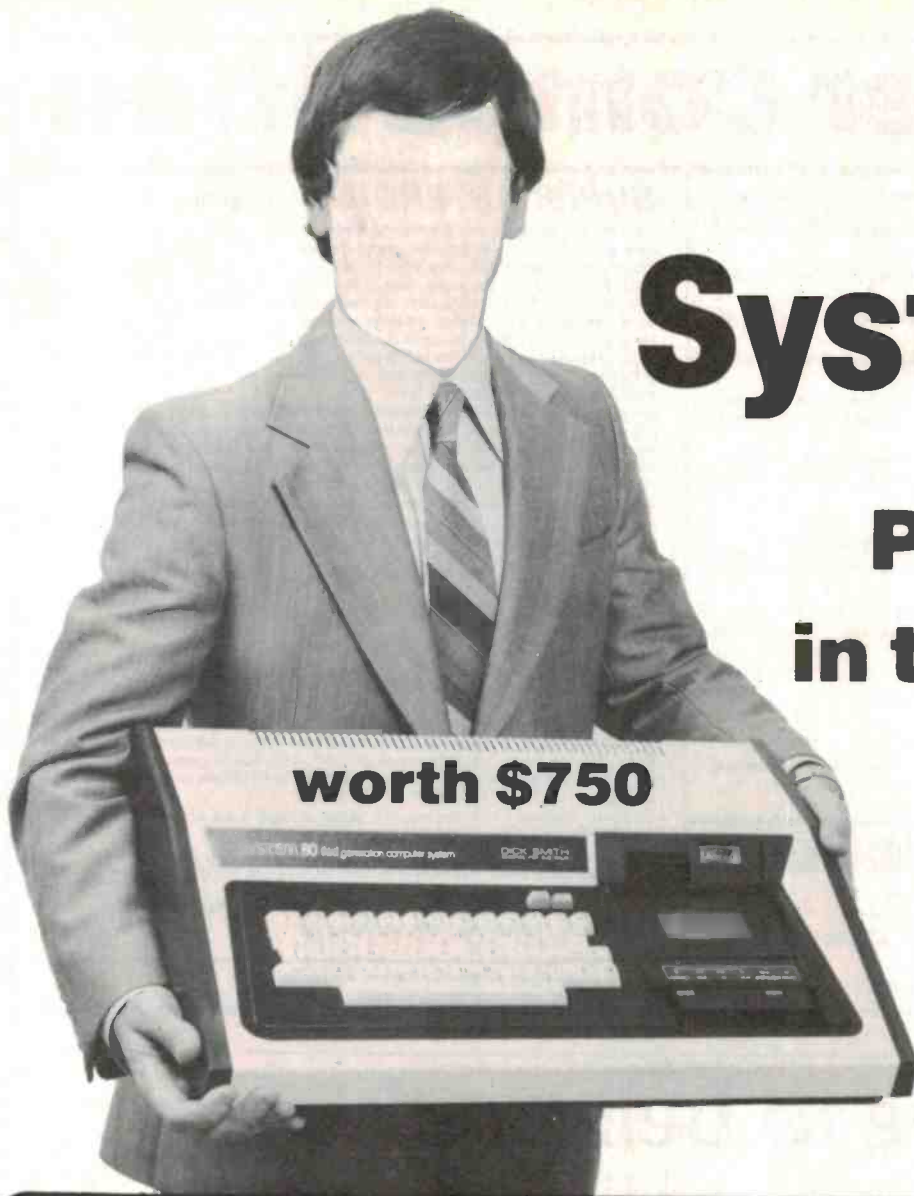
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A Dick System 80

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Enter this contest and you too could use this computer featuring the most popular microprocessor IC — the Z80. The door to the world of microcomputing could open for you. Just load the crossword with your data (sorry, we've no level meter like the System 80), write an essay and send us the coupon (or a copy plus the bottom corner of the page).

WHAT COULD YOU DO WITH A PERSONAL COMPUTER?

More to the point, what could you do with Dick Smith's System 80 personal computer? Thousands of purchasers seem to have found plenty of applications. Dick Smith Electronics claim the System 80 is Australia's fastest selling computer in its field. It's quite a powerful machine, having 16K of user RAM and offering a full 12K version of the industry-standard Microsoft BASIC programming language. The microprocessor employed is the powerful Z80 — the most popular 8-bit microprocessor chip in the world.

A whole range of software is available for use on the System 80, which incidentally is compatible with almost all TRS-80 software, according to Dick Smith. You can play fun games like 'Poker Pete', 'Rescue at Rigel' (a space adventure game), 'Flight Simulator' (pilot your own plane), 'Interlude' (spice up your love life!), 'Super Maze' and of course the one and only 'Space Invaders'. A System 80 can become a learning tool with software such as 'Typing Tutor', 'Speed Reading Course', 'Learn Music', etc. You can turn a System 80 into a small business computer too.

WHAT'S IT GOT?

The System 80 features a built-in cassette, a built-in power supply, S100 buss expansion capability, RF output (you can connect it to any TV set), two motor-controlled cassette interfaces (you can add an extra cassette), memory expansion to 48K (total) possible, 12K

Microsoft BASIC in ROM, 16K of RAM on-board and software compatible with most level II Tandy software.

THE CONTEST

Last year, in conjunction with Dick Smith Electronics, we ran a contest with a System 80 as a prize. It attracted an extraordinarily high level of entries and was one of the most successful contests we had ever run. Once again, Dick Smith has offered a System 80 as a prize for a contest. This time all you have to do is correctly complete the simple crossword and tell us in a short essay what you would do with a System 80.

Here's your chance to win a Dick Smith System 80, worth \$750, for nothing!

This contest is jointly sponsored by ETI Magazine and Dick Smith Electronics — who have generously donated the prize.

You may enter as many times as you wish but you must use a separate entry form for each entry and include the month and page number cut from the bottom right hand page of the contest. You must put your name and address where indicated on each entry form and sign and date each.

NOTE: Please read contest rules carefully, especially if sending in multiple entries.

Smith to win!

RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Dick Smith Electronics, Murray Publishers Pty Ltd, Australian Consolidated Press, Offset Alpine Pty Ltd, or associated companies.

Entries should be addressed to ETI System-80 Contest, Electronics Today International, 15 Boundary St, Rushcutters Bay NSW 2011.

Closing date for the contest is January 31 1982. Entries received within seven days of that date will be accepted if postmarked prior to and including January 31 1982.

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

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

Contestants must enter their names and addresses 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 right hand page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

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

Entrants must sign the declaration accompanying this contest that they have read the above rules and agree to abide by their conditions.

YOU'LL FIND THE CROSSWORD ANSWERS ON THESE PAGES!

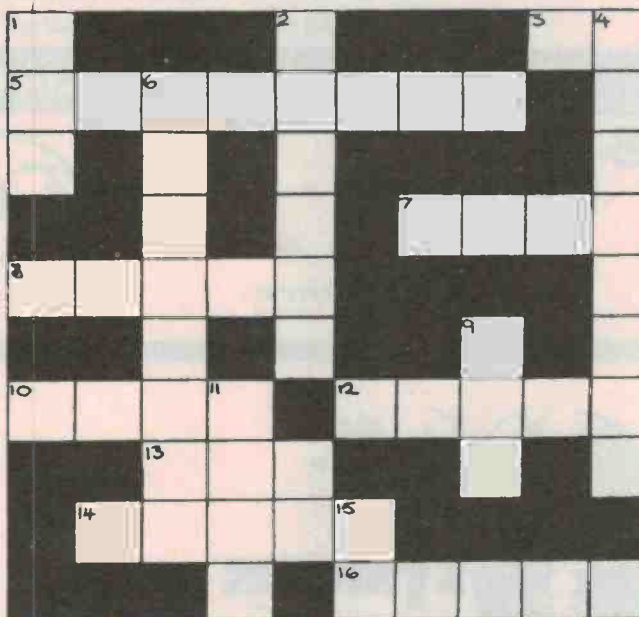
CROSSWORD CLUES

ACROSS

3. I see, it's got great capabilities.
5. There's something about my Tess that was a good seller last year.
7. The fish is alone on the old block.
8. Teren! Come in and turn around.
10. Hello, add this to your computer.
12. This shop keeps information.
13. I program my sheep to remember in the end.
14. Measure it. Electronically, not with a rule.
16. This type of pasture can be filed away.

DOWN

1. Us? That's not complete to be put to a purpose.
2. I recall everything about my Rome.
4. The Commanding Officer and 1000 put errors together to operate efficiently.
6. Cassettes are soft. Warehouses should be loaded.
9. Caesar's capital loses in the end.
11. Ted, at a keyboard, has information.
15. Robert Fulton initially creates interference.



TO ENTER, JUST COMPLETE THE CROSSWORD AND WRITE US A SHORT ESSAY

Tell us, in 50 words or less, how you would use a System 80 personal computer.

Name

Address

Postcode

I have read the Contest Rules and agree to abide by their conditions.

Signed

Date

**Don't forget to fill out the coupon.
Contest closes 31 January 1982.**



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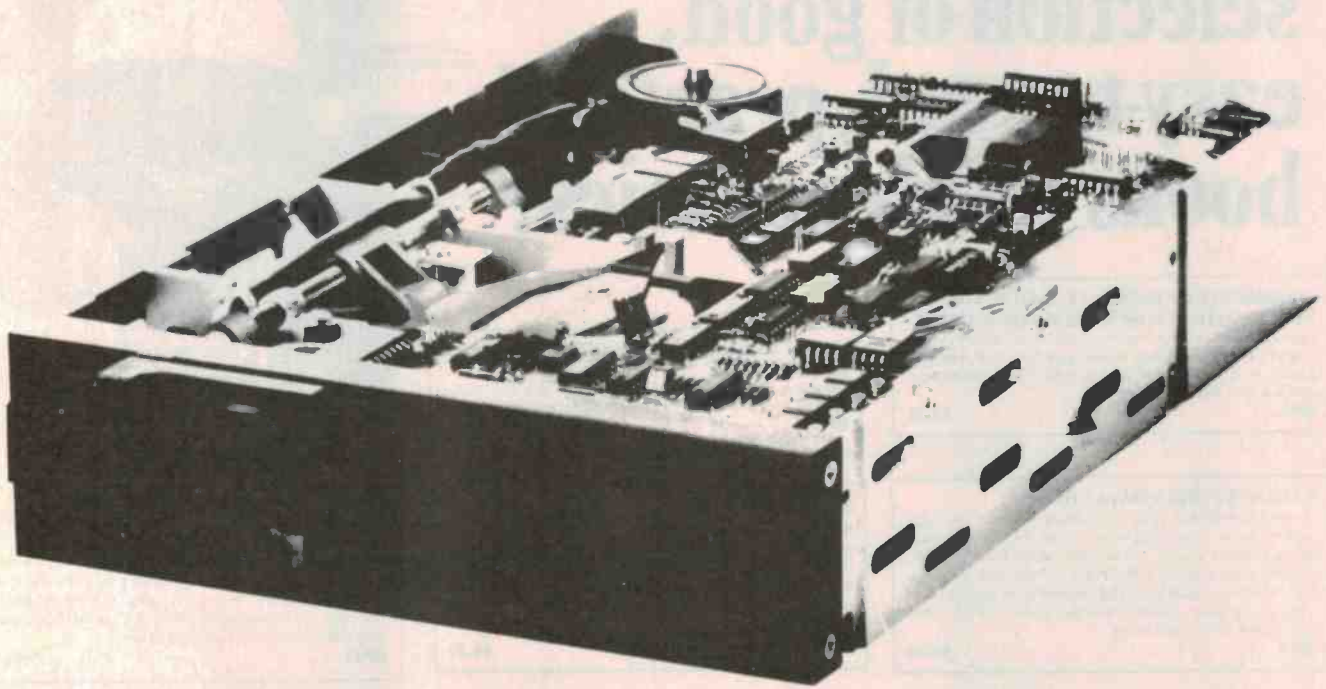
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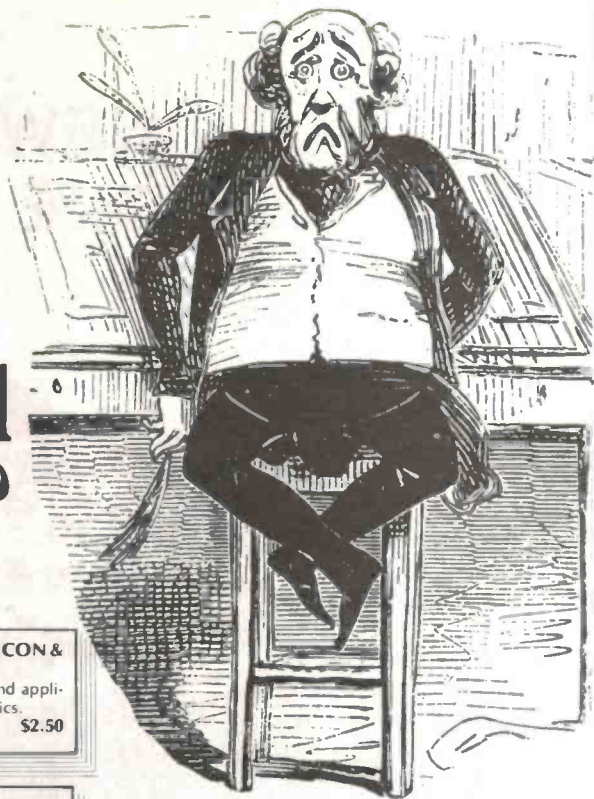
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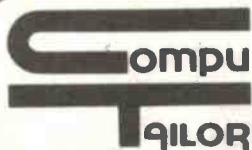
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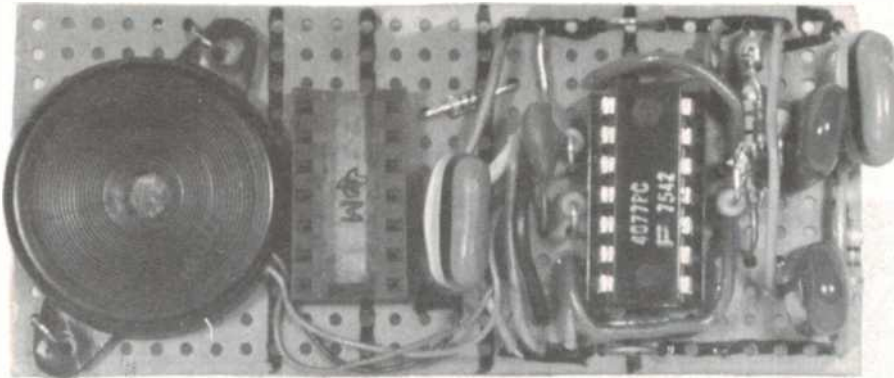
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Keyboard beeper for the Exidy Sorcerer

This ultra-simple circuit for your computer beeps to alert you that the machine is ready for your next entry. It uses only one IC and no software is required.



