CANADA'S OWN ELECTRONICS MAGAZINE

# electronics today

APRIL 1978

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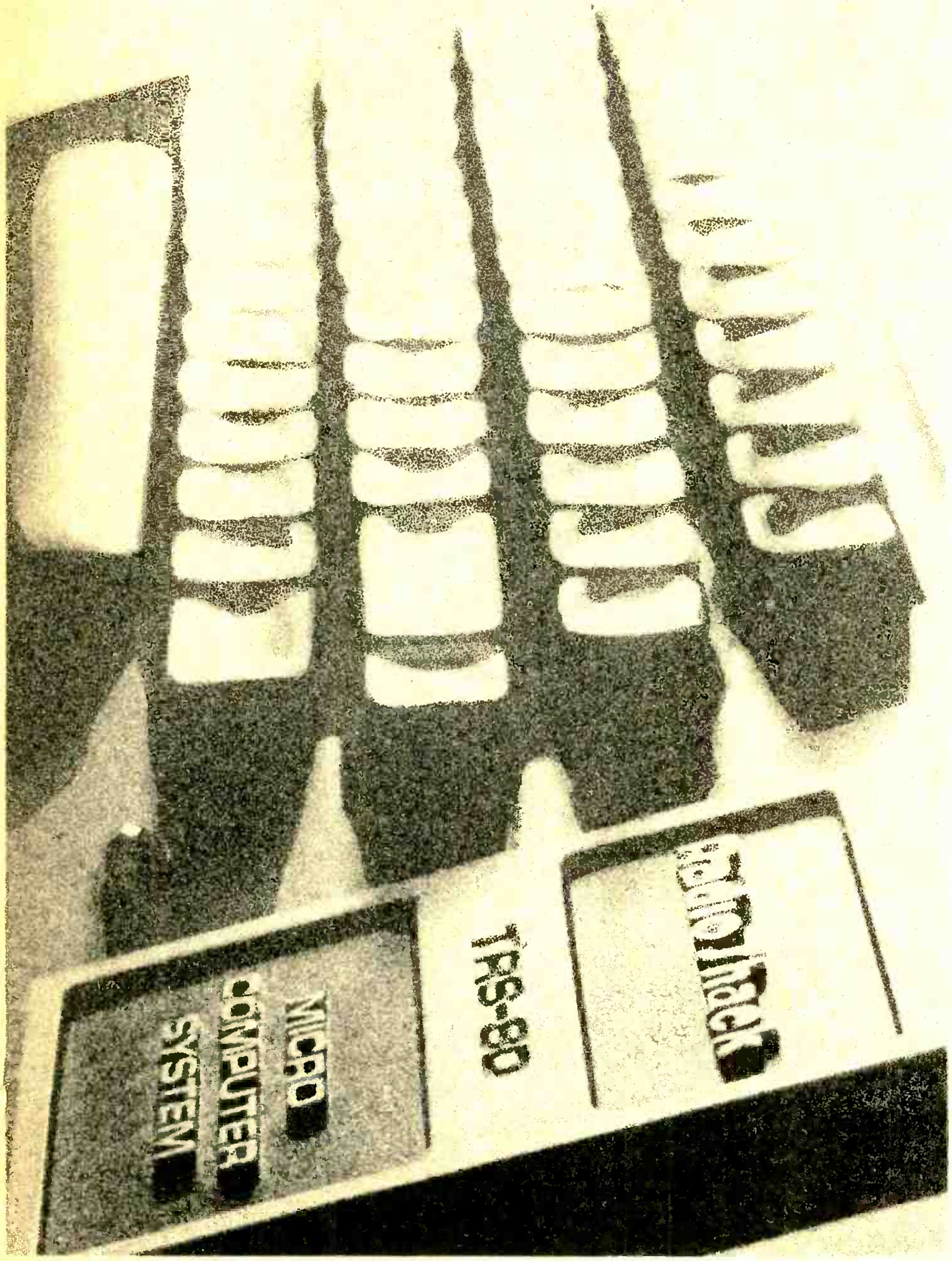

## Projects

## Bucket-Brigade Delay Line

## Dangerous Gas Alarm

## Computer Power Supply

## More PCB Negatives

## New Section for the Educated Audiophile

## ETI's X-Ray Examination of the Radio Shack Computer


Service from coast to coast

**VOL. 2 NO. 4**
**APRIL 1978**

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# electronics today international

## CANADA'S OWN ELECTRONICS MAGAZINE

## PROJECTS

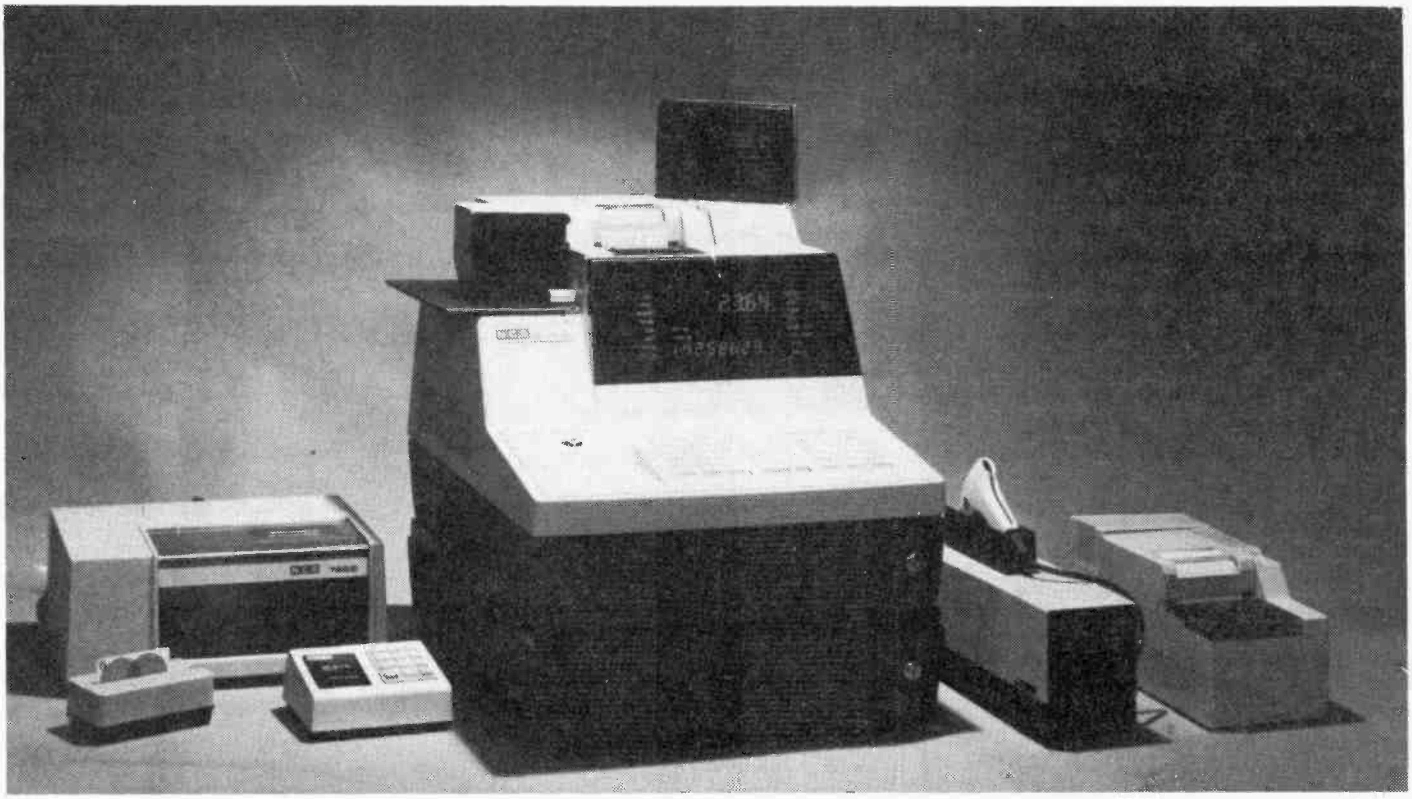
## FEATURES

## NEWS & INFORMATION

**Cover: We didn't really use X-rays, of course, but we gave the machine a very thorough check-up. See page 15.**

*Second Class Mail registration number 3955. Return postage guaranteed. Post Office returns to Unit 6, 25 Overlea Boulevard, Toronto, Ontario, M4H 1B1.*

# NEWS DIGEST



## New NCR Retail Terminals

What is claimed to be a new generation of electronic point-of-sale terminals, whose performance can be increased by adding plug-in modules, was announced recently by NCR Canada Ltd. Features include the use of proprietary NVRAM (Non-Volatile Random Access Memory), and the ability to use more than one processor. The 2140 can automatically read merchandise tags with a scanning device or automatically read information encoded on the magnetic strip of a plastic card.

Additional modules include: Data communications to a computer system at another location; data consolidation, in which one "master" terminal automatically summarizes totals for up to 15 other units memory capacity up to 128K bytes; Electronic Funds Transfer transactions, the ability to handle credit-authorization or debit transactions; and up to three printing stations.

Prices for the 2140-2000 begin at $2,950.

## Digital AC Volts Amps Freq Meters

AC Volts, Amps and Frequency can be monitored with an AC digital panel meter from Electro Industries. The LM Series will simultaneously measure both AC volts with 1 volt resolution and frequency between 42 and 99.9 Hz with 0.1 Hz resolution. The indicator utilizes the double LED display 0.3" high. The VA series is an AC volt/amps monitor with the same double LED display. Amps are displayed up to 999.9 amps AC and volts up to 600 volts. The LF series offers a choice of 3 models of frequency monitors with a full 4 digit display offering up to 0.01 Hz resolution, using 0.4" high LEDs.

For free detailed technical information contact Metermaster, 214 Dolomite Drive, Downsview, Ont. M3J 2P8.

## RF Data

Motorola has a new RF data manual, with complete data sheets, practical application notes, and cross-references. The two pound, 736 page volume describes RF power transistors with outputs up to 150 W, operable in commercial, military, aircraft, marine and ham bands from 1.5 MHz to 1 GHz.

Detailed application information includes impedance matching networks, mechanical RF construction techniques, biasing, reliability, noise figure and gain optimization procedures, mounting and heat sinking, as well as discussions of SSB linearity, broadbanding, and power combining.

Motorola's RF data manual is available for US $3.50 each from US Motorola distributors.

## Rockwell's Bubble Business

Rockwell International has announced it has chartered a new organization to convert its bubble memory technology into a commercial business, and plans to announce new product specifications and prices very soon.

John L. Archer, formerly manager-Applied Magnetics, heads the new enterprise with the title of business director - Bubble Memory Products. Mr. Archer worked at Rockwell's Electronics Research Center where the first operating 1-megabit bubble memory devices were developed and produced in February last year.

## Cesco Appointed HEP-Motorola Rep

Cesco Electronics Ltd, have announced their appointment as the HEP-Motorola stocking representative for Canada.

HEP-Motorola is a line of packaged semiconductors intended for hobbyists and as service replacements. The line is accompanied by cross reference guides, technical information guides and Hep-notes which provide complete details of different projects.

HEP-Motorola will be sold to electronic parts distributors through a number of representatives in different areas of Canada. Cesco will carry good stocks of the line for fast service and delivery. Pricing policy is based on HEP-Motorola's own price list. Further information and the name of the rep in your area may be obtained by writing to Cesco Electronics Ltd, 4050 Jean Talon St West, Montreal, Que.

## HP Programmable Calc Books

Ten new books designed to provide owners of HP-19C and HP-29C programmable calculators with solutions to problems in such fields as finance, statistics and engineering are available from Hewlett-Packard. The books are $10.95 each (plus tax and duty if applicable).

Each HP-19C/29C Solution book provides the user with 12 programs. For each there is a summary of the program, a listing of program steps, and an explanation of how the results are displayed on the calculator. The ten books in the "Solutions Library" are identified by subject:

1. Surveying. 2. Mathematics. 3. Statistics. 4. Finance. 5. Electrical Engineering. 6. Navigation. 7. Mechanical Engineering. 8. Civil Engineering. 9. Games. 10. Student Engineering. HP-19C/29C Solution books are available from Hewlett-Packard and selected retail outlets and college bookstores.

## Errata: Project Book

Please note that in Canadian Projects Book Number One, Fifty/One Hundred Watt Amplifier, Q6 is incorrectly shown as a 2N4250. It can be replaced by a 2N3904.

## Video Editor

The BVE-500A broadcast editing console from Sony permits fully automatic editing for a pair of Sony BVU-200A U-Matic videocassette recorders. A major advantage of the unit over existing editing consoles is "bidrex" — two self-return search dials that operate with picture in both forward and reverse modes.

Other features include a digital tape time counter (up to 79mm/59 sec/29 frames for both player and recorder), blinking lamp indicators (guide sequence of operation), automatic entry, butt edit, manual edit, automatic "on air" capability, edit preview and review, and entry time shift.

## Annual Recording Workshop

The third annual summer seminar on the fundamentals of recording will be held at The Banff Centre, School of Fine Arts, Mon May 29 to Fri, June 2, 1978. Stephen F. Temmer, President of Gotham Audio Corporation (New York and Hollywood) will be on hand. The intensive course features six hours daily of scheduled class and hands-on recording work. In addition, there will be evening discussion sessions probing the philosophy of recording and exploring ideas on future technology.

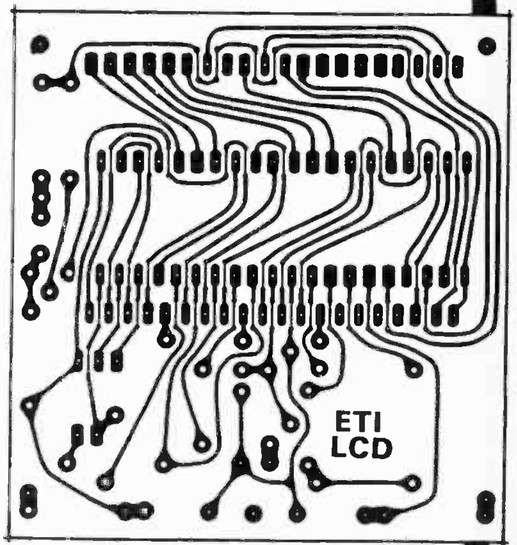
Lending the course greater weight is the fact that students and faculty of the Music Division of The Banff School of Fine Arts will be available for actual recording sessions.

The fee for the week-long course is $225.00.

Address all queries to Communications, The Banff Centre, Box 1020, Banff, AB, T0L 0C0. Registration closes April 30, 1978.

## LCD Panel Meter PCB

In our February issue we inadvertently omitted the PCB pattern we were so proud of. Here it is.



## Micro Seminars

E&L Instruments will present four one-day "hands-on" microcomputer seminars to product designers attending the 25th ASME Design Engineering Show at McCormick Place, Chicago, Illinois, April 17-20, 1978. Design engineers and mechanical engineers will learn how to program and interface microcomputers in traditionally mechanical applications such as appliances, tools, process control, automative instrumentation, and consumer goods.

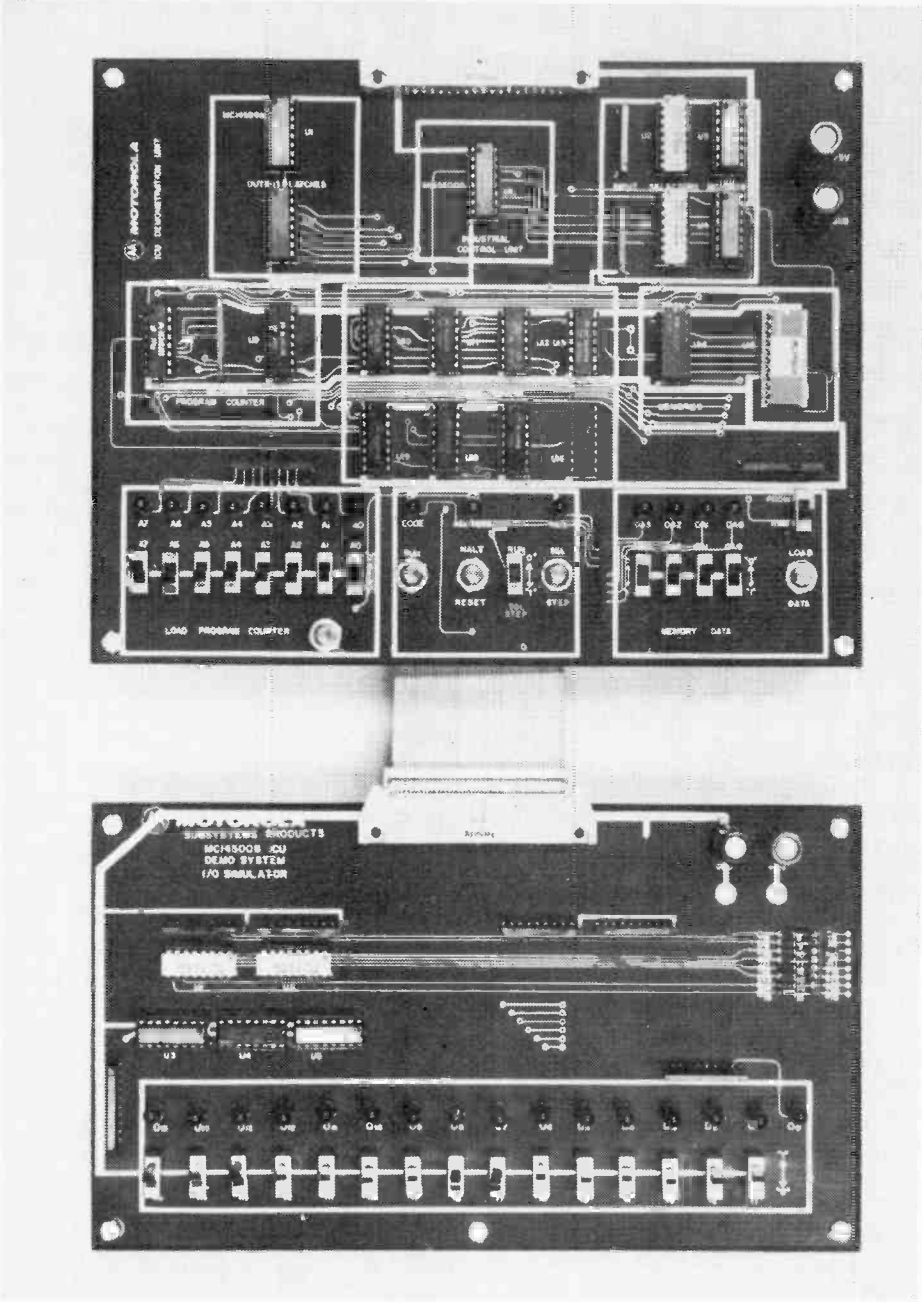
For seminar registration information, contact Clapp & Poliak Inc, 245 Park Avenue, New York, New York 10016; telephone: (212) 661-8410.

## TDS-M68 Micro

The TDS-M68 microcomputer Training and Development System guides the user step-by-step through the learning process (from elementary introductory material to interrupt based sequential control examples), a lab package that includes real world devices (LEDs, relays, small motors, etc.) that are interfaced to and controlled by the computer, plus a practical, applications oriented, textbook covering programming, interfacing and application concepts (including worked out sample application examples). An instructor's guide and overhead transparencies are also available.

Six general purpose I/O ports (utilizing the SWTPC bus configuration) accept a line of interface boards that includes parallel and serial I/O ports, a cassette interface, an interrupt timer, a calculator module, an EPROM programmer, etc.

All items are available separately or as a total package. A descriptive brochure is available upon request from SDS Technical Devices, 1138 Main St., Winnipeg, Man., R2W 3F3.



## Programmable Control Unit/Learning Aid

Motorola has announced a 2-board Industrial Control System that combines a prewired programmable logic controller (PLC) with an ancillary Input/Output Simulator that serves as a system development tool and demonstration unit. Based on the company's recently introduced single-bit microprocessor — the MC14500B Industrial Control Unit (ICU) — Motorola claim this sytem can serve as a learning tool to acquaint designers with the power and potential of a one-bit MPU and, thereafter, as a dedicated functional control system. As a functional system, the I/O Simulator is replaced by the actual I/O devices associated with the working system.

The system has 15 inputs and 16 outputs, and incorporates a RAM capable of holding 128 ICU program instructions. The user is able to examine or change the contents of any memory location and has the option of single stepping or running his program. Alternatively, a programmed PROM may be installed in an available socket to run the program. Built-in LEDs display the state of the program within the system, thereby providing an easy means for monitoring or troubleshooting. The system accepts 16 instructions and can be uniquely tailored to a user's particular requirements. Designed with CMOS technology, it utilizes very little power and operates from a 5 volt power supply.

In the USA the DS14500A Industrial Control Unit Demonstrator System sells for $295.00. This includes the Processor Board, the I/O Simulator Board and an appropriate 40-conductor ribbon cable. In addition, the Processor Board is available separately under part number DS14500B, at a cost of $197.00 (unit quantity), for end-use application where an I/O simulator is not required.

## 6800 Programming

Bob Southern's "Programming the 6800 Microprocessor" was written to teach programming to community college students. He assumes no previous knowledge of programming and teaches the fundamentals of assembly language and machine-code programming of the 6800 processor and its peripheral devices. The ACIA and PIA are explored in detail in both non-interrupt and interrupt modes. The workbook asks the student questions after each new piece of information, and then gives the correct answer.

The book is available ($6.75, prepaid) from The Algonquin College Bookstore, 1385 Woodroffe Avenue, Ottawa, Ontario, K2G 1V8.

## First $I^2L$, Monolithic 10-Bit A/D Converter

A complete, 10-bit monolithic analog/digital converter, which for the first time in bipolar technology combines linear and digital circuitry on a single integrated circuit chip, has been developed by Analog Devices Semiconductor. The new AD571 is produced using the integrated-injection logic ($I^2L$) technique which allows very high circuit densities to be fabricated on a single chip.

In addition to representing an advance in the application of $I^2L$ technology, the AD571 is also the first monolithic A/D converter to be laser wafer trimmed.

The AD571 is a successive approximation converter and includes a DAC, voltage reference, clock, comparator, successive approximation register and output buffer on a 120 x 150 mil chip. The device executes a complete conversion to 10-bit accuracy - 1/2 LSB with no missing codes in 25 microseconds.

Contact Tracan Electronics, Downsview, Ont.

## Data Terminal Mart

The competitive data terminal market is now being served by a new style of retail operation. Data Terminal Mart reduces their overhead by limiting field sales staff, encouraging the small customer to come in to their sales outlets and save money. Hazeltine, Digital Equipment, Texas Instrument, Tektron, Teletype, Interdate, MI$^2$ and Misco Manufacturing are among the lines they handle, of particular interest to computer hobbyists would be DTM's less expensive lines such as Soroc (a spin off from Lear Siegler) and competitively priced Dec-writers.

DTM finds that being located in hotels in Toronto, Montreal, and Calgary is very advantageous to business. In Toronto they are to be found in the Skyline Hotel, and in Montreal at l'Hotel Quatre Saison.

Franchises are also available in Vancouver and Ottawa, interested parties should phone Keith Tomlinson at (416) 677-0184.

## Monitor And Debug Interface Buses

The new Hewlett-Packard Model 10050A Adaptor and a companion 10051A Test Probe are designed to provide a fast and easy way to look at activity on the Hewlett-Packard Interface Bus (HP-IB/IEEE-488). Used in combination with the HP Model 1602A Logic State Analyzer, these accessories let the user monitor bus operation at full operating speeds without interfering with bus operation.

The Hewlett-Packard Model 10050A Adapter costs $43.44 in Canada. The Hewlett-Packard Model 10051A HP-IB Test Probe which includes a 10050A is $230. Duty and Taxes extra where applicable.

## Zentronics Data Products

Newly-formed Zentronics Data Products Division will incorporate the Data Products Group of Nedco Ltd. to coordinate the marketing and distribution of a full line of data products including those of Lear Siegler, Teletype and Extel and the microprocessor systems produced by several leading manufacturers.

The headquarters of Zentronics Data Products will be at 99 Norfinch Drive, Downsview, Ontario. Other locations include Montreal and Ottawa, and a fourth will open shortly in Vancouver. For more information call (416) 635-2822.

## Programming Courses

The Computer Mart (Toronto) is organizing a series of Programming classes. Initially, the following courses will be held:

Introduction to Microprocessors (April 10), $135.

Programming the 8080 (Mar. 21), $179.

Programming the Z80 (April 11), $179.

Introduction to the BASIC Language (no details available).

These courses will be held on weekday evenings. Each course runs for three weeks, two lessons each week on Tuesday and Thursdays (except Introduction to Microprocessors). Indicated dates are the actual start dates for one course. The fees include the necessary text books, supplies and the cost of 'hands on' computer time where applicable.

The lecturer for these courses is Andy Johnson-Laird. Andy has fifteen years of programming, systems analysis and teaching experience.

The courses will be held at the Holiday Inn at the Don Valley Parkway and Eglinton Avenue. More details from Computer Mart Ltd, 1543 Bayview Ave, Toronto, Ont., M1K 4K4.

## Microcomputer Exposition

The International Microcomputer Exposition will be held in the Dallas Convention Center, Sept. 29 through Oct. 1. "Co-sponsored by several groups, including the American Association of Microprocessors, the exposition will be directed toward all levels of technology." (That's what the Press Release says: things have really advanced when microprocessors are so smart they can form their own association and hold an expo for all the other technologies. Ed.)

Further details from Beverly Tanner, 214-271-9311.


electronics today
international

# Audio Today

Wally Parsons, ETI's Contributing Audio Editor, introduces this new column.

ONE GREAT THING about writing a column is that the first one is the easiest. At least, that's what everyone tells me. Seems that you don't have to write about anything in particular. It doesn't even have to be relevent to the subject with which it normally deals. Talk about what a great magazine you have, what a nice guy the editor is, and of course, the unusually perceptive readers.

Following along those lines, I might tell of the day early in January, when Steve asked me how I felt about doing a regular department on Audio. Being a man of humble mein, all I could say was, "Aw, shucks, fellas" And then I'd start off this column by telling you how this is your column, the readers', and what you say goes and all that.

But I'm not a humble kind of person, I'm arrogant, opinionated, stubborn, argumentive, impatient, and I like the sound of my own voice. And this column is not the readers', it's mine. It's mine to include what I deem suitable. But it is for the readers, a means of exchanging ideas, information viewpoints, so that I may teach you, you may teach me, and also teach each other. Anyone who doesn't like what appears in these pages is invited to move on, with no hard feelings.

This is not to say that I don't care. I do. But even more, I care about audio, and how to use its marvelous magical technology. Of special concern is the need to establish standards of excellence, and to encourage the application of rigourous critical standards in examining new techniques, and equipment, to distinguish real technological achievement from hype and faddism. You won't find any "gee whiz" reporting in these pages, but you will find praise for worthwhile and interesting ideas and products. Or acid.

As for "unbiased", forget it; there's no such thing, and any reporter or commentator who claims to be is either a liar or a fool. Or both. But the biases will be obvious.

Readers' letters are more than welcome, indeed they are the life-blood of such a column. They tell me what concerns you, and form the basis for real dialogue. And you don't have to agree with me any time; audio is such a marvellous blend of hard technology, aesthetics, and fashion , with so many built-in contradictions, that you can't cast moulds. Readers should also be advised that politically I'm a left-wing nationalist with a certain Messiahnist zeal to promote a real Canadian audio industry. Without it the amateurs and hobbyists are just play-acting. Therefore, I hope to be able to devote a great deal of attention to Canadian developments and products.

Yes, products, because product reviews will also be part of this department but not the sort of reviews you may be accustomed to. For one thing, these kind of test results are available elsewhere. Rather, more emphasis will be placed on the concepts embodied in new products and, in some cases, extended listening and in-use evaluation. This means that products will receive less than rave reviews, from time to time, but every attempt will be made to be fair. It's a different approach, and one which we hope will be well received by our readers. It is my hope that Canadian advertisers will quickly realize the value of product reviews which are not only honest, but appear to be honest. Some reviewers seem enthusiastic about everything, so eventually the reader believes nothing he reads. I don't want that to happen here.

Record reviews are out. Obviously, if a recording illustrates some particular aspect of audio and is relevent, it will be discussed, but only on the technical level. An obvious example would be a direct-to-disc recording, while discussing such techniques. My feeling is that ETI's readers are reading these pages for technical material. If they want record reviews they will do as I do, subscribe to publications which specialize in that sort of thing. Too many audio magazines are really record magazines, and I don't think we need another one. ETI isn't supported by tax money, unlike some music publications, so we have to make it by writing for our readers.

Letters may or may not be published at the discretion of myself and other staff, unless the writer specifically requests that they not be, and are subject to editing. Again unless you request that it be with-held, publishing the writer's initials and home town will be a matter of discretion and common sense (we hope). By the way, if you want a personal reply, please enclose a stamped self-addressed envelope. Answers will be as prompt as our hectic schedule allows. Anyway, on with show.

## AUDIO HARDWARE

Back in the early '50s, a gentleman named Bachman, having pioneered work on the modern magnetic pickup, set about developing an appropriate arm. This was subsequently manufactured by Gray Research and Development Co as their Model 108 and was to be found in almost every broadcast installation up until the '60s. One of its most novel features was the use of a unipivot suspension with integral fluid damping. I was rather proud at the time of being able to fast-cue with it by throwing it above the record surface and have it gently lower itself right onto the starting groove. But even more important is the fact that that arm and its damping system was a major factor in the General Electric pickup's fine reputation among professionals, but not with audiophiles. Proper damping enabled it to deliver its full potential. The technique fell into disuse over the years, and I suspect that one of the reasons was the inability of many people who should have known better to distinguish between damping and friction drag.

## DAMPING

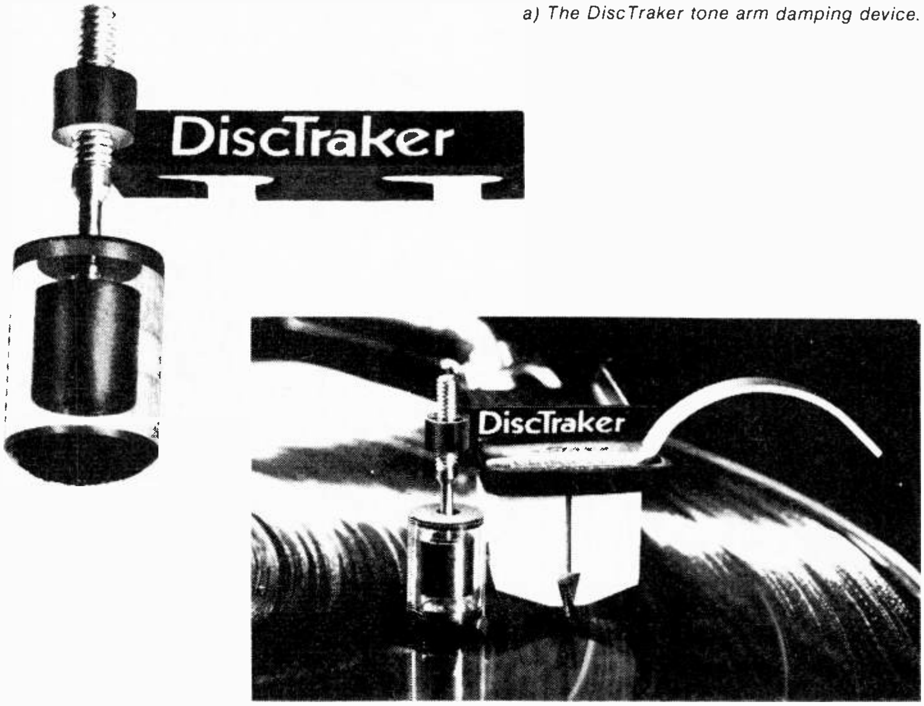
But damping has attracted some attention recently, largely as a result of records cut with excessive modulation levels and pickups with excessive compliances. In re-discovering the wheel, engineers have learned what we all knew way back: that pickup compliance and arm mass combine to produce resonance, that resonance produces a response peak at record warp frequencies and makes the system sensitive to external shock. Given the realization that a resonance condition is undesireable, and that any compliance/mass combination has a natural resonance, but that its effects can be virtually eliminated by proper damping, it naturally follows that any undamped arm/pickup combination is improperly designed. Further, since pickup and arm form a system, it is not possible to design one properly in isolation from the other. The fact that most pickup manufacturers do not manufacture arms, and most arm manufacturers do not equip their arms with pickups, therefore, speaks for itself. It is worth noting, then, that one of the very best pickups in the world, the Decca, really shows its stuff when used in the (damped) Decca arm, yet is often disappointing when used in other ways.

## DISC TRAKER

A few manufacturers are catching on, though, and are scrambling to redesign their products along more rational lines, but there is still a vast area, particularly with regard to automatic, and semi-automatic single play turntables where some means of adding on appropriate damping would seem to be in order. One such device is manufactured by the Discwasher group under the name of "Disc Traker". It's a little gadget which is attached to the arm and has a part which rides on the record surface and another rigidly fixed to the arm. The fixed piece fits into the other as a piston and is said to provide pneumatic damping. In other words, it's what used to be called a dashpot. There's no way it will attach to my arm, but reports as to its effectiveness have been mixed. For example, it was tried on a Decca arm and pickup with results which could only be described as terrible, yet with a Formula 4 arm it turned an already excellent moving coil pickup into a spectacular performer.

I must confess to somewhat mixed feelings on this whole idea. It looks great, but . . .! A 14-page booklet put out by the manufacturer goes into considerable detail on the subject of damping, but the absence of electrical equivalent models results in several statements having to be taken on faith, including some very questionable analogies with automotive shock absorbers. It deals with other systems of damping, but dismisses them in cavalier fashion without substantiating its objections. For example, the claim that oil pivot damping **increases** sensitivity to external shock runs quite contrary to experience, especially broadcasting studios where it's not unusual for inexpert and/or non-technical help to kick turntable consoles, stomp the floor and otherwise deliberately or inadvertently try to bounce the pickup around. As for accoustical feedback, I've run control room monitors, in the past, at levels which would make a disco habitue blanche. But you wouldn't hear the effect of any of these things at home.

Or the claim that dynamic damping is very delicate to adjust and unsuitable where the audiophile selects his own arm and pickup. Well, it just happens that for the past year I've



*a) The DiscTraker tone arm damping device.*

been using a dynamic damping system which adjusted so easily, and so effective that I'm considering looking for financing in order to market it.

However, this device does seem to offer a reasonable alternative to buying another, properly designed, arm, especially if you have an integrated arm/turntable. I have serious reservations as to its effectiveness in damping most resonances, and I very much doubt that it is effective on lateral resonances and the other kind of torsional, and secondary resonances, including the "collison effect' which Joseph Grado describes. However, it should be quite effective in controlling the wild overloads which result from record warp. These warps tax the elasticity of stylus suspensions, cause wild fluctuations in tracking force; drive armatures into non-linearity, overload amplifiers and send woofer cones into mad paroxysms of flutter.

I would suggest, however, that before you run out and buy one you read the Disc Traker brochure, then find a dealer able to demonstrate it on the same arm and pickup you now use, preferable with a speaker with extended low end response, but subject to woofer flutter, and a low damping amplifier such as a tube unit. Listen carefully both before and after, and watch the woofer. And bring your own record. At $45.00 list I think you ought to be sure it will work on *your* set-up. If it does, it's a good buy. Also get a static neutralizer; you'll need it.

## THE SME APPROACH

A different approach is taken by SME, with the FD200 add-on unit for the Model 3009 Mk II, and which is an integral part of the Mark III. It consists of a little paddle mounted to the arm, and a trough attached to the base, and filled with a fluid. The paddle rides in the trough and the fluid damps arm movement caused by resonances, but does not interfere with normal movement of the arm as it tracks inward. The intriguing thing about this little gadget is that it seems to be a prettified version of a technique popular with amateurs for many years and written up on several occasions. Either they've been reading our mail or won't let pedigree stand in the way of a good idea. The technique is particularly useful on arms using needle or knife bearings, because, in one fell swoop it bypasses the problem of limited surface area and fluid migration. An additional plus which no one seems to have considered, is that the device could probably be adapted to other arms including some automatic changers. Obviously, the experimenter is on his own, and it will cost $43.00 to find out.

If you have an SME Mk II it will not upgrade it to a Mk III, which is a new design in several respects, but it will correct the one serious fault in what is otherwise an excellent arm.

Pickup arm damping is a sufficiently involved subject as to require an article by itself. As it is I've devoted enough time to it to crowd out Stanton's new stylus configuration which I've been using for the past few months, so it will have to wait.

DiscTraker is distributed by H. Roy Gray Ltd., 14 Laidlaw Blvd., Markham, Ontario L3P 1W7.

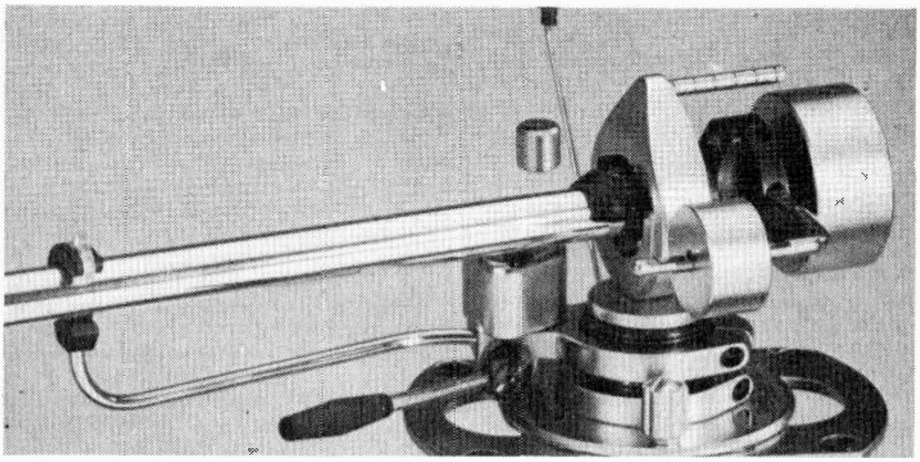
SME is distributed by A.C. Simmonds & Sons Ltd., 975 Dillingham Rd., Pickering, Ontario L1W 3B2.

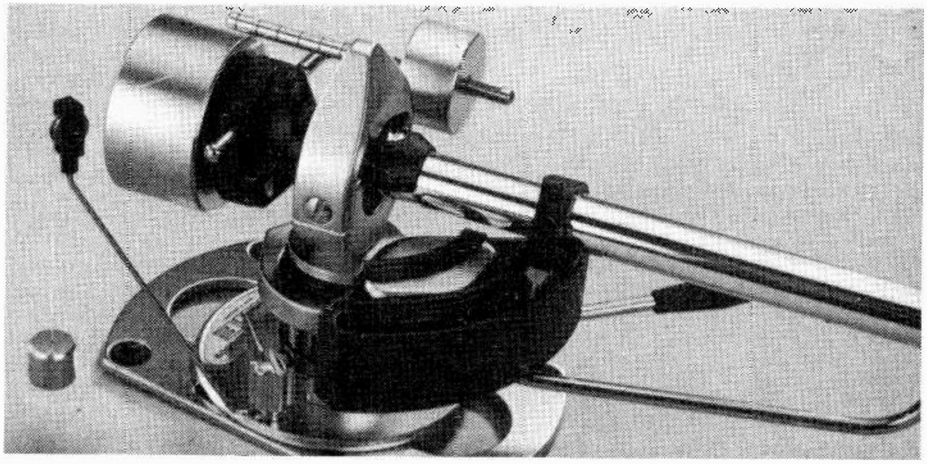
## AUDIO CLUB NEWS

The Toronto Chapter of the AUDIO ENGINEERING SOCIETY held its January meeting at George Brown College, and was addressed by Lennox Blizzard, who teaches the acoustics course at George Brown College. Techniques of measuring various accoustical materials were demonstrated. This is an area in which many audiophiles are ill-informed, and find information hard to come by. The Society's membership is open to applicants on several levels, from Student, to Fellow, and with various degrees of expertise. Readers interested may contact me directly at ETI.

If you belong to an audio club or are interested in forming one, I'd like to hear about it and so would many others. Please write to me at ETI.

*b) A close-up of the SME FD200 fluid damper.*





# Audio Today

## 50/100 Output

Dear ETI:

In your Apr/77 issue, I have come across a problem in the 50/100 Amp. In the schematic on page 26, it shows only one output. I am not sure where the other output should be connected to, directly to the input (the lower lead) or to OV. Please help me.

Also, when are you going to publish plans for a suitable pre-amp for this amp. I presume that the pre-amp will have volume control, loudness control, high and low filters and bass and treble controls. I hope this is possible.

M.W. Winnipeg

*The amp is really a bridge circuit in which each power supply and each output device forms one of the legs, the output being taken between the two power supply junctions and the output devices junction. Strictly speaking, it doesn't matter which of the four junctions is grounded, or even if none is grounded. In this circuit, though, the "OV" point may be connected to ground, thus allowing the return side of the speaker to be grounded. In addition, since any preamp is likely to have a grounded return, the "Input Comm." terminal should also be grounded, preferably at the input terminal itself. A word of caution: since this project does not include chassis, etc., watch your grounding system carefully to avoid instability. Especially avoid stringing chassis grounds any old places which happen to be convenient. In general, keep inputs and outputs well apart, and be ready to experiment. And DO follow the setup alignment carefully.*

*A pre-amp project is a good idea, one which I'm considering tackling myself, sometime this year. Several good ideas appear in* ETI Circuits No. 1 *which you might find useful. In addition, our first* Canadian Projects Book *contains details of audio modules (plus the 50/100W Amp for those who missed it) which may be combined to suit your desires.*

## Tube Tale

Dear Sirs:

I have purchased lately some old tube amps. They are brand names, and I am about to rebuild and use them.

Even after using them for hours, they sound O.K., though the highs are not crisp and they are boomy at the low end.

The tubes passed the test. There is no audible hum or distortion. I tested out the power amp with a 1000Hz signal and observed the wave form at the speaker terminals (on both channels) on the scope. The lower part is a bit smaller and thinner than the upper one. What does it mean? I did some research, and learned that the new tube amps are built of low noise tubes, metal film resistors and polyester and silvered mica capacitors.

The amps I own utilized 10-20% resistors and capacitors. If I change them to the above quality what results can I get?

Are there any low-noise 12AX7s and 6BQ5s on the market?

Since the output transformers are relatively small, by changing them with bigger and slightly more powerful quality transformers, would the overall performance be better?

I would appreciate all the advice I can get.

Mr. C.J., Toronto

*I mentioned in an article in ETI ("V-FETS For Everyone", Oct/77) that only a perfectionist, masochist, or a nut like me would get involved with tube amplifiers. Nice to know I have company. Welcome to the club.*

*To begin with, any comments I might make are limited by the fact that you supply no circuits, or make and model number, so I must speculate on the circuitry used. It's difficult to comment on the sound quality without knowing something about your speakers and other equipment. My own tube amps have a bright, clean, detailed high end, but not the rough edge often called crisp. As for the boom, this is really a fault of the speakers. Most speakers sold today exhibit poor impedance/frequency characteristics, the most noticeable fault being a pronounced impedance rise at the bass resonant frequency. Since efficiency rises at resonance, output also rises (See "Equalization", ETI March 78). Also since this corresponds to a condition of poor damping, there is a lot of hangover, resulting in a boomy sound. Most designers get away with this by counting on the high damping factor of transistor amplifiers to eliminate the peak and the hangover. This may be bad design but it is the way things are done. Generally tube amplifiers will exhibit damping factors of less than 20, as against upto 1000 for a big super-amp. Also, high effective damping factors are difficult to achieve with low power designs. Because of the phase compensating circuits used even the full damping may not be available at very low frequencies because the feedback rolls off from as high a point as 100 Hz. Your first instinct, then, would seem at first to be a good one: improve the low frequency response wtih a large transformer. While you're at it replace the coupling capacitors with larger value units. This will give better low frequency response and damping. It will probably also cause the amplifier to break into violent oscillation. At both audio extremes. Chances are this is a fairly simple circuit with two pentode output tubes driven by a paraphase phase splitter, and RC coupling. Such a circuit has a different number of phase shifts on each half of the circuit, making stability a problem. There is obviously no room here to deal with this aspect properly, and in fact I'm in the process of preparing an article on feedback and I hope to cover tube circuits and their special problems. But as you can see, unless you have a lot of knowledge of feedback circuits you're asking for trouble if you play with it, especially if the manufacturer played some fancy tricks with phase margin.*

*I wouldn't pay much attention to the tube tests. The best test here is to substitute new tubes and see what happens. Use European or U.S. tubes wherever possible, not Japanese. The low noise version of the 12AX7 is a 12AX7A/7025, and its European counterpart (very quiet) is the ECC83. The 6BQ5 is a beam power tube and would not have a low noise equivalent. However if you don't mind paying a premium price you might try 7199A, an industrial tube available from such places as Electro-Sonic, Saynor, etc.*

*As for your proposed changes in resistors and capacitors, I don't know about you, but if I did it, along with the premium tubes, the most likely result would be a letter from my bank, specifically the guy who doesn't like overdrawn accounts. In a well-designed, sophisticated circuit they can make all the fancy circuitry meaningful, especially when dealing with direct-coupled circuits, cross-coupled phase splitters, differential amplifiers and push-pull drivers, and balanced primaries. Otherwise it isn't worth it.*

*The asymmetry of amplitude and shape in the scope trace you sent suggest high levels of odd and even harmonic distortion and I'm surprised you can't hear it. I hope this helps.*

## His Master's Voice

Sir:

In ETI Nov/77 issue, an article by Wally Parsons (The First Century) made mention of a poster of Nipper, and the machine he made famous.

I was wondering if you could suggest where I could get one of these posters (in colour if possible), for my music room.

Thank you.

R.G.H., Calgary, Alta.

*I didn't check at the time of the show, but a close look at my original colour slides suggest that this was not a new poster but an early copy of the original. In any case RCA informs me that they have not made posters generally available.*

*However, if you would write to the following address they might be able to help: Public Relations, RCA Ltd., 21001 N. Service Rd., Trans Canada Highway, Ste. Anne de Bellevue, P.Q.*

*Also, the inside liner of "The Worst of Jefferson Airplane" (RCA LSP 4459) has a large reproduction.*

*And, if all else fails, I have several photographs of a large stuffed "Snoopy" in front of one of my 6-foot high Transmission Lines. Looks pretty happy, too.*

## Organ Keyboards

Dear Sirs:

I enjoy your publication very much. I hope you can help me. I am interested in building an electronic piano or organ. Do you know if there are any companies in Canada who carry keyboards or plans, or kits for these projects? I have ordered plans from England (Maplin), however I would very much like to spend my money in Canada.

Thank you.

Ralph Sperry, 11112—134 Ave., Edmonton
Alta. T5E 1K4
P.S. Besides Heathkit

*Amateur organ building is almost a subculture in itself, and the only person I know who is involved in it could not come up with a single Canadian manufacturer. If there were any recently, they may have followed the Prime Minister's advice and left the country.*

*One U.S. source is: Devtronix Organ Products, 5872 Amapola Dr., San Jose, CA 95129.*

*There are organ building clubs in existence, and contacting one of them might help. Keep your eyes on our Club News section; as soon as we hear from such a group it will be included.*

*I am publishing your address so that any readers who wish to help may contact you.*

*This would also be a good time to remind potential advertisers that Mr. Sperry is undoubtedly not the only organ buff among ETI readers.*

## Spring Quest

Dear ETI:

I am interested in reverb and echo units. I was wondering if you will be putting any projects related to these areas in any of your future issues. What I am looking for is a method of producing reverb or echo effects. A circuit with component values could be greatly used.

A few companies have advertised springs which, when a signal is passed through them, produce a reverb effect. However, the springs seem to be in short supply as all my efforts to obtain one have been unsuccessful. The suppliers have either not had the springs in stock or they have been discontinued. If you might possibly be able to refer me to a supplier who might have these springs in stock I would greatly appreciate it.

D.A., Stettler, Alta

*Every supplier I know informs me that they are unavailable. Conjecture is that no one is making them any more. This strikes me as a likely explanation. The spring reverb system has usually been a method of accomplishing on the cheap what would ordinarily cost thousands of dollars in studio equipment (At CBC in the early days of television we saved even more by using existing facilities — one of the ladies' washrooms. Sometimes got some interesting sound effects too!). The first one I ever built was plagued by the production of gong-like tones due to poor control of resonance damping, but even after solving these problems, it's not a satisfactory technique unless you spend thousands of dollars in refining it as AKG did with their unit.*

*The preferred approach today is to introduce delay digitally using a Bucket Brigade Device (BBD). A project using this technique is to be found in this issue.*

*Another approach is the Madsen tube, a long hollow tube, coiled up and carefully damped, with an input transducer at one end, and a pickup critically located along its length. If taping early Toscanini 78's is your forte, you might like this, but it's tricky.*

## AUDIO TODAY

Audio Today is ETI's new regular section dealing with news and views on topics ranging from loudspeaker design to audio circuits, from auditory perception to concerthall acoustics, from microphone techniques to designing domestic listening rooms.

If you want to express your views or report on news write to Audio Today, ETI Magazine, Unit Six, 25 Overlea Blvd, Toronto, Ont. M4H 1B1.

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# Radio Shack TRS-80

In the February 1978 issue of ETI we reviewed Commodore's PET system, and we were quite impressed. Radio Shack's TRS 80 aims at a similar market. Mark Czerwinski and Graham Wideman investigate.

WE ARE STILL not quite sure whose machine was "pre-hinted" first but the way we heard it, Radio Shack's preliminary announcement about the TRS 80 followed very closely the first words from Commodore on their PET. Is one machine a reaction to the other, or did both companies see the same market area opening up independently? We don't know. One thing is clear however, the two products are vastly different.

## THE MARKET

There must be alot of people who could be made interested in home computing so long as **no** tinkering was involved. In addition, they are looking for convenience of operation, paying little attention to what is inside the box, but rather are concerned with what it can do.

What then are the characteristics of a machine that will fulfil their needs? It would need to be elementary to put together, include keyboard and video monitor, have built in easy-to-use programming language (such as BASIC) and the facility for long term storage of programs. It would also need to be inexpensive.

Both the PET and TRS 80 are designed on these lines, and it is particularly the built in BASIC that sets them apart from most other home computing systems.

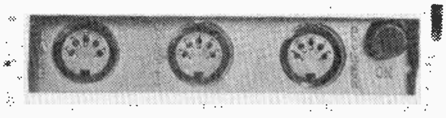
## WHAT YOU GET WITH THE TRS 80

You can buy the package in the various separate units, or as a complete system. Let's suppose you buy the whole lot — what does it include? Out of the big box comes the main keyboard unit which contains the "brains" of the machine. Next there's a Radio Shack cassette recorder for storing data and programs over a long period. The biggest unit is the 12" video monitor included in the system. To complete the system there's a separate power supply to run the electronics.

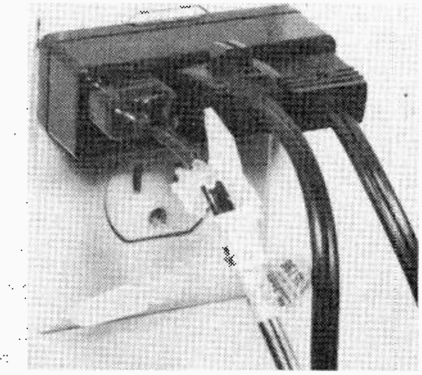
In addition a comprehensive instruction manual, cassettes, and cables come with the set.

## THE FIRST RUN

Initial set-up is quite easy — simply put all four units on the same table, grab the cables and plug them all together. Three five-pin DIN plugs go in the back of the keyboard, and they **can** be interchanged — but this does not appear to cause much damage. The sockets are labelled so this should avoid trouble. Plugging into the cassette recorder is less obvious since two of the plugs can be interchanged, with no labelling other than being different colours. Finally, you will have to run out and buy an "octopus" adapter, since there are three power cords to plug in.



*Removal of cover exposes sloping PCBs.*

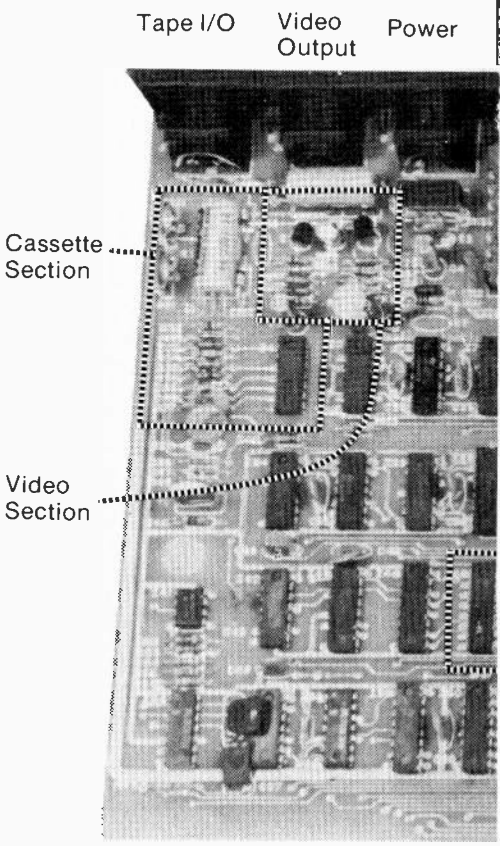


This sounds like a total of many cables running all about. It is.

Now you're ready to go, so on with the two power switches. Your friends are all standing around some eager to play with your new toy, some skeptical of computers, as the screen springs to life with a "READY". Now what? If you're a neophyte programmer you are going to have to reach for the programming manual.

We had very mixed feelings about this 233 page book. It is written in a very friendly, "let's get to know your computer" style as it takes the reader excruciatingly slowly through every nook and cranny of BASIC LEVEL 1. The manual assumes you know nothing of computers or mathematics — which could get somewhat frustrating.

If you do have some experience you could probably skip straight to 232 — "Summary of Level 1 BASIC," and not miss too much. Refer to the contents to find any section you're not clear on, such as graphics etc.



*Overview of the main computer board.*

In fact, what you'll most likely want to do is discover that CLOAD is the magic word for loading one of the cassette programs included with the set — such as Black Jack or Backgammon. Having thus won over your friends you can sit back and learn BASIC later.

Let's take a look at the hardware and software in more detail.

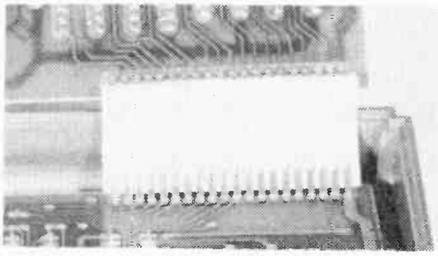
## HARDWARE

Looking at the total system, there are advantages and disadvantages to having four separate units. The main "pro" is the flexibility of being able to move the keyboard, video monitor and cassette recorder to suit your convenience. On the other hand, having such a multitude of cables and units lying about is a nuisance. A far nicer approach, in our opinion, would have been to combine the cassette deck and power supply in the keyboard box, reducing the packages to two. We suspect that the lack of integration was due to a rush effort in getting the TRS 80 on to the market, an impression supported by various other details.

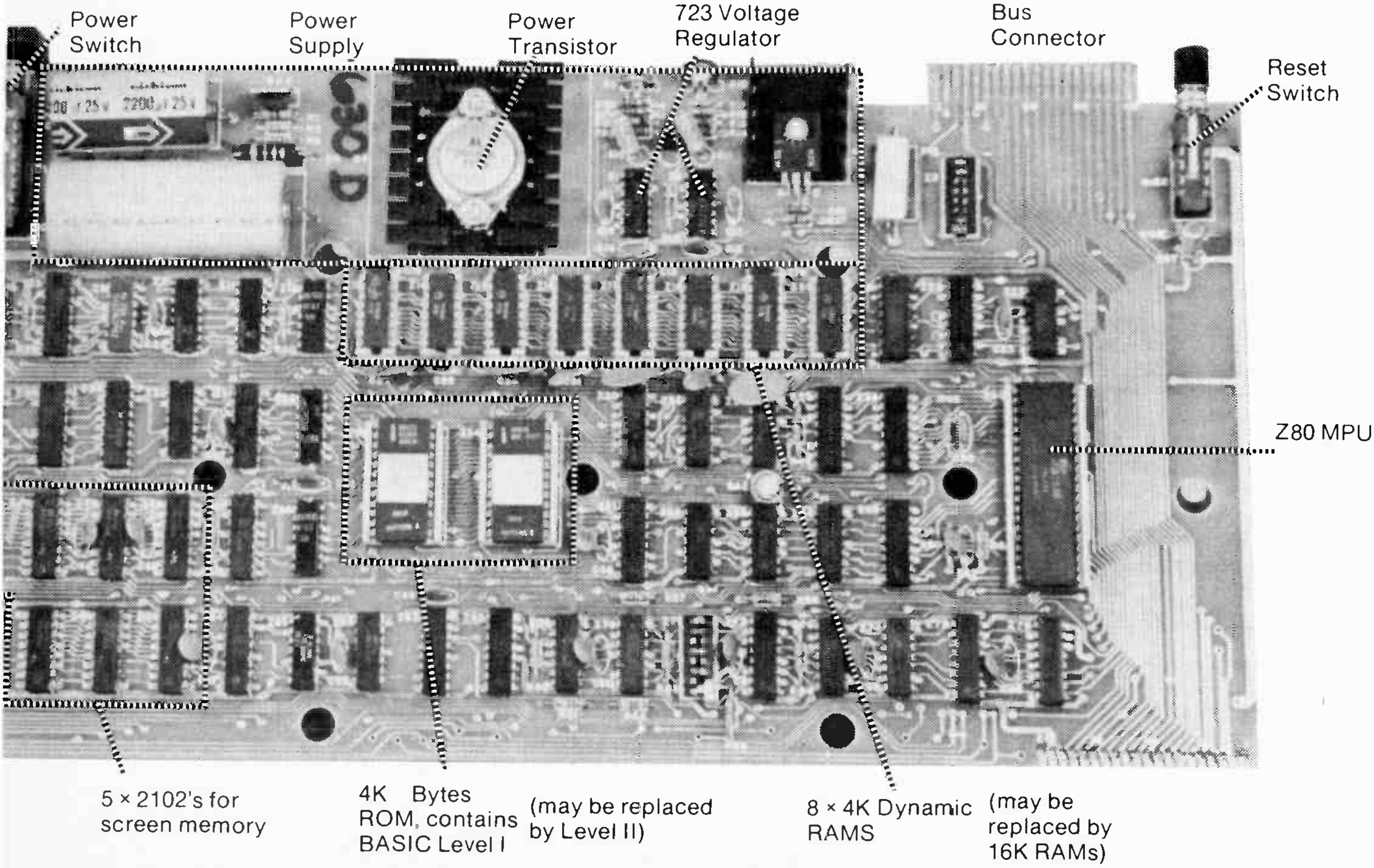
## KEYBOARD UNIT

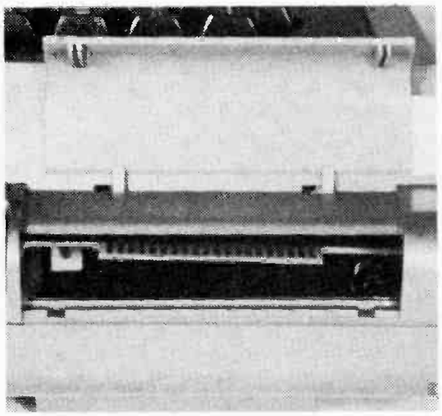
The keyboard itself is typical of that used with most hobby computers, fairly reasonable quality and operation. Also contained in this case is the main computer board. On this board are found a Z80 processor, 4K of ROM (BASIC Interpreter etc., see "SOFTWARE"), 4K of dynamic RAM (the Z80 does automatic refresh), and interfaces for keyboard, cassette and video monitor. On board regulation of the power supply is used.

We don't feel that this system would be much fun for hardware enthusiasts. It's difficult to manage when taken apart, the keyboard and main board are attached by an easy to break flexible cable with no plug. No I/O ports are on board, which rules out simple add-ons, such as switching devices on and off, hooking up a speaker, and other popular experiments and applications. The back connector brings out the address, data and control buses. Thus a separate box with interface adapter could be added. Also on this connector are the keyboard lines, which would presumably facilitate adding more keyboards (possible numeric pad) in parallel with the existing one. The keyboard interface is done not with a Peripheral Interface chip as might be expected, but with ordinary buffers and latches, a cheap but less flexible system.



To summarize, this product does not appear to be aimed at the serious hardware person. Add-ons are difficult, although Radio Shack is coming out with an I/O unit. In addition, an S-100 interface is in the works, according to Radio Shack literature. The TRS-80 must then be best suited to software type, keyboard plus video (and later on a printer) applications. The suggested retail price of the keyboard and guts unit plus power supply is $575.95 Canadian. The system including cassette and monitor is available for $879.95.





*Opening the flap on the back of the keyboard provides access to the expansion connector and reset button.*

## CASSETTE STORAGE

Data may be recorded on cassettes by means of the built in cassette interface which converts the data to a series of audio tones. Thus, any reasonable quality cassette recorder will do the trick. In fact, even our $15 special managed the task, if a little unreliably. The cassette itself should also be fairly good since any tape "drop-outs" mean lost data. Radio Shack plans to introduce high quality five minute-per-side cassettes for this purpose.

The particular recorder recommended for this system, the CTR-41 is one of Radio Shacks better models at $69.95. Cables from the keyboard connect to the "AUX" input, "EAR" output, and also the remote on/off jack. Thus, when recording or playing cassettes, the operator (you) pushes the desired keys on the recorder and the TRS-80 switches the recorder on and off at appropriate times. You also need to set the volume level when playing back tapes. When recording, a dummy plastic plug must be stuck in the MIC jack to deactivate the built-in condenser microphone. Altogether a bit messy, but it works.

## VIDEO DISPLAY

Described as "designed especially for the TRS-80" this monitor displays the 16 lines of 64 characters, or 128 by 48 dot graphics, with reasonable quality on a 12 inch CRT . . . at $299.95!

Opening up the box to discover what you get at that price — inside there's the equivalent of a portable TV set, minus tuner, IF, sound section and speaker. The circuitry is AC-DC, which is very inexpensive to produce, but requires some kind of isolation between the monitor circuitry and the video output from the keyboard. To achieve this, an opto isolator circuit is included.

Should you happen to be part of the 99% of the population who like to save money — here's how. First, we measured the video output signal, it's a fairly popular arrangement with 0V for sync level, 0.6V for black and 2V for white, into 75 ohms. Then you can refer to our January 78 issue to see how to modify your TV to accept video signal input.

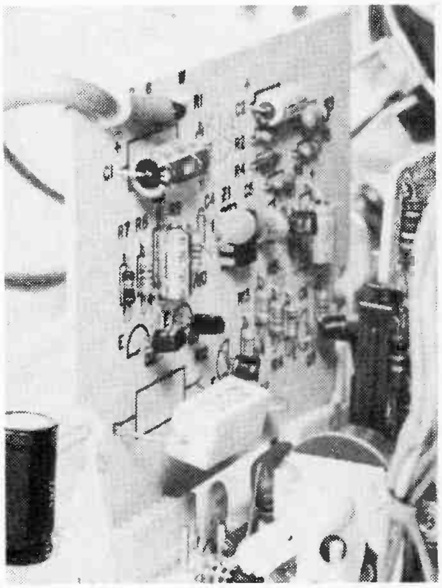
Alternatively, you could get hold of an RF modulator (less than $20) and use your TV without any modifications.

Finally, take a look at our pictures to see what you're getting inside that $299.95 monitor.

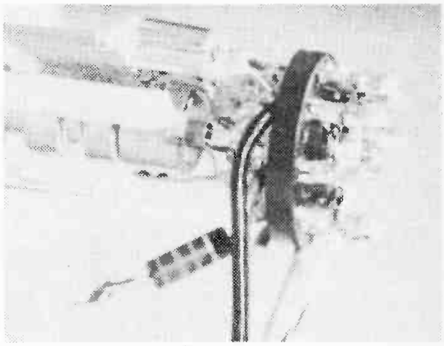
## POWER SUPPLY

A Radio Shack brochure describes this unit as follows: "Important to any computer is a reliable source of pure DC power. This regulated supply converts standard 120VAC house current into the stable direct current required." This appears beside a picture of the TRS 80 system with each unit labelled, including the Power Supply.

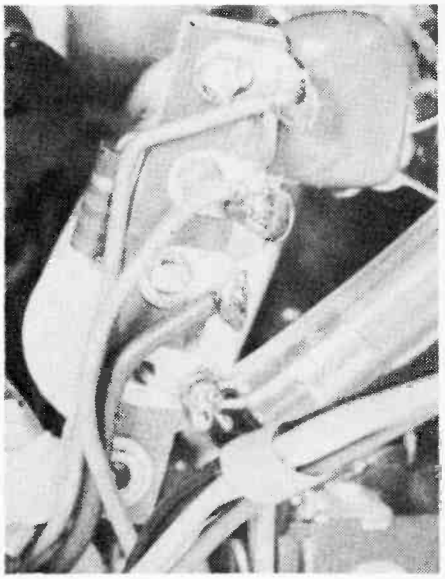
In actual fact, the Power Supply unit output is 17V AC. (Regulation is done on the main board) This kind of



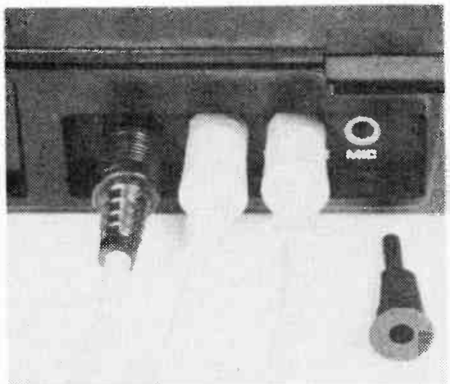
*The upright board pictured here is the opto-isolator module, (Isolator in the mini-DIP)*



*We thought point-to-point wiring was out of date, but point-to-mid-air? This hanging resistor connects to the CRT in the $299.95 video monitor.*

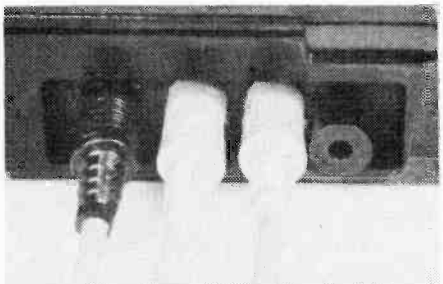


*Another example of sloppy construction in the video monitor, tie strip off at an angle and only rivetted at one end. We hope the monitor internals will be cleaned up a bit.*



*Here's the "Non-Maskable Hardware Microphone Interrupt Unit"*

*NMHMIU shown in place.*



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misleading advertising serves only to confuse the public and increase their distrust of electronics and probably doesn't do Radio Shack any good either.