I built my keyboard beeper on Veroboard, which results in a compact assembly, and mounted it inside my Sorcerer (see later photos).

Graham Wideman

SITTING IN FRONT of a computer monitor for long periods of time can be eyestrain enough, without having to watch the screen attentively to ascertain when the machine is ready for your next key entry. This is particularly so if there are lengthy calculations, disk or cassette accesses to be performed between keyboard inputs. To relieve this tedium it is a good idea to equip your machine with a beeper which prompts you when the machine is ready. Such a circuit is described here, which although specifically tailored to the Exidy Sorcerer is applicable to most other machines too.

How does it know when to beep?

Our beeper must somehow know when to beep. One possible approach would be to write the software which reads the keyboard in such a way that some output is activated before a key is read to trigger the beeper. This is however not feasible for use with most personal computers, whose keyboard reading program is in ROM and hence cannot be readily modified. The approach we take here is a completely hardware one.

The typical computer program, be it yours or the built-in monitor or BASIC, proceeds as follows. First some processing, then look at the keyboard. And keep

on looking at the keyboard until a key is picked up. Then do some more processing and again look at the keyboard. And so on. We want the beep to sound when the software looks at the keyboard. But when the software is looking at the keyboard, it is actually sampling the keyboard perhaps hundreds of times per second. So we can't have the beeper triggered every time the keyboard is sampled, or the beeper would be on continuously if you didn't hit a key. So the beeper must be triggered when the software *starts* to look at the keyboard. An easy way to detect this, it turns out, is to figure out when the software is *not* looking at the keyboard, and then beep when the keyboard starts to be looked at again.

What kind of keyboard?

Two kinds of keyboard systems are in common use, 'hardware-scanned' and 'software-scanned'. The hardware-scanned type is conceptually easier to understand. In this design the keyboard circuitry actually looks at all the keys, and when a key is pressed the code for that key is stored in a latch. When the software gets around to needing some keyboard input (which may occur hundreds of times per second if you are just entering text, for example) it looks at that latch and if there is something in

it that keycode is taken and used. In this case we can know if the software is asking for keyboard input by looking at the signals associated with reading the keyboard latch.

Our circuit was primarily intended for the Sorcerer, however, which like many personal computers has a software-scanned keyboard. In this case there is no latch whose signals we could use to determine if the keyboard is being looked at. However, because the keyboard scanning is done by the software, no scanning is being done when the software is busy doing something else! Thus if we look at one of the scan outputs and can distinguish scan and no-scan conditions, we'll be able to make the beeper know when to beep. In the Sorcerer's case there are four such scan output lines which determine which column of keys is being looked at. (Electrically speaking, Sorcerer has five rows of 16 keys, with some missing.)

Scan to beep

The scan line that we choose is normally 'low' when the keyboard is not being scanned, and rapidly alternates low and high during scanning. The input to our beeper circuit distinguishes between these two cases, and triggers the beeper if the scan line has been low for longer than a preset length of time. There is

something of a trade-off to be made here, since if this preset time is too short a beep will sound for ordinary typing (the scanning stops during the time a key is held down), and if too long the beeper will not usefully alert the operator. The components shown should give a good compromise.

The circuit also contains the timing components, which give a beep length of about 0.2 sec. Finally, the beep feature may be turned on or off by depressing one or other of the Sorcerer's two reset buttons. (*Not both!!*)

How it works

A very handy tip to remember when trying to design a project with a minimum number of ICs is that both inverters and non-inverters can be 'made' from exclusive-OR (XOR) gates, and also from inverting XOR gates (XNOR). In this case we have used a CMOS 4077 quad two-input XNOR IC. If one of the inputs to this gate is tied high (+5 V) then the output will be the same as the remaining input. If one input is tied low the output is the inversion of the other input.

First we'll deal with the scan detection circuitry involving IC1a, which is wired as a non-inverting buffer. Under normal scanning conditions the scan input (00B2 in Exidy's notation — bit 2 of output port OFEH) will rapidly alternate between high and low states. Each time it goes high C1 is charged via D1. During scanning the time interval

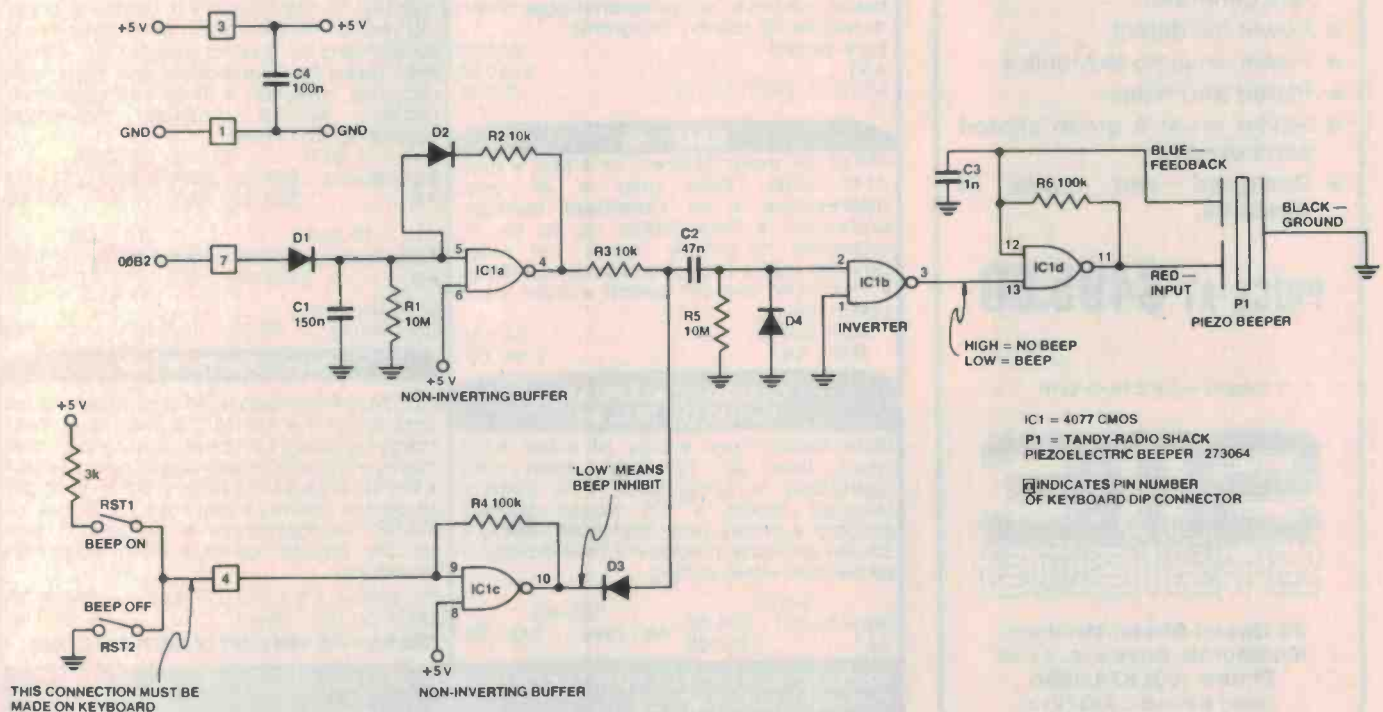
between charging pulses to C1 is so short as not to allow C1 to discharge very much, and consequently IC1a pin 5 is held high, resulting in IC1a pin 4 also being high. If scanning stops, as during lengthy processing or disk or cassette access, C1 slowly discharges via R1 until the voltage on C1 gets to the threshold where IC1a thinks input pin 5 is low. When this happens output pin 4 goes low. C1 is now quickly further discharged via D2 and R2, ensuring a sharp high-to-low transition. When scanning recommences, C1 is again charged and IC1a pin 4 again goes high. It is this low-to-high transition which is eventually to trigger the beeper.

Assuming that IC1c pin 10 is high and thus D3 has no effect on the signal at the junction of R3, C2 and D3, the aforementioned low-to-high transition will be transferred via C2 to the input pin 2 of IC1b. Since IC1b is connected as an inverter this will cause its output (pin 3) to go low. But pin 2 will be dragged low after about 0.2 seconds or so by R5, this in turn returning pin 3 to the high state. What has happened then is as follows: resumption of scanning after a short non-scanning period causes a 0.2 s pulse low at IC1 pin 3. This pulse is to turn on the beeper for its duration.

The beeper circuit itself involves IC1d and the piezoelectric element P1. P1 has three connections, an input, a ground, and a feedback terminal. In order to

generate a sound it is necessary to apply a signal of the piezo crystal's resonant frequency to the input, to make it resonate (somewhere around 6.5 kHz). You don't have to guess this frequency, however; it is merely necessary to arrange the piezo element to be in the feedback loop of an inverting amplifier circuit, and the whole combination will resonate away at the appropriate frequency. When IC1 pin 13 is low IC1d acts as an inverter, and with its output driving the piezo element and the element feedback terminal connected to IC1d's inverting input, a beep results. When IC1 pin 13 is high, as is normal, IC1d becomes a non-inverter, and no sound emits, or at least it shouldn't. However, with some IC and beeper combinations it still oscillates, so C3 and R6 are included to dampen this oscillation and only allow the desired beep to come forth.

IC1c acts as a flip-flop. If RST2 is depressed pin 9 is forced low, causing pin 10 to go low. When RST2 is released, pin 9 will still be held low by R4 connected to pin 10. If RST1 is depressed, pin 9 will be pulled high. The pulling up via the Sorcerer's internal Reset line pull-up resistor (about 3k) vastly outweighs the pull-down influence of R4 (100k), while R4 has almost no pull-down effect on the Sorcerer's Reset line. So, with pin 9 pulled high, pin 10 also goes high, and now when RST1 is released pin 10 stays high. If pin 10 is high no current can



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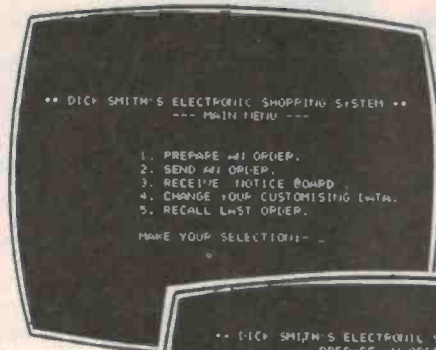
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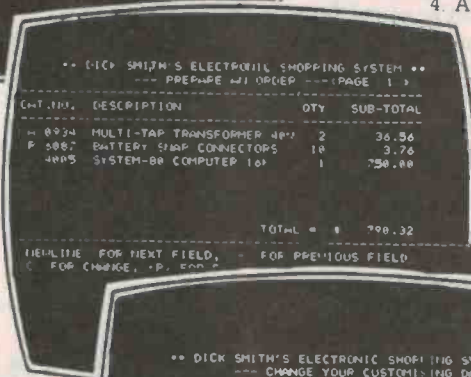
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flow through D3 and there is no effect on the beep-triggering signal at R3-C2. However, if pin 10 is low, R3-C2 will be held low, and as a result no beeps can be triggered. RST2 is then the beep-inhibiting button, and RST1 the beep-allowing key.

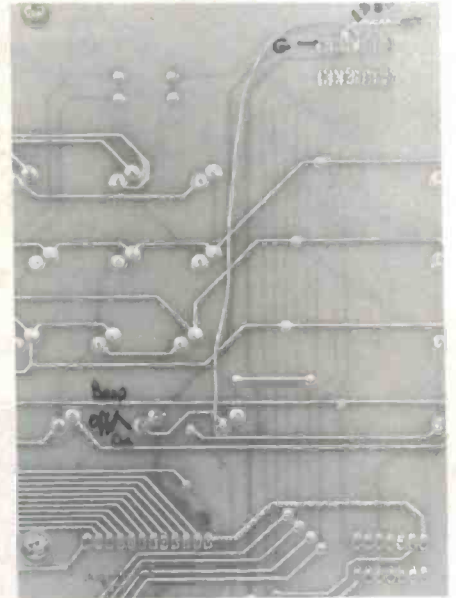


Mounted inside the Sorcerer.

There are two time constants which you can adjust to suit your preference. If your beeper is too prone to emit annoying beeps during ordinary typing, increase the value of C1. If it has the opposite fault, and instead doesn't beep unless there has been a very long no-scan interlude, decrease C1. If that part of the circuit is OK but you'd like a longer beep, increase C2, vice versa to shorten.

Construction

The prototype for this simple circuit was built on a piece of Veroboard. The Sorcerer keyboard is connected to the main computer pc board via a ribbon cable with a 14-pin DIP connector on the computer end. We soldered a 14-pin DIP 'header' (bare plug) on the bottom of the Veroboard, and a 14-pin IC socket on the top. The keyboard plugs into the beeper, which then plugs into the socket on the main computer pc board. It is also possible of course to simply screw your beeper board onto the keyboard pc board. All the necessary connections can be made to the ribbon cable connector at the keyboard end, or the computer end, which is what makes the plug-in idea neat. However, one con-



Connection to the common of the reset switches.

nection must be made elsewhere, which is to the common connection between the two reset switches. If the plug-in design is used then it will be necessary to connect this point to the unused wire in the ribbon cable, which is available at pin 4 of the DIP connectors at each end. ●

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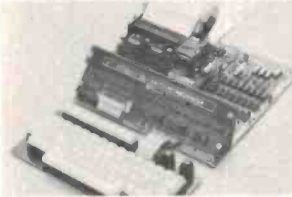
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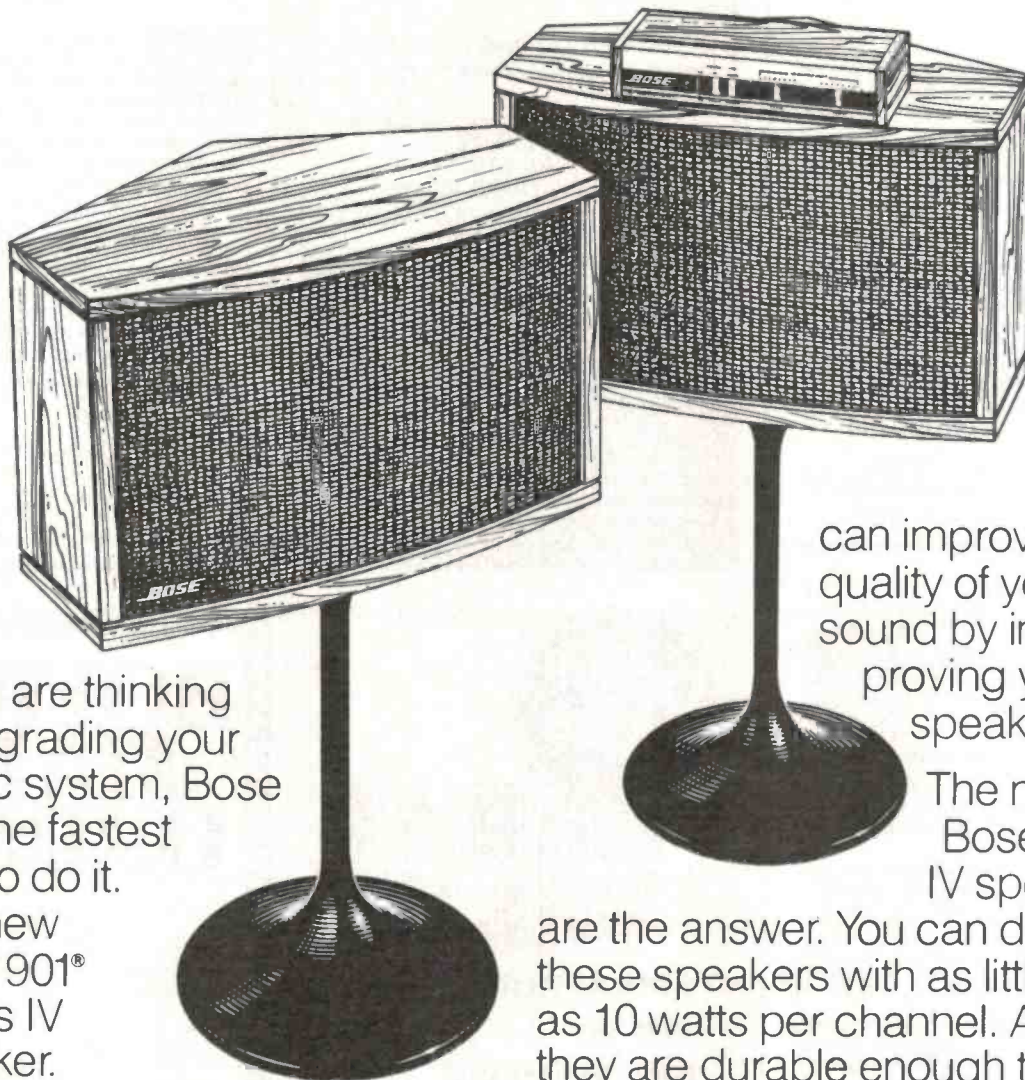
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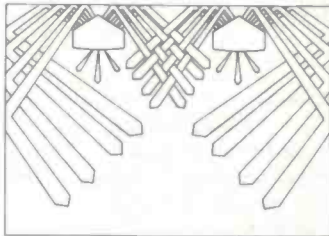
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SIGHT & SOUND

Blank tape levy — inquiry urged

Following the Attorney-General's announcement that audio visual provisions of the Copyright Act will be reviewed, the Australian Audio-Video Tape Association (AAVTA) is urging a public enquiry on this whole subject.

The AAVTA represents the magnetic tape industry, with member companies including 3M, TDK, Ampex, Greencorp, BASF, Fuji, Maxell and Agfa.

The Association believes that consumers are likely to be forced to pay the penalty of heavy levies on all audio and video cassettes if Government approval is given to proposals suggested by representatives of the Australian Copyright Council in a lengthy report recently presented to the Attorney-General's Department and at a Symposium on October 1 and 2 at the Opera House on 'Copyright and Technology'.

The AAVTA points out that no consumers or consumer groups are represented on the Council to provide the Government with a balanced input for the proposed copyright review.

To date much of the argument of copyright owners and the record industry hinges on claims that they have suffered substantial losses directly attributable to the ability consumers have to easily re-record

copyright material.

The AAVTA believes that copyright owners have benefited enormously from new technology, in that it has given them a far wider audience and medium for propagation of their work. An AAVTA spokesman says that any proposals which seek to discourage private recording by the imposition of a penalty or levy would have an opposite and limiting effect upon the popularisation of works.

Similar attempts to impose levies on blank tapes have been made in other countries, and no country with British law has introduced legislation which provides for a levy on goods where it might be possible to breach copyright.

In the UK Government's long-awaited Green Paper on copyright reform, the Government says it has received no convincing evidence that a levy on audio or video hardware or on blank tapes should be introduced. It goes on to say the Government would hesitate to impose this on the public, especially

since the imposition of a levy would involve 'rough justice', with many tape users who do not record copyright material having to pay.

The AAVTA claims it does not endorse piracy of copyright material which involves systematic illegal duplication for financial gain, saying the main use of home video recorders and tape decks is to 'time shift' and be able to watch and listen to programmes at a more convenient time than when they are broadcast.

The Association believes that single copying of this nature for private and domestic use is no more an abuse of the rights of copyright owners than is the current trend towards the legitimate use of home video films rather than Super-8 home movies, or the sending of privately recorded audio cassettes rather than letters. It believes that neither of these quite reasonable practices should be penalised by the imposition of a blanket tax or levy on all cassettes.

Copyright Acts in all countries which are contracting parties to international copyright conventions, like Australia, permit overseas governments reasonable freedom to set their own laws regarding what constitutes valid non-infringing use

for private and domestic purposes, or for the purposes of education and research. The AAVTA believes that now is the time for the Commonwealth Government to legalise single copy domestic use that does not result in any financial gain for the consumer, and believes that copyright owners will not suffer if this is done.

The AAVTA points out that there are many other complex issues which must be considered in relation to the proposed amendments to the audio-visual copyright. As all of these issues affect the consumer, the Association claims they must be debated publicly, rather than be considered on the basis of a minimal number of written submissions by bodies such as the Copyright Council, whose stance on the subject the AAVTA claim amounts to the type of 'rough justice' rejected by the UK Government only a few months ago.

The Association believes that a public hearing should be arranged, preferably along the lines of an IAC enquiry. For further information contact Mr. Peter A.G. Rose, Vice-Chairman and Spokesman, Australian Audio-Video Tape Association, c/o 3M Australia, 950 Pacific Hwy, Pymble NSW 2073. (02)498-0033.

ITT moves towards digital television

ITT Semiconductor headquarters in Germany have made an important move towards digital television by producing an experimental colour receiver which operates from digital signals. The company intends to supply this type of receiver to its main customers by the end of 1981.

ITT has been looking into the idea of digital television since 1977, but design work for the VLSI devices required began only about a year ago. Digital signal processing is employed in the video processor, in the deflection unit and in all audio circuits following the discriminator. In addition, all control functions are digital.

It is anticipated that the new design will have an enormous impact on television production. The number of separate components that are required is dramatically reduced and computer adjustment of the receivers during the production process is greatly simplified.

Digital test signals can be

monitored and adjustments made automatically by incorporating the adjustment program on a PROM or EPROM within the receiver. This is far easier than using the adjusting potentiometer required on analogue receivers and does not require the same investment for mechanical tooling for automation.

The prototype receiver is based on VLSI chips. Although ITT have not stated the number of such chips used in their receiver, it is far less than the number of components in the conventional analogue receivers currently in production (typically

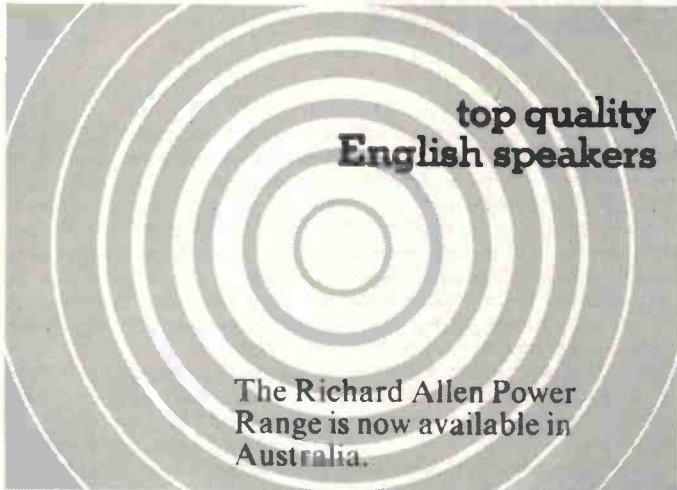
some 300 passive components, 60 transistors and about 12 ICs).

ITT hope that the digital television receiver will provide the European market with highly cost-effective production of receivers, which will make the industry far more competitive in the world markets. Several Japanese manufacturers have already expressed an interest in the ITT concept, because they appreciate its importance and possible influence on world markets.

Brian Dance

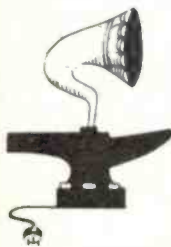
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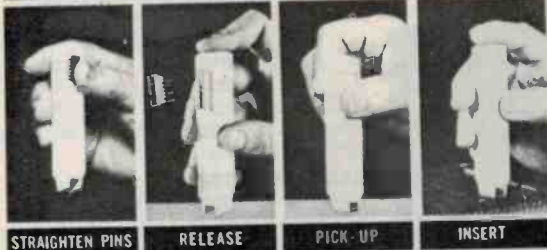
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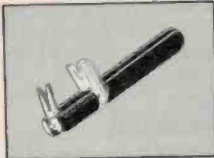


Aligns bent out pins. Includes terminal lug for attachment of ground strap.

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26 ga. Wire Cut and Strip Tool	ST-100-26-875	7/8"	1 3/8"
28 ga. Wire Cut and Strip Tool	ST-100-28	7/8"	1 1/2"
30 ga. Wire Cut and Strip Tool	ST-100-30	7/8"	1 1/2"

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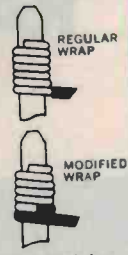
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The R-2000 contains several preamp features to improve the sound reproduction, including Yamaha's 'Spatial Expander', which allows the listener to create the 'open' impression of live music without the need for extra speakers or amplifiers. There is also a built-in, high performance moving coil head amp, and R-2000 offers three different cartridge loads for optimum compatibility with most available cartridges.

Other preamp features are the 'Auto-Phono Function', which will automatically switch the receiver back to another selected music course at the end of a recorded album, and a continuously variable loudness control. This compensates for human insensitivity to bass and treble frequencies at low

volumes by boosting these frequencies at these volumes and suppressing the midrange to avoid noise and distortion.

The R-2000's tuner produces no interference-causing RF noise, unlike many quartz phase-locked loop synthesiser tuners. In addition, the tuning system is said to lock the tuner's frequency extremely accurately onto that of the broadcast station, giving completely distortion-free reception.

Seven FM and seven AM stations may be preset, and tuning level buttons allow the user to choose among all stations or only those with strong signals. Automatic DX/Local switching gives higher receptivity when a weak station is received and broader selectivity with a strong signal, which also provides more accurate and distortion-free reproduction.

The R-2000 comprises several other features too numerous to mention here, and the whole is enclosed in a simulated ebony cabinet with chrome-finished faceplate. The recommended retail price is \$1000.