## FUTURE HARDWARE

The first expansion of a TRS 80 that is possible is the replacement of the 4K RAM chips with 16K chips ($399.95) (no kidding, it's that easy) and replacement of the 4K ROM, with the Level II BASIC kit contained in 12K ROM ($159.95 — see "LEVEL II"). We have advanced details on a variety of other add-ons as well.

The key to further expansion is the "Expansion Interface" unit, which comes in its own TRS-80 style plastic box designed to sit under the keyboard. At $399.95 this unit enables you to add more additional RAM (16 or 32K), dual cassettes, four mini floppy disks and a line printer. It includes a clock, and space for an extra PCB. And guess what, it has a separate power supply, but it has a slot in the back in which to place the power supply, and also the original TRS-80 power supply. The interface requires BASIC Level II.

The Mini Disk unit stores up to 96K bytes, comes with operating system, and for $799.95 gives you an access time for any single byte of less than half a second.

Two printers are to be available. The "Line Printer" is a modified Centronics dot matrix impact printer capable of up to 110 characters per second and 80 or 132 characters per line, at $1,899.95. Level II and the interface box are required. On the other hand a "Screen Printer" can be obtained for $899.95, which according to Radio Shack literature will at the touch of a button reproduce your screen (including graphics) on 5½" electrostatic paper at a rate of 2,200 characters per second!

## SOFTWARE

As a home computer system, the TRS 80 is probably the least hardware oriented. There are two points which support his thinking: you can't get at the internal hardware without voiding the warranty and there is no hardware interface capability other than to the display and the cassette recorder.

So how would you go about evaluating a relatively complex product like this? Probably in the same way as you'd evaluate another type of product which enjoys a high profile at Radio Shack Stores: a home **stereo** system.

In choosing a computer system, the potential customer will be influenced by what he sees (ie: packaging) and by what he can be led to believe about it (by advertising, by friends, by using the system, and even by reading electronics magazines). That customer's attention will be focused on the keyboard and display not on the internals. It won't matter to him that a Z-80 incorporates efficient machine language instructions for data searching and moving or that it's a microprocessor that can run at a 2MHz clock rate. He will be more interested in what it can do as opposed to how it does it (he's buying capability, fun and perhaps even status, not speed).

## A LOOK AT WHAT YOU GET ON THE SOFT SIDE

The TRS 80 comes with "Radio Shack Level 1 BASIC" in 4K ROM. Level I claims to support "standard BASIC statements". But whose standard? It seems to be Radio Shack's since some important capabilities are missing (for example: exponentiation and array dimensioning). All calculations are performed in floating point with 5 or 6 decimal place accuracy. Twenty-six numeric variables are available (A to Z) along with one numeric array variable. Two 16-character string variables can also be used. Actually, these are more properly called "string things", since they cannot be compared, manipulated, indexed or used in any but the most mundane ways. You can input and output using them, but that's all folks.

Cassettes can be used to handle programs (CSAVE and CLOAD commands) or data (PRINT # and INPUT # statements). Since whatever you have in memory will be wiped out if you cut off the power (intentionally or otherwise), having a cassette recorder to store your information permanently is invaluable. And it makes entering of other people's programs (such as the Backgammon and Blackjack games supplied by Radio Shack) especially convenient.

Speaking of which, the Backgammon game makes extensive use of the TRS 80's rather limited graphics capability: there are virtually no special graphics characters — you've got to construct whatever image you have in mind by turning on some points on the display (48 points vertically by 128 points horizontal). This can be tedious. Mind you, in the low cost home computer system field this is not unusual. To compensate you can write sub-programs which draw vertical and horizontal lines, draw patterns, fill them in etc.

## YOU AND YOUR PROGRAM

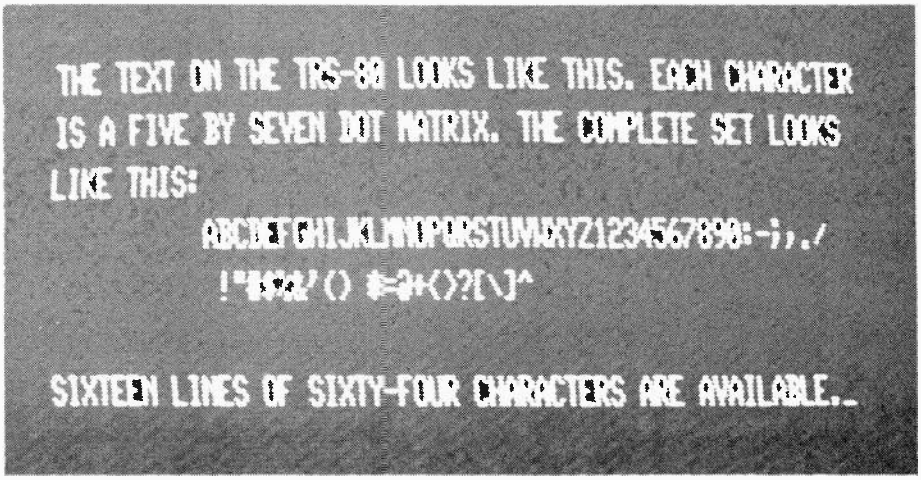
Immediately after powering up your display and keyboard, the following will appear:

```
READY
```

At this point you can:

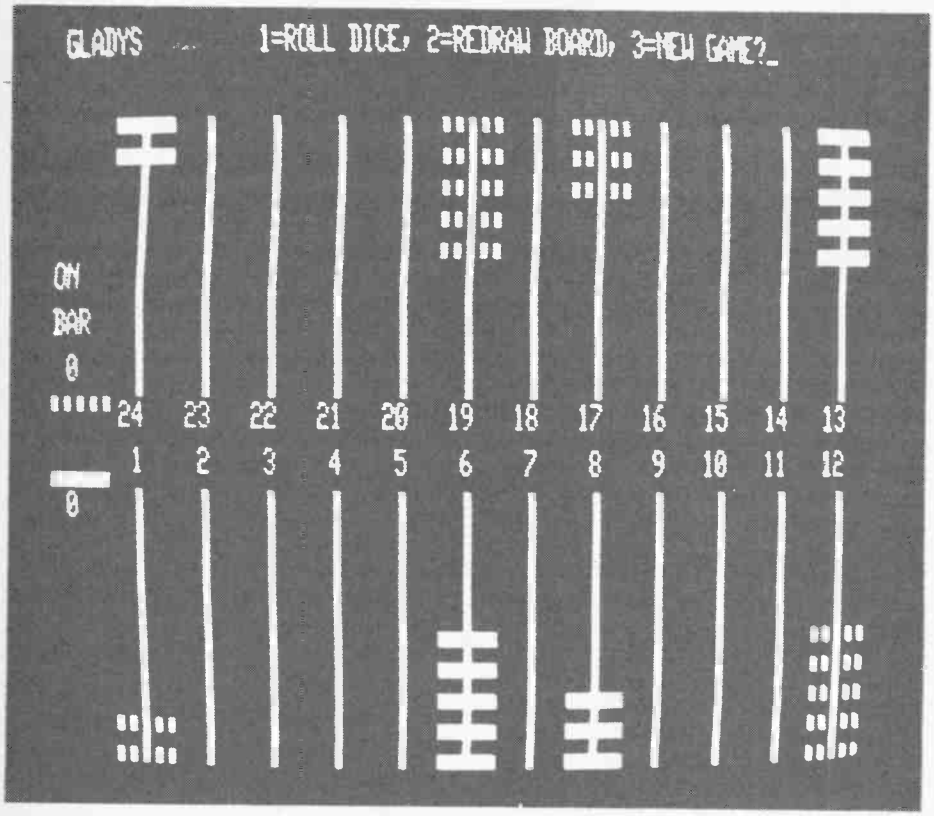
1) do simple calculator type computations (immediate execution)
2) bring in a program from tape.
3) type NEW and enter a program

Program statements are preceded by line numbers to distinguish them from immediate execution statements, and keep them in order. A LIST command is available to display the program. Unfortunately the cursor control keys cannot be used to edit this display, so if you want to change a line in a program, you must retype the entire line.



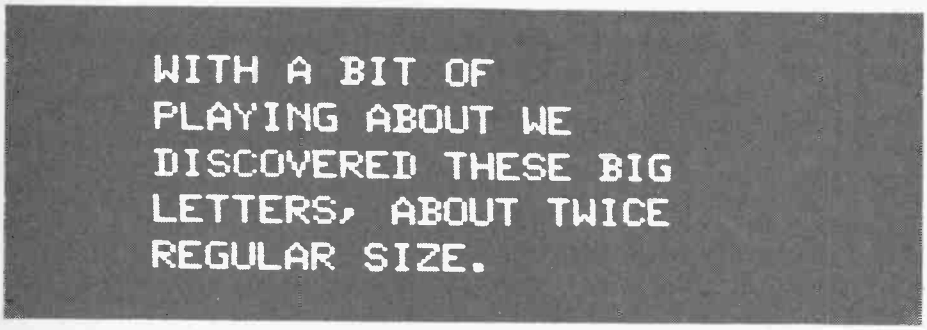
```
THE TEXT ON THE TRS-80 LOOKS LIKE THIS. EACH CHARACTER
IS A FIVE BY SEVEN DOT MATRIX. THE COMPLETE SET LOOKS
LIKE THIS:
          ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890:-;,./
           !"#$%&'() *=@+<>?[\]^

SIXTEEN LINES OF SIXTY-FOUR CHARACTERS ARE AVAILABLE._
```

*This is the TRS-80 character set.*



```
GLADYS ...    1=ROLL DICE, 2=REDRAW BOARD, 3=NEW GAME?_
```

*Here's the TRS-80 version of Backgammon.*



```
WITH A BIT OF
PLAYING ABOUT WE
DISCOVERED THESE BIG
LETTERS, ABOUT TWICE
REGULAR SIZE.
```

*We did it again . . . . . wonder where those big letters came from?*

Output which would otherwise stream by while your program is executing can be frozen by depressing any key. Unfortunately, if you interrupt the program itself, you cannot modify the variables it is using and then return to the point of interruption. So your only alternative is to rerun the program and in many cases, that's a nuisance.

As for error messages, they are confined to: WHAT? HOW? or SORRY (along with an indication of where the problem is). These terse messages are not unexpected when you consider that the interpreter was written to fit into 4K of ROM. In a tradeoff of readability against the amount of program code you can fit into the standard 4K of RAM, Level I has a "shorthand dialect". For example: G.=GO TO, N.= NEXT, and P. = PRINT. However, REA. seems to be a shortform of dubious value for READ (probably done for consistency).

## MAKE IT FIT

The overriding philosophy controlling the design of this interpreter seems to have been "make it fit". It's hard to believe that a 4K interpreter is anything but "stripped down" after you've used this one. Radio Shack has dropped a few hints about releasing a Level II BASIC. Until then it is unfair to compare this software package with, say, the 14K monitor/interpreter that comes in Commodore's PET. They're just not in the same leagues.

At the same time, it is somewhat unrealistic (no pun intended) for Radio Shack to claim, as they have in their sales literature, that "applications of the TRS 80 are limited only by the imagination and ability to write programs". Try something quite unimaginative like sorting a list of names. Good luck! You'll need it.

## LEVEL II

Sketchy details are available on Level II BASIC, an interpreter written by Microsoft. From the list of statements and functions to be available, it appears that this version of BASIC is at least as powerful as PET's including many editing features. In fact we would go so far as to say that Level II is the most significant upgrade for the TRS-80. We wonder how logical it is to sell a home computer with such a limited BASIC and then offer the upgrade as an option. Will this turn people off computing, or will most of them jump for BASIC II anyway? At the time of writing it was expected that Level II would be available after March '78.

## OVERALL IMPRESSION

Firstly, we were not nearly so impressed with this machine as with the PET, and for the same price range we should have been. Lack of hardware access, and software which is primitive, combined to make it a less attractive product to anybody with even a little experience in home (or for that matter any) computers.

In our opinion, to have a satisfactory computing machine, one needs the "optional" Level II BASIC. The cost of this system would then be $1,039.90 ($879.95 for TRS-80 plus monitor and cassette recorder plus $159.95 for Level II). This machine would compare very favourably on a software application basis with the 4K PET. But you still don't have any hardware interface capability, something which ups the system cost to $1,439.85.

The end result is that if you're in the market for a machine like this you should look very carefully at what you need and what you can get for the money.

Any guesses on where we'll be with systems like these 20 years from now? Buy yours now — in 20 years they'll be collectors' items.

# Fast Fourier Transforms

You may have heard of Fourier Analysis, but more often than not explanations of what this is all about are drowned in mathematics. E.J. Hughson describes how it's done electronically.

MUCH OF ELECTRONICS is concerned with the processing of signals of some sort or another. It is only natural then, that a lot of effort has gone into analysing these signals. On one hand one must know certain basic things about the signals in order to be able to build useful circuits. On the other hand, investigating signal properties with no particular applications in mind, has led to various useful results that later helped to simplify, improve or introduce new circuit designs. The field of study concerning signals is known, naturally enough, as "Signal Analysis".

In order to go deeply into some of the theory in this field, some pretty heavy math must be employed. However, it is quite easy to understand the majority of the material intuitively, and besides, that's a much more entertaining approach.

## THINK OF A SIGNAL . . .

How do most of us think of signals? Probably "signals" conjures up images of a scope with a waveform on it. Let's use this waveform as an example — suppose it's a 1KHz triangle wave. What characteristics does this waveform have? It is a voltage (say) varying up and down periodically, thus it has an "instantaneous amplitude" at each instant in time. This is what we see on the scope, an amplitude versus time graph. We can also say that the waveform has a characteristic we call frequency. Most of us use the term frequency to mean the basic frequency of repetition of the entire waveform. Why this distinction? Here's where a theoretical concept must be just accepted if we're not to get submerged in abstraction.

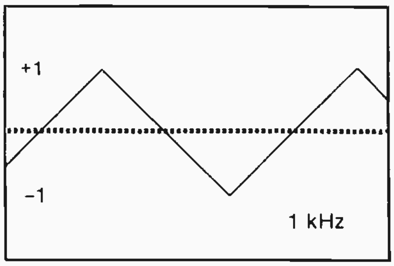


*Fig. 1. Scope trace showing triangle wave*

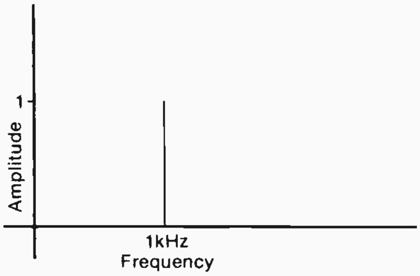


*Fig. 2. Amplitude vs. frequency plot of 1KHz sine wave*

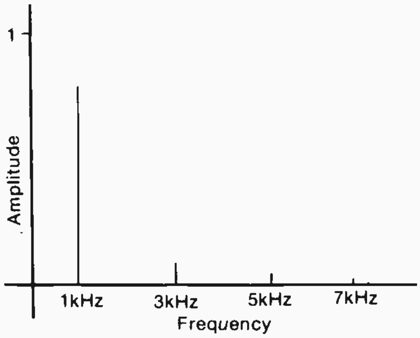


*Fig. 3. Amplitude vs. frequency plot for triangle wave.*

## FOURIER ANALYSIS

It is convenient to think of a **sine** wave as the "purest" waveform, and use this kind of wave as a basis for study of other waveforms. It has been found possible to make any other kind of waveform from a combination (sum) of sinusoidal waves of various frequencies and amplitudes. This is analogous to being able to combine the three basic colours of light, green, red, blue to form other colours.

In fact we have cheated a little bit, we should correct the above to say that any kind of waveform can be made from combinations of sine **and cosine** waves of various frequencies and amplitudes, a cosine wave being simply a sine wave but one quarter wave ahead.

Ok, so what? The next step is to introduce a graph of amplitude versus frequency. Figure 2 is an example in which we plot the "frequency content" of a sine wave of amplitude 1 and frequency 1KHz. There is only one point on the graph, because as we said before, a sine wave is considered to be "pure" or only one frequency.

So how about our triangle wave? What does its frequency content look like? Figure 3 shows that the frequency content is quite complex.

The graph shows that there is a large content of the fundamental frequency, with decreasing content of odd order harmonics.

The process of converting the "time" waveform to the "frequency" graph is called the Fourier Transform. The reverse process is called the Inverse Fourier Transform.

In the case of a repetitive waveform (such as the triangle wave) the Fourier Transform yields a frequency content graph which has non-zero points only at multiples of the fundamental frequency. Thus, a series of numbers may be used rather than a graph to represent this information. For the triangle wave, the series is:

.81 × (1kHz sine) - .09 × (3kHz sine) +
.032 × (5kHz sine) - .017 × (7kHz sine) +
. . .

For a 1KHz, ±1V square wave the series is:

1.27×(1kHz sine)+.424 x (3KHz sine)
+ .255 x (5 KHz sine) + . . .

On the other hand, you are no doubt already familiar with frequency plots of noise, and particularly audio equipment response curves, which are nothing more than the frequency content graphs of the output with "all frequencies" fed in. (Fig. 4.) Note that the frequency plots in this example are continuous rather than just the odd point here and there.

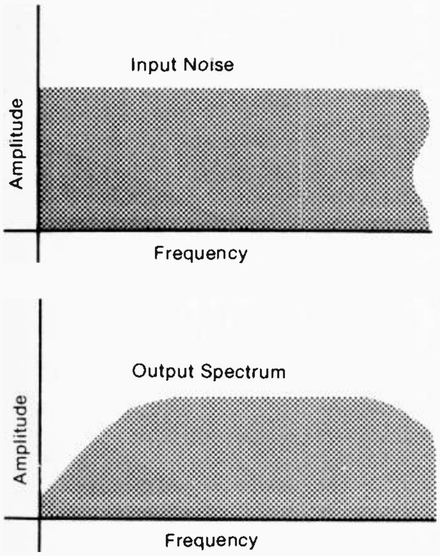


*Fig. 4. Noisy amplitude vs. frequency spectra*

## DOING IT .

A picture of actually doing the transform is shown in Fig. 5. The "transformer" could be a person with a piece of paper working out the graph or more usefully a machine doing the work. Suppose a computer was used to do the task on an input waveform, how would it do it?

## AUTOMATIC TRANSFORM

If an analog waveform is sampled at regular intervals, we get what is called a discrete time series — discrete because it is a series of separate points and time series because we have something changing with time. Figure 6 shows a sampled sine wave displayed on an oscilloscope.

If we were to measure the level of each of the points we would get a series of numbers. If we do this electronically using analog-to-digital conversion we get a series of digital numbers representing the discrete time series. OK so far? It is this set of digital samples which a Fourier Transform (or "Discrete" FT in this case) takes and turns into information directly showing the frequency or harmonic content of all signals which make up the original time series. The technique shows any components from DC to half the sampling frequency. (It is not possible to obtain any frequencies higher than this since it would contradict a fundamental rule concerning sampled waveforms, established by Nyquist.)

## ADDING NEW FREQUENCIES AND FILTERING

If the output numbers undergo an inverse DFT we get a series of numbers outputted which represent the original waveform.

By taking a waveform and analysing it using a DFT, then performing an inverse DFT on the output we can arrive back at the original waveform. A filter can be made by performing an inverse DFT only on those numbers representing the frequencies which are required.

Similarly, by adding numbers to represent new frequencies before performing an inverse transform extra frequencies will be present in the output time series (and after digital-analog conversion, in the output waveform).

The DFT does not work on analog or continuous information: only on a set of numbers representing the instantaneous values of a portion of a waveform. The result is a set of numbers corresponding to the frequency content of the waveform. Not only does DFT give us each frequency present in the original waveform, it also gives the relative phase and amplitude of each frequency component.

By performing a power calculation on the output frequencies a power spectrum may be obtained. Of course the more numbers or samples which are input to the DFT, the more information is available at the output. However, for a fixed set of numbers inputted, a fixed set of numbers is outputted.

## INTERPRETING THE NUMBERS ON THE OUTPUT

To illustrate how outputted numbers are interpreted consider a DFT performed on a portion of a time series containing 1000 samples. The 1000 numbers inputted will have various arithmetic operations performed on them and 1000 numbers (known as frequency cells) will be outputted. Of these 1000 cells only the first 500,

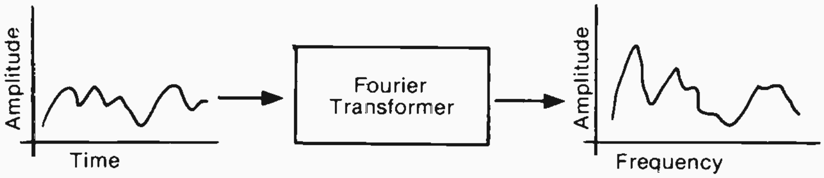


*Fig. 5. The transform process*

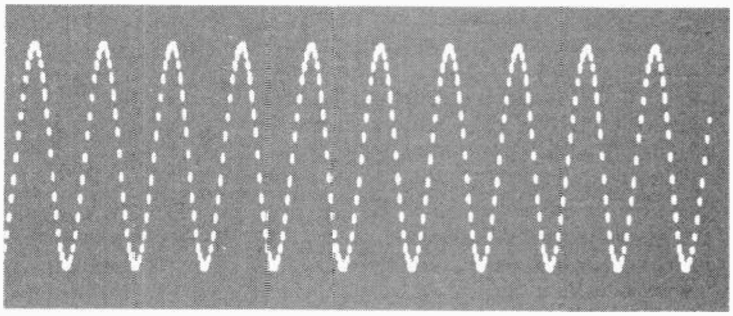


*Fig. 6. Analog sine wave sampled at intervals*

representing the frequency range, will have any real meaning.

For example, suppose all input numbers representing samples from an analog-to-digital converter are the same. (This would mean that a DC voltage would have had to have been applied to the converter.) Of the 1000 numbers obtained by the forward transform, only the first would have a value other than zero, since this first number is reserved for the DC content of the input series and all the energy of the input is in form of DC. (See Fig 7a)

Suppose now the output of an analog-to-digital converter is being sampled at 1000 samples/sec, also suppose a sine wave of 1 Hz is applied to the input of the converter. One thousand numerical samples or one second's worth of data is collected. If these 1000 numbers are used as the input of a Fourier Transform, then of the 500 numbers output, the first will have zero value (DC) but the second, reserved for frequency of 1 Hz, will have maximum value (Fig 7b). All others will have zero value also.

If the frequency of the sine wave inputted to the converter is now increased to 2 Hz, and the 1000 samples at 1000/sec are collected, the Fourier Transform processor output will consist of zeroes in all 500 numbers except the third corresponding to 2 Hz (Fig 7c). The output numbers, are the cells, cell 0 to cell 499 in this case being reserved for frequencies of 0 (DC) to 499 Hz. Figure 7 gives a graphic representation of these inputs and outputs. (NB, since the output cells are numbered starting from zero so also are the input samples, for clarity.)

## CELL NUMBER AND FREQUENCY

The example given above assumes a sampling frequency of one thousand per second so that with a 1000 point transformer the cell numbers automatically correspond to the frequencies they represent in the input time series. It is of course, not always practical to have the sampling frequency tied to the number of samples in the DFT as rigorously as this. But it is a very simple matter obtain the actual frequency to which a cell output corresponds. This is obtained by the following relationship:

Frequency corresponding
to Cell Number (1st cell = 0)

$$= \frac{\text{Cell No. x Sampling Frequency}}{\text{No. of points in FFT}}$$

The outputs depicted by Figure 7 are of course idealized. In practice slight errors will occur due to the finite number of bits used in the arithmetic of the calculation.

As so far discussed, the Discrete Fourier Transform both forward and reverse has been put in terms of numbers which are inputted, the calculation process and numbers outputted. The calculation process is very involved and tedious but could be carried out by a computer or even a hand calculator (if you had the time and patience). To perform a 1000 point transform, it would require over 2 million discrete calculations, tedious indeed!

## FAST TRANSFORM

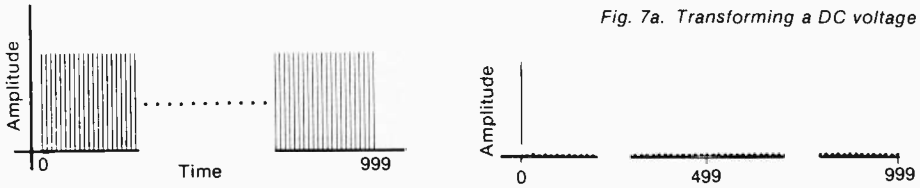
The Fast Fourier Transform technique is able to reduce the calculations of a similar size transform to about 22,000 which is a significant reduction in the number of calculations and hence the amount of computer time. (Still a little much for the average pocket calculator, however!) So although digital computers can be used to obtain the results of FFTs under the control of a program, the amount of time needed to load the samples into the machine, to access and compute the data and to output the results makes even a general purpose digital computer an impractical signal analyser.

For this reason, analysers using hardware capable of only performing FFTs are a far more practical proposition. Such analysers are capable of taking an analog wave form input performing analog-to-digital conversions on it, sampling accordingly, loading the desired number of samples into a dedicated FFT calculator and presenting the results to some display for presentation. See Fig. 8.

The instruments using FFT analysers usually come complete with accumulators and memories so that frequency spectra may be integrated and compared to each other. Integrating (or summing) the results of continuously computed FFTs over some period of time has the effect of showing up signals buried in noise. No matter how deeply the signal is buried the cell or cells which the signal occupies will eventually build up over all the other cells where the noise will be randomly distributed. This technique is now used, for example, in submarine detection where the noise from the vessel is discriminated over the sea noise by continuous integration of FFT results.

Figure 9 illustrates a sampled wave form consisting of 2 sine waves of equal amplitude and the displayed results of an FFT performed on a set of numerical samples taken from the time series. The display has its own

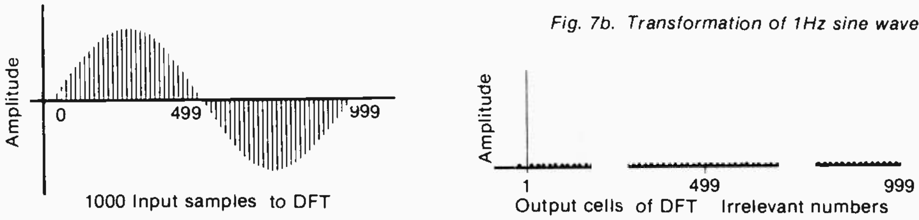
*Fig. 7a. Transforming a DC voltage*



1000 Input Samples to a DFT

Output cells of DFT Irrelevant numbers

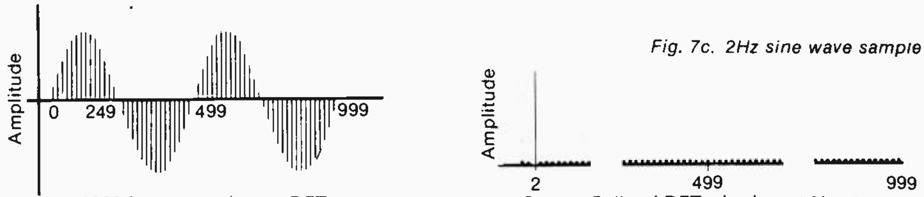
*Fig. 7b. Transformation of 1Hz sine wave.*



1000 Input samples to DFT

Output cells of DFT Irrelevant numbers

*Fig. 7c. 2Hz sine wave sample*



1000 Input samples to DFT

Output Cells of DFT Irrelevant Numbers

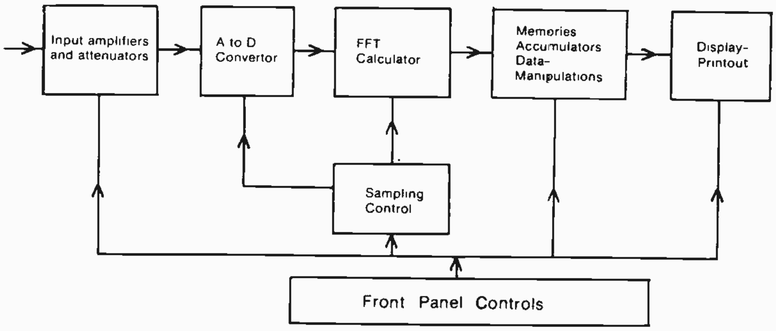
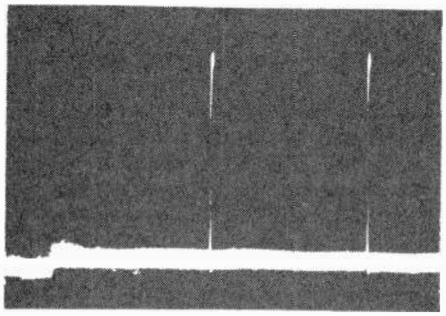


*Fig. 8. Typical FFT Analyser basic functions*

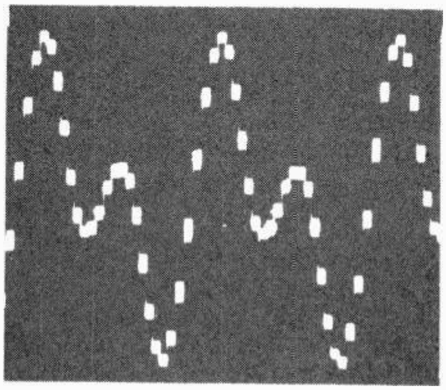
amplitude graduations and the two lines represent the energy in the cells corresponding to the frequencies of the 2 sine waves. (Note no other lines appear as all other cell values are zero). The display is produced by continuously outputting the cell numbers from the FFT result to a digital-to-analog converter and including the amplitude graduations.

## THE MATHEMATICS

This article is not the place to consider the in depth mathematical theory necessary to fully understand the processes which form part of the Fourier transform. Numerous books and technical articles now exist on the subject. However the basic operation and its adaptability to digital hardware is quite easily understood.



*Displayed FFT output with two cells only present, corresponding to the series input. Note lines are same height and the second twice as far from zero frequency as the first.*



*Original sampled times series — two sine waves with one twice the frequency of the other, both same aplitude.*

*Fig. 9. Actual inputs and output of a FFT processor*

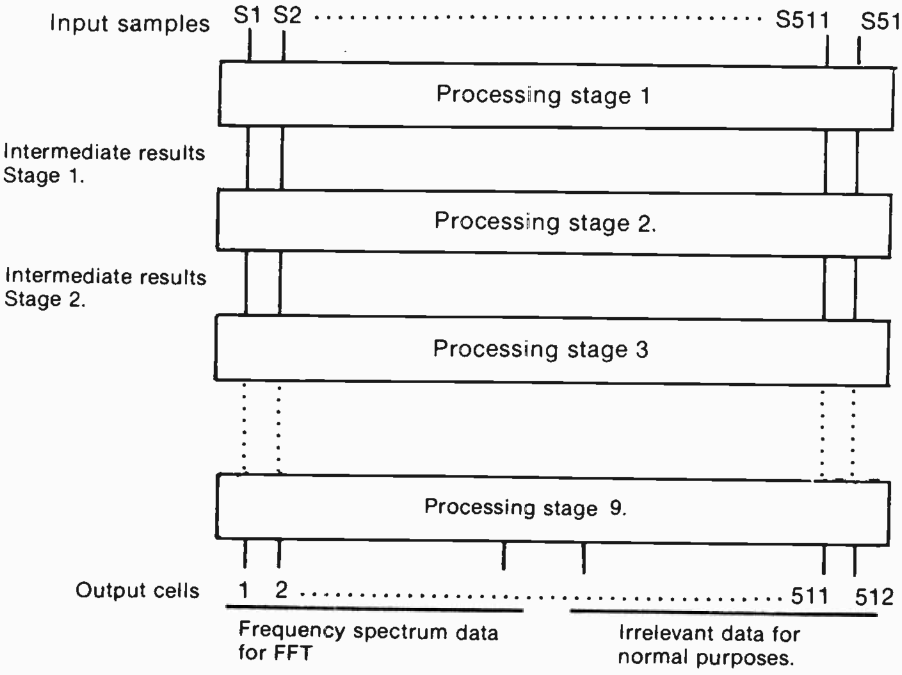
One major constraint on an FFT processor is that the number of samples inputted to it cannot be varied completely. With most processors, the number of samples in fact have to be a power of 2, e.g., 32 or 64 or 256 or 1024. The more samples taken then the larger the range of frequencies which can be determined or alternatively the narrower the band width between cells. However, the calculation process takes longer. In practice sample blocks of 512, 1024, 2048 are amongst the most commonly chosen as these offer a compromise between frequency range and computation time.

Essentially in the case of a Forward Transform the samples from the time series are loaded into a buffer and combinations of samples are added and subtracted from each other, multiplied by trigonometrical values usually looked up from a Read Only Memory. This process is repeated using different combinations of samples and trigonometrical values. The number of processing stages is related to the number of samples, eg, if 2048 samples were inputted, then 11 processing stages are needed. ($2^{11}=2048$). If 512 samples were inputted, then 9 stages are required, etc. This is illustrated in outline by Fig. 10.

The advantage over the old 'conventional' method of computation is that with the conventional method the number of stages of calculation equals the number of samples. In a 512 point transform the process would be 512/9 or approximately fifty-five times shorter by using an FFT. In a continuous process where FFTs are being continuously computed, obviously a very real saving is made in terms of result presentation.

As mentioned earlier the FFT processing idea lends itself very easily to a dedicated machine and the idea of pipeline processing is used in most of these. Pipeline processing is used where a number of calculations in series are performed and where an unacceptably long delay results for the

*Fig. 10. FFT Processing stages for 512 point transform*



computing of an answer before the next inputs are applied. Figure 11 shows an arrangement where this is likely to happen.