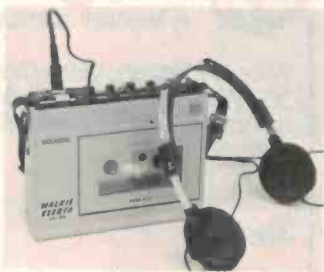
For further information contact the Public Relations Manager, Yamaha/Rose Music, 17-33 Market Street, South Melbourne Vic. 3205. (03)699-2388.

Dick Smith 'Walkie' Stereo

The Dick Smith 'Walkie Stereo' (Cat. No. A-4055) has especially lightweight headphones, making it ideal for joggers, golfers, walkers, etc. who like to listen to their favourite music when they are on the move.

The Walkie Stereo has a tone selector and an auto shut-off mechanism to protect the tape, plus two headphone sockets so that friends can share the music. There is even a 'Talk' button that enables communication between the two people wearing the headphones!

The Walkie Stereo cassette player costs \$99 and is available from Dick Smith stores.



Four-hour VHS cassette from National

Due to demand by industry and government departments, National has developed a four-hour VHS video cassette (said to be 'problem-free') — the longest VHS video cassette now available throughout the world.

According to the Australian distributors, the Electronics Division of GEC, quality has not been lost with the increase in playing time, and the tape is the same standard thickness as that used on other quality National video cassettes.

The extra 70 m of tape have been accommodated inside the standard-size cassette cartridge by reducing the size of the core round which the tape is wound. All other internal mechanisms remain the same.

It is claimed that the extended-length video tape (designated the

NBE-240) will not foul like some long-playing audio tapes, and that it is subject to less wear and tear during continuous use.

It is expected that the four-hour tape would be used in security and surveillance or time lapse monitoring, as well as allowing more reference material to be stored in one place.

The NBE-240 has only just been released in Australia, and is available from the Electronics Division of GEC Australia Ltd. For further information contact David Rose on (02)212-5488.

New MD for Sharp Australia

Mr. Hiroshi Kawai has been appointed managing director of Sharp Corporation, Australia.

A veteran of the Japanese and American electronics boom, Mr. Kawai has played a leading role in the company's export operations for the past 22 years. He was a member of the second sales team to be sent by Sharp to the United States in 1960, and was largely responsible for the company's first contract to produce television sets for the US market. More recently he was Executive Vice-President of Sharp's business equipment division in America.

Before coming to Australia Mr. Kawai spent seven years at Sharp in Japan, where he headed the worldwide export division for home



appliance products, including the microwave oven market, which Sharp leads in Australia.

Fisher products for Australia

Following Sanyo's acquisition of the Fisher Corporation of the USA in 1977, it has been announced that Sanyo will market Fisher-branded products in Australia, to be available from early 1982.

It is envisaged that Fisher products will cater for 'up-market' tastes in hi-fi and home recording, and will provide a wide range of innovative products. Marketing and service functions for Fisher will be handled by Sanyo Australia through its existing staff and organisation.

Three 'up-market' portable tape recorders with recommended retail prices starting at \$399 will be released in January, followed in March by a range of sophisticated hi-fi systems with prices starting around \$1500.

On the home video scene, Sanyo has adopted a corporate philosophy of non-alignment to any one video format in tape or disc. It will manufacture players for all three disc formats, and in addition to its factory in Osaka manufacturing Beta

system VCRs has established a new factory in Tokyo to manufacture VHS system VCRs. This new factory is already supplying VHS system VCRs to the USA under the Fisher brand; Beta system VCRs will carry the Sanyo brand.

Sanyo is also expanding its Beta system range to four models, including a new portable, commencing this Christmas; the first Fisher-branded VCRs will be available around the middle of 1982.

In the long term the Fisher range will be extended to other product areas.

For further information contact Mr. Mike Hart, Australian Sales Manager, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02)436-1122.

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Henry Royce, founder of Rolls-Royce, 1906.

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NEW DOLBY C SYSTEM JUDGED SUPERIOR

DD DOLBY B-C NR

by GEOFF MATTHEWS

There has never been much doubt that compact cassette decks have been the most exciting thing to happen to hi-fi systems since hi-fi was first invented.

However there has always been a question of which noise reduction system is the best one to own — the Dolby system or one of the more recently devised American, Japanese or European noise reduction systems.

Recently though, the question seems to have been laid to rest.

In the past few months, the Dolby system has emerged the clear choice by just about every important maker of cassette decks throughout the world.

DOLBY B

Dolby B noise reduction was a key factor in launching the cassette as a viable hi-fi medium. Dolby B quickly became the standard noise reduction system amongst consumers with three major factors contributing to its success: a decisive 10 dB improvement in high frequency S/N; minimal audible side effects; and, fairly inexpensive circuitry. Since 1968 when Dolby B was introduced, the phonograph record has become much better with a movement towards direct cut disks, digital mastering and half speed cutting. Improvement in cassette heads, electronics and tapes have broken the 20 kHz barrier and cassette recorders with response to 25 kHz have become a reality. Taken together, these factors have created a demand for a noise reduction system with greater capability than Dolby B, which reduces tape hiss and other high frequency noise generated during the tape recording process by a maximum of 10 dB.

LINEAR COMPANDERS

While Dolby is the acknowledged leader in the field of noise reduction for consumer audio products, the Dolby system is hardly alone any longer. Several noise reduction systems have been devised by American, Japanese and European companies, and simple linear companders that offer greater dynamic range than Dolby B are available. However they have unfortunate side effects — audible "pumping" and "breathing". In short, they can be heard "working" and this is unacceptable. As a rule of thumb, the greater the noise reduction, the greater the possibility of audible colouration. In fact the success of Dolby B is due largely to its adroit trade-off between S/N improvement and audible side effects.

DOLBY C

Since Dolby Laboratories announced and demonstrated their newest noise reduction technology which they called Dolby C, just about every important maker of cassette decks has introduced one or more models which incorporate the newest of Dolby's consumer type noise reduction systems.

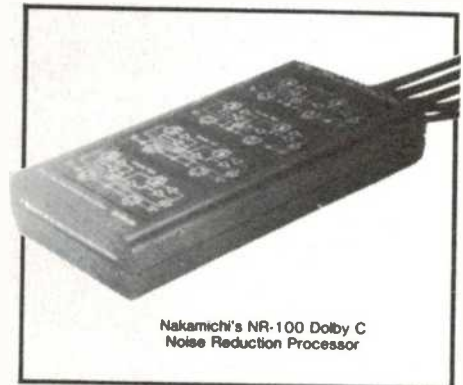
The new Dolby C noise reduction system offers up to 20 dB of noise reduction at high frequencies and begins operating at a lower frequency point in the spectrum than did Dolby B. However, Dolby C is not "across the board" circuitry that will be used by manufacturers in all of their cassette deck models from most expensive to least costly. Dolby C, while usable by Dolby licensees without having to pay any additional royalty, costs approximately 2½ times as much to incorporate into a deck than does Dolby B. Furthermore, as some manufacturers are finding out, the new noise reduction system only works best when it is used in high quality decks which have reasonably uniform frequency response capabilities to begin with.

INCREASED DYNAMIC RANGE

Noise reduction and increased dynamic range are closely related. When the noise threshold decreases, greater dynamic range can be stored by a music storage medium such as disk or tape. Dolby has always stressed the noise reduction qualities of their systems but points out that with Dolby B, they can approach dynamic range capabilities of 80 dB on a properly designed cassette deck. Dolby C affords substantially greater dynamic range without increased colouration.

COMPATIBILITY

Dolby suggests that new cassette recordings made using the Dolby C



Nakamichi's NR-100 Dolby C Noise Reduction Processor

process will sound reasonably good when played back on decks which are equipped only with Dolby B decoding circuitry. Whilst shunning the word "compatibility", they have maintained that Dolby C recordings played back with no decoding whatever will be "listenable" to non-critical ears.

On the other hand, makers of other noise reduction systems make no such claims admitting that a recording made using one of them cannot be played back properly using equipment that contains a decoder of a competing system. In that sense, none of the systems are compatible with either their competing systems or with play back systems not equipped with any noise reduction system.

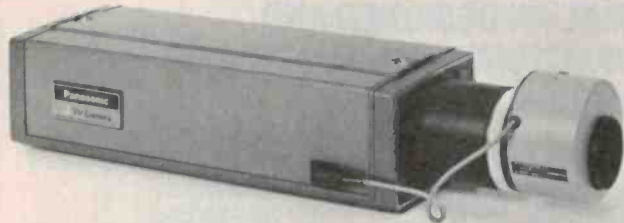
DOLBY RANKED NUMBER ONE

In offering 20 dB of noise reduction, substantially greater dynamic range without increased colouration and "compatibility", Dolby has taken another major step forward in improving the compact cassette as a hi-fi medium. And its choice by major cassette deck manufacturers clearly indicates that the experts believe that the Dolby system offers better technology, better features and better hi-fi.

Inserted for reader information by Convoy International, 4 Dowling Street, Woolloomooloo 2011, (02) 358 2088, the exclusive distributor of Nakamichi products in Australia.

The word "Dolby" and the Double-D symbol is the trademark of Dolby Laboratories.

NOTE: Any person practicing tape recording should observe the provisions of the Copyright Act 1968.



New National Panasonic low light cameras

National Panasonic have released a new series of low light level cameras onto the Australian market which are specifically designed for security, surveillance and other specialised closed circuit applications.

Particular use is being made of the camera in situations where the use of expensive lighting is prohibitive.

Apart from the obvious security applications, such as defence installations, other areas of use include industrial instrumentation application, mines and tunnels, on wharves at night, various medical laboratory procedures involving TV microscopy, engineering laboratory procedures requiring a minimum of light, and also in the study of animals and their nocturnal activities. The camera has been used in the study of insects and their night flights.

The WV-1900 and its 24 Vac low voltage counterpart, the WV-1904, are lunar light cameras which provide usable video pictures under

moonlight conditions.

The secret to the success of the camera is the sensitive Newvicon tube with fibre optics, which incorporates an image intensifier to ensure high performance in limited light conditions. High-quality integrated circuitry is also used to create clear pictures in adverse conditions.

Minimum illumination for the moonlight camera is only 3×10^{-4} footcandles for a usable picture and 3×10^{-3} footcandles for recommended illumination.

These cameras, along with other CCTV products in the National Panasonic range, are available through the Electronics Division of GEC. For further information contact David Rose on (02)212-5488.

In-car sound from Kenwood

Kenwood Hi-Fi recently introduced a matching range of hi-fi stereo components intended for mounting on the dashboard of a car.

The range includes the KTC-767 AM/FM stereo tuner (rrp \$345), whose features include an automatic noise reduction circuit which monitors FM signal quality and automatically switches to a sequence of alternative reception modes to provide the best available sound, and the Automatic Broadcast Search System, which automatically seeks a stronger station when any AM or FM signal becomes too weak.

The KXC-757 is an auto-reverse cassette deck with Dolby, and has an rrp of \$325. The same size as the tuner, it incorporates many features, including a 'cassette standby', whereby a cassette may be cued up indefinitely — without damage to tape or machine — and programmed to activate automatically when radio reception falls below acceptable limits.

Equalisation functions are pro-

vided by the KGC-747 graphic equaliser (rrp \$185), also the same dimensions as the tuner and cassette player. An alternative is the KGC-737 graphic equaliser/amplifier (at \$245), with the same measurements and low-level equaliser circuitry as the KGC-747, but with four built-in power amplifiers that provide five watts of drive to each of the front speaker systems and 15 watts to those in the rear.

Two power amplifiers are available to complement the equalisers: the KAC-801 (rrp \$245) and the KAC-727 (rrp \$185). These amps are small enough to be mounted either in the boot or underneath a seat, and the KAC-801 features a remote control power switch and delivers 50 watts per stereo channel. The KAC-727 delivers 15 watts per channel, and matches the tuner, cassette deck and equalisers in appearance.

Will the videodisc survive?

The much-heralded videodisc is still meeting serious problems, and Europeans are seriously questioning whether it is in its death throes. Both Philips and JVC have postponed its launch in Europe, although Philips attribute their repeated delays in the launching of their product to the inability of their Blackburn plant to manufacture the discs in adequate quantities.

However, many people are asking whether the videodisc can be a viable commercial proposition for the mass consumer market. Can it really provide effective competition to the video cassette recorder? Surely anyone with the necessary cash to spend on equipment will purchase a VCR on which programmes can be recorded off the air and immediately wiped out when not required? Few families will wish to spend their hard-earned cash on two separate items of equipment for home video systems.

The videodisc does have the advantages that it will not wear appreciably, the discs will probably be priced at about half that of a pre-recorded video cassette and one may obtain better quality from a disc. However, who could wish to pay perhaps \$100 for his favourite film on videodisc when he can wait for it to appear on television or record it from a rented pre-recorded tape using a VCR?

It has been suggested that the videodisc will survive because of the

interest it will arouse in potential commercial users, who can pay relatively high prices for material unobtainable in other forms. However, RCA's experience with a low-priced videodisc system which has been selling in the USA for the best part of a year has been that sales volume is relatively low.

Even Sony has decided to back out of the consumer videodisc market, preferring to concentrate on institutional users such as schools, colleges and private companies. Although the sales volume will be relatively small, it could be profitable.

Many people in Europe feel the videodisc system will become viable only if playing equipment comes onto the market in a very cheap form (perhaps of the order of \$200), with discs selling for not more than perhaps \$10 each at current price levels. It seems doubtful whether any manufacturer can offer a satisfactory product — or indeed any product — at such prices.