In this example an adder precedes a multiplier followed by another adder. With no pipelining, no further inputs can be supplied until enough time is allowed for the results of previous input numbers to be stored away. However with a pipeline processor, (Fig. 12) latches are included in strategic places allowing sets of numbers to follow each other as though they were coming down a pipe. Thus after the first set of results have trickled through the latches, a much faster throughput of numbers will result.

This type of arrangement is very suitable in FFT processors since a large throughput of samples with much number crunching takes place.

## PRESENT & FUTURE FFT ANALYSERS

Essentially an FFT processor (which is the heart of modern spectrum analysers, voice print identifiers, etc) usually consist of a memory which stores the samples and intermediate results and a processor which computes intermediate results. The total samples are stored internally in the memory and when the FFT process begins, the samples are taken in pairs, arithmetically operated on to form intermediate results and stored ready for the next level of processing. Two memories are sometimes used where samples and results are alternately read from one memory through the pipeline processor into the other memory, where they are ready for the next level of processing. This technique saves still more time in computing FFTs. See Figure 13.

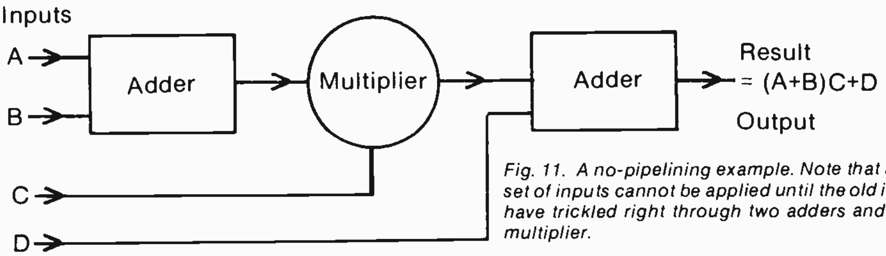
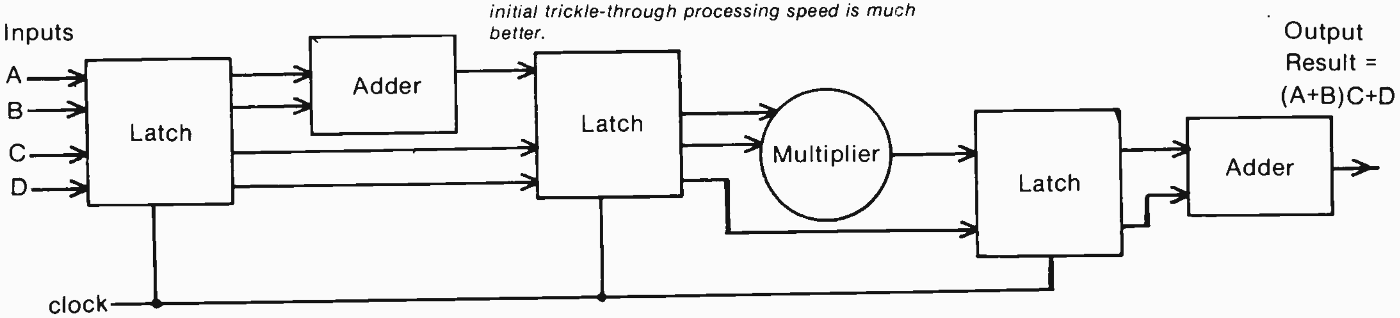


*Fig. 11. A no-pipelining example. Note that a new set of inputs cannot be applied until the old inputs have trickled right through two adders and a multiplier.*

*Fig. 12. Pipelining arrangement, here new inputs can be applied after only one adder's delay. After initial trickle-through processing speed is much better.*



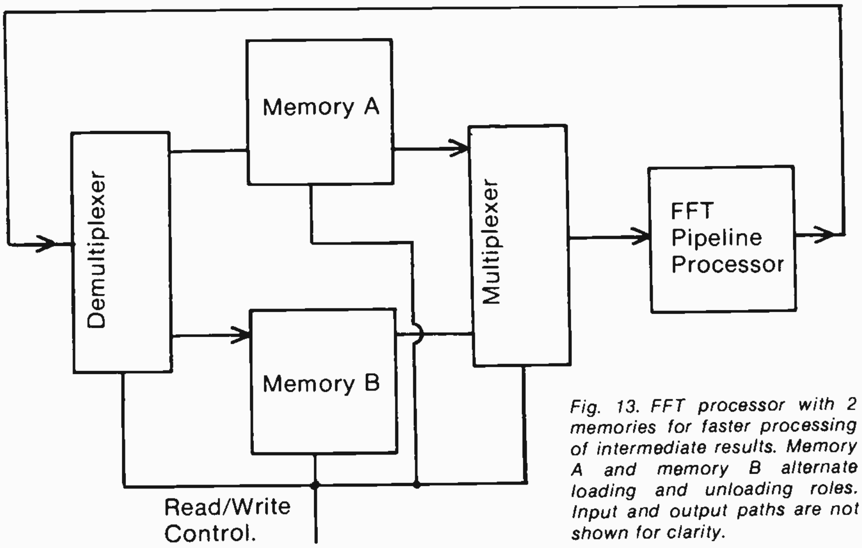


*Fig. 13. FFT processor with 2 memories for faster processing of intermediate results. Memory A and memory B alternate loading and unloading roles. Input and output paths are not shown for clarity.*

This article has only touched onto the now very broad field of FFT processing technology. The approach lends itself easily to band shifting, frequency zoom effects and other features made relatively easy with a digital system.

Until the 1970s few people knew of Fourier Transforms. At best the term would evoke a feeling of something obscure, very mathematical and having few, if any practical applications. But in recent years a whole new world of applications has been unleashed.

FFT techniques are today used for a variety of applications including extraction of signals buried deep in noise, sonar processing, spectrum analysis of complex waveforms, voice print analysis and the digital synthesis of music. Research is finding still more uses, such as in the oral synthesizing interface of talking computers. Some day you may be able to phone a computer and hold an intelligent conversation with it, obtaining such things as account balances, travel reservations, etc, with tonal expressions no different from those of a helpful person!

With the advent of bubble memories and the ever decreasing size but increasing complexity of micro circuits, it appears that the FFT processing field will expand to a point where it will soon be a part of every day life, a truly big step forward from just 10 years ago when the technique was not even heard of.

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ETI 478

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INSTRUMENT DIVISION, SCIENTIFIC/ MEDICAL DIVISION,
SPECIAL PRODUCTS DIVISION

# Microcomputer Power Supply

This supply has been specifically designed to power S100 (Altair and IMSAI type) computer systems. You can modify it to suit your applications.

ALTAIR/IMSAI TYPE microcomputers which use the Altair, or S100, bus use separate cards for the CPU, memory, I/O and special functions. These 250 x 130 mm (approx.) cards each have on-board regulators to reduce cost by not requiring expensive high current regulation and b) avoid the damage which would be caused by catastrophic failure of such a regulator. With the on-board regulator scheme, if a regulator fails, damage is limited to one board.

S100 cards require three supply voltages; 8 V which provides the 5 V supply, +16 V which is regulated to 12 V to supply some MOS and linear IC's and −16 V for a −12 V supply to accomodate MOS substrate bias and op-amps. Although early Altairs had problems with an 8 V 8 A supply, the power consumption of memory has dropped considerably since then, and the 28 A supply of the IMSAI may be viewed as a slight over-reaction.

If the 16 V secondaries are not loaded, this supply can give up to 10 A at 7 V, though the transformer must be adequately ventilated — this is sailing rather close to the wind. We have used a pre-regulator to avoid problems with the output voltage rising too high on light loads. A side benefit of the SCR regulator is the provision of a 120 Hz sync pulse which can be used as a Real Time Clock.

## SPECIFICATIONS

| | |
|---|---|
| **Nominal outputs** | +8 V @ 7.5 A<br>+16 V @ 750 mA<br>−16 V @ 750 mA |
| **Actual output voltages**<br>@ full load, 120 V input | +7.5 V<br>+15.3 V<br>−16.2 V |
| **Regulation** | |
| +8 V output, 0 − 7.5 A | 100 mV |
| +16 V output, 0 − 750 mA | 1.5 V |
| −16 V output, 0 − 750 mA | 1.5 V |
| **Ripple voltage** | |
| @ full load +8 V | 0.7 V p - p |
| +16 V | 1.0 V p - p |
| −16 V | 1.0 V p - p |

## DESIGN FEATURES

We initially had the transformer designed to give the required output voltage at full load but the moment we removed the load we knew that either a pre-regulator was needed or a much larger transformer to keep the voltage between the limits. Cost ruled out the larger transformer so that left the regulator.

We first designed a series regulator but due to the additional losses involved (a total of about 20 watts at 10A output) this was ruled out. The SCR (silicon controlled rectifier) regulator was chosen as it has very little extra power loss compared to a straight rectified supply. As high regulation is not

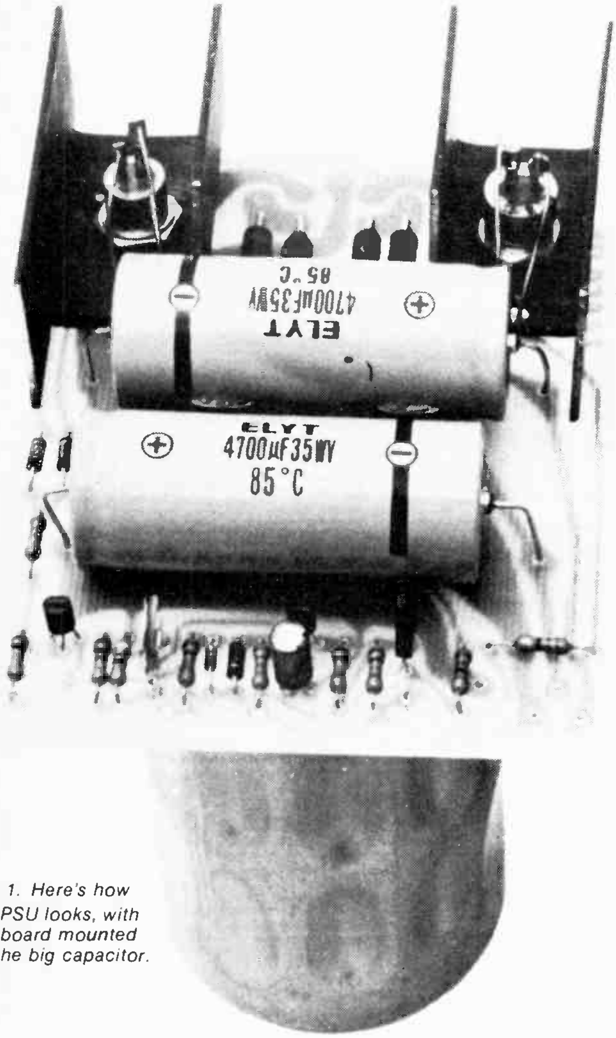


*Fig. 1. Here's how the PSU looks, with the board mounted on the big capacitor.*

needed we used a simple circuit without the usual choke associated with this type of regulator. Even so the output is maintained to approximately ½ volt over the load range.

## CONSTRUCTION

Mount all the components except the transformer onto the printed circuit board. Due to the size of the main filter capacitor, the PC board is mounted directly to it. The capacitor is then bolted to the chassis by its clamp. When mounting the capacitor ensure that the tracks on the PC board are clean or tinned, preferably use the star tvpe lock washers between the board and the capacitor.

The SCRs must have heatsinks fitted, the ones shown are the minimum recommended. Alternatively a separate heatsink could be used. Remember that the currents are fairly high(peak currents around 40A in SCRs) and the cables used should be an appropiate size.

If the unit is to be used continuously at full load in an enclosure adequate ventilation must be provided.

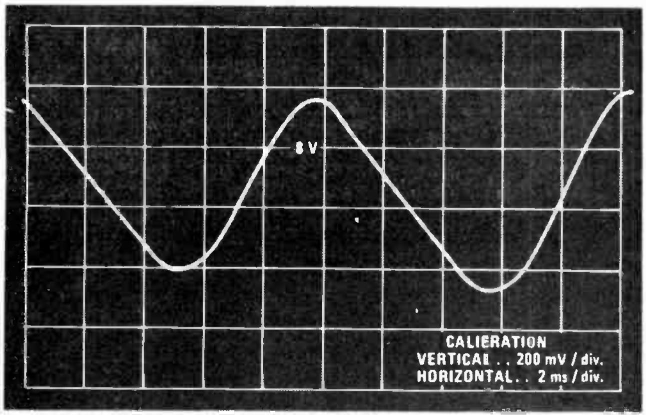


*Fig. 2a. Ripple voltage on 8 volt output at 7.5 amps.*

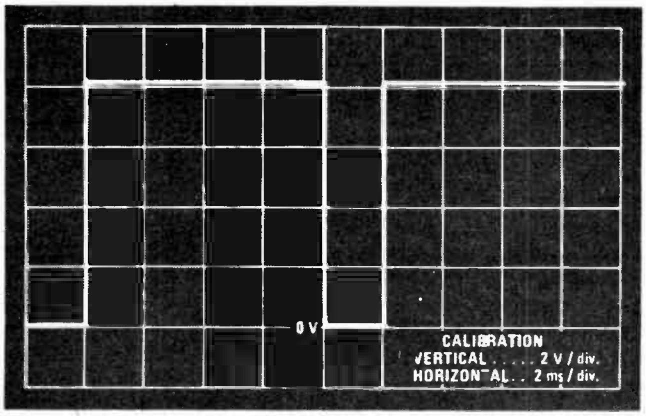


*Fig. 2b. Sync pulse output.*

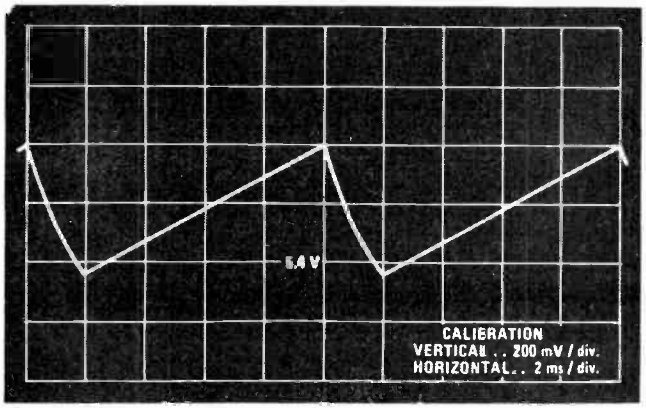


*Fig. 2c. Waveform on the base of Q2.*

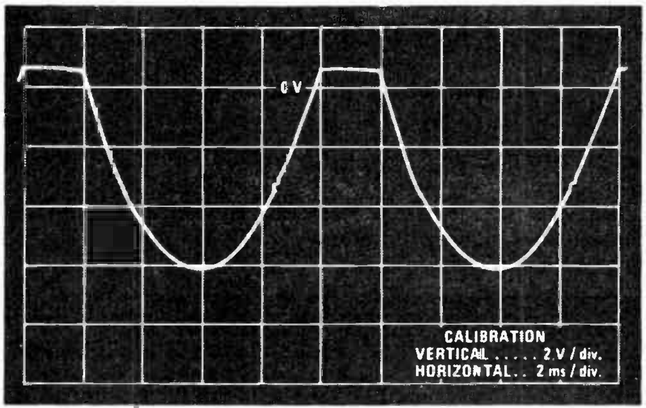


*Fig. 2d. Waveform on the base of Q3.*

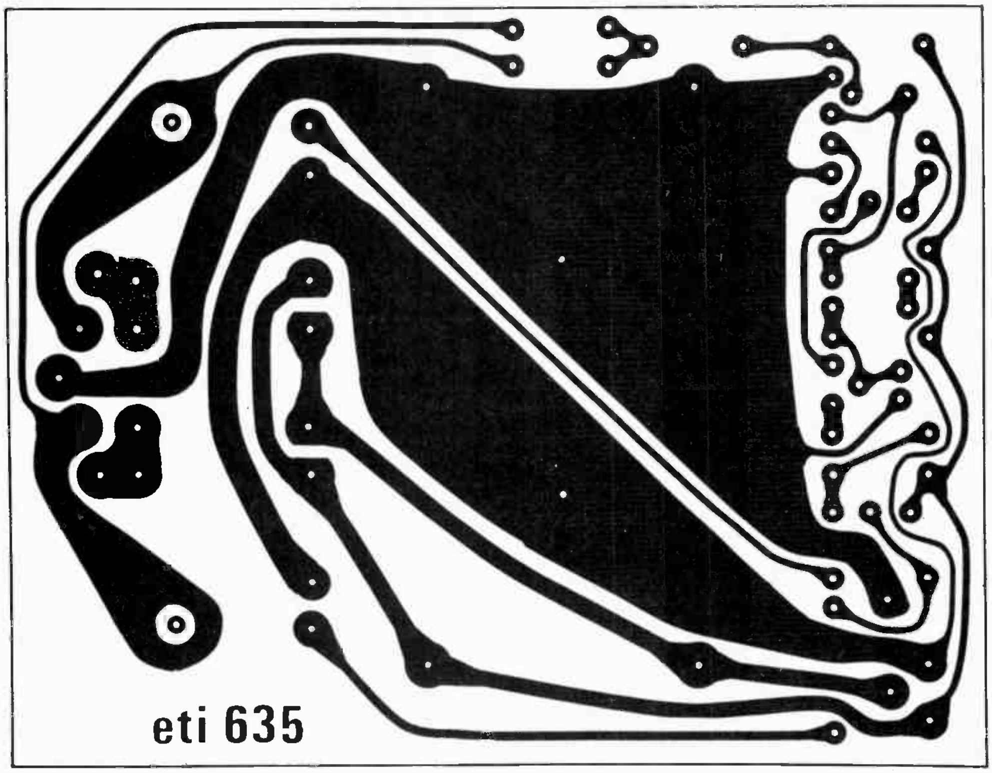


*Fig. 3. Printed circuit layout. Full size 130 x 100 mm.*

## PARTS LIST

RESISTORS all ¼W 5%
unless otherwise marked

| | |
|---|---|
| R1, 2 | 220 |
| R3 | 100 |
| R4 | 470 |
| R5, 6 | 10k |
| R7 | 2k2 |
| R8 | 22k |
| R9,10 | 10k |

POTENTIOMETER

| | |
|---|---|
| RV1 | 500 trim |

CAPACITORS

| | |
|---|---|
| C1, 2 | 4700µ35V electro |
| C3 | 68000u (or more) 16V Philips or Mallory etc |
| C4 | 10u 25V electro |

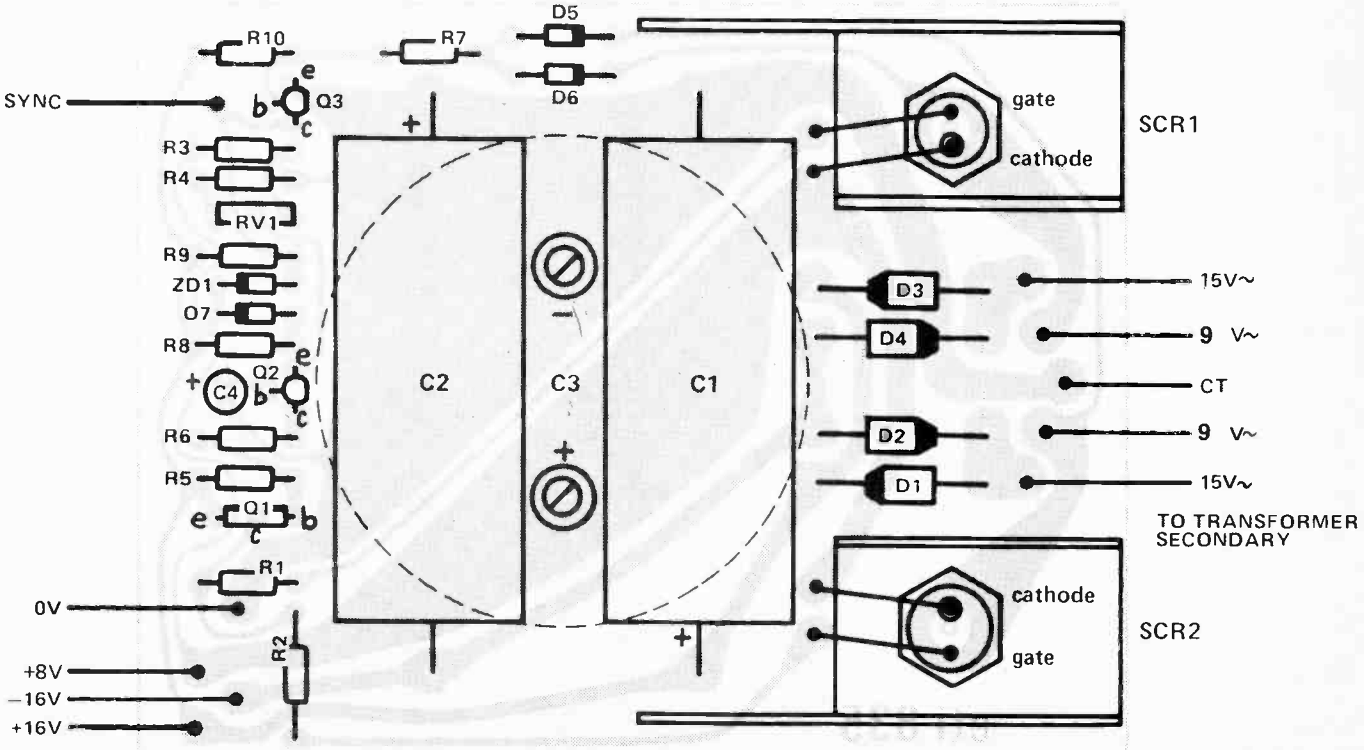
SEMICONDUCTORS

| | |
|---|---|
| Q1 | TIP30C |
| Q2, 3 | 2N3904 |
| ZDI | 5.1V Zener 300mW |
| DI-D4 | 1N5404 |
| D5, 6 | 1N4004 |
| D7 | 1N914 |
| SCRI,2 | 20A SCR |

MISCELLANEOUS
PC board ETI 635

TRANSFORMER
For 8V supply — 18Vct @ 5A
For 16V supply — 30Vct @ 1A
Hammond Mfg supplies suitable types.

*Fig. 4. Component overlay of the power supply. Note that capacitor C3 is bolted onto the copper side of the board.*



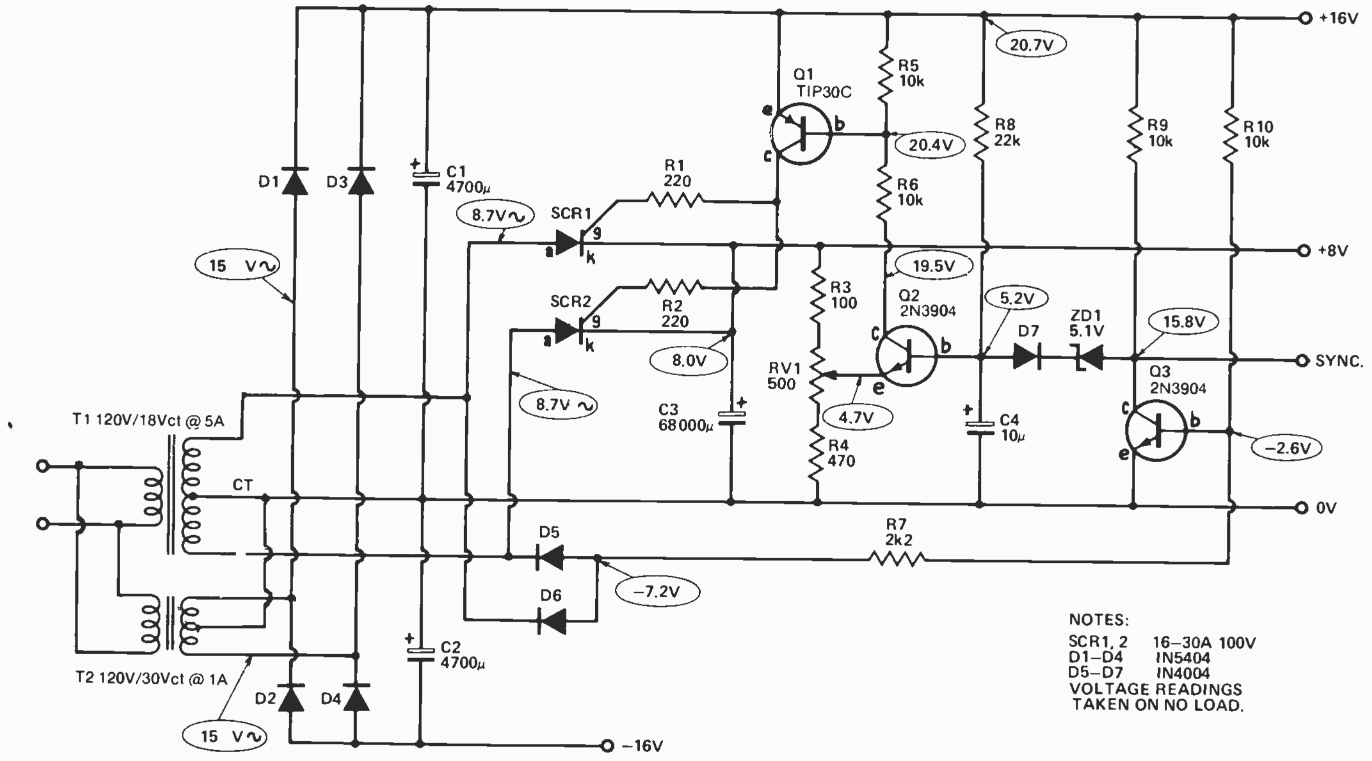


*Fig. 5. The circuit diagram of the power supply.*

## HOW IT WORKS

The ± 16 volt supplies are simply fullwave rectified and filtered, this giving adequate regulation and ripple rejection. The 8V supply however needs regulation. With this the normal rectifier diodes are replaced by SCRs (silicon controlled rectifiers) where the turn on point can be varied. The control of the SCRs is as follows.

Transistor Q3 is used to synchronise the triggering of the SCRs to the line frequency. It is normally biased "off" by the negative voltage generated by D5 and D6. However when the voltage approaches zero this transistor turns on for about 3ms. During this period capacitor C4 is discharged to about 5.6 volts and then it is allowed to charge up again via R7. The voltage rises only about 1V before it is again discharged by Q1.

This generates a sawtooth waveform at 120 Hz rate, transistor Q2 compares the voltage to that on RV1 which is proportional to the output voltage. The comparator transistor, Q2, controls the SCRs via Q1. Because the reference waveform is a sawtooth, as the output voltage falls the firing angle of the SCR moves forward in the cycle until the SCRs are on permanently and control is then lost. This point occurs at about 10A in this unit.

Due to the lack of a choke which is normally employed in this type of regulator, the relative fast charging of C3 causes the unit to move into a type of halfwave rectified output under light loads. The ripple still remains well within the 1Vp.p. limit specified.

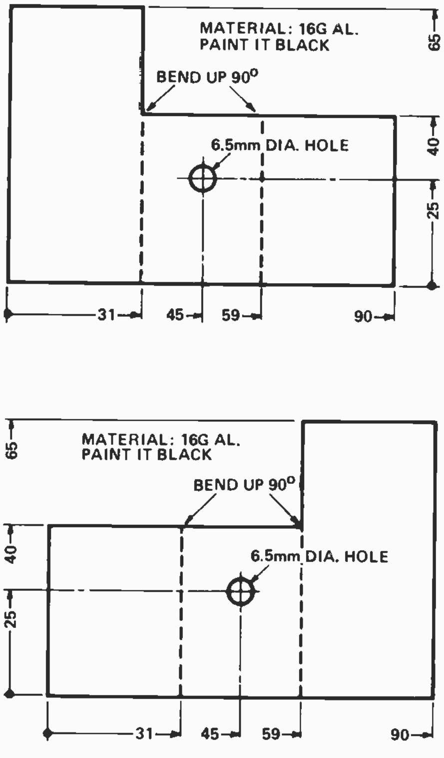


*Fig. 6. Details of the heatsinks used on SCR 1 and SCR 2. Heatsinks of similar or larger area may be used if required.*

# Bucket Brigade Audio Delay Line

This audio delay line uses the latest in IC technology, the 'Bucket Brigade' to give a simple unit suitable for various effects. However this is a project for the experimenter as full details for any particular use are not given.

ANYONE WHO has been in an anechoic chamber will appreciate the need for some reverberation. In music the use of artifical reverberation or echo can compensate for a 'dead' room or create a new effect. Up until recently reverberation was normally obtained by mechanical means such as a spring or plate which is vibrated or excited by an electrical signal; a pickup elsewhere on the plate or spring receives the delayed signal. Due to the nature of resonances in springs, multiple echos occur giving the effect of reverberation.

A single echo is obtainable by using a tape loop, recording the signal on one head and playing back through a second. The distance between the heads and the tape speed determines the delay. Echo can also be obtained accoustically by a long tunnel with a microphone and speaker.

When the price of digital ICs started to come down a number of digital delay lines were developed. These used an A–D (analogue to digital) converter, a long shift register and finally a D–A converter. To accomodate the wide dynamic range required very good, fast, A–D, D–A converters along with a large shift register. Even with the low price of ICs these units still cost around $500.00 or so (this is the main reason we have not published one as a project).

A number of years ago several IC manufactures started playing with a 'digital' delay line which works by storing an analogue voltage on a capacitor and then transferring this voltage to another and then successive capacitor. This is accomplished by switching FETs on and off under digital control. The circuit became known as a bucket brigade and this name has stuck.

The IC we have chosen is the MN3001 which is a dual 512 step device. Brief specifications of other devices we know about are given below.

## USES OF BBD

- Variable or fixed delay of analog signals
- Reverberation
- Echo
- Tremolo, vibrato, flanging or chorus effects
- Voice control of tape recorders
- Time compression of telephone conversations
- Voice scrambling

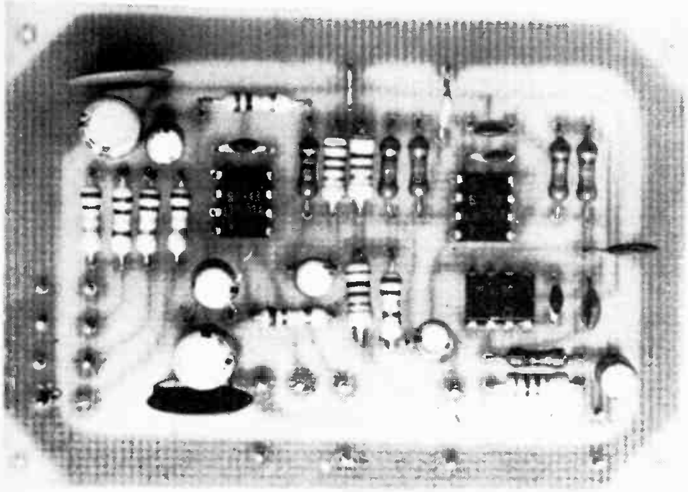
## CONSTRUCTION

As we are describing no mechanical arrangement our description of construction is limited to the assembly of the PC board. It is recommended that a socket be used for the BBD IC as it is an expensive MOS device. The inputs are protected but it should be handled with care. The same care should be taken with the CMOS IC but as a socket costs more than the IC it is hard to recommend it!

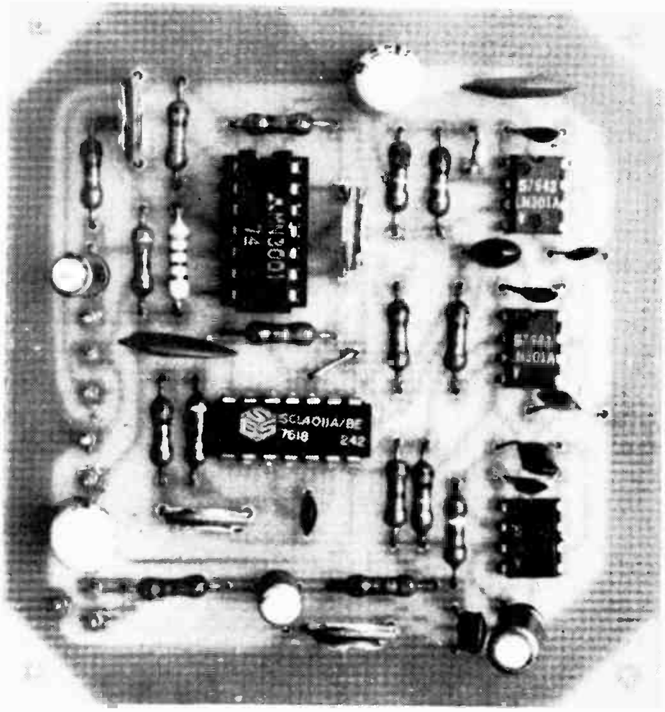
The interconnection between the pc boards depends on the effect needed.