Brian Dance



Anti-feedback amp introduced

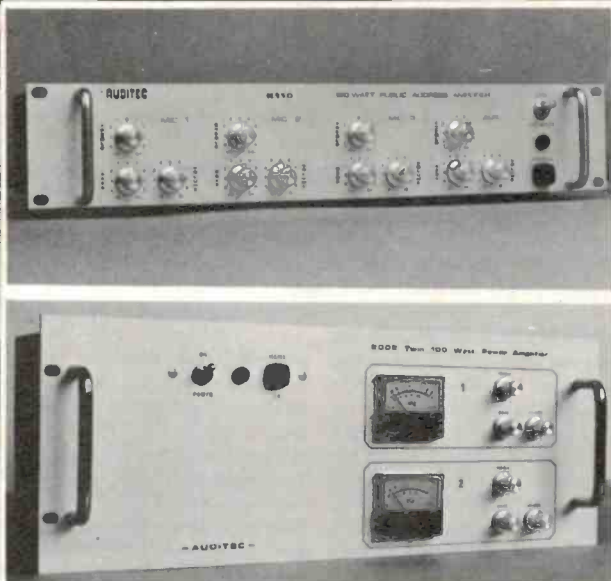
Audio Telex Communications, who make the successful DI Series public address amplifiers, recently released a new anti-feedback unit, the AF100, which is primarily designed for use in areas of high feedback or reverberation, such as churches, lecture halls, halls and airports.

The AF100 series features a number of facilities specifically inbuilt to eliminate feedback and poor intelligibility. These include:

- Graphic equaliser with six notch filters
- Compression circuitry, up to 10 dB, switchable on/off
- Limiter with 100% overload capacity, switchable on/off
- Battery-charging circuitry (trickle)
- 100 watts RMS output with a frequency response of 35 Hz to

17.5 kHz
 • 240 Vac, 24 Vdc operation.
 The AF100 is moderately priced and is said to cost less than many conventional public address amplifiers.

The unit is available from Audio Telex Communications Pty Ltd, P.O. Box 421, Parramatta NSW 2150, (02)633-4344; P.O. Box 468, Mt. Waverley Vic. 3149, (03)277-5311; and P.O. Box 44, West End Qld. 4101, (07)44-6328.



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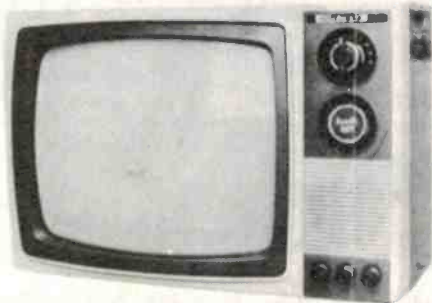
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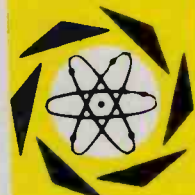
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Inside Quad's latest electrostatic loudspeaker

No new loudspeaker development has probably been heralded by more rumour, speculation and comment than Quad's new electrostatic model. Their 'original' electrostatic loudspeaker has been in continuous production for more than 25 years and has enjoyed a reputation as a 'standard' by which many other speakers are judged. Let's see what the 'new' one is all about...

Brian Dance

IT IS OVER a quarter of a century since the Quad electrostatic loudspeaker was introduced as a new approach to high-fidelity sound reproduction. When it first became available, many people considered it to be the ideal loudspeaker for domestic use, and over a prolonged period it has been widely adopted as a standard of reference by engineers in the recording and broadcasting fields. It is remarkable that this loudspeaker has been able to keep such a reputation for so long in spite of intensive developmental work on loudspeaker design by many manufacturers. Can you think of

any other specific product in the high-fidelity field which has been a leader for so long?

This same Quad electrostatic loudspeaker will continue to be produced by the Acoustical Manufacturing Company Ltd of Huntingdon, Cambridgeshire, England, but this manufacturer is now introducing a new and improved successor to its original design. The new electrostatic loudspeaker is designated the Quad ESL-63 and is currently priced about 65% higher than the earlier model. The development of the new model has

taken many years — indeed, there are no prizes for guessing what the 63 in its new model number signifies!

Electrostatics

The basic idea of an electrostatic loudspeaker is very attractive, since the moving diaphragm can be driven in a controlled manner over its whole surface and can therefore be very light and flexible. Indeed, work on the electrostatic loudspeaker was carried out well before Rice and Kellogg invented the moving coil loudspeaker; the latter is driven by a coil fixed to a small region of the cone and therefore the cone must be of a fairly rigid and heavy material. Such a heavy moving cone stores much energy, and problems arise because it is necessary to mount a moving coil loudspeaker in some form of a cabinet to achieve satisfactory energy coupling at low frequencies to the air, and the cabinet introduces undesirable resonances of its own in addition to the speaker resonances.

One may therefore wonder why the electrostatic loudspeaker has not been much more widely used in the past instead of the moving coil. In order to obtain adequate sensitivity, the gap in which the light diaphragm moves must be kept small (since the force between electrostatic charges decreases as the inverse square of the distance between them) and this tends to restrict its use to the higher frequencies. Indeed, many electrostatic high-frequency 'tweeter' units have been produced for use with moving coil bass and mid-range speakers.

Another problem is the inherent non-linearity of the simple type of electrostatic construction, although this difficulty can be removed by suitable constructional techniques. In addition, an electrostatic loudspeaker offers what

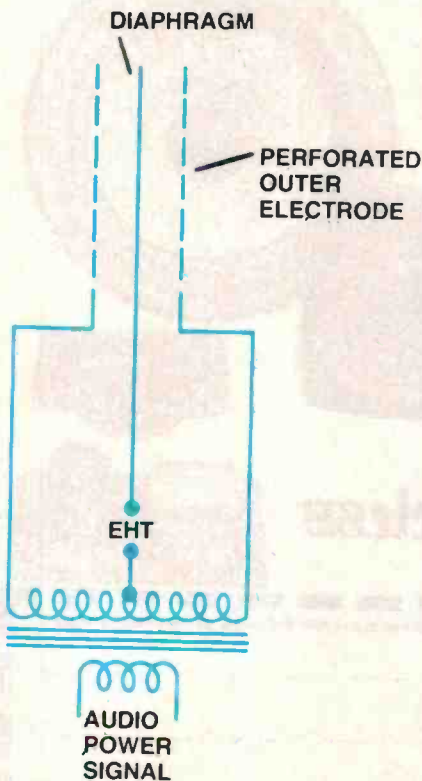


Figure 1. The basic electrostatic speaker push-pull drive system.

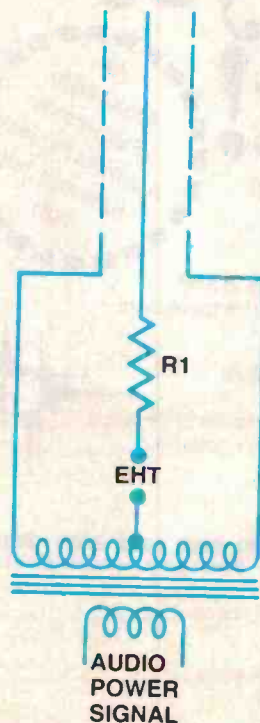
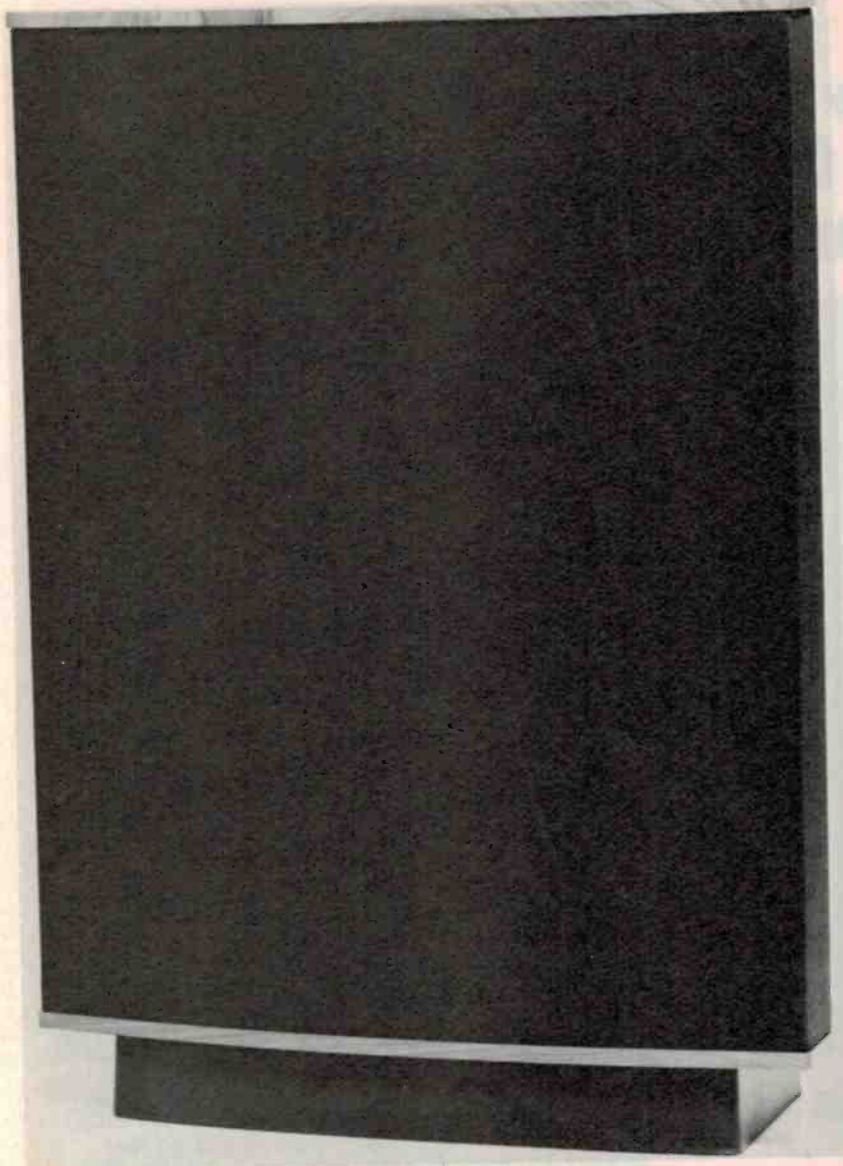


Figure 2. Linear electrostatic speaker drive system with a constant charge on the diaphragm.



is essentially a capacitive load to the power amplifier feeding it and this may give rise to matching problems.

The basic form of an electrostatic loudspeaker can be represented as in Figure 1, in which a very light diaphragm moves between two electrodes in a push-pull system. A high polarising voltage is applied between the moving diaphragm and the two outer electrodes, while the audio signal is coupled by means of a step-up transformer so that it appears in anti-phase between the two outer electrodes. The diaphragm is attracted by electrostatic forces, but unfortunately this attraction is non-linear.

In order to produce a loudspeaker with a linear response, one needs to make the charge on the diaphragm constant and independent of its position relative to the other two electrodes. This can be accomplished by inserting a large resistor, R1 in Figure 2, between the high voltage polarising supply and

the diaphragm, so that the time-constant formed by this resistor and the electrode capacitance is large when compared with the period of the audio frequency signals. The force on the diaphragm at any instant is now proportional to the instantaneous value of the signal voltage across the transformer secondary winding.

The two outer electrodes will normally be stationary grids which can allow air to pass easily through them. The centre electrode is a piece of stretched membrane which is sufficiently light and unrestrained that if it is placed in a sound wave, it will vibrate to follow the motion of the air molecules without affecting their motion appreciably. In other words the speaker system is acoustically transparent. Such a loudspeaker can provide a response which is level at frequencies of up to at least 20 kHz, after which the effective mass of the diaphragm may reduce the output power by some 6 dB

per octave. At low frequencies the response is limited by the stiffness of the diaphragm required for stable operation, but the response can be extended to lower frequencies by increasing the electrode spacing and reducing the diaphragm stiffness; however, this reduces the acoustic output for a given input signal power and a higher polarising voltage is needed.

The original Quad electrostatic loudspeaker was designed to provide the full audible frequency range from a unit which should be placed a little way from any obstructions at either the front or the rear. Its efficiency (sound output level for a given signal input power) is somewhat less than that of many moving coil loudspeakers, and a power amplifier with a 25 W output is required. Like all electrostatic loudspeakers, a mains power supply is required for generating the polarising voltage. One of the main attractions is the absence of any sound colouration from cabinet resonances.

Sound dispersion

The main way in which the new Quad ESL-63 differs from other types of loudspeaker (both moving coil and electrostatic designs) is the technique by which a satisfactory sound dispersion pattern is obtained over the full audible frequency range without the use of the conventional multiple drive units, with or without crossover systems.

Let us imagine a theoretically ideal point source of sound, A in Figure 3, radiating sound pressure waves to a listener at B. The waves are concentric spheres like the two-dimensional waves formed on the surface of water after a stone has been thrown into the water.