## SPECIFICATIONS

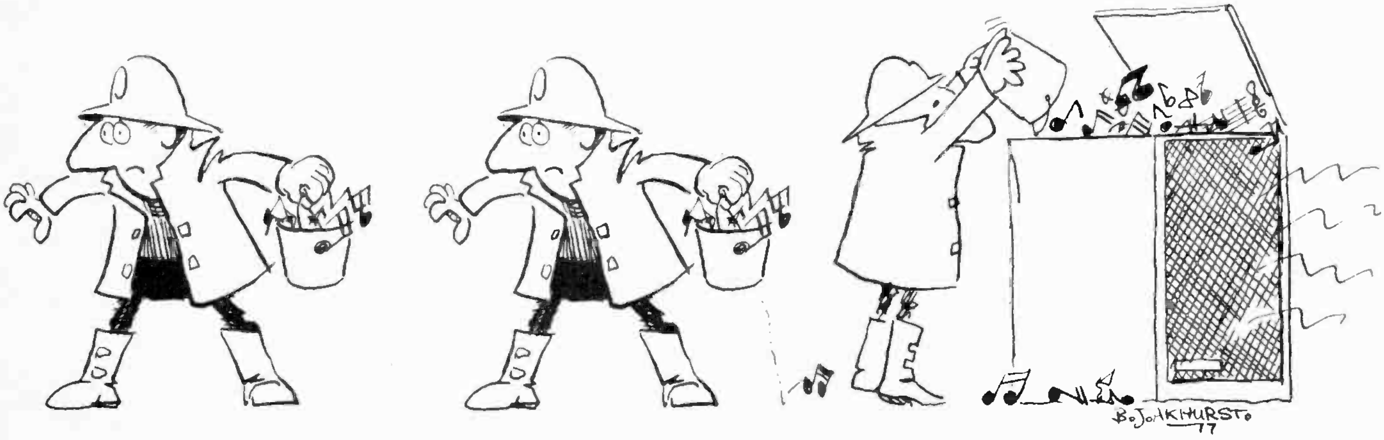
| | | |
|---|---|---|
| Maximum input < 3% distortion | | 2.0V RMS |
| Delay time internal oscillator | | 6 – 30ms |
| Frequency response | | see graph |
| Distortion 1V in 1kHz | | 0.3% |
| Signal to noise re 2V input | | 67dB |
| Supply current (A) | + 5V | 6mA |
| | – 15V | 9mA |
| (B) | + 5V | 6mA |
| | –15V | 6mA |

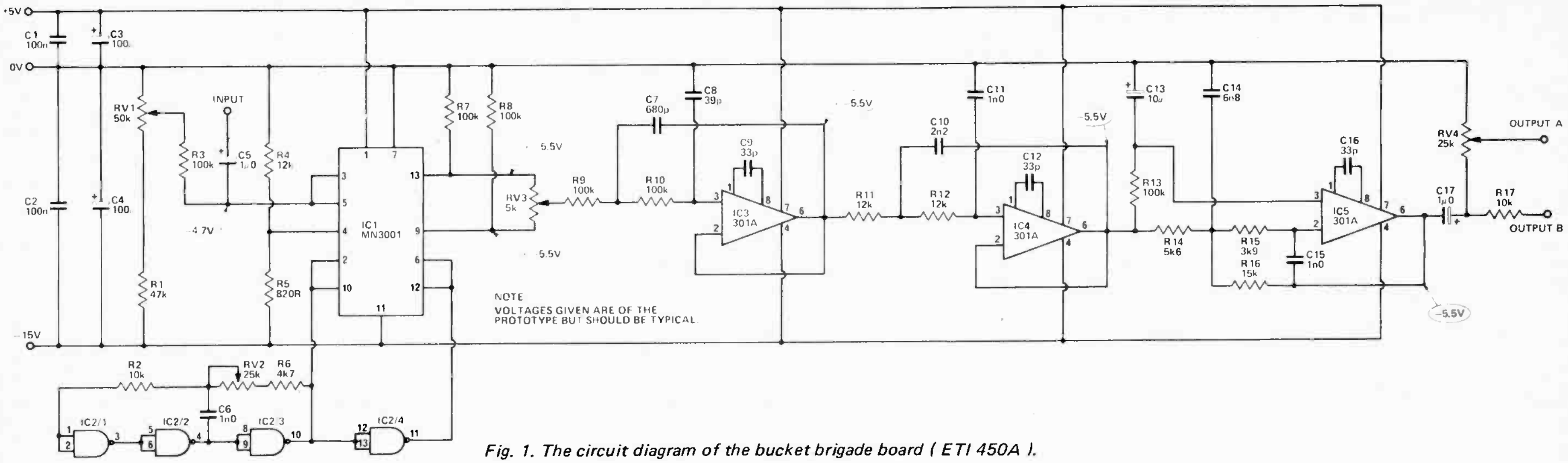


*The mixer, filter board ETI 450B.*



*The bucket brigade board ETI 450A.*





NOTE
VOLTAGES GIVEN ARE OF THE PROTOTYPE BUT SHOULD BE TYPICAL

*Fig. 1. The circuit diagram of the bucket brigade board ( ETI 450A ).*

## HOW IT WORKS

The bucket brigade device is an analogue delay line which samples the input waveform at an instant in time and stores this voltage on a capacitor. As we need more than just one point on the waveform we sample the input at least 2 times faster than the highest frequency required. A single capacitor cannot store more than one voltage at one time and so a series of capacitors is used. Before the second sample is taken the energy in the first capacitor is transferred to the second capacitor thus freeing the first to sample the input again. Then before the third sample the energy in the second capacitor is transferred to the third. The first into the second and the first again samples the input. This process continues on each sample with the energy in each capacitor being transferred to the next. Eventually we run out of capacitors and this then becomes the output. The number of capacitors, or stages, and the sample (clock) frequency determine the time it takes an input sample to appear at the output.

In the device we have used there are 512 stages in each of two identical and independent sections. The internal circuit diagram of the initial part and of the output stage is shown below (there are over 1000 capacitors and 2000 FETs in the IC!)

The transfer of energy is done using FETs which are controlled by the two clock lines CP1 and CP2. These are complementary square wave signals. Using a 40 kHz clock the input is sampled every 25μs then 'remembered' and transfered every 25μs. On the output, from stage 509 on, the signal is divided into two paths, one having an extra stage. This is needed as the signal on the output is only there for half the 25μs period. By adding these two out-of phase outputs a continuous output results.

All of this transferring of energy does however waste energy and the output is of a lower amplitude than the input. In the MN3001 it is about 8.5dB lower. To increase the delay it is normal to connect two sections (or more if needed) in series. However the output has then twice the loss and even with an intermediate amplifier this results in a lower signal to noise ratio.

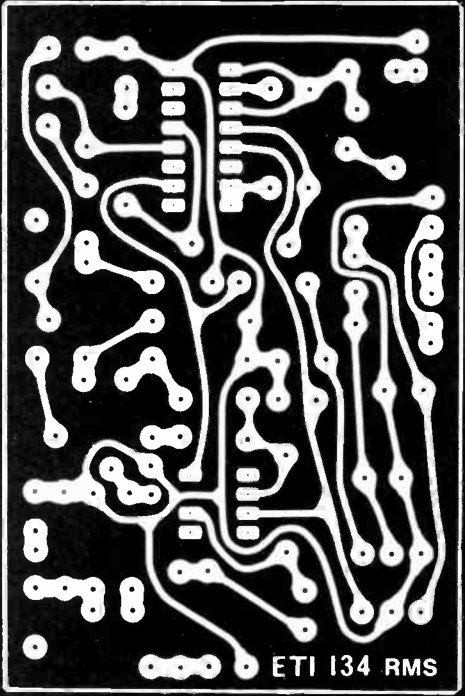
A second method of obtaining a large delay is to run the two sections in parallel with each sampling on alternate half cycles of the clock waveform giving effectively two sampling periods per clock pulse. This allows the clock frequency to be halved for the same frequency response giving twice the delay with only one attenuation loss. However as you never get anything for nothing the lowering of the clock frequency increases the low frequency energy content of the noise, making the filter do more work.

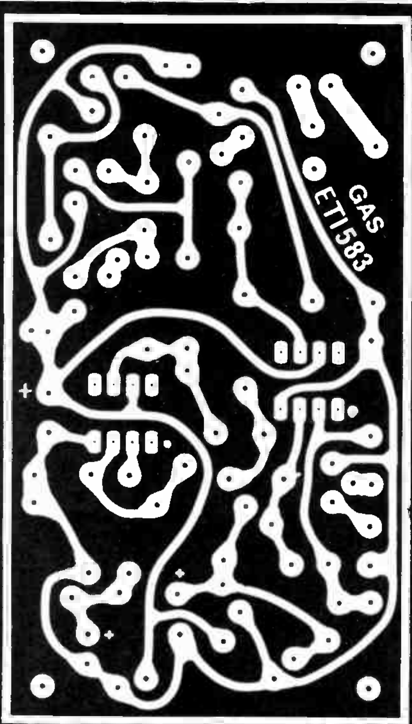
Getting back to the circuit diagram we see that the input signal is coupled to the input of both halves of the BBD with dc biasing being provided by RV1. IC2 is used as an oscillator with frequency adjustable from about 20kHz to 90kHz giving delays of 5-25 ms per section. The output of IC2/3 is inverted by IC2/4 giving the two complementary clocks required by the BBD. The outputs of the BBD are mixed with RV3 being used to remove the clock frequency before the 6 pole filter IC2 – IC4 removes all the other hash generated by the clocking. The first two sections of this filter have unity gain while the third stage has a gain of 8.5dB to compensate for the loss in the BBD. These gains are of course below the cut off point!

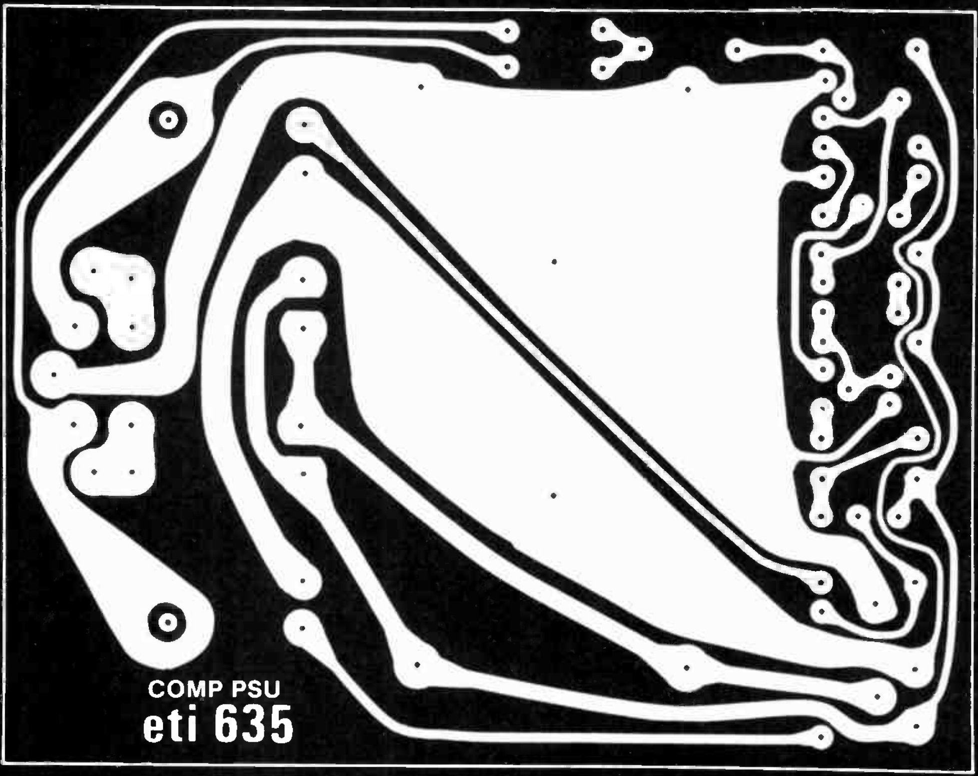
The second board used is simply a mixer and 4 pole filter which can be used together or in separate parts of the unit. Due to the sampling done by the BBD, the frequency of an input signal must not exceed half the clock frequency otherwise it will appear at the output at some other frequency lower than the clock frequency. This effect is similar to modulation where two signals are multiplied together and produce components at the sum and difference frequencies. In this case, (if the input signal exceeds half the clock frequency) the square wave clock tends to multiply with the input signal. The sum and difference frequencies would then fall at quite objectional frequencies in the audio range. For this reason the 4 pole filter is used before the BBD.

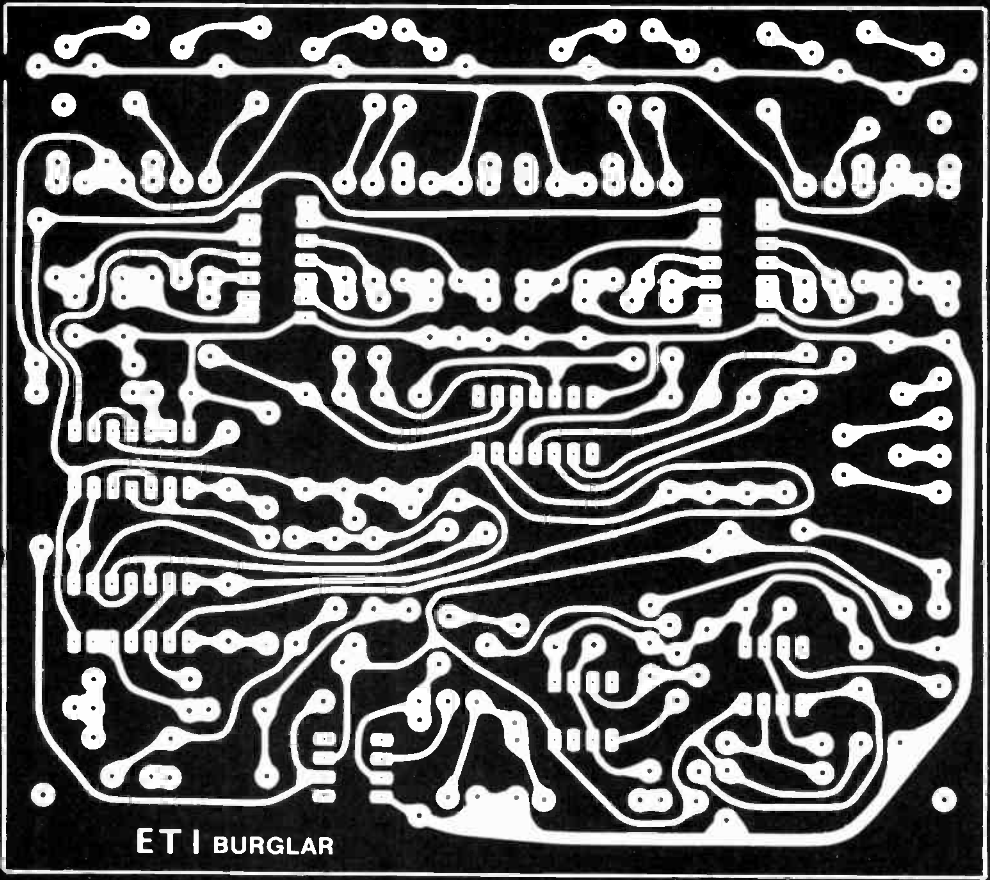
# ETI PCB Negatives

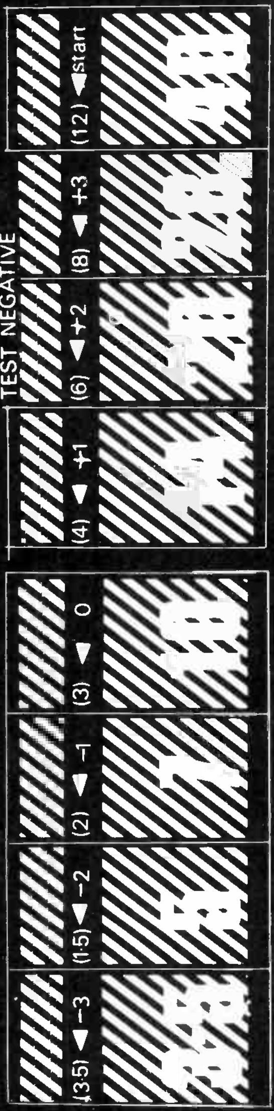
HERE WE present negatives for Feb, March and April issues. (We will try to squeeze in the Hammerthrow pcbs next time). These negs can be used with presensitized boards (eg. Injectoral). Typical exposure times under a No. 2 photoflood bulb with reflector at ten inches we expect to be around 20 minutes. Use test strip to make test exposures to find optimum exposure for your setup. Full details were given in Jan 78 ETI.

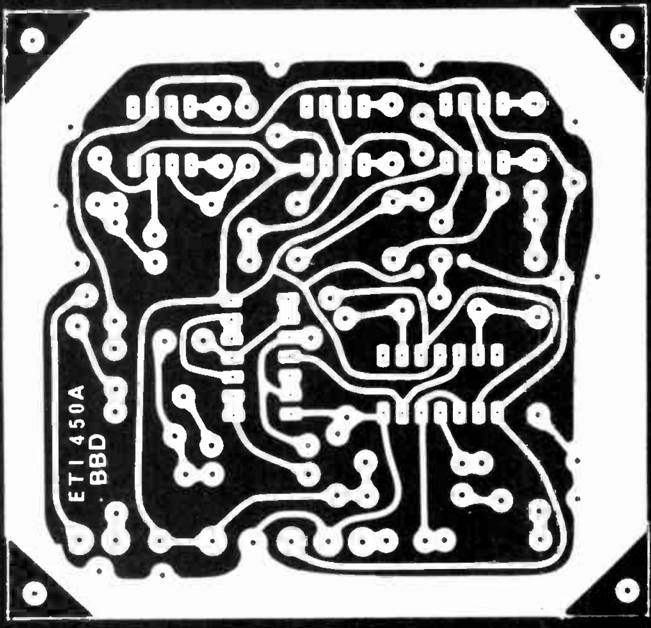


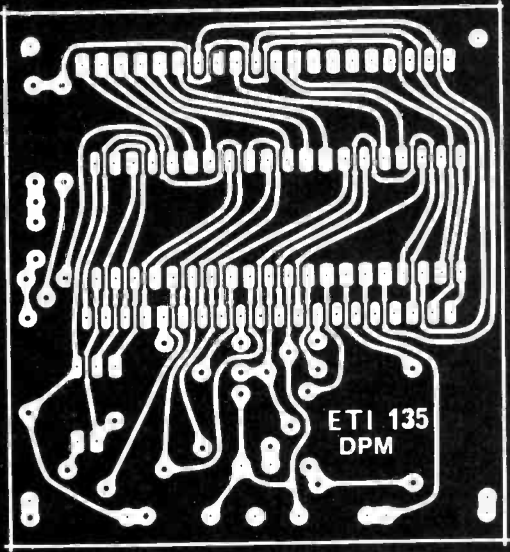


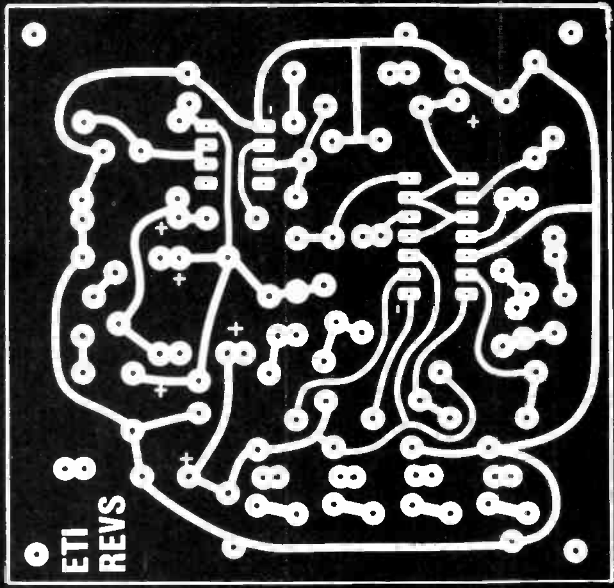


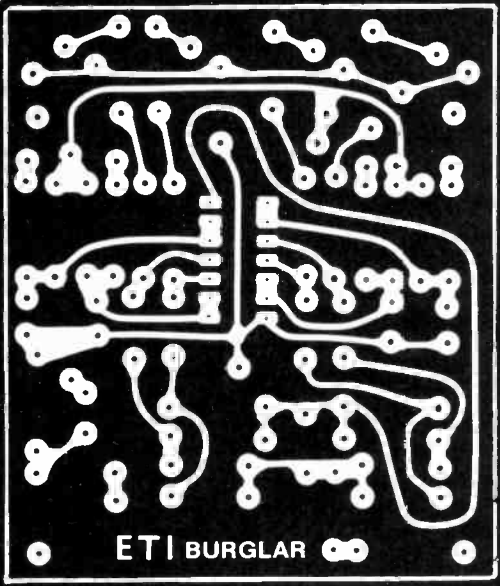


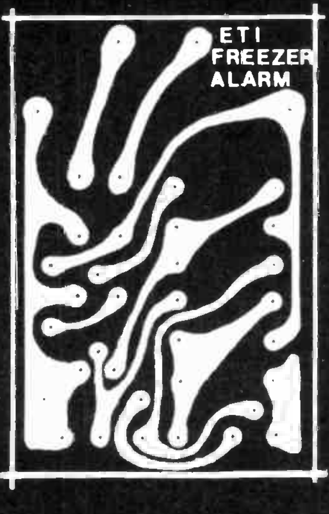

TEST NEGATIVE
(12) ◄ start
(8) ◄ +3
(6) ◄ +2
(4) ◄ +1
(3) ◄ 0
(2) ◄ −1
(1·5) ◄ −2
(3·5) ◄ −3

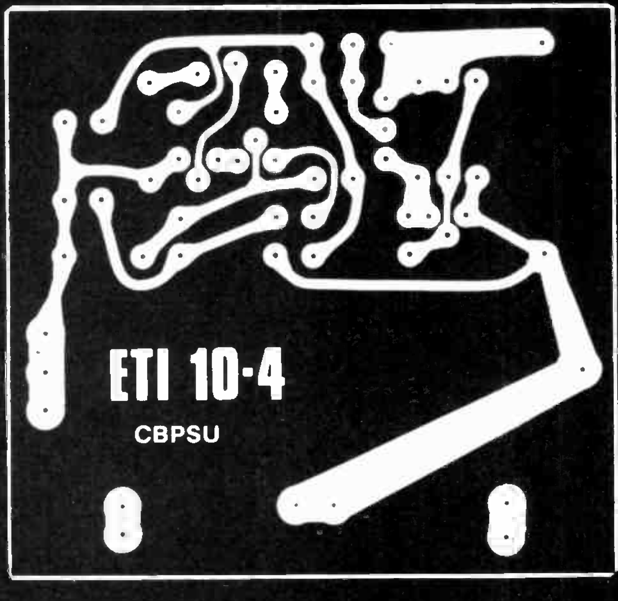

ETI 450A
BBD

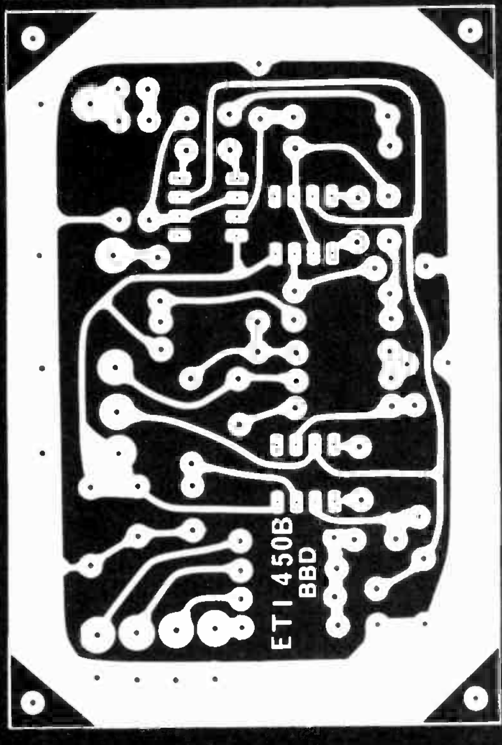

ETI 135
DPM


ETI
REVS


ETI BURGLAR


ETI
FREEZER
ALARM


ETI 10-4
CBPSU


ETI 450B
BBD

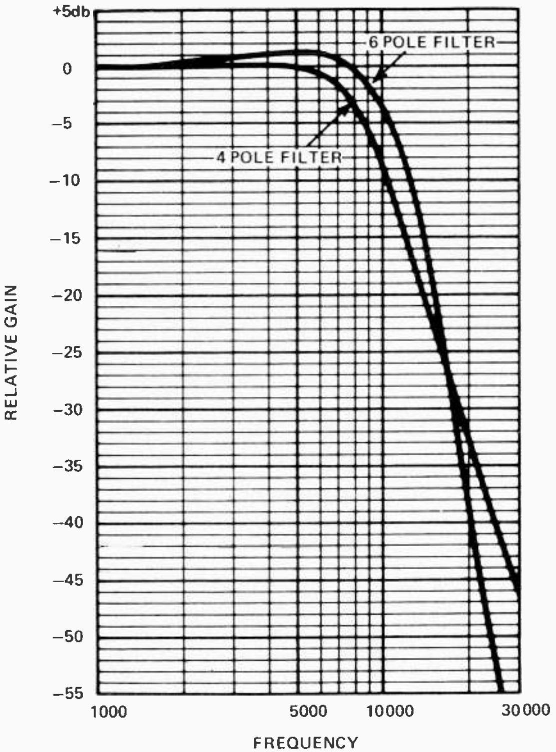


*Fig. 3. The frequency response of the two filters. The overall response is approximately the sum of these two filters provided the clock frequency is at least 20 kHz.*

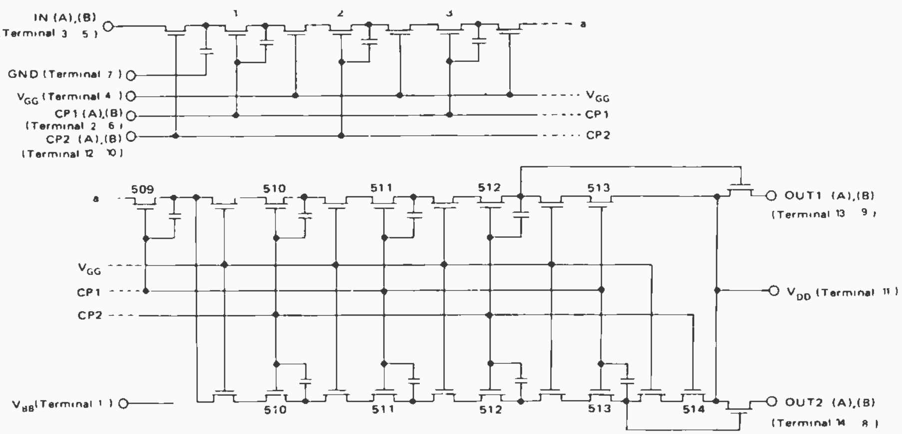
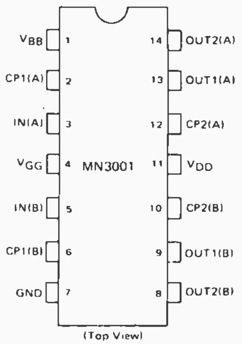


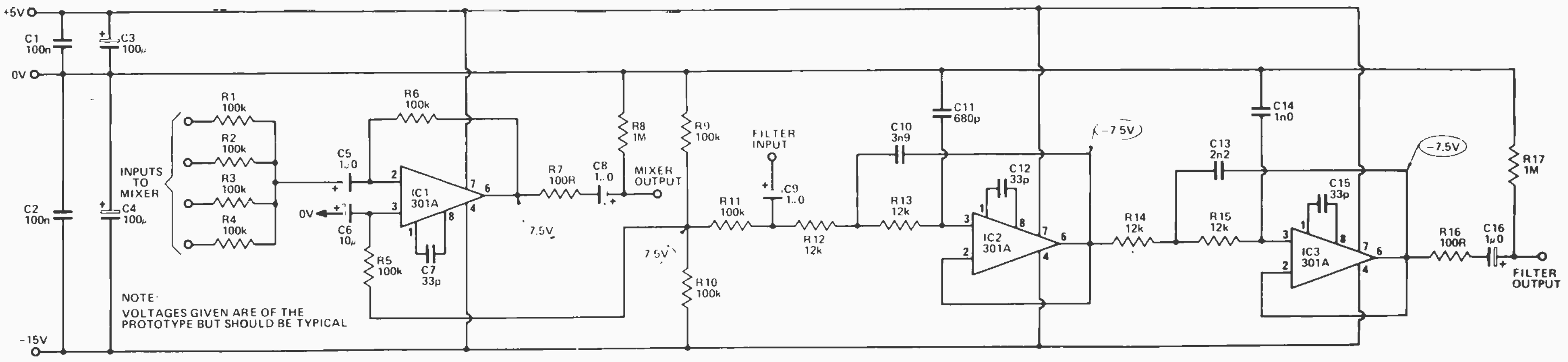
*Fig. 2. The internal circuit of the MN3001 showing the first three and last four stages.*



| TYPE | MN 3001 | MN 3002 | MN 3003 | MN 3004 | TDA 1022 | SAD 1024 |
|---|---|---|---|---|---|---|
| NO OF STAGES | 2 X 512 | 512 | 2 X 64 | 512 | 512 | 2 X 512 |
| DELAY (ms) | 1–25 | 1–25 | 0.16–3.2 | 2.5–3.2 | 0.5–50 | 0.2–170 |
| INSERTION LOSS (dB) | 8.5 | 8.5 | 3.5 | 1.5 | 4.0 | |
| DISTORTION (%) | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 1.0 |
| SIGNAL TO NOISE (dB) | 70 | 70 | > 68 | 85 | 74 | > 70 |
| SUPPLY VOLTAGE (V) | +5, –14, –15 | +5, –14, –15 | –8, –9 | –15 | –15 | –15 |

*Fig. 4. Summary of bucket brigade ICs*

*Fig. 5. The circuit diagram of the mixer, 4 pole filter board ( ETI 450B ).*



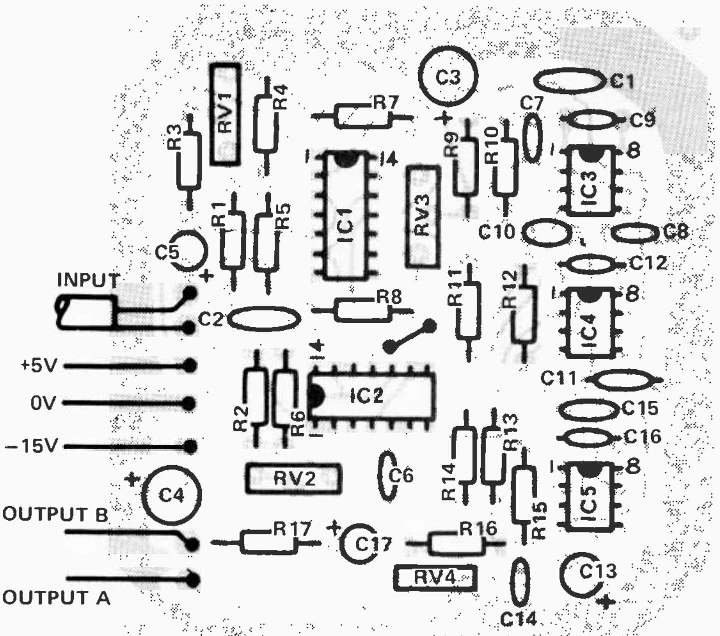


*Fig. 6. The component overlay of the bucket brigade board.*

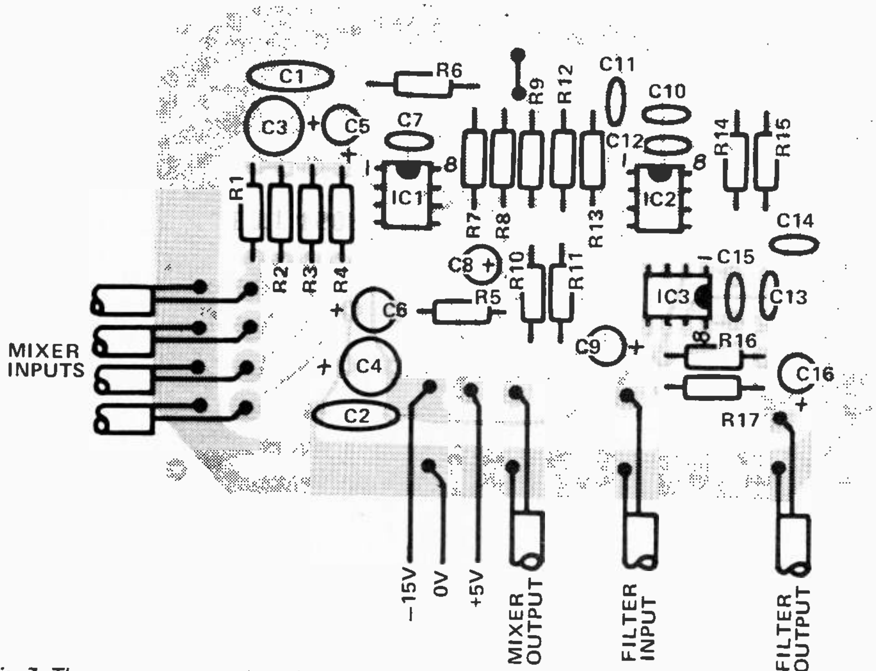


*Fig. 7. The component overlay of the mixer – filter board.*

## ADJUSTMENT

RV1 is used to set the bias voltage. If an oscilloscope is available look at the output of the board while feeding in a sine wave signal. Adjust RV1 to allow the maximum input signal without clipping. RV2 adjusts the delay while RV4 sets the output level to compensate for differences in the loss of the BBD sections. RV3 is used to remove the clock frequency from the output. If an oscilloscope is available look at the wiper of RV3 and adjust to give the smoothest output. The switching transients at this point are very high but these are removed by the filter.

## PARTS LIST

RESISTORS all ¼W 5% unless otherwise marked

| | |
|---|---|
| R1 | 47k |
| R2 | 10k |
| R3 | 100k |
| R4 | 12k |
| R5 | 820R |
| R6 | 4k7 |
| R7–R10 | 100k |
| R11,12 | 12k |
| R13 | 100k |
| R14 | 5k6 |
| R15 | 3k9 |
| R16 | 15k |
| R17 | 10k |

POTENTIOMETERS

| | |
|---|---|
| RV1 | 50k trim |
| RV2 | 25k trim |
| RV3 | 5k trim |
| RV4 | 25k trim |

CAPACITORS

| | |
|---|---|
| C1,2 | 100n polyester |
| C3,4 | 100μ 25V electro |
| C5 | 1μ0 25V electro |
| C6 | 1n0 polyester |
| C7 | 680p ceramic |
| C8 | 39p ceramic |
| C9 | 33p ceramic |
| C10 | 2n2 polyester |
| C11 | 1n0 polyester |
| C12 | 33p ceramic |
| C13 | 10μ 25V electro |
| C14 | 6n8 polyester |
| C15 | 1n0 polyester |
| C16 | 33p ceramic |
| C17 | 1μ0 25V electro |

SEMICONDUCTORS

| | |
|---|---|
| IC1 | MN3001 |
| IC2 | 4011 ( CMOS ) |
| IC3–IC5 | 301A |

MISCELLANEOUS

PC board ETI 450A

Kits are available for these from Livingstone Electronics and Dominion Radio. See their ads elsewhere in this issue.

## PARTS LIST

RESISTORS all ¼W 5% unless otherwise marked

| | |
|---|---|
| R1–R6 | 100k |
| R7 | 100R |
| R8 | 1M |
| R9–R11 | 100k |
| R12–R15 | 12k |
| R16 | 100R |
| R17 | 1M |

CAPACITORS

| | |
|---|---|
| C1,2 | 100n polyester |
| C3,4 | 100μ 25V electro |
| C5 | 1μ0 25V electro |
| C6 | 10μ 25V electro |
| C7 | 33p ceramic |
| C8,9 | 1μ0 25V electro |
| C10 | 3n9 polyester |
| C11 | 680p ceramic |
| C12 | 33p ceramic |
| C13 | 2n2 polyester |
| C14 | 1n0 polyester |
| C15 | 33p ceramic |
| C16 | 1μ0 25V electro |

SEMICONDUCTORS

| | |
|---|---|
| IC1–IC3 | 301A |

MISCELLANEOUS

PC board ETI 450B

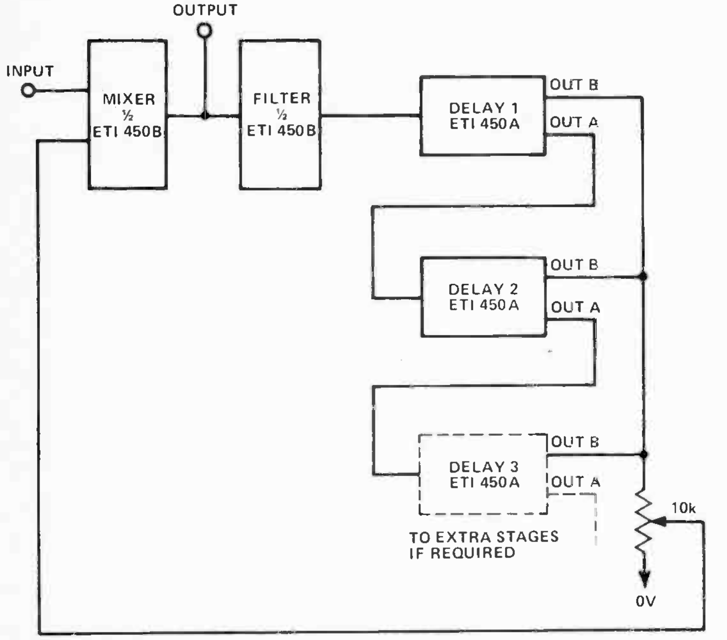
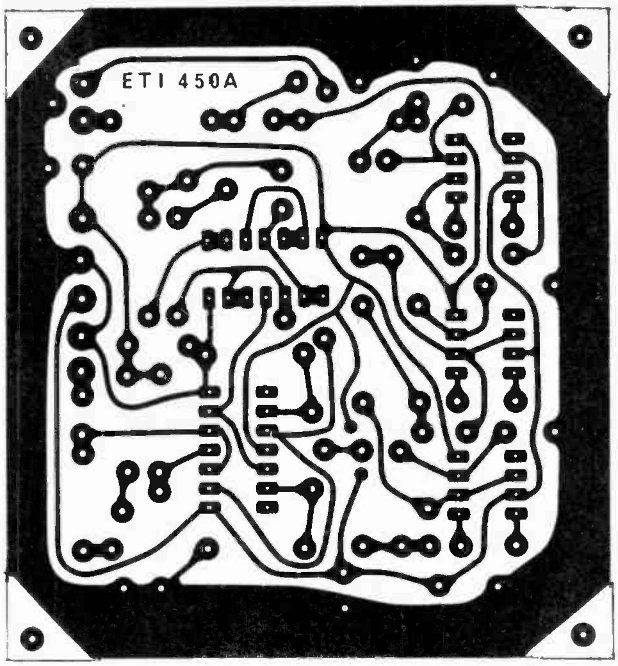
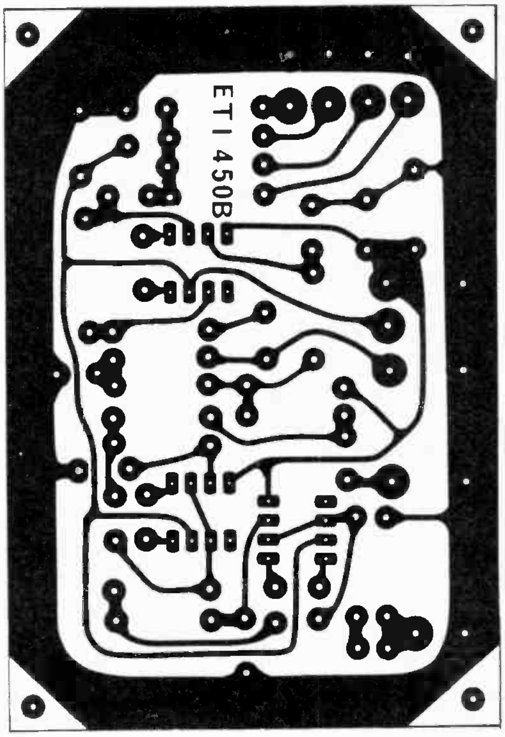


*Fig. 8. The interconnection for reverberation.*





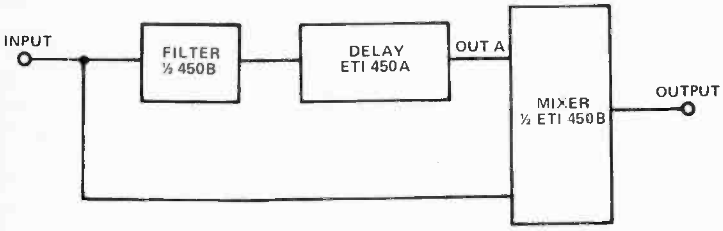


*Fig. 9. Connections for a single echo. With a short delay this becomes a phaser.*

## REVERBERATION

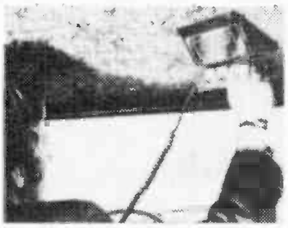
If the audio signal is fed via a mixer into the delay line and its output fed back into the mixer we have a feedback system which will repeat a single sound many times. This is reverberation. If several different delays are used the effect will seem more natural. With all feedback systems if the sum of all the delayed outputs exceeds the original sound uncontrolled oscillations will result. This is similar to howl-round in PA work and careful adjustment is needed if long reverberation times are required.

## ECHO

This is similar to reverberation except the delayed signal is not fed back to its own input. A single echo only results (from a single delay) and it can be of any amplitude in relation to the original signal.

## PHASING (FLANGING)

By varying the delay times and by mixing in the right proportions total cancellation of some frequencies can occur. Now if the clock frequency is made variable a phasing or flanging effect occurs. A variable clock can be made by replacing potentiometer RV2 by an LDR and illuminating it with a bulb the brilliance of which is controlled (try a 555 timer). We must leave details of this to the individual constructor.



# ETI CIRCUITS No. 1

## ALARMS

Basic Alarm
Photo Intruder Alarm
Intruder Alarm
Photo Electric Relay
Low Temperature/Lights out
Temperature Sensor
Coolant level
Water Level
Electronic Lock
Car Battery Watchdog
Simple Car Alarm
Simple Lock

## AMPLIFIERS & PREAMPLIFIERS

High Input Impedance
High Impedance Buffer
Low Output Impedance
High Input Impedance
Low Frequency Extender
Virtual Earth Preamp
IC Tape Head Preamp
Simple Stereo Tape Player
2.5 Watt
20 Watt Slave
10 Watt
Loudspeaker Microphone
Voltage Controlled Amp
Wide Band Amplifier
Video Power Amp
Broadband Amp

## SIGNAL PROCESSORS

Fuzz Box
Guitar Fuzz
Fuzz Box
Waa Waa
Disco Autofade
Simple Autofade
Information Transfer
Optical Pulse Conditioner
TV Sound Pickoff
Cracklefree Potentiometer
Voltage to Frequency
Sine to Square Wave
Precision AC to DC
Voltage Processor
Universal Meter
Double Precision
Fast Half Wave
Simple Chopper
Noise Rejecting SCR Trigger
Phase Shifter

## SIGNAL GENERATORS

Simple
Variable Duty cycle
Fast Edge
FET
Improved Multivibrator
Variable Duty cycle
Stable R C
Cheap (CMOS)
Simple TTL XTAL
Uncritical XTAL
Pulse
Zero Crossing
Simple Pulse
Needle Pulse
Stable Linear Sawtooth
Zener
Noise
Pink
Simple Relaxation
Triangle with independent slope
Exponential
Widerange Multivibrator
Multiple Waveform
Linear Sweep
Step Frequency
Beeper
7400 Siren
Simple Siren
Ship Siren
Two Tone
Toy Siren
Kojak, Startrek
Sound Effects
Sound Effects

## FILTERS

Bandpass
Low & High Pass
Rejection Notch
Bandpass
Cartridge EQ & Rumble
Hum Stopper
Tape Hiss Reduction
Simple Crossover

## DIGITAL

Thermometer
Heads or Tails
Binary Calculator
Voltmeter
Seven Segment to Decimal
Die
Random Binary
CMOS Die
Multiplexer Hints
Learning Memory
CMOS Clock

## POWER SUPPLIES

Constant
Temperature Stable
Constant
Voltage Controlled
Precision Voltage Divider
Dual Polarity
Simple Balanced
Voltage Divider
Low Regulated
Short Circuit Protected
Simple TTL Supply
ZN414 Supply
Stable Reference
Transformerless invertor
DC to DC AC
Voltage Multiplier
Automobile Convertor
Shaver Adaptor
DC-DC
High Voltage From Battery
Variable + ve or -ve output
Simple
12V from Battery Charger
Bucket Regulator
Adjusting Zener Voltage
Variable Zener
Zener Boosting of Regulators
High Power
Electronic Fuse
Better Fuse
Regulator & Fuse
Fast Acting
SCR Crowbar
Voltage Polarity
NI CAD Discharge
Current Limiting

## TEST

Diode Checker
GO NO GO Diode Tester
Zener Check
GO/NO GO Transistor Tester
Quick JFET Test
Current Gain Tester
Basic Transistor Tester
Simple Transistor/SCR
SCR Tester
Crystal Check
Crystal Checker
Good/Bad Battery Tester
Battery Tester
Op-Amp Tester
Op-Amp Checker
Cheap Logic Probe
Audible TTL Probe
Audible Slow Pulses
Logic Probe
Logic Analyser
I and O Display Probe
Simple High Impedance Voltmeter
Audio/RF Tracer
Thermocouple Thermometer
Metering Stabilised supplies
Simple Frequency Meter

## TIMERS & DELAYS

Low Standby Drain
741 Timer
Self Triggering Timer
Pulse Timer
Pulse Delay
Voltage Controlled Monostable
Sequential Relays
Door Chime Delay

## SWITCHING

Touch Triggered Bistable
Touch Sensitive Switch
Electronic Switch
Sound Operated 2 Way
SPST Switch Flip Flop
Two Signals on one Wire

## INDICATORS

Line-o-Light
3 Step Level
Light Level
Bargraph Display
Fuse Failure
Blown Fuse
Back Up Lamp
DC Lamp Failure
FM Tuner Station
Current Flow
Disco Cue

## FLASHERS

Dancing Lights
Low Frequency Strobe
Flasher
Ultra Simple

## POWER CONTROL

LDR Mains Control
Floodlamp Control
Zero Crossing Sync
Train Controller
Low Differential Thermostat
Simple Temperature Control
Full Wave SCR Control

## AUTOMOBILE

Brake Lamp Failure
Courtesy Light Delay
Simple Hazard Light
Light Extender & Reminder
Four Way Flasher
Headlamp Dipper
Wiper Delay
Suppressed Zero Voltmeter
Rev Counter/Tachometer
Auxiliary Battery

## DETECTORS & COMPARATORS

Peak Detect & Hold
Window Detector
Peak Program
Positive Peak
Reaction Comparator

## RADIO FREQUENCY

Crystal Marker
100 kHz Marker
RF Voltmeter
RF Detector
LED RF Indicator
RF Amplifier Protection
FET-Radio
Op-Amp Radio

## MISCELLANEA

Phase Locked Loop
Touch Doorbell
Phase Lock Control
Audio Mixer
Virtual Earth Mixer
Plop Eliminator
Loudspeaker Protection
Digital Capacitance Probe
Digital Tape Recorder Adaptor
Breakdown Diode Substitution
Dual Function Charger
Dual Mode Amp
Capacitor Substitution
Electronic Capacitor
Speeding Up Darlingtons
Shutter Saver
Thyristor Sensitivity
Sound Operated Flash
Strength Tester
Logic Noise Immunity

## TIPS

Identifying 74 Series Supply Pins
Soldering IC's
Tinning With Solder Wick
PCB Stencils
Front Panel Finish
DIL Drilling
Fluorescent Starting
Avoiding Insulated Heat Sinks
TTL Mains Interface
Boost Your Mains
High Resistance on Low Meters
High Voltage Electrolytics
Transistor Identification
Template & Heat Sink for Power Transistors
Transistor Socket
Solder Flow Problems
Odd Resistor Values
Resistors in parallel
CMOS DIL Handling
Identifying Surplus ICS
Extending Battery Life
Battery Snaps
Power Supply or Battery
Battery Checking
Muck Remover
Transformers in reverse
Loudspeaker Checking
Improving UJT Linearity
Signal Tracer
Crystal Earpieces
Cheap Varicaps
Zener Lifts Capacitor Rating

## DATA

741 Op-Amp Data
BC 107-109 Data
BC 177-179 Data
CMOS & TTL Data
2N3055 Data
MJ2955 Data
Bipolar Data Tables
Bipolar FETs Rectifiers
Diodes Pinouts Zener Misc

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# Panasonic MN3001

THE MN3001 is the heart of our BBD experimenter's boards featured in this issue.

Each device contains two 512-stage BBDs with independent input, output and clock terminals. A pair of output terminals is provided in each BBD for cancellation of the clock component superimposed on the output signals.

**P-channel silicon gate technology is used to fabricate the BBDs from chains of tetrode type MOS transistors and storage capacitors. The MN3001 is packaged in the standard 14-lead DIL plastic package.**

### TYPICAL CHARACTERISTICS (Ta = 25°C)

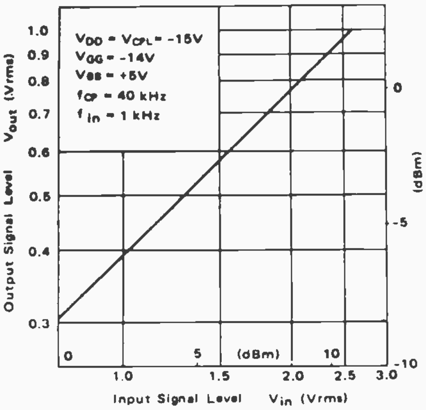


*Fig. 2. Voltage transfer characteristics.*

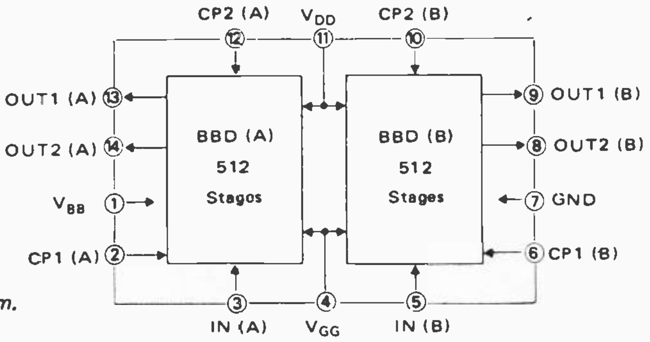


*Fig. 1. Block diagram.*

### OPERATING CONDITIONS (Ta = 25°C)

| Item | Symbol | Conditions | Typ. | Unit |
|---|---|---|---|---|
| Drain Supply Voltage | $V_{DD}$ | | - 15 | V |
| Gate Supply Voltage | $V_{GG}$ | | - 14 | V |
| Back-gate Bias Voltage | $V_{BB}$ | $V_{CPH} = 0 \sim -1V$ | + 5 •1 | V |
| Clock Voltage "H" | $V_{CPH}$ | $V_{BB} = +4 \sim 6V$ | 0 •1 | V |
| Clock Voltage "L" | $V_{CPL}$ | | - 15 | V |

•1 The MN3001 can be used at $V_{BB} = 0V$, if $V_{CPH}$ is fixed at -3V.

### ELECTRICAL CHARACTERISTICS ($Ta = 25°C, V_{DD} = V_{CPL} = -15V, V_{GG} = -14V, V_{BB} = +5V, R_L = 100\ k\Omega$)

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Clock Input Capacitance | $C_{CP}$ | | | | 350 | pF |
| Clock Frequency | $f_{CP}$ | | 10 | | 800 | kHz |
| Signal Delay Time | $t_D$ | | 0.32 | | 25.6 | msec |
| Clock Pulse Width •2 | $t_{CPW}$ | | | | 0.5T •3 | |
| Clock Rise Time •2 | $t_{CPr}$ | | | 0.05T | | |
| Clock Fall Time •2 | $t_{CPf}$ | | | 0.05T | | |
| Input Signal Frequency | $f_{in}$ | $f_{CP} = 40$ kHz,3dB down | 0 | | $0.3f_{CP}$ | kHz |
| Input Signal Swing | $V_{in}$ | 2.5% Distortion | | | 2 | Vrms |
| Output Signal Attenuation | | $f_{CP} = 40$ kHz, $f_{in} = 1$ kHz | | 8.5 | 11 | dB |
| Output Distortion | Dtot | $f_{CP} = 40$ kHz, $f_{in} = 1$ kHz<br>$V_{in} = 2$ Vrms | | | 2.5 | % |
| Noise Level | $V_N$ | $f_{CP} = 100$ kHz<br>Weighted by"A"curve | | 0.25 | | mVrms |
| Signal to Noise Ratio | S/N | Max. Output Voltage<br>vs. Noise Voltage | | 70 | | dB |

# Panasonic MN3001 Bucket Brigade

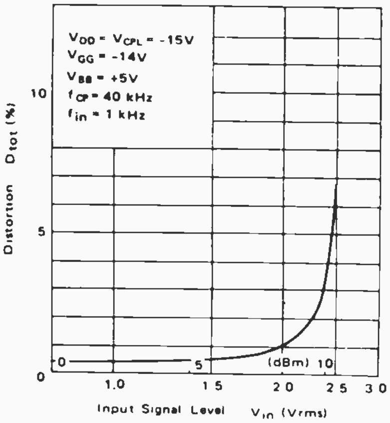


*Fig. 3. Distortion characteristics.*

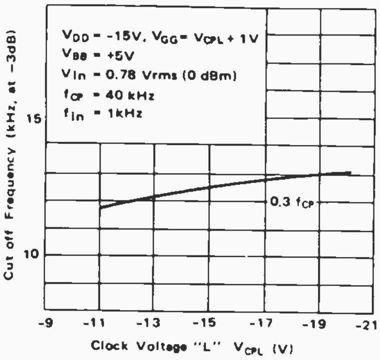


*Fig. 4. Cut-off frequency.*

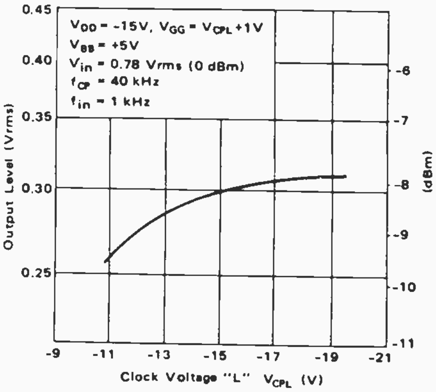


*Fig. 5. Output voltage swing.*

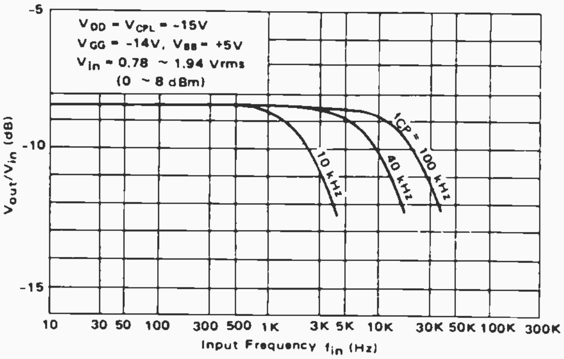


*Fig. 6. Frequency response.*

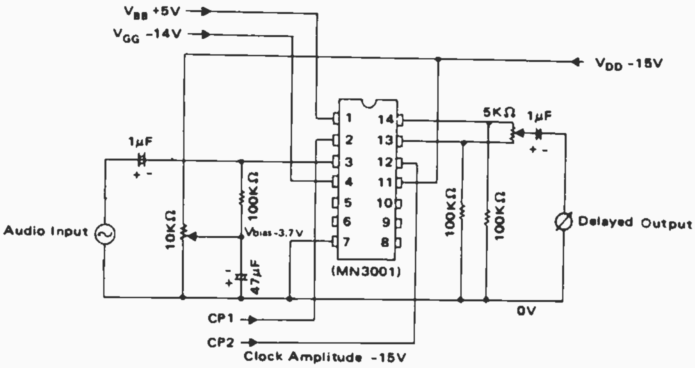
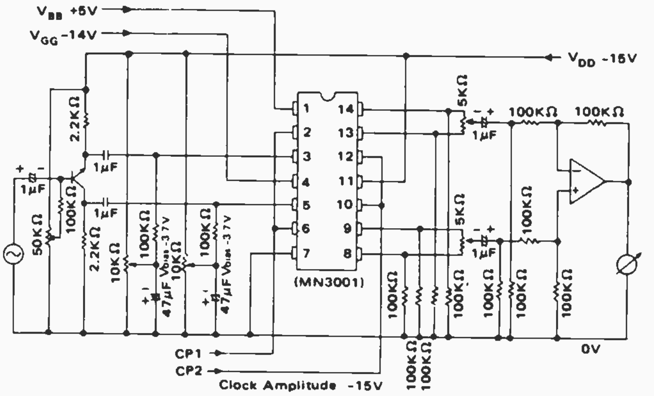


*Fig. 7. Basic circuit with clock component cancellation (single channel).*

*Fig. 8. Compensation of DC level shift due to clock frequency change using two BBDs.*



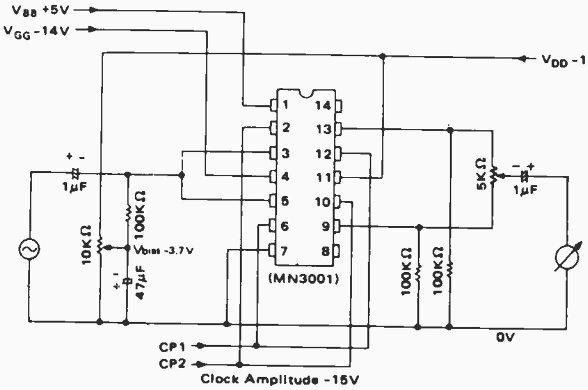
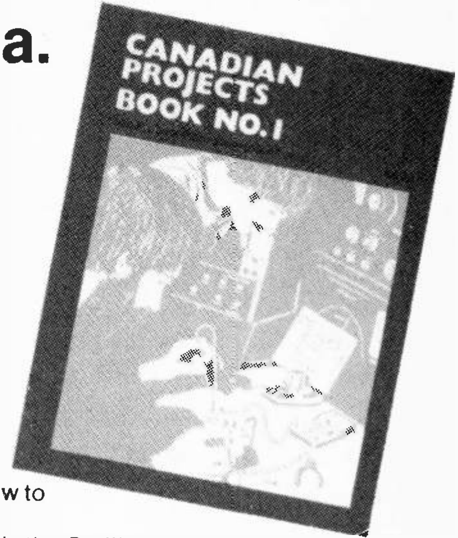


*Fig. 9. Extension of bandwidth nearly twice using two BBDs. Effective sampling rate becomes twice clock frequency.*

# Canadian Projects Book Number One gives you twenty-five projects from issues of ETI sold in Canada.



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While you are building our electronic version of the Mastermind game you can keep your kids/parents/roommates occupied with your homebuilt reaction tester and double dice games. If the excitement gets too much you can relax with our biofeedback GSR (Galvanic Skin Response) meter (and if you want to do more experiments with biofeedback you can build our heart-rate monitor).

Another project for the experimenter is our sound-activated photographic flash trigger. With this device you can photograph a bullet leaving the barrel of a gun, or a balloon bursting, etc.

In addition to the projects mentioned above we have designs for fifteen audio projects. Eight of these can be connected together to make the mixer and power-amp sections of a discotheque sound system. For the musician we have plans for a fuzz box and for a phaser; for the beginner in electronic music we have our clever twenty-five note electronic organ which uses a touch-sensitive keyboard etched into half of the single PCB (and we include variable-depth tremolo, volume control, and two voices).

For the hi-fi enthusiast we have do-it-yourself instructions on how to build a simple LED indicator to tell you when you are overloading your amplifier. If you aren't getting the bass response you would like from your speakers you can build up a little gadget to put that right. If you are more adventurous with your sound system you will be interested in our audio limiter. This project can be used to protect your group's amplifiers from distorting when high-level signals are produced, it can be used to compress the dynamic range of a signal for recording or addressing public meetings, or it can be used as a voltage-controlled volume control for remote or automatic adjustment.

**There's got to be something in this book for all ETI readers. All the projects have been reworked since they were first published to update them with any information we might have received about availability of components, improvements, etc.**

# All for the amazingly low price of three dollars.

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# Gas Alarm

This versatile alarm prevents the engine being started or electrical equipment used if there is a build up of gasoline vapour or gas thus protecting your boat against fire.

GASOLINE VAPOUR, closed space and electrical sparks are not ideal companions. Many a boat has been destroyed when the owner has switched on the ignition without realising there had been a fuel leak and that the vapour content in the engine compartment is at a dangerous level. Unfortunately the circumstances also lead to injury and loss of life. Therefore any system which can prevent this is of great value.

This unit is designed to meet this requirement and uses a semiconductor gas detector (TGS cell) to monitor the atmosphere in the engine compartment and either prevent the engine being started or shut it down if a high vapour concentration occurs during operation.

## CONSTRUCTION

This is relatively easy if the printed circuit board is used and the wiring diagrams are followed. Some precautions should be taken if the unit is to be used in a boat to prevent corrosion. The rear side of the board should be coated with a cellulose spray (dope, nail polish, etc.) and the box, while having to be near the control panel, should be shielded from direct spray. Although we have used a separate box the unit can be mounted behind the control panel if desired.

A small heatsink (about 25 mm square aluminium) should be bolted on to IC1 to keep it cool.

The relay we used can handle up to 6 A current but if higher currents are required it can be replaced with any 12 V relay providing its coil resistance is over 100 ohms.

Obviously the sensor must be mounted in the engine compartment and while it must be in free air it must also be protected against mechanical damage.

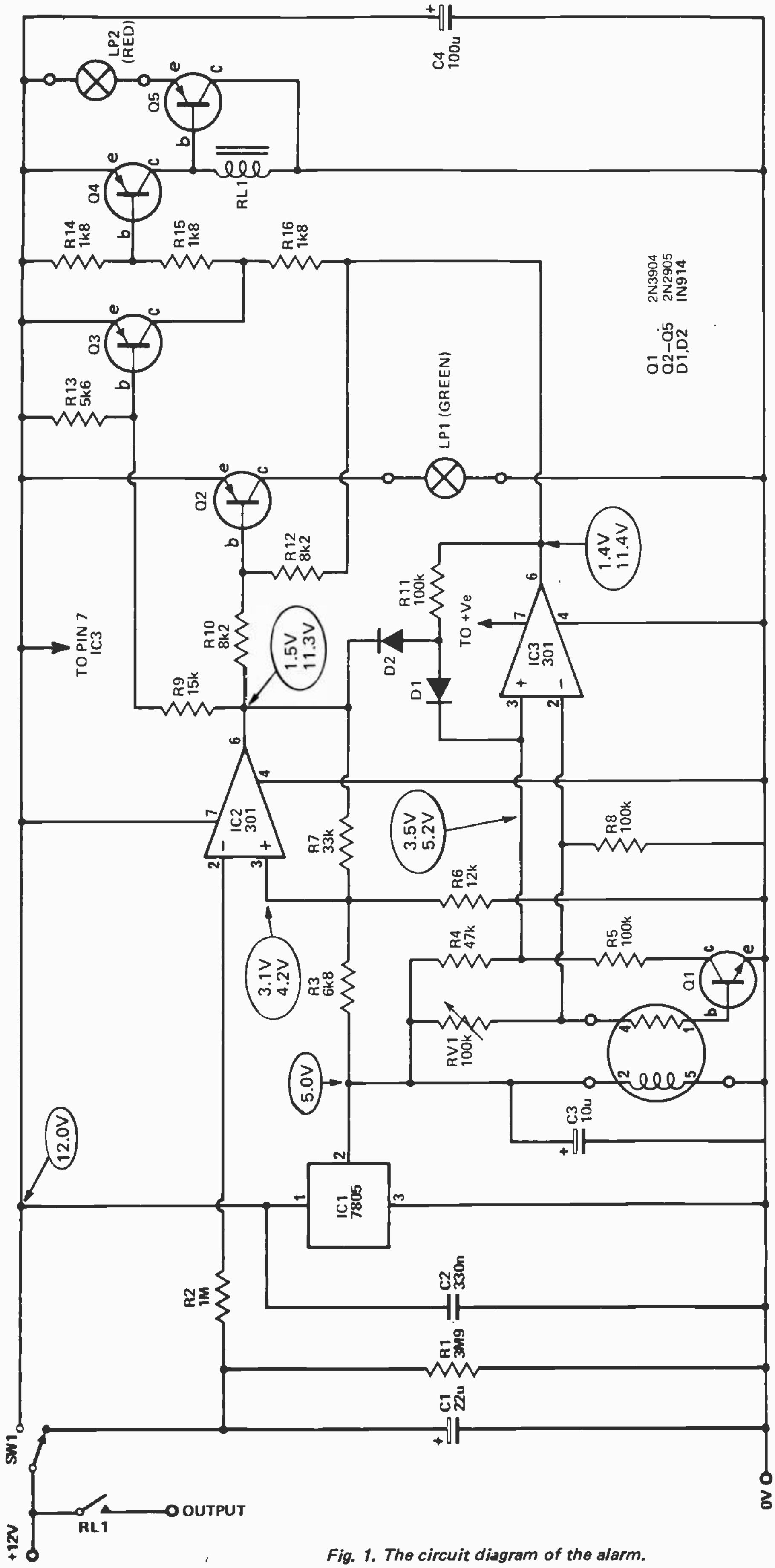


*Fig. 1. The circuit diagram of the alarm.*

## HOW IT WORKS

This project is designed primarily to monitor the concentration of volatile gases inside the bilge of gas-engined boats. The circuit provides an electrical cutout which prevents the engine from being started if fumes are present and also will remove all electrical power if fumes become present at any time.

The unit acts as a master switch and due to its warm up requirements, a two minute delay occurs on switch on. Two indicator lights indicate either "safe" or "fail" condition and in the initial warm up period both lights are on. The initial timing is performed by C1 and IC2. With the main switch off there is +12 V across C1. When it is switched on the capacitor is allowed to discharge through R1. IC2 compares the voltage on C1 with that on pin 3 (about 3 V). During this period the output of IC2 will be about +2 V.

IC1 is a 5 V regulator and supplies the power for the heater of the sensor. The sensor's resistance element is in series with RV1 and this voltage is compared to the voltage set by R4/R5.

The transistor Q1 gives a fail safe operation and if the sensor is not connected this transistor will be off giving +5 V on pin 2 of IC3. Resistor R8 ensures that the voltage on pin 2 will always be slightly less than +5 V.

If vapour is present the sensor resistance will be low and the output of IC3 will be high. During the first two minutes the diodes D1 and D2 prevent the feedback loop (R11) operating. After two minutes if the output goes high the reference voltage on pin 3 of IC3 will go above 5 V and therefore the IC will latch in that position.

The relay is operated by Q4 and for it to close the output of IC3 must be low (no vapour) and also the output of IC2 must be high (more than two minutes after switch on). If the unit does switch off, or prevents initial switch on, it must be switched off and then on again (after clearing the fumes) and the two minute delay operates again.