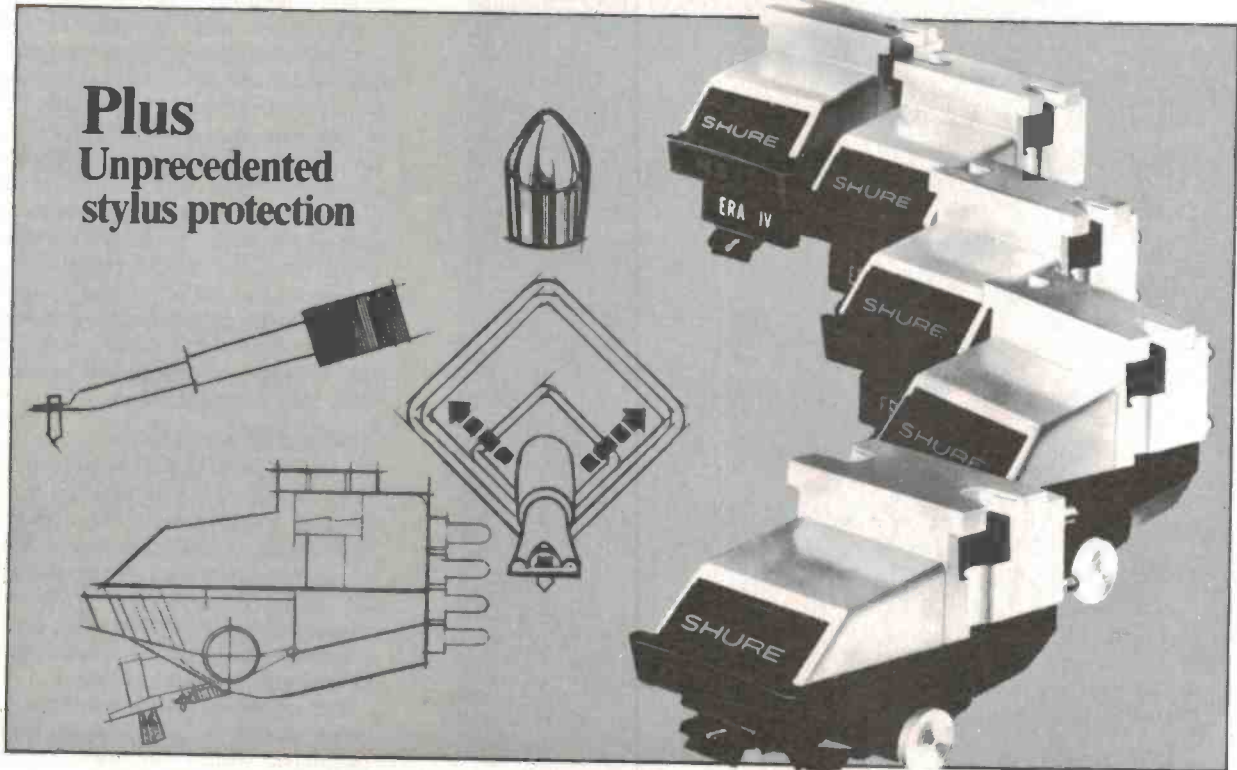
If one considers the place CD a little way in front of the source A at right angles to the direction of propagation of the sound wave, the air molecules will be moving in the direction shown to generate the concentric waves shown on the right hand side of this plane. In Figure 4 this imaginary plane is replaced by a very light membrane of an electrostatic loudspeaker, and the original sound source is removed from behind the plane. If the membrane moves in the same way as the air molecules of Figure 3, the resulting waves produced should be heard by the listener so that they are quite indistinguishable from the original sound source A of Figure 3.

The listener therefore forms in his mind a virtual image of the source of sound at E in exactly the same way that a virtual image is formed in a plane mirror by light waves, except that the mirror is not the source of energy.

The Quad ESL-63 operates on this ►



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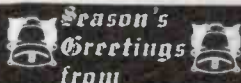
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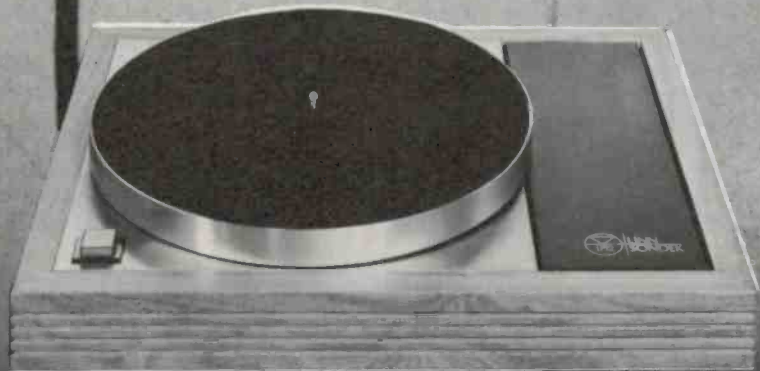


The beginning of a record playing chain is the record. If the turntable does not extract the musical information from the record, it is lost for ever. No amount of money spent further along the chain, on speakers for example, will recreate a signal which is lost at the beginning. In fact, you may only amplify original deficiencies by reproducing them more faithfully.

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principle. It consists of a diaphragm (which is very light and electrically polarised) suspended between two sets of rigid, acoustically transparent, concentric annular electrodes. These electrodes, which spread the sound pressure pattern across the diaphragm, can be seen in Figure 5. Signals are fed to the electrodes via sequential delay lines so that the diaphragm produces a sound pressure pattern which is an exact replica of that from an ideal source placed about 300 mm behind the plane of the diaphragm.

In order that the system will produce such a sound pressure pattern, the membrane must vibrate in the form of the annularly expanding rings, the amplitude falling with distance from the centre. A radial delay line system incorporating the required attenuation of the form shown in Figure 6 is used in the ESL-63 to produce the required signals for the membrane. In practice the design is complicated by the fact that any loudspeaker must have a finite area, and compensation must be introduced for the interference waves which would otherwise be generated at the edge of the loudspeaker; this can be done by using a suitable design of the lossy delay line.

The Quad ESL-63 is stated to be a totally homogeneous source of sound, phase true and very aperiodic, with a frequency response both on and off axis which is quite free from the irregularities which are inevitable in any multi-way loudspeaker system.

The designer has complete control over the directivity of the loudspeaker, and the mean spherical radiated energy is tapered smoothly at the higher frequencies. The Quad ESL-63 acts as a dipole source with a figure-of-eight dispersion pattern, and has been known

by its development engineers as FRED — Full Range Electrostatic Doublet! (*We used to know FRED as a 'Frequently Ridiculous Electronic Device', so that's a new one ... Ed.*)

Such a dipole source has important advantages both in connection with the placement of the loudspeaker in a room and with stereo perception. There is no radiation in the plane of the diaphragm, so it does not excite modes of room vibration which lie in this plane. In practice, the loudspeakers are normally placed at an angle to the horizontal axes of the listening room and excitation of both horizontal axial modes is 3 dB less than with an omnidirectional sound source, while discrimination is imposed against vertical modes.

The ratio of direct-to-reflected sound is much greater with a dipole source than with omnidirectional sources, so the localisation of the stereo image is much improved.

Amplifier requirements

The impedance of the Quad ESL-63 is nominally 8 ohms, predominantly resistive, thus presenting no problems at all to an amplifier. However, it is vitally important to note that amplifiers which do not incorporate short-circuit protection should not be employed with this loudspeaker. The amplifier should have an output capability of 40 V peak (corresponding to 200 W peak or 100 W mean into 8 ohms). Amplifiers with output capabilities of up to 55 V peak (190 W into 8 ohms) can be used, but there is no advantage in doing so.

Two protection circuits are fitted into the ESL-63. One of these limits the maximum input voltage which is fed into the loudspeaker; the other detects

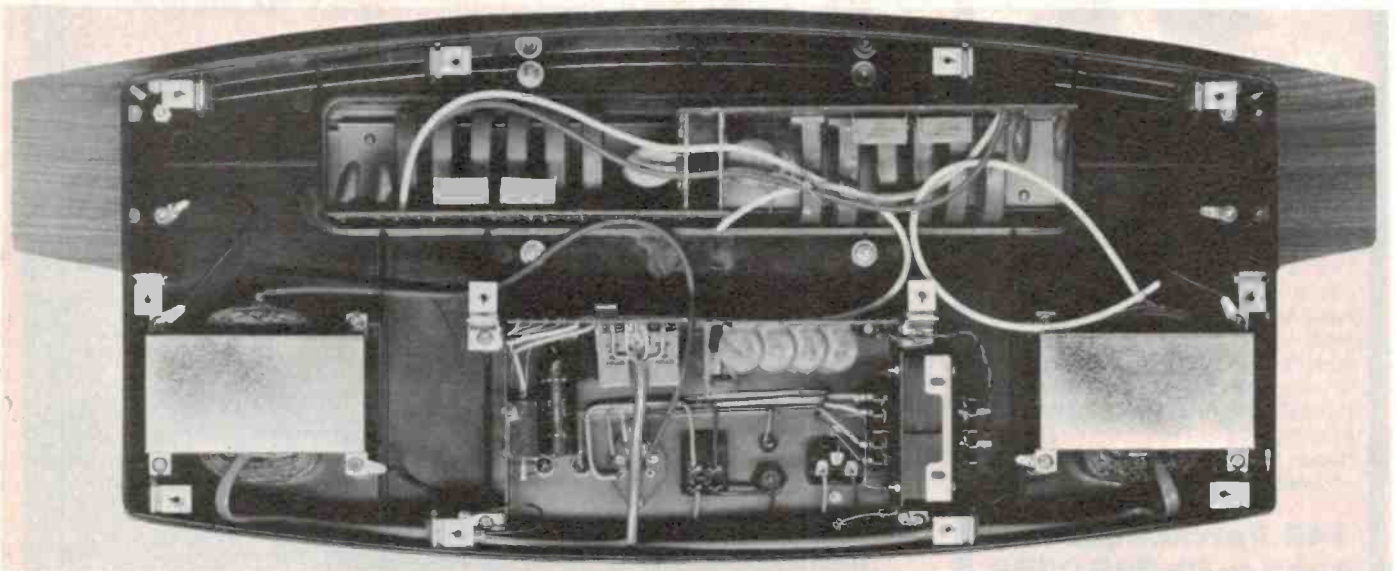
fault conditions and instantaneously shorts the signal being fed into the loudspeaker — hence the need for an amplifier with short circuit protection. It is impossible to damage the loudspeaker element itself, but the input voltage limiter has a limited thermal capacity and persistent overdrive will overheat this section of the equipment.

The dimensions of the ESL-63 are: height 925 mm, width 660 mm and depth 270 mm, including the 150 mm-deep base which contains all the electronics. It is quite heavy, the net and gross weights being 18.7 kg and 23 kg respectively. It requires a mains supply of either 200/240 V or 100/120 V at 50 to 60 Hz at 5 VA.

The earlier Quad electrostatic loudspeaker could be confused with a room heater with its open-mesh metal grille, but the ESL-63 is a completely re-styled version which many people feel is more suitable for a domestic living room both in appearance and in the convenience brought about by its reduced width.

For the technically minded reader, the maximum output is 2 N/m² at 2 m from the loudspeaker on its axis. The bandwidth referred to the -6 dB limit on its axis at low levels is 35 Hz to over 20 kHz. The sensitivity is 86 dB for a 2.83 V RMS input (1.5 μ bar per volt referred to 1M).

Australian availability:
The Acoustical Manufacturing Co. of Huntingdon, England, have informed Brian Dance that the address of their Australian Distributor is:
Audioson International Pty Ltd
P.O. Box 361
Brookvale
NSW 2100
The new ESL-63 is expected to be available from this supplier by about early 1982.



View underneath the base of the ESL-63, showing the driving and delay line components.

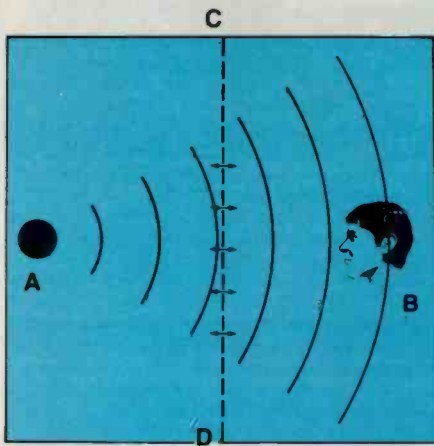


Figure 3. The listener at B hears sounds from the source after it passes through the plane C-D.

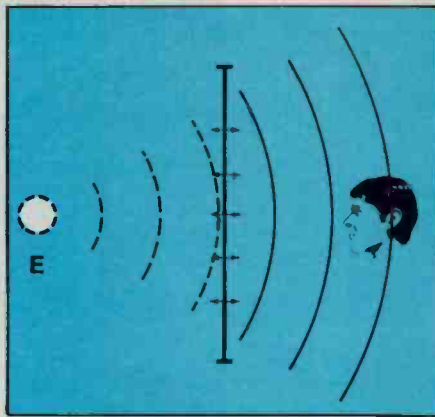


Figure 4. A diaphragm can generate waves identical to those from the virtual source at E.

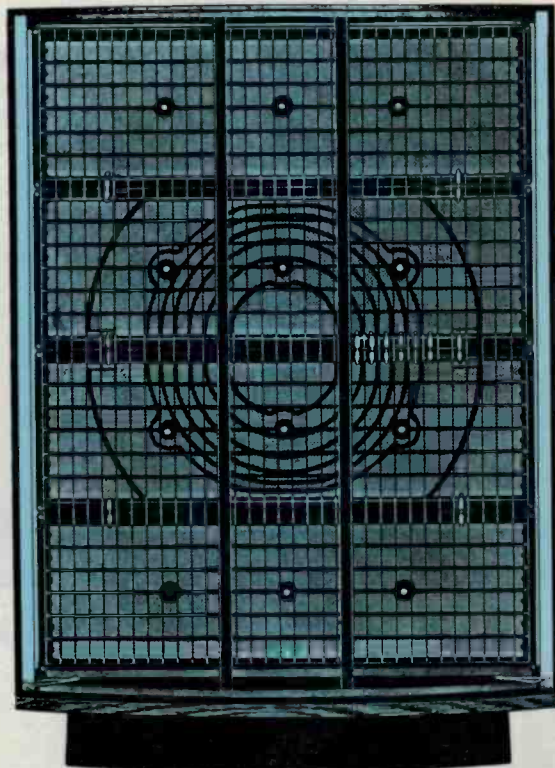


Figure 5. The Quad ESL-63 with the grille cloth removed to show the concentric annular electrodes.

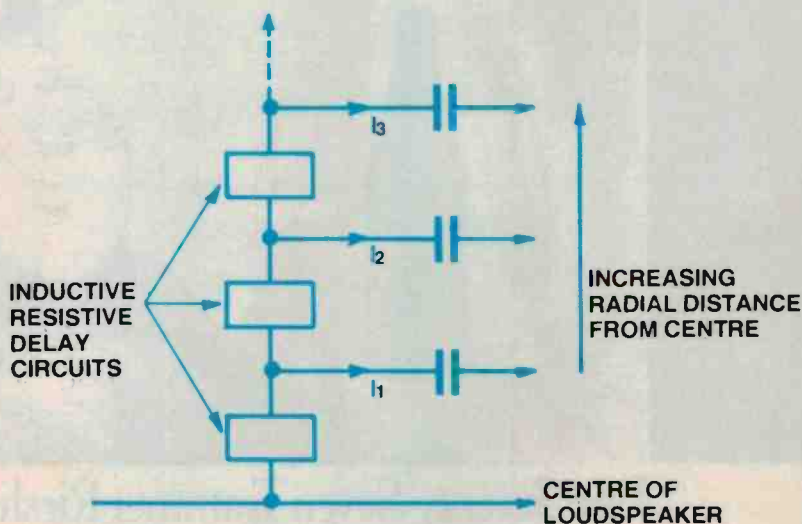


Figure 6. The form of the delay line used to supply the annular electrodes.



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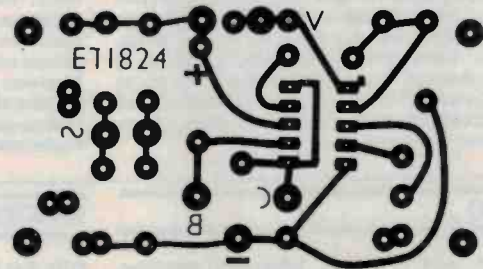
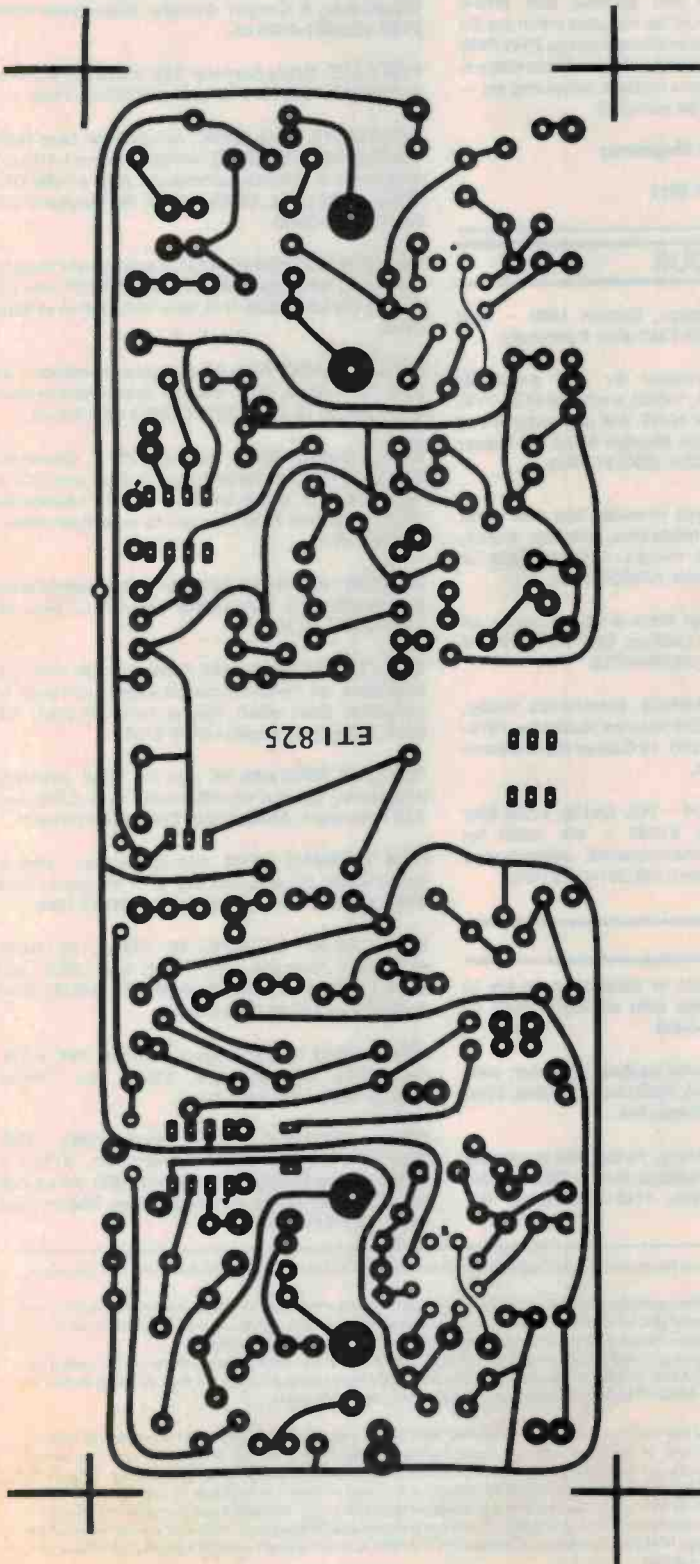
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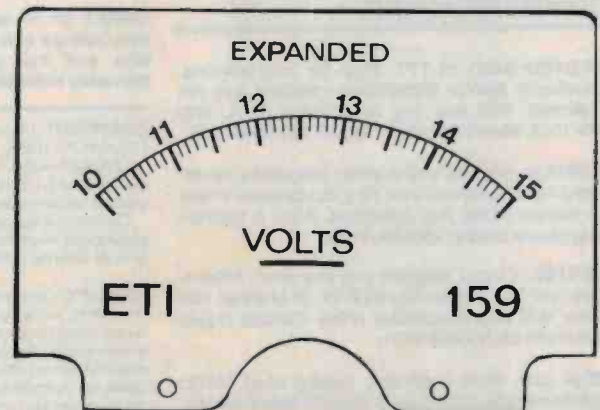
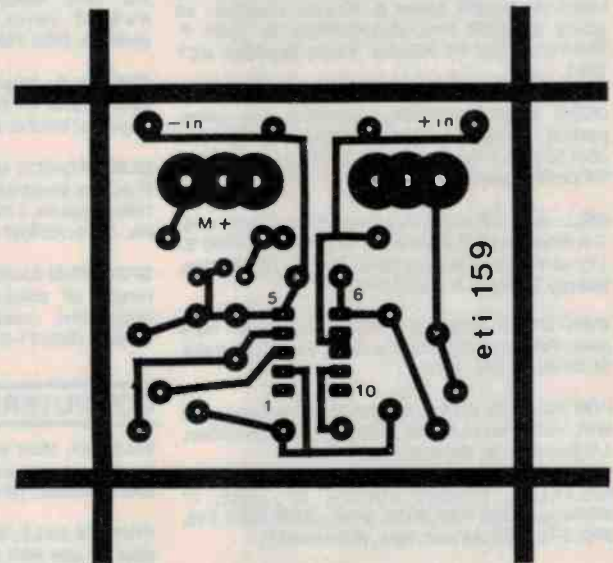
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reduces or eliminates *all* types of distortion, not just harmonic or switching or TIM.

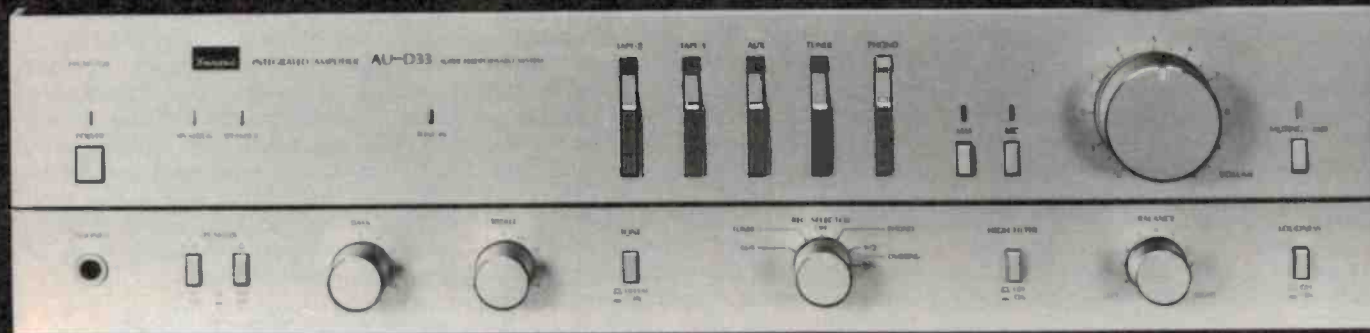
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Louis Challis

IT IS OFTEN perplexing how many pieces of equipment developed for laboratory use over the last two decades have found their way into the consumer electronic market. Much of this equipment may be treated as a gimmicky approach to create a demand where none actually exists, but in certain cases it is practical equipment to truly assist the novice in areas which were previously regarded as the domain of the professional.

One such piece of equipment has unquestionably been the graphic equaliser; another has been the real time spectrum analyser. When the two are combined in one instrument they have the potential to become a truly effective and useful tool to assist in one's day by day work or play with audio equipment.

I saw my first equaliser about 18 years ago in the form of a one-third octave band spectrum shaper for use with laboratory set-ups to measure vibration. That particular piece of equipment was developed by General Radio, and provided a very effective means of frequency equalisation as part of a dedicated piece of equipment for use with a military environmental test set up. It featured such innovative extras as a key locking system, to stop some unwanted person from changing the predetermined spectrum shape (many home equalisers could do well to incorporate a similar feature to hold knob-twiddling children at bay!).

In the following ten years many consumer electronics firms have seen the benefit of this linear spectrum display approach, which provides an optical analogue of the filter frequency curve. By selecting octave band centre frequencies the simplest and yet most convenient graphical display is superimposed on one's interpretation of the

frequency response of the filter curve so produced. There are today, needless to say, many hundreds of graphic equalisers, some of which offer good performance and a few exceptional performance.

Real time display

I saw my first real time analyser about twelve years ago. It consisted of a rather large cathode ray tube display unit seated on top of a large box of electronics, with the combined height in excess of 800 mm, a weight something in excess of 50 kg and a cost tag sitting somewhere round about \$12 000, which was a lot of money in those days! This equipment was designed for acoustic research and was highly regarded by most of the competing manufacturers.

It did not take long for the high fidelity industry, and most particularly the recording segment of that industry, to realise the benefits that such a device could provide. The greatest benefits were achieved in the frequency equalisation of electro-acoustic systems and for checking the frequency characteristics of studios. This could be carried out with great ease and practicality and so the need, benefit and advantages of producing lower cost versions of the same equipment were realised. These versions had less restrictive parameters, lower performance and generally much lower price tags. By reducing the quality and accuracy of the filter networks it soon became possible to produce devices that used even simpler displays and yet still provided adequate performance for equalising an electro-acoustic system, measuring the overall performance of the resulting system, and more importantly for equating the objective parameters with one's subjective requirements.

Obviously, the graphic equaliser and

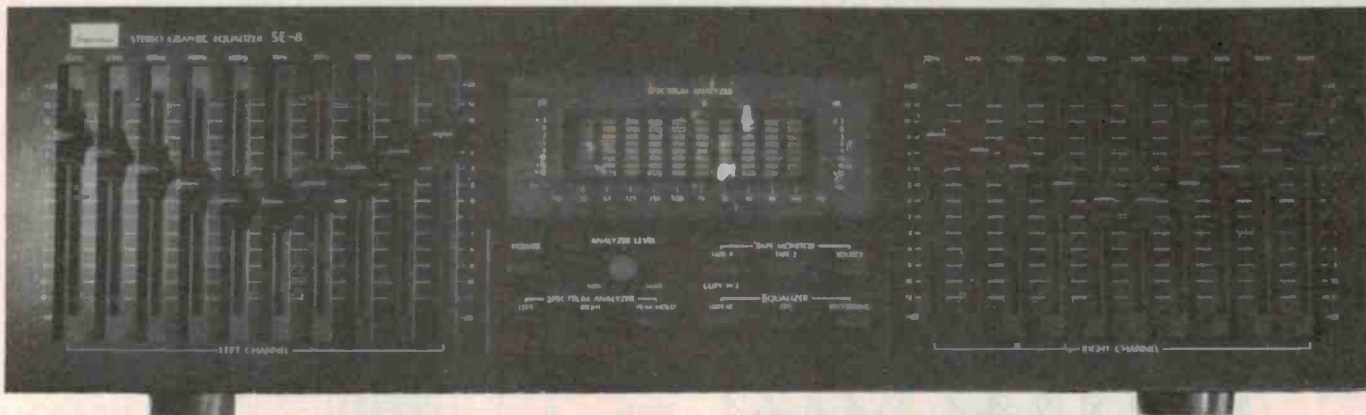
the real time octave or one-third octave band analyser were often used together to perform the function of frequency equalisation and objective assessment. They were always produced as separate pieces of equipment.