## INSTALLATION AND ADJUSTMENT

The sensor should be mounted in a position where vapour may be expected and should be mechanically protected against damage. The connection to the sensor should be via a 4 core cable (on long runs use a shielded cable) and the connection of the sensor is shown in Fig. 3. Note that it is symmetrical in layout and also the fact that it will fit into a standard 7 pin miniature tube socket.

The only adjustment is the sensitivity control and this is set by bringing a small container of gasoline near the sensor and ensuring it operates. The adjustment should be as sensitive as possible without giving false operation.

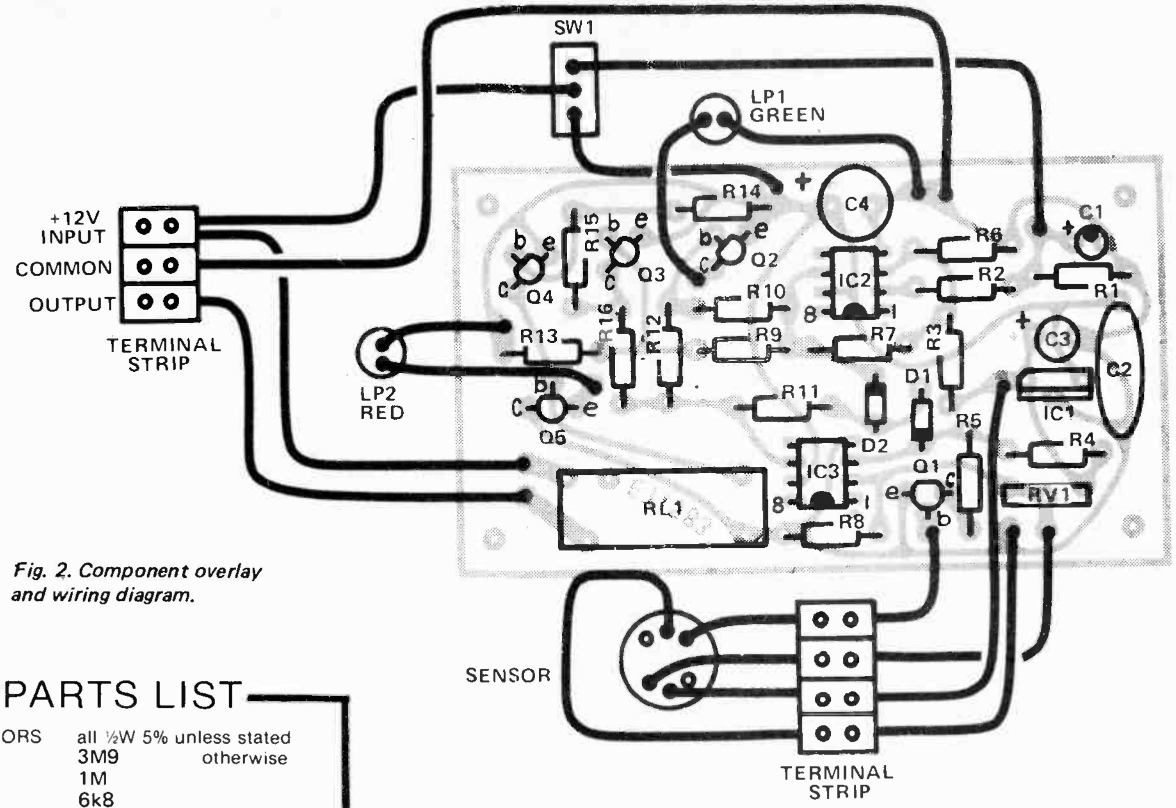
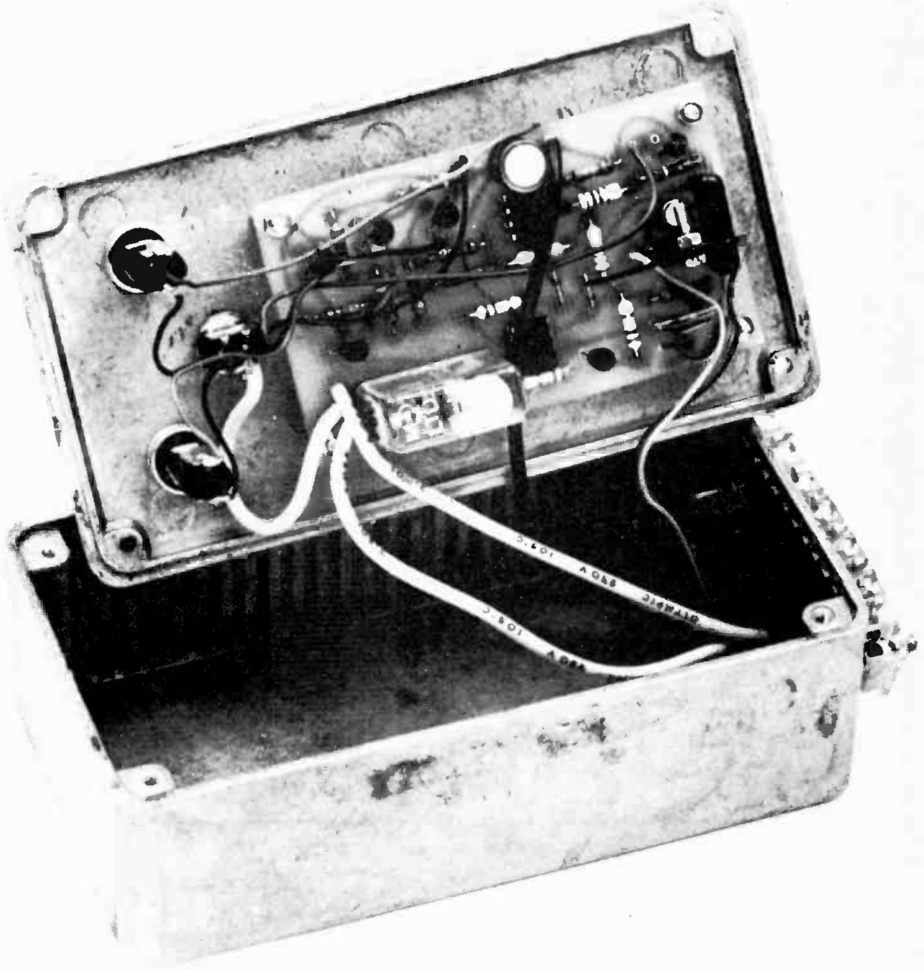


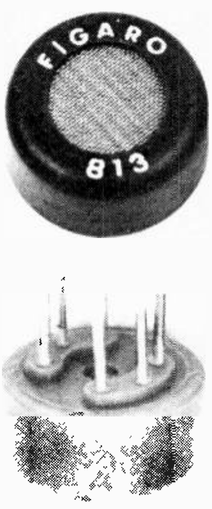
*Fig. 2. Component overlay and wiring diagram.*

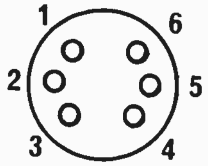
## PARTS LIST

| | |
|---|---|
| RESISTORS | all ½W 5% unless stated otherwise |
| R1 | 3M9 |
| R2 | 1M |
| R3 | 6k8 |
| R4 | 47k |
| R5 | 100k |
| R6 | 12k |
| R7 | 33k |
| R8 | 100k |
| R9 | 15k |
| R10 | 8k2 |
| R11 | 100k |
| R12 | 8k2 |
| R13 | 5k6 |
| R14-R16 | 1k8 |
| POTENTIOMETERS | |
| RV1 | 100k trim |
| CAPACITORS | |
| C1 | 22µ 16V tantalum |
| C2 | 330n polyester |
| C3 | 10µ 16V electro |
| C4 | 100µ 25V electro |
| SEMICONDUCTORS | |
| IC1 | 7805 regulator |
| IC2,3 | 301 or 741 |
| Q1 | 2N3904 |
| Q2-Q5 | 2N3638A, 2N2905 |
| D1,D2 | 1N914 |
| MISCELLANEOUS | |
| Gas Sensor: Figaro 812 or 813 | |
| PC Board | ETI 583 |
| LP1,2 | Indicator lamps 12V 100 mA max. |
| SW1 | single pole toggle |
| RL1 | 12V relay 280Ω coil single pole |
| Metal box to suit | |

The individual gas sensors and complete kits of parts are available from Livingstone Electronics, see their ad in this issue.







Underneath view.
Note that pins 1 and 3 are internally connected as are pins 4 and 6.

*Fig. 3. Connections of the sensor.*

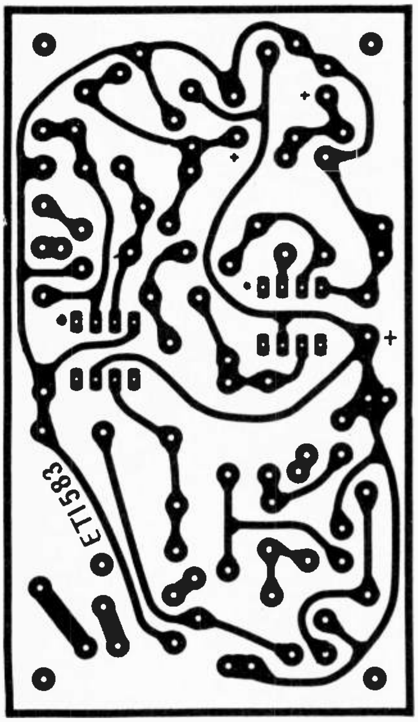


*Fig. 4. Printed circuit layout.
Full size 52 x 92 mm.*

# WHAT TO LOOK FOR IN MAY'S ETI

## Audio Feedback Eliminator

By raising the signal from a microphone by 5Hz before it is fed to the PA system you can eliminate audio feedback in many cases. This project can also be modified for special effects (with variable frequency offset).

## Add-On FM Tuner

This PCB tuner can be added to a stereo amplifier or can be mounted in its own box. Then you can add up to three meters, a couple of switches, a rotary or slider tuning pot, etc., to your own custom-design.

## White-Line Follower

Mount this project in a suitable model car and it will follow a white line drawn on the ground.

## Tools in Canada

Tools aren't boring. Read about the new developments in this field and see how you can save yourself a lot of time in future. We look at what's on the market and who's selling it.

# MAKE SURE YOU DON'T MISS IT!

These articles are in an advanced state of preparation, but in order to keep you up-to-date with the fast-changing world of electronics we may have to change our plans at the last minute.

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| | |
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| Mixer-Filter board kit 450B | 15.00 |
| MN3001 IC & Socket | 25.00 |
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Rapitype

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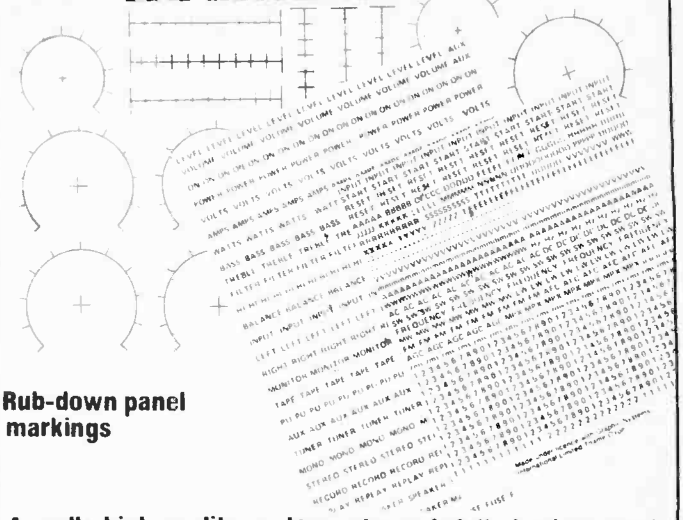
no 1



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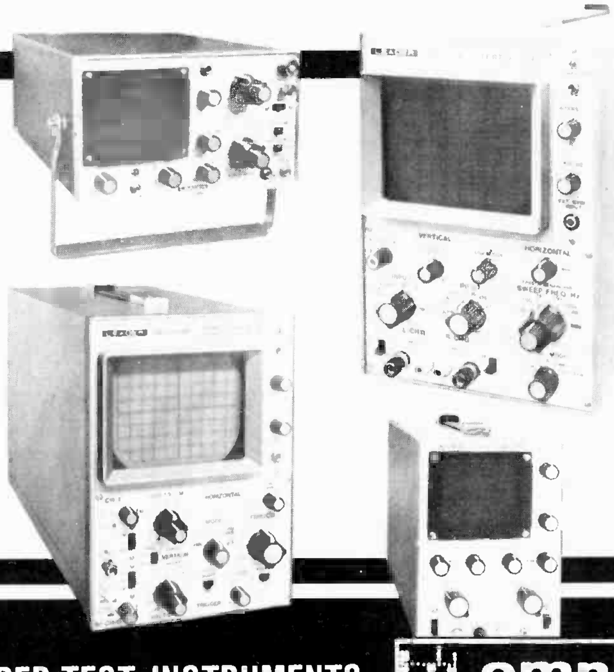

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# BITS, BYTES and BAUDS

A review of Bill Johnson's six-part introduction to personal computing concepts.

IN THE SEPTEMBER 1977 issue Bill Johnson started a six-part series to introduce the computer hobby to readers who previously knew nothing about computers. The series puts together all the main concepts of personal computing and enables the reader to construct a mental picture of how a computer works (and what all the common buzz-words mean) without needing to have any contact with the computers themselves. With this simple model stored in his cerebral memory the reader can tackle articles and sales literature written for the experienced computerist. The basic model will help the newcomer identify and file new information without any mental block.

To refresh the memories of readers who have followed the series (and to prompt you into going back over areas that were perhaps a bit hazy on first reading) and to guide any new ETI readers we will now briefly go over the main headings in the various sections.

Bits, Bytes and Bauds No 1 (Sept 77) looked at the state of data transmission before microcomputers were developed. This area is the nearest that hobbyists got to computers in the days before IC logic. From the start of the series Bill assumes the reader has no knowledge of digital electronics. This first part mentions the Baudot and ASCII codes, the asynchronous transmission of serial data and the use of the parity bit.

The microcomputer is introduced in the second part of the series (Nov 77), with a look at how a piece of data can be stored in a memory. Briefly the arithmetic of binary numbers is examined. (But what's single precision arithmetic, as opposed to double precision? Maybe you'd better dig out your Nov ETI and make sure you've got it straight.)

In the December issue Bill pulls back from the memory and looks at the roads of access — the address bus and the data bus. So you should know what is a synchronous bus, and what is an asynchronous type. Also in this section the problem of communication with peripherals is introduced — what happens when the peripheral communicates much slower than the computer?

A further look at I/O techniques follows in part 4 (Jan 78). Here you can learn about interrupts and the clever way the computer uses the stack and the stack pointer during an interrupt. Pushing and popping the stack, the index register, maskable and non-maskable interrupts, priority setting, vector addresses, polling by the interrupt service routine, direct memory access. . . all these fearsome-sounding concepts are really very simple, aren't they?

Previously memory was an abstract place where data could be stored. In part 5 (Feb 78) Bill looks at what memory is like in practice. His words on ROM, paper tape, cassettes and floppy disks, are as easy to assimilate as the stuff on the back of a cornflakes packet. The need for leader, preample and checksum is clear to everyone.

Bill's final part (March 78) puts together a complete system and talks about the software ingredients — text editor, assembler, etc. The reader learns about the levels of language at which the programmer can communicate with the machine. Do you know whether you'd prefer a compiler-type or an interpreter-type high level language?

The course finishes without looking at specific components in the computer. You have a program, you have various forms of memory and you have peripherals. To know more about how the computer executes the program, how it actually drives peripherals, or how the program is written the reader can now look elsewhere. Much can be learned about specific microcomputer ICs by reading Microbiography in ETI (8008 and 8080 in Oct 77, 8085 and Z80 in Nov 77, 6800 and 6500 in Dec 77, 1802 in Jan 78, 2650 in Mar 78, and more to come). Reading the reviews of the PET (Feb 78) and the TRS 80 (this issue) personal computers will help the newcomer to appreciate the relative importance of hardware and software facilities.

Bits, Bytes and Bauds is completed but this doesn't mean ETI will move away from computer articles. On the contrary we intend to lead our readers from the beginner's stage further into personal computing as the hobby develops in Canada.

# AN IMPORTANT MESSAGE FOR READERS WHO DON'T HAVE A SUBSCRIPTION

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# Pseudorandom Number Generator

This month we have two more programs submitted by P. Cornes for the Sinclair Programmable calculator.

Object – To generate a random number of any required length up to eight digits in such a way that each digit can take any value from K to L.
OR generate single random numbers with values from K to L.
OR play an ESP game such that the player has the opportunity of entering a single digit number before the calculator generates a random number, both digits being displayed at the end of the run for comparison and statistical purposes.

## SLOT MACHINE

Use execution 1 with K = 1 and L = 4 and score wins according to the following table.

| Display | Win |
|---|---|
| 111 | 10 |
| 222 | 10 |
| 333 | 10 |
| 444 | 10 |
| 221 | 5 |
| 331 | 5 |
| 441 | 5 |
| 11- | 4 |
| 1--- | 2 |

With the values of win shown, the program gives a 95% pay-out.

## RACE

Use execution 2 with K = 1 and L = number of players (say four). Run the program and each time a number comes up enter a one in the table shown, in the next empty square down, underneath the number displayed. The first player to fill the column below his number is the winner.

## BATTLE

Use execution 3 with K = 0 and L = 5. Each player takes it in turn to enter his own number (one to five) and run the program. When the display appears subtract the smaller digit from the larger and then add the larger digit to this answer. The player with the highest number at the end of the round wins the round. The first player to win five rounds wins the game.

## EXECUTION

Execution 1 –

Any number between 0 and
1/▲▼/Sto/▲▼/▲▼/goto/0/0/$^{C}$/ce/
RUN/random digit/ if you require a two digit random number then press RUN again and a second random digit will be displayed alongside the first, a three digit random number, press RUN a third time etc . . . .
When you have a random number of the required length and wish to generate another number press the clear button followed by RUN/random-digit/ etc. . . .

Execution 2 –

Any number between 0 and
1/▲▼/Sto/▲▼/▲▼/goto/0/6/$^{C}$/ce/
RUN/random number/
RUN/random number/
RUN/random number/ etc . . . .

Execution 3 –

Any number between 0 and
1/▲▼/Sto/▲▼/▲▼/goto/0/0/$^{C}$/ce/
Your guess/RUN/random number and your guess
Your guess/RUN/random number and your guess
Your guess/RUN/random number and your guess

With the program as it stands the variables take the following values:–

K = 1
L = 6

Obviously with these values the program can be used to simulate the throwing of dice with executions 1 or 2.

When you come to change the variables you should do it in the following way:–

Executions 1 and 3

Choose a value for K from 0 to 8 (integer).
Choose a value for L from K to 9.
Replace line 9 and 10 with the value of L-K.
Replace lines 29 to 31 with the value of K — 1 (including sign).
Run as per execution instructions.

Execution 2

Choose a value K from 0 to 9 (integer).
Choose a value L between K and 99 (integer).
Replace lines 9 and 10 with L – K.
Replace lines 29 to 31 with K – 1 (including sign).
Run as per execution instructions.

With a moments thought you will see that there are one hundred and one uses for this program, a few of these are given above.

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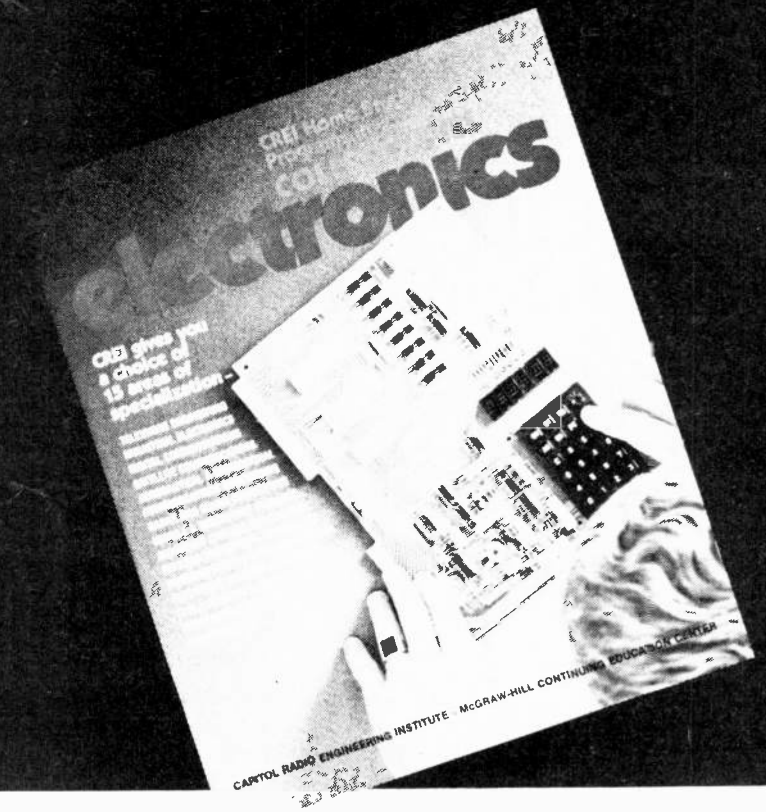

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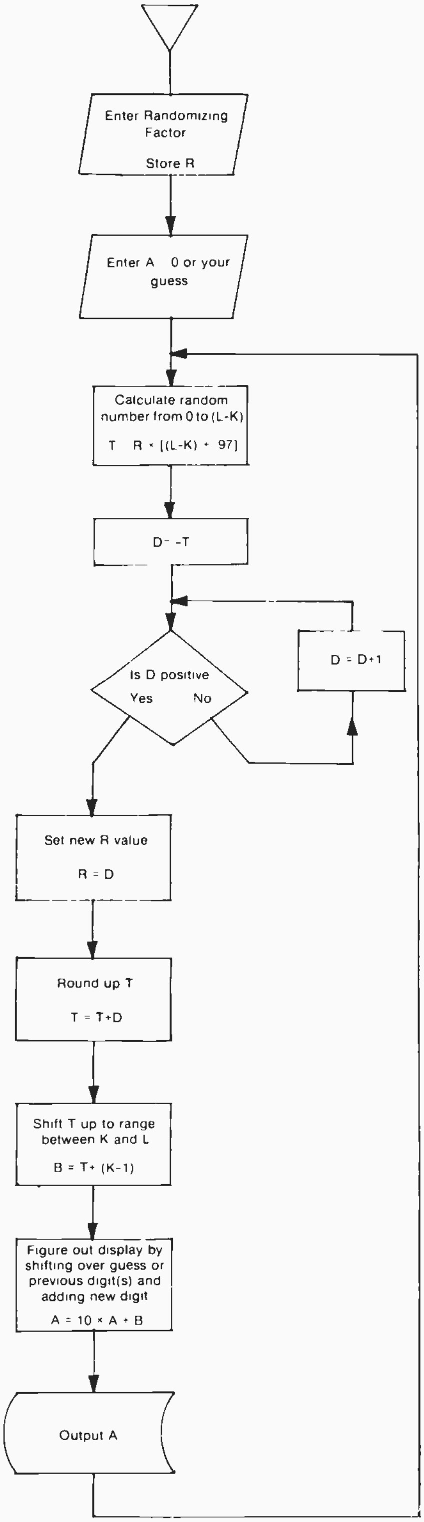
# Pseudorandom Number Generator

## FLOW CHART



## PROGRAM

FINDS NEXT RANDOM NUMBER (steps 05–33)

DISPLAYS RANDOM NUMBER (step 35)

| | | |
|---|---|---|
| x | . | 00 |
| # | 3 | 01 |
| 1 | 1 | 02 |
| 0 | 0 | 03 |
| + | E | 04 |
| ( | 6 | 05 |
| Rc1 | 5 | 06 |
| x | – | 07 |
| # | 3 | 08 |
| 0 | 0 | 09 |
| 5 | 5 | 10 |
| . | A | 11 |
| 9 | 9 | 12 |
| 7 | 7 | 13 |
| = | – | 14 |
| Sto | 2 | 15 |
| – | F | 16 |
| + | E | 17 |
| # | 3 | 18 |
| 1 | 1 | 19 |
| = | – | 20 |
| ▼ | A | 21 |
| GIN | 1 | 22 |
| 1 | 1 | 23 |
| 7 | 7 | 24 |
| ▼ | A | 25 |
| MEx | 5 | 26 |
| + | E | 27 |
| Rcl | 5 | 28 |
| – | F | 29 |
| # | 3 | 30 |
| 0 | 0 | 31 |
| = | – | 32 |
| ) | 6 | 33 |
| = | – | 34 |
| Stop | 0 | 35 |

The program above runs on the Sinclair Cambridge Programmable.

A: Last guess or number

B: Random digit from K to L

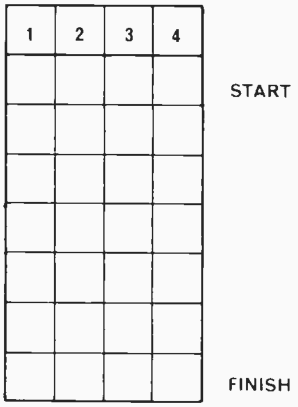
D: Temporary storage

K: Bottom limit

L: Top limit

R: Randomizing factor

T: Temporary storage for random number from 0 to (L–K).



*Above: the score sheet for the battle game and left are the listing and flow chart for the overall game.*

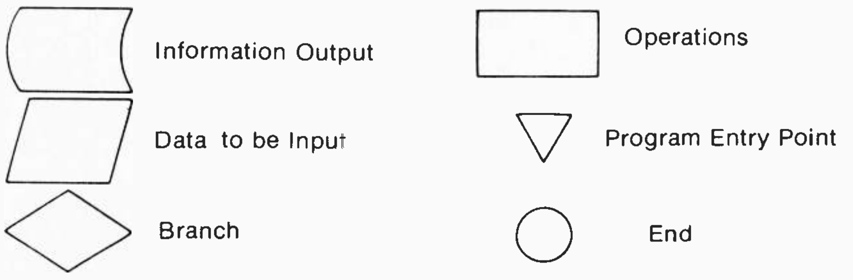
SOFTSPOT is ETI's programmable calculator software department. We know there are many of you who have gone to a lot of effort to write routines for your machines — how about sharing the fun. Send us a copy of your pet program, preferably with flow chart. To make things interesting we will restrict our choices to only those programs making use of loops or conditionals.

All programs we publish will be paid for.

Mail to: ETI Softspot
Unit 6, 25 Overlea Blvd.,
TORONTO, Ontario
M4H 1B1

Don't forget to mention what kind of calculator you use — and we'd also be interested to know where you bought it.

## FLOW CHART SYMBOLS



# Atomic Decay Game

Object — To simulate the decay of M grams of a radioactive material with a half-life of H seconds in such a way that:—

1. The player has the opportunity of guessing how much of the material (plus or minus T grams) is left after each second.
2. The player is given indications of right and wrong (hit and miss) guesses.
3. A running total of the player's score is displayed after each guess.

## EXECUTION

1/0/0/▲▼/sto/▲▼/▲▼/goto/0/0/0/RUN/ score (0) /
Your guess/RUN/Hit-Miss/RUN/ score/
Your guess/RUN/Hit-Miss/RUN/score/ etc . . .

With the program listing and execution sequences given the variables take the following value:—

M = 100 grams. H = 10 seconds. T = 1 gram.

Should you wish to change the variables (When you get used to playing the game) then:

To change M — Put the new value in place of the 100 at the beginning of the execution sequence.

To change T — Change lines 21 and 22 in the program to your new value (any 2 key-stroke number between .1 and 99)

To change H — This variable is the most difficult of the three to change as it requires calculation of a new F.

F = exp(-.693/H)

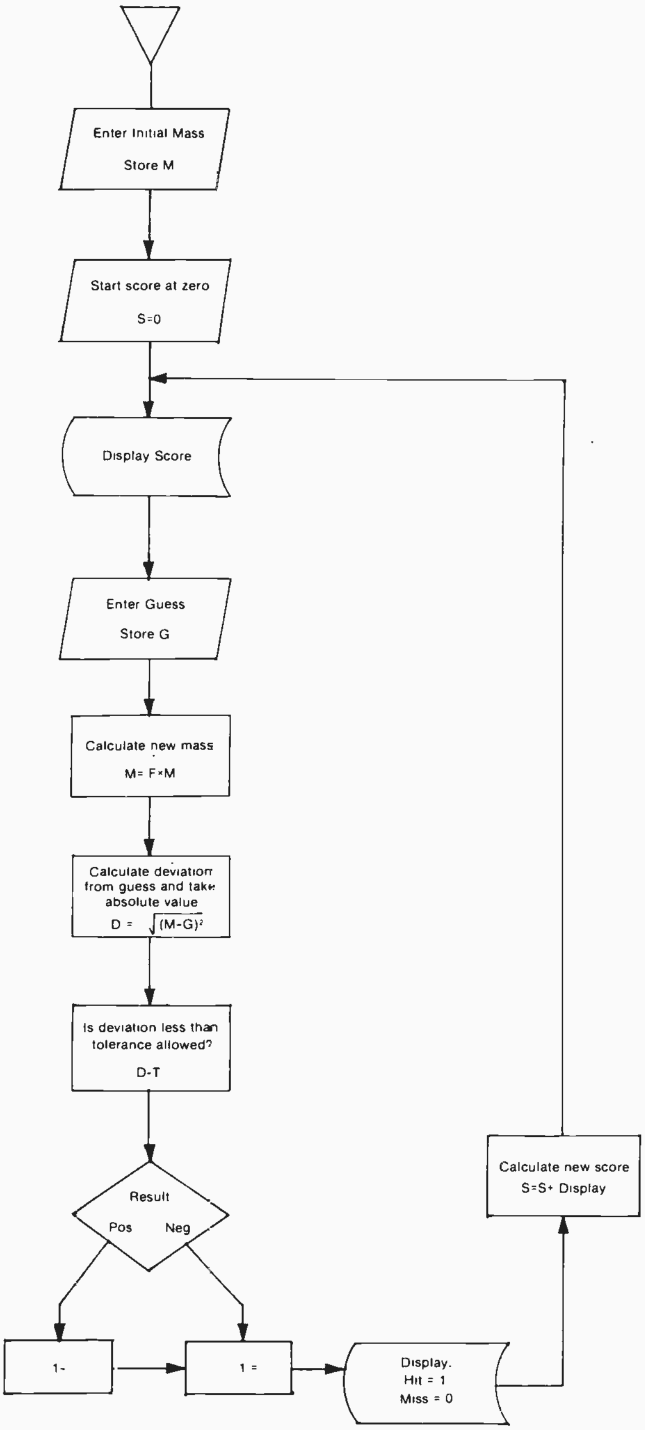
If the answer is less than one, then replace lines 08 to 10 with the three most significant digits after the decimal point. If the answer is greater than one then replace lines 07 to 10 with the four most significant key-strokes. e.g. If answer is 0.9330114 then put 933 into lines 08 to 10.

N.B. The only way the answer to this sequence can be greater than one is if your value for D is —ve in which case you are no longer working with a radioactive decay curve but with an exponential growth curve.

D= Difference between new mass and guess
F= Decay Factor
G= Guess
H= Half Life
M= Initial Mass
S= Score Total of Hits
T= Tolerance on guess

See next page for program.

## FLOW CHART



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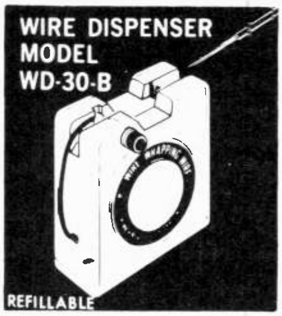
## Atomic Decay Game

### PROGRAM

| | | | | |
|---|---|---|---|---|
| | | + | E | 00 |
| | | ( | 6 | 01 |
| | SCORE DISPLAYED | Stop | 0 | 02 |
| | | ▼ | A | 03 |
| | | MEx | 5 | 04 |
| | | x | . | C5 |
| | | # | 3 | 06 |
| | CALCULATES NEXT VALUE OF DECAY CURVE | | A | 07 |
| | | 9 | 9 | 08 |
| | | 3 | 3 | 09 |
| | | 3 | 3 | 10 |
| | | = | – | 11 |
| | | ▼ | A | 12 |
| | | MEx | 5 | 13 |
| | | – | F | 14 |
| | | Rcl | 5 | 15 |
| | | x | | 16 |
| FINAL VALUE OF BRACKETS AODED TO TOTAL RUNNING SCORE | COMPARES GUESS WITH VALUE CALCULATEO PLUS OR MINUS C GRAMS | = | – | 17 |
| | | √x | 1 | 18 |
| | | – | F | 19 |
| | | # | 3 | 20 |
| | | 0 | 0 | 21 |
| | | 1 | 1 | 22 |
| | | = | – | 23 |
| | | ▼ | A | 24 |
| | | SIN | 1 | 25 |
| | CALCULATES HIT/MISS FIGURE 1 = HIT 0 = MISS | 3 | 3 | 26 |
| | | 1 | 1 | 27 |
| | | # | 3 | 28 |
| | | 1 | 1 | 29 |
| | | – | F | 30 |
| | | # | 3 | 31 |
| | | 1 | 1 | 32 |
| | | = | – | 33 |
| | HIT/MISS DISPLAY | Stop | 0 | 34 |
| | | ) | 6 | 35 |

The program above runs on the Sinclair Cambridge Programmable.