Graphic display of power level settings or inputs has become the vogue in certain high-priced amplifiers over the last five years, generally in the form of a graphic display using light emitting diodes.

One innovative model, which aimed at achieving the same result with a combined spectrum analyser, was released earlier this year by Sansui in their B77 amplifier. Not surprisingly, when this unit hit the market I borrowed an example from the local Sansui agents (Vanfi) to evaluate in our laboratory. It has reposed there for some six months now, during which time we have made use of its special merits and its now well-proven attributes. The electronics that went into producing the real time analysis feature of that particular amplifier have formed the basis of the Sansui SE-8 Octave Band Graphic Equaliser. By combining a well-proven real time analyser design into a box containing two octave band equalisers Sansui has, in our opinion, achieved a positive breakthrough in graphic equaliser design.



The first equaliser I ever saw was this 1/3-octave band spectrum shaper made by General Radio. It featured key-locked controls.



The SE-8

The SE-8 stereo graphic equaliser, which is available in black or silver brushed satin fascia versions, contains the two equaliser sections on both sides of a central spectrum analyser unit. Each of the graphic equalisers contains the conventional slider controls for octave band centre frequencies of 32 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz and 16 kHz with a genuine ± 12 dB range. These controls may be set so that any individual filter can achieve a nominal ± 12 dB setting relative to the zero setting, or +24 dB relative to the -12 dB setting, if a range adjustment greater than 12 dB is required.

Thus, for example, if all the controls are placed at -12 dB and one or more controls requires a boost of up to 24 dB, this is acceptable and is a feature of the basic design.

In the centre of the display panel is a window, behind which is a ten-band spectrum analyser with a 21 dB total display range with eight steps, each of 3 dB. The analyser uses a bright blue plasma display with an exceptionally rapid response and yet far more modest cost than that provided by either a LED display or the far more costly cathode ray oscilloscope type of display. The plasma display is perfectly suited for the task and performs very well.

In the quadrant immediately below the plasma display are two rows of controls, with the top row providing a power on/off switch, an uncalibrated analyser level setting potentiometer and tape monitor switches for tape one, tape two or source. The bottom row of controls contains a spectrum analyser switch for left channel, right channel or peak hold on the left. On the right hand side is a graphic equaliser defeat switch or ON switch and a recording switch. This recording switch should be used when a signal coming in at the input is to be re-equalised before being set to either tape recorder 'one' or tape recorder 'two', or from tape recorder

'one' to tape recorder 'two' at the output. On the rear of the unit, stereo pairs of RCA-type coaxial sockets are provided for input, for record and playback for tape recorder 'one', record and playback for tape recorder 'two', and output sockets for left channel and right channel respectively. The unit is fabricated from steel and is well made.

The inside of the unit contains one large 'mother' board, with the equaliser control circuitry for left channel and right channel all located together on one side of the board. This features thirteen integrated circuits, its own power supply stage on the left hand side of the board, and a protection circuit at the rear. The selector stage for switching between the stages of the unit are all placed in the middle of the board. Immediately above the front of this board the real time spectrum analyser display and control board are located.

The plasma display is directly wired onto this board and is mechanically protected by additional metal covers. There is still enough space left within the module to accept a medium sized power amplifier, as well as various types of preamplifier. One really wonders if the whole of the unit could not have been effectively reduced in size to achieve a neater and more compact product.

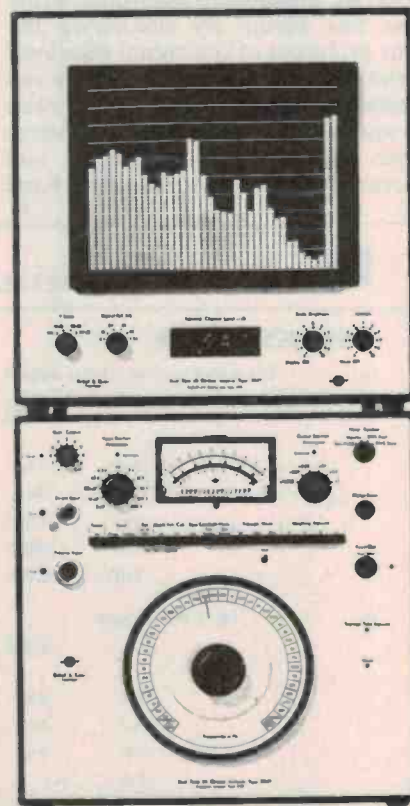
On test

The objective testing of the unit proved to be an eye-opener. The frequency response is extremely flat, extending from 2.5 Hz at the lower frequency limit to beyond 100 kHz at the upper 3 dB point (with the tone control centred). With one volt input (and one volt output) the distortion figures are exemplary, being less than 0.008% at 100 Hz, less than 0.007% at 1 kHz and 0.01% at 6.3 kHz. At the rated nominal maximum output of 4 volts these figures only increase slightly to a still satisfactory value of less than 0.02% at 100 Hz, 0.015% at 1 kHz and 0.016% at 6.3 kHz. The maximum output voltage at clipping point is a phenomenal 59 volts

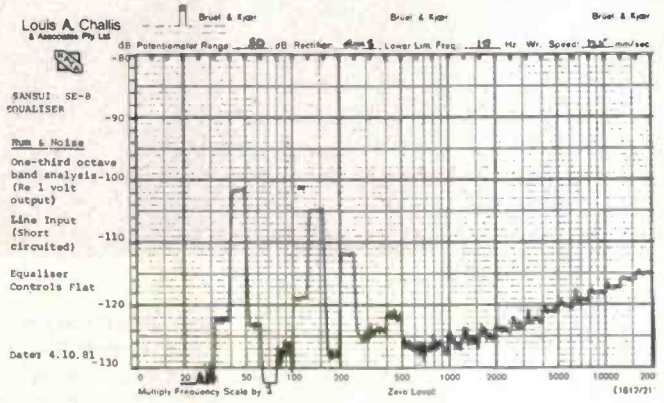
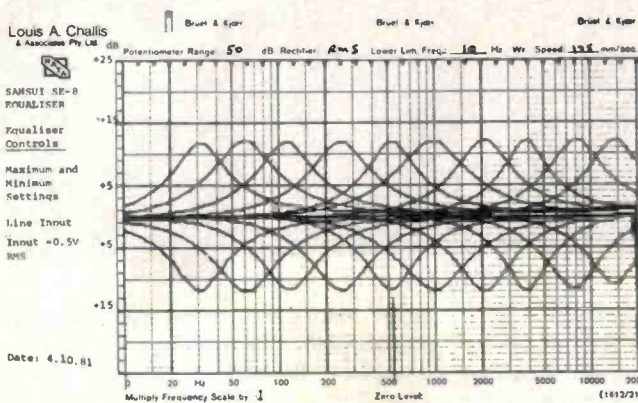
RMS, which indicates that this unit would readily be used as a high-level equaliser, feeding directly into power amplifier output stages without distress. Another outstanding feature is the hum and noise level, which is -99 dB unweighted, relative to the 1 volt output, and a phenomenal -110 dB(A) relative to that same level.

The transient intermodulation distortion is also extremely low, being less than 0.01% with the standard 3.15 kHz square wave and 15 kHz sine wave mixed in a four-to-one ratio.

The separation between channels is extremely good, and the highest level that is fed through from channel one to channel two (left to right or right to left) is at a -71 dB level at 20 kHz when compared with the fundamental in the main channel.



A real-time analyser - expensive!



To hear

The objective tests were positively impeccable, but we were keen to see how the unit would perform in subjective tests. Anybody who has ever tried to use a graphic equaliser knows that without effective metering or monitoring instrumentation facilities it is hard to tell by ear alone whether one has really achieved the optimum balance setting.

The difference between this unit and others currently available is that it is able to provide a direct visual assessment of what has been achieved. This may be on either real programme content or alternatively using a preferred broadband electronic white noise test signal. By monitoring the input or output of the signal displayed on the octave band plasma display you can see directly what the characteristics are and take the appropriate corrective action (within the physical and practical capabilities of the octave band

equalisers). There can be no denying that octave band equalisers are not the most refined means of achieving spectral balance adjustment, but for the majority of residential situations and within the scope of what the majority of amateurs are looking for, it provides the best compromise between cost and performance. In listening to programme content, equalising tape recorders and adjusting the spectral balance of signals feeding to loudspeakers of less than perfect performance, I found that the Sansui SE-8 Equaliser comes closer to the amateur's expectation of a panacea than anything else I have yet seen in the marketplace.

Whilst the equipment can equalise out the majority of problems (but not all) in amplifiers, tape recorders and loudspeakers, I did not find that it is capable of providing perfect correction for room acoustics or room standing waves (eigen tones). The Sansui SE-8

may not, in the end, be a true panacea, but it offers a more innovative solution and more other practical features than almost any other piece of equipment that has yet been produced that is not a professional spectrum analyser combined with a professional graphic equaliser.

SANSUI GRAPHIC EQUALISER TYPE SE-8

Dimensions: 430 mm wide, 130 mm high, 277 mm deep.
Weight: 4.4 kg
Price: \$499 rrp
Manufactured: In Japan by Sansui Electric Company Ltd.
Distributed by: Vanfi (Aust.) Pty Ltd, 297 City Rd, South Melbourne Vic. 3205. (03) 690-6200.

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MEASURED PERFORMANCE OF SANSUI GRAPHIC EQUALISER SE-8 S.N. 831070624

HARMONIC DISTORTION:

(A) (At Rated level of 4 Volts output)

	100Hz	1kHz	6.3kHz
2nd	-76.7	-91.6	-88.6dB
3rd	-80.2	-77.1	-76.4dB
4th	-85.7	-	-dB
5th	-88.0	-	-dB
THD.	0.019	0.014	0.016%

(B) (At 1 Volt output)

	100Hz	1kHz	6.3kHz
2nd	-83.5	-84.1	-81.3dB
3rd	-89.2	-96.1	-85.4dB
4th	-94.8	-	-91.7dB
5th	-	-	-dB
THD	0.0077	0.0064	0.01%

TRANSIENT INTERMODULATION DISTORTION: Very low: less than 0.01%

(3.15kHz square wave and 15kHz sine wave mixed 4:1)

NOISE & HUM LEVELS:

re 1 Volt output) LINE -99dB (Lin) -110dB(A)

MAXIMUM OUTPUT VOLTAGE AT CLIPPING POINT:

59 V RMS

FREQUENCY RESPONSE:

(-3dB re 1 Watt, 0.5V input to Aux)

Equaliser Tone Controls Centred

Left 2.5Hz to >100kHz

Right 2.5Hz to >100kHz

SENSITIVITY:

(controls flat)

	Left	Right
LINE GAIN	0dB	GAIN 0dB

INPUT IMPEDANCE:

	Left	Right
LINE	32k Ω	32k Ω

OUTPUT IMPEDANCE:

480 ohms (@ 1kHz)

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are raving about
the Magnetic
Field Amplifier**



M-400 Magnetic Field Amplifier

"Its distortion and noise levels are entirely negligible . . . it's hardly conceivable that a small, inexpensive lightweight cube such as this could deliver as much clean power as any but a few of the largest conventional amplifiers on the market."

That's what Julian Hirsch reported in Stereo Review about the Carver M-400 — the unique magnetic field power amplifier. It's a cube that weighs around 4 kgs and delivers 200 watts per channel. And costs a lot less than you think.

Equally startling, the M-400 can safely drive speaker-load impedance as low as 2 ohms. And in mono it can deliver more than 500 watts into an 8-ohm load, with peaks to 900 watts! (Bring on digital audio!)

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Say it again, Sam

Amateur radio 'field days' are regular events on radio club calendars. Generally they're for getting together and having fun with various competitions, etc, looking at trade displays, selling/buying junk — all with the object of raising money for the club.

It is traditional at ham radio field days to include a few 'events' to amuse the ladies — generally referred to as YLs or XYLs (all this is horribly sexist — never become involved with a ham... Ed's wife). Topping the list of ladies' events at every field day is the 'Ladies Radio-Throwing Contest'. A little something to relieve the frustrations of playing second fiddle to the transceiver, no doubt.

This time-honoured event appeared on the agenda of a certain club field day attended by the Editor recently. To advise competitors of impending events, and to broadcast announcements, etc, the club had organised a PA system and had rostered various announcers.

Came the appointed time for the Ladies Radio-Throwing Competition. An announcement was duly made, but, it seems, the response was not immediate so another announcement was made. It seems this too was missed (or likely, ignored) by the populace.

At this stage, for one reason or another, the announcer appeared to become somewhat flustered. He was doubling as events scorekeeper as well and he was attempting to record the results of the previous event, which had run late, and start the next — the Ladies Radio-Throwing Competition.

The next announcement came out as the "Radio Ladies-Throwing Competition..." and he was swamped with entrants — all men, wanting to know where the ladies were for throwing!

DREGS



IT'S SOME TIME since we had computer cracks in these columns, so it seems appropriate to launch Dregs this month with a software joke — only it's more irony than joke.

The latest computer language to storm the bastions of the software computerists (now **there's** a buzzword for you!) is called 'FORTH'. FORTH is reputed to be not only cunningly devised but powerful to boot

(... if you'll pardon the pun). You start out with a 'core' and build out your FORTH as you go — new instructions are added as you use it. FORTH defines new instructions in terms of existing instructions and a huge branch network multiplies from the 'core'.

Which Bible character is alleged to have said "...go forth and multiply..."?

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