# wire wrapping ok center ok



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| *Data with Application Notes.....* | *$ .50* |

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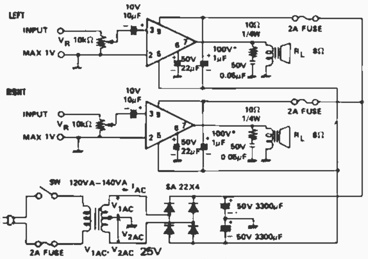

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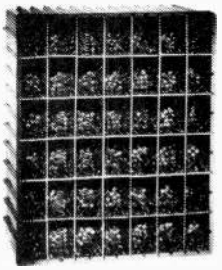

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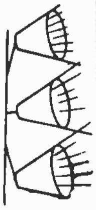

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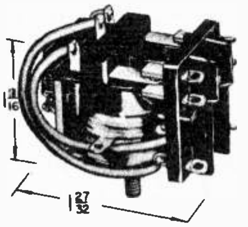

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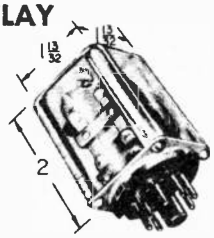

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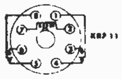

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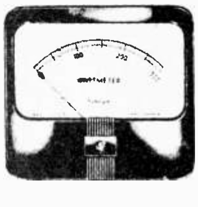

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|---|---|
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| 500 | 200 v. |
| 1,500 | 100 v. |
| 1,500 | 150 v. |
| 2,000 | 50 v. |
| 2,000 | 100 v. |
| 3,500 | 75 v. |
| 3,750 | 75 v. |
| 5,000 | 55 v. |
| 11,000 mfd | 19 v. |
| 14,000 | 13 v. |
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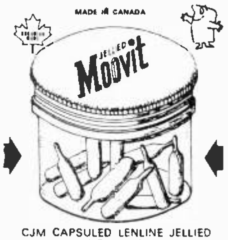

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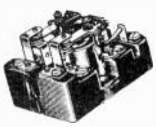

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# tech-tips

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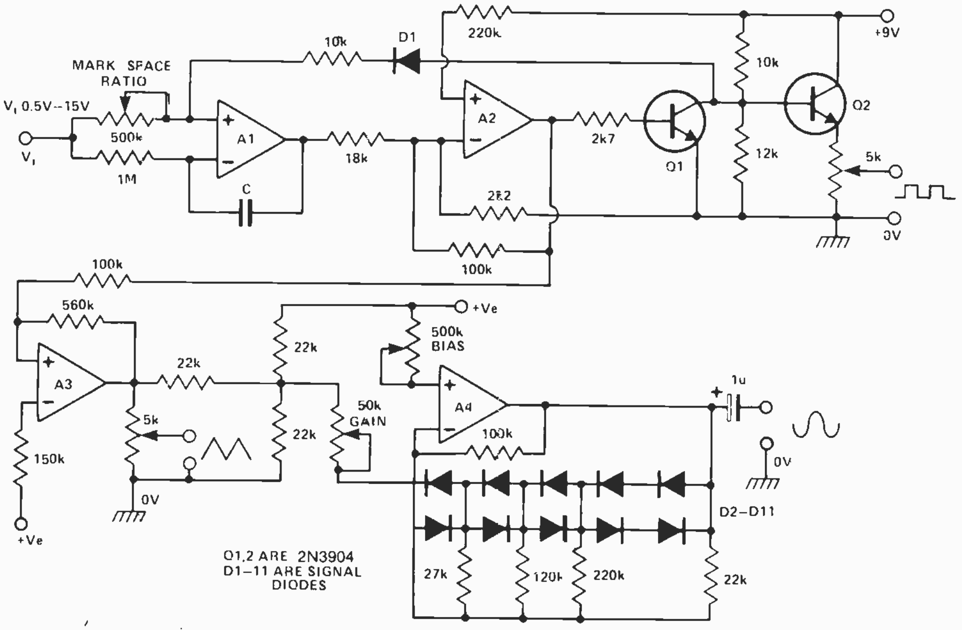
## BATTERY OPERATED VCO

R. Zaman.

BY USING the LM3900N quad-op-amp, a simple portable battery operated VCO can be made very cheaply. A1 forms a integrator, the ramp rate depending on the voltage Vi and capacitor C. This ramp is fed to a Schmidt trigger which switches at about 5.8V, making A1 ramp down, generating a triangular wave of about 0.85 V.

The Schmidt trigger feeds a transistor switch and an emitter follower.

The triangular wave is then fed to A3 which acts as an inverting amplifier, and the output is fed to A4 which is an exponential integrator set at a pseudo-ground of 4.5 V. The bias and gain pots must be adjusted to give the best sine waveform.



Vi can be any positive voltage from +0.5 ↔ +15.0 V, giving a frequency range of about 1:100. Capacitor C can be any value from 10n↔47n and the outputs have a low distortion up to about 20 kHz.

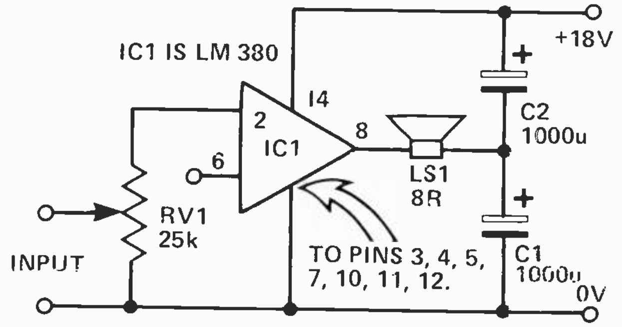
## NOVEL LOUDSPEAKER COUPLING CIRCUIT

P. Mills.

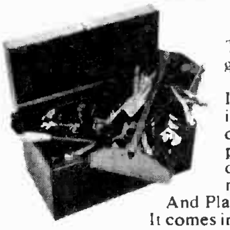
In most amplifier designs the speaker is fed by a high value capacitor to provide DC blocking, but this may result in a heavy switch-on surge, as the capacitor charges up.

An alternative approach, which is worthy of experiment, is shown in the diagram below. Here the ground side of the speaker is connected to the junction of two equal high value capacitors (1000 uF is typical), across the supply.

The amplifier output voltage will be at $V_s/2$, and so will the voltage across $C_1$ (if $C_1$ and $C_2$ are equal); so as the supply voltage builds up, the DC voltage across the speaker will remain zero, eliminating the switch-on surge. The circuit is shown with the LM380,but could be applied to any amplifier circuit, providing that theDCvoltageat the output is half the supply voltage.



**Where's the ✳!✩≋$⋆☆◎% screwdriver?**



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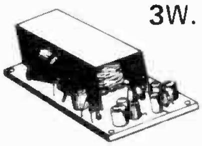

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## CHANNEL SPLITTER FOR RADIO CONTROL

G. Bathe.

This circuit is designed to replace the electromechanical reed units used as channel-splitters in radio controlled models.

The circuit is based on the MC 1310P integrated circuit, a chip that is primarily a stereo decoder for use in stereo radio tuners. When used as a stereo decoder, the MC 1310P automatically switches itself from the mono mode to the stereo mode whenever its input contains the 19 kHz subcarrier of a stereo multiplex signal at a sufficiently high level (16 mV), and switches back to the mono mode when the 19 kHz subcarrier ceases to be present. Pin 6 of the integrated circuit drives a stereo indicator lamp to give a visual indication of whether the circuit is operating in the stereo or mono mode.

It is this lamp driver facility of the MC 1310P that makes it an ideal chip to use as a channel-splitter. When used as a channel-splitter the circuit is not tuned to the 19 kHz of the stereo decoder but to the audio frequency that the circuit is required to detect, and the lamp driver output from pin 6 is used to drive a power transistor controlling a motor or other device.

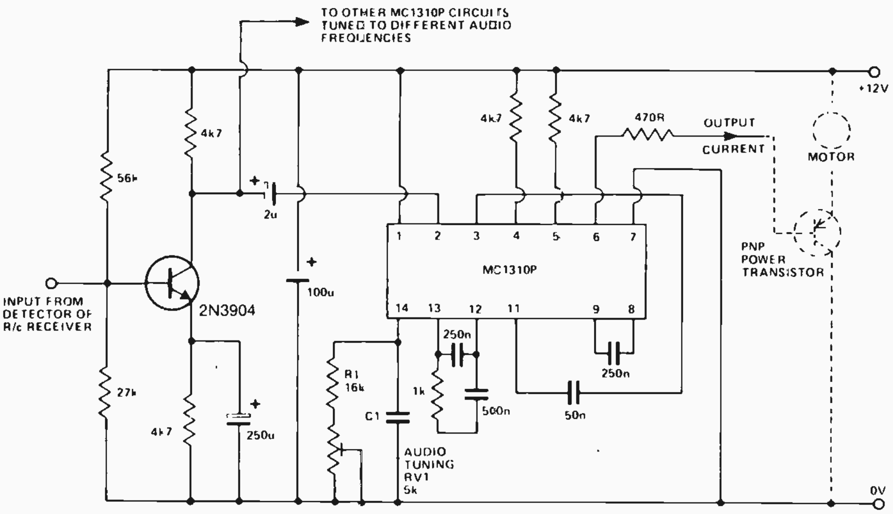
The output from the detector of a radio receiver is amplified by the 2N3904 and then fed into a series of MC 1030P channel-splitters (connected in parallel) each tuned to a different audio frequency.

The audio frequency to which the channel-splitter responds is determined by the tuning circuit R1, VR1 and C1, and is given by the formula:-

$$f = \frac{1}{2\pi \ C1\ (R1 + RV1)} \text{ Hz}$$

The value of C1 is chosen to give the required tuning range for the preset RV1. For example, if C1 is 10,000 pF, then the tuning range is approximately 750 Hz to 1,000 Hz.

The output is a switched current output between Pin 6 of the chip and the positive supply rail. This current should not exceed 35 mA and so a 470 ohm resistor is inserted in the output connection from Pin 6 as short circuit protection. If a voltage output is required then a resistor can be connected from Pin 6 to the positive supply and the voltage output taken from Pin 6.



The MC 1310P is triggered when the input to Pin 2 contains its tuned frequency at a level greater than 16 mV. It can be triggered by noise if the noise level is greater than 16 mV. Some radio control transmitters tend to transmit noise when they are not transmitting a tone, and if this is the case the transmitter should be modified to prevent noise being transmitted. This could be done by making the transmitter transmit an extra unused tone whenever it is not transmitting one of the used audio tones.

## CMOS RADIO

J. P. Macaulay

The circuit shown is of a simple AM receiver based on the 4011 CMOS IC.

The four gates in this package are used as linear amplifiers by connecting their inputs together and applying negative feedback.

L1, 80 turns of 22 SWG enamelled wire close wound on a 3/8" diameter ferrite rod, is the pickup coil. This is tuned by the 500p trimmer and the resulting tank circuit referred to ground at RF by C1.

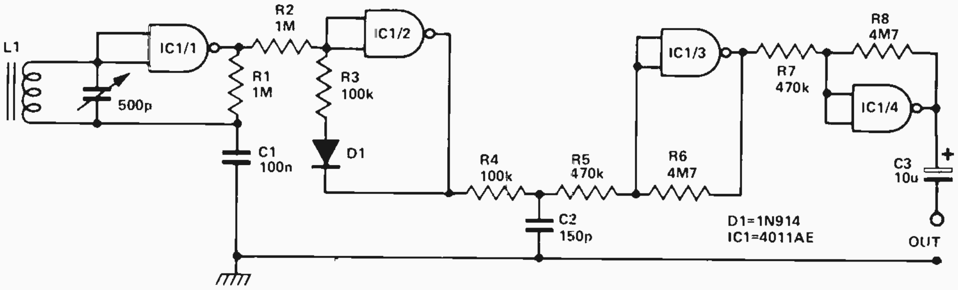
The high input impedance, that of IC1/1, 'seen' by the tank circuit ensures that little damping occurs, and thus the receiver is highly selective. The output of IC1/1 is an amplified RF signal and is passed to IC1/2 for detection.

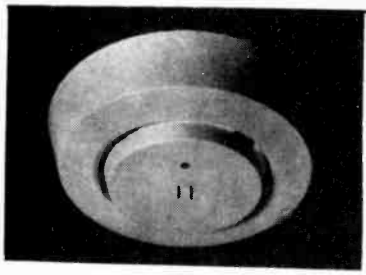
The unwanted RF appearing at the output of the detector is removed by the lowpass filter formed by R4 and C2.

The audio signal is then fed to an amplifier formed by IC1/3 and IC1/4.

The circuit's current consumption is about 10 mA when operated from a 9 V supply.

Note that the IC used must be a 4011AE and not the 4011B whose input protection network will prevent it from operating in the linear mode.





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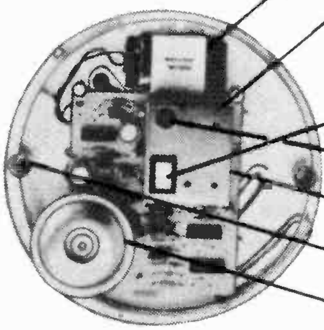

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- **ALARM:** 85 DECIBEL ALARM to alert sleeping occupants AUTOMATICALLY RESETS when the hazardous condition has passed.

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# Club Call

## The Ontario DX Association

ODXA Headquarters, 1202 York Mills, No. 1910, Don Mills, M3A 1Y2.

**Aims and Objectives:** The Ontario DX Association, ODXA, is a body of Ontario radio listeners which seeks to unify listeners in this province and assist them to grow in and enjoy the hobby more. This is done by means of a monthly bulletin, entitled "DX Ontario", personal contact at local and province-wide meetings and other means of communication amongst the members. The ODXA is also commited to promote the hobby to the public and assistance and information is provided to those expressing an interest.

The idea to form the ODXA originated in the summer of 1974 and a three-man organizing committee then undertook to bring the club into reality. By February of 1975 our first bulletin was off the press. The club has continued to grow at a steady rate since that time and "DX Ontario" has been published monthly ever since.

**Newsletter:** "DX Ontario" presently averages 40 to 45 pages per month and deals primarily with listening to the medium and short wave bands. There are columns of loggings and verifications as well as news and schedules. We also have a monthly column discussing the programming heard on shortwave. Other columns include articles on stations, equipment, DX programs, and English broadcasts audible in Ontario.

**Meetings:** In the Toronto area members of the ODXA may attend a meeting held on the first Monday of each month, at 7:30 pm at the Downsview Public Library (Keele and Wilson). Often there are meetings held on Saturdays at the homes of members. And there are one or two weekend-long get-togethers held each year. All of these meetings are publicized in advance in "DX Ontario". Any listener is welcome to attend, and information on upcoming meetings may be obtained from ODXA Headquarters.

**Directors:** The ODXA is operated by the membership. An elected three-man Board of Directors directs club operations, supervising other such staff as Publisher, Managing Editor, Treasurer, Membership Secretary and Publicity and Awards Committees. Approximately ten editors are on staff to edit the columns for the bulletin.

**Membership:** Membership in the ODXA is restricted to residents of Ontario. Annual dues are $11.00 (special rate of $8.00 for full-time students). Members receive a certificate, personal identifier (number), 12 issues of "DX Ontario" and are entitled to participate in all club elections and activities. Members are encouraged to make contributions to the bulletin, such as their loggings, reports of verifications received, etc.

If you would like to inquire about joining the ODXA, write to: ODXA Membership Secretary 18 Riverview Road Lindsay, Ontario K9V 1B1.

## The Canadian Computer Correspondence Club for Hobbyist Computer Users

5768 Davies Ave. Cote St. Luc, Montreal, Quebec, H4W 2R4.

**Aims and Objectives:** We at CCCC are a computer mail correspondence club formed to aid the hobbyist in programming in the most common hobbyist language, BASIC. We are non-profit and request that all new members enclose stamped, self-addressed envelopes or at least enclose an extra postage stamp when writing to us, so that we may keep expenses down.

**Membership:** Any person wanting to join, whether this person has access to or owns a BASIC computer, or not, will be accepted. Bimonthly (and maybe even monthly, depending on the number of members) newsletters will be sent out. In these letters, we will include information about the club, answers to members' problems, and interesting programs that members have sent in.

Contributions in the way of programs will be greatly appreciated. If a member has a program that has a bug in it, we would be glad to offer any assistance.

**Executive Members:** We, the executive members of CCCC, are experienced programmers in BASIC and we would like to hear and correspond with other computer enthusiats. We feel that we have enough experience to solve or help solve almost any problem.

I am presently the Chairman and the Chief Public Relations Officer of CCCC, and I hope to be able to have many ETI readers as members. There is no present charge for membership. Interested parties should send a SASE (self-addressed, stamped envelope) to the club address.

M. Salonin

## Club Help

I am working with students at our small school in Elphinstone (pop. 215), grades 7-12. There are a few students interested in electronics and lately we decided to get together weekly at noon. That's how ECEC (Elphinstone Collegiate Electronics Club) got together.

We started by dismantling TVs and other old equipment for parts, and by fixing minor ailments in electronic equipment.

Is there anyone who can suggest how we might obtain electronic components and appropriate projects for beginners in electronics with a very limited budget? The club would also be interested in hearing, from anyone who started out using salvaged components, what can be done with them in terms of building projects.

E.M. Shemeliuk, ECEC, Box 157, Elphinstone, Man. R0J 0N0.

## Previously Listed Clubs

TRACE: Computer Club, Toronto. See p7 Jan 78 ETI.

CSWLI: SWL Club, Thunder Bay. See p7 Mar 78 ETI.

TRAC: Amateur Radio Club, Thornhill. See p7 Mar 78 ETI.

## Club Call

Send information about any clubs not mentioned on this page to ETI Club Call, ETI Magazine, Unit 6, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.

## DIODES/ZENERS

| | | | |
|---|---|---|---|
| 1N914 | 100v | 10mA | .05 |
| 1N4005 | 600v | 1A | .08 |
| 1N4007 | 1000v | 1A | .15 |
| 1N4148 | 75v | 10mA | .05 |
| 1N753A | 6.2v | z | .25 |
| 1N758A | 10v | z | .25 |
| 1N759A | 12v | z | .25 |
| 1N4733 | 5.1v | z | .25 |
| 1N5243 | 13v | z | .25 |
| 1N5244B | 14v | z | .25 |
| 1N5245B | 15v | z | .25 |

## SOCKETS/BRIDGES

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|---|---|---|---|---|
| 8-pin | pcb | .25 | ww | .45 |
| 14-pin | pcb | .25 | ww | .40 |
| 16-pin | pcb | .25 | ww | .40 |
| 18-pin | pcb | .25 | ww | .75 |
| 22-pin | pcb | .45 | ww | 1.25 |
| 24-pin | pcb | .35 | ww | 1.10 |
| 28-pin | pcb | .35 | ww | 1.45 |
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## TRANSISTORS, LEDS, etc.

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| 2N2907A | PNP | .15 |
| 2N3906 | PNP (Plastic) | .10 |
| 2N3904 | NPN (Plastic) | .10 |
| 2N3054 | NPN | .35 |
| 2N3055 | NPN 15A 60v | .50 |
| T1P125 | PNP Darlington | .35 |
| LED Green, Red, Clear, Yellow | | .15 |
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| XAN72 | 7 seg com-anode (Red) | 1.25 |
| MAN71 | 7 seg com-anode (Red) | 1.25 |
| MAN3610 | 7 seg com-anode (Orange) | 1.25 |
| MAN82A | 7 seg com-anode (Yellow) | 1.25 |
| MAN74A | 7 seg com-cathode (Red) | 1.50 |
| FND359 | 7 seg com-cathode (Red) | 1.25 |

## C MOS

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|---|---|
| 4000 | .15 |
| 4001 | .15 |
| 4002 | .20 |
| 4004 | 3.95 |
| 4006 | .95 |
| 4007 | .35 |
| 4008 | .95 |
| 4009 | .45 |
| 4010 | .45 |
| 4011 | .20 |
| 4012 | .20 |
| 4013 | .40 |
| 4014 | .95 |
| 4015 | .90 |
| 4016 | .35 |
| 4017 | 1.10 |
| 4018 | 1.10 |
| 4019 | .50 |
| 4020 | .85 |
| 4021 | 1.00 |
| 4022 | .85 |
| 4023 | .25 |
| 4024 | .75 |
| 4025 | .30 |
| 4026 | 1.95 |
| 4027 | .50 |
| 4028 | .95 |
| 4030 | .35 |
| 4033 | 1.50 |
| 4034 | 2.45 |
| 4035 | 1.25 |
| 4040 | 1.35 |
| 4041 | .69 |
| 4042 | .95 |
| 4043 | .95 |
| 4044 | .95 |
| 4046 | 1.75 |
| 4049 | .45 |
| 4050 | .45 |
| 4066 | .95 |
| 4069 | .40 |
| 4071 | .35 |
| 4081 | .70 |
| 4082 | .45 |
| MC14409 | 14.50 |
| MC14419 | 4.85 |

## – T T L –

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|---|---|
| 7400 | .15 |
| 7401 | .15 |
| 7402 | .20 |
| 7403 | .20 |
| 7404 | .15 |
| 7405 | .25 |
| 7406 | .35 |
| 7407 | .55 |
| 7408 | .25 |
| 7409 | .15 |
| 7410 | .10 |
| 7411 | .25 |
| 7412 | .30 |
| 7413 | .35 |
| 7414 | 1.10 |
| 7416 | .25 |
| 7417 | .40 |
| 7420 | .15 |
| 7426 | .30 |
| 7427 | .45 |
| 7430 | .15 |
| 7432 | .30 |
| 7437 | .30 |
| 7438 | .35 |
| 7440 | .25 |
| 7441 | 1.15 |
| 7442 | .45 |
| 7443 | .65 |
| 7444 | .45 |
| 7445 | .65 |
| 7446 | .95 |
| 7447 | .95 |
| 7448 | .65 |
| 7450 | .25 |
| 7451 | .25 |
| 7453 | .20 |
| 7454 | .25 |
| 7460 | .40 |
| 7470 | .45 |
| 7472 | .40 |

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| 7473 | .25 |
| 7474 | .30 |
| 7475 | .35 |
| 7476 | .40 |
| 7480 | .55 |
| 7481 | .75 |
| 7483 | .95 |
| 7485 | .75 |
| 7486 | .25 |
| 7489 | 1.35 |
| 7490 | .55 |
| 7491 | .95 |
| 7492 | .95 |
| 7493 | .35 |
| 7494 | .75 |
| 7495 | .60 |
| 7496 | .80 |
| 74100 | 1.15 |
| 74107 | .35 |
| 74121 | .35 |
| 74122 | .55 |
| 74123 | .55 |
| 74125 | .45 |
| 74126 | .35 |
| 74132 | 1.35 |
| 74141 | .90 |
| 74150 | .85 |
| 74151 | .65 |
| 74153 | .75 |
| 74154 | .95 |
| 74156 | .95 |
| 74157 | .65 |
| 74161 | .85 |
| 74163 | .85 |
| 74164 | .60 |
| 74165 | 1.50 |
| 74166 | 1.35 |
| 74175 | .80 |

| | |
|---|---|
| 74176 | 1.25 |
| 74180 | .75 |
| 74181 | 2.25 |
| 74182 | .95 |
| 74190 | 1.75 |
| 74191 | 1.05 |
| 74192 | .75 |
| 74193 | .85 |
| 74194 | 1.25 |
| 74195 | .95 |
| 74196 | 1.25 |
| 74197 | 1.25 |
| 74198 | 2.35 |
| 74221 | 1.00 |
| 74367 | .85 |
| 75108A | .35 |
| 75110 | .35 |
| 75491 | .50 |
| 75492 | .50 |
| 74H00 | .15 |
| 74H01 | .25 |
| 74H04 | .20 |
| 74H05 | .20 |
| 74H08 | .35 |
| 74H10 | .35 |
| 74H11 | .35 |
| 74H15 | .45 |
| 74H20 | .30 |
| 74H21 | .25 |
| 74H22 | .40 |
| 74H30 | .20 |
| 74H40 | .25 |
| 74H50 | .25 |
| 74H51 | .25 |
| 74H52 | .15 |
| 74H53J | .25 |
| 74H55 | .20 |

| | |
|---|---|
| 74H72 | .45 |
| 74H101 | .75 |
| 74H103 | .75 |
| 74H106 | .95 |
| 74L00 | .25 |
| 74L02 | .25 |
| 74L03 | .30 |
| 74L04 | .30 |
| 74L10 | .30 |
| 74L20 | .35 |
| 74L30 | .45 |
| 74L47 | 1.95 |
| 74L51 | .45 |
| 74L55 | .65 |
| 74L72 | .45 |
| 74L73 | .40 |
| 74L74 | .45 |
| 74L75 | .55 |
| 74L93 | .55 |
| 74L123 | .85 |
| 74S00 | .35 |
| 74S02 | .35 |
| 74S03 | .30 |
| 74S04 | .30 |
| 74S05 | .35 |
| 74S08 | .35 |
| 74S10 | .35 |
| 74S11 | .35 |
| 74S20 | .35 |
| 74S40 | .20 |
| 74S50 | .20 |
| 74S51 | .25 |
| 74S64 | .20 |
| 74S74 | .35 |
| 74S112 | .60 |
| 74S114 | .65 |

| | |
|---|---|
| 74S133 | .40 |
| 74S140 | .55 |
| 74S151 | .30 |
| 74S153 | .35 |
| 74S157 | .75 |
| 74S158 | .30 |
| 74S194 | 1.05 |
| 74S257 (8123) | 1.05 |
| 74LS00 | .25 |
| 74LS01 | .35 |
| 74LS02 | .35 |
| 74LS04 | .30 |
| 74LS05 | .45 |
| 74LS08 | .25 |
| 74LS09 | .35 |
| 74LS10 | .35 |
| 74LS11 | .35 |
| 74LS20 | .25 |
| 74LS21 | .25 |
| 74LS22 | .25 |
| 74LS32 | .40 |
| 74LS37 | .35 |
| 74LS40 | .45 |
| 74LS42 | 1.10 |
| 74LS51 | .50 |
| 74LS74 | .65 |
| 74LS86 | .65 |
| 74LS90 | .95 |
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| 74LS107 | .85 |
| 74LS123 | 1.00 |
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| 74LS153 | 1.20 |
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# FEEDBACK

## PCBs AND VEROBOXES

I want to make the ETI Option Clock: where can I obtain the PCB and at what price?

Also, who is the distributor for the Verobox, and is it possible to obtain one catalogue?

N.M., Thetford Mines

*ETI PCBs are advertised in the magazine (there is at least one company who supplies them for all projects). The distributors for Verobox are Electronic Packaging Systems PO Box 481, McAdoo Park, Hwy 38, Kingston, Ont K7L 4W5. Catalogues are available from this company.*

## COVERS & CODES

In your "Feedback" column of Aug 77 a couple of readers were bitching about your June 77 cover — can one judge a book by its cover? If an individual is familiar with your publication one might expect that individual to concern himself not only with the cover, but also the contents. I'm wondering if the same individuals wrote back the following month regarding your July 77 cover, claiming subliminal significance of the young lady and/or the beverage. Some people can find fault with anything! I'm sure you'd be criticized by someone if your next issue appeared with no picture whatsoever on the cover (lack of imagination).

Allow me to commend you on your adoption of the International Standard of component notation and units in an attept to eliminate errors. It obviously works well for resistance and capacitance values (4k7, 5p6, etc.) so why not other measurements as well? eg, 6V3 for 6.3V, 1A5 for 1.5A, etc.

Back to covers again — your May 77 cover was absolutely stunning! With a bit of cropping, I think it would make an excellent conversation-piece to frame and proudly display on the wall of my shop.

T.McD., Hyde Pk., Ont.

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| 4002 | $ .28 | 4024 | $1.16 | 4071 | $ .38 |
| 4007 | $ .28 | 4025 | $ .28 | 4072 | $ .38 |
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# 6 ETI Publications

## Canadian Projects Book No. 1 **$3.00**

Top projects from the early issues of ETI's Canadian edition, plus some of the projects from the UK edition's issues which were distributed in Canada in 1976. All projects use parts available in Canada. Those projects from UK edition have been completely re-worked in Canada for Canadian constructors. Includes a series of modular disco projects, plus games, biofeedback, metal locator, etc.

## Circuits No. 1 **$5.00**

A brand new concept from the house of ETI. More than 100 pages packed with a wide range of experimenters circuits. Based on the 'Tech Tips' section carried in the overseas editions of ETI, Circuits 1 is the first of a series of specials — produced for the enthusiasts who know what they want, but not where to get it! Circuits 1 will also act as a catalyst for further development of ideas, ideal for the experimenter. The collection of more than 200 circuits is complemented by a comprehensive index, making searches for a particular circuit quick and simple. Also, similar circuits can be compared easily, due to the logical layout and grouping used throughout. Last and by no means least, Circuits 1 has no distracting advertisements in the main section!

## Top Projects No. 3 **$2.50**

Twenty-eight projects from the UK edition of ETI. Includes Twenty-Five Watt Hifi Amp, FM Tuner, Line Amp, Dual Beam Scope Adapter, Impedance Meter, DVM, Ignition Timing Light, Colour Organ, Radar Intruder Alarm, Electronic Ignition, Fluorescent Light Dimmer, Drill Speed Controller, etc.

## Top Projects No. 4 **$2.50**

Now available in Canada, this book contains 27 projects reprinted from the UK edition of ETI. Includes WaaWaa, Hifi Amp, Car Alarm, Audio Millivoltmeter, Pushbutton Dimmer, Expander-Compressor, Dual Tracking Power Supply, Photo Timer, Car Amp, Touch Switch, Exposure Meter, etc.

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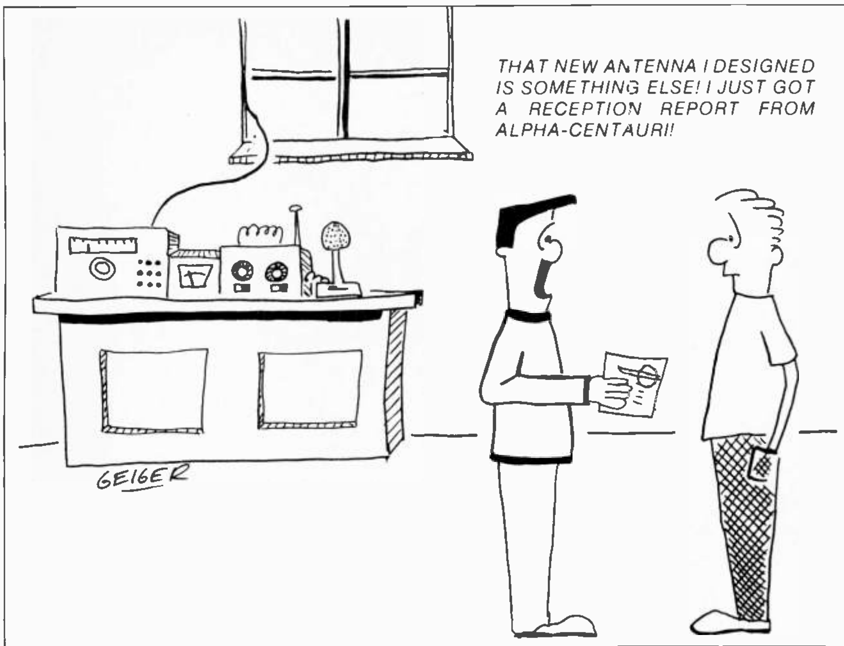
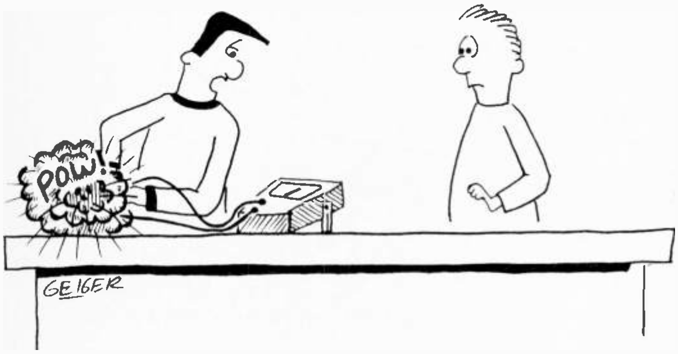
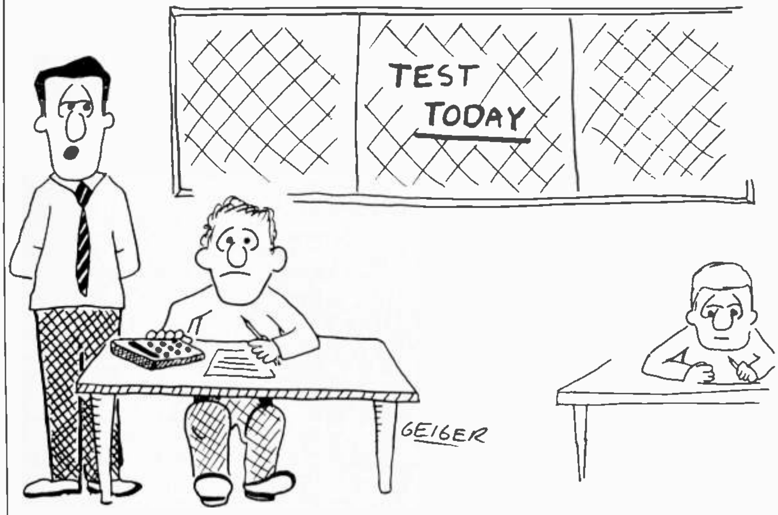


THAT NEW ANTENNA I DESIGNED IS SOMETHING ELSE! I JUST GOT A RECEPTION REPORT FROM ALPHA-CENTAURI!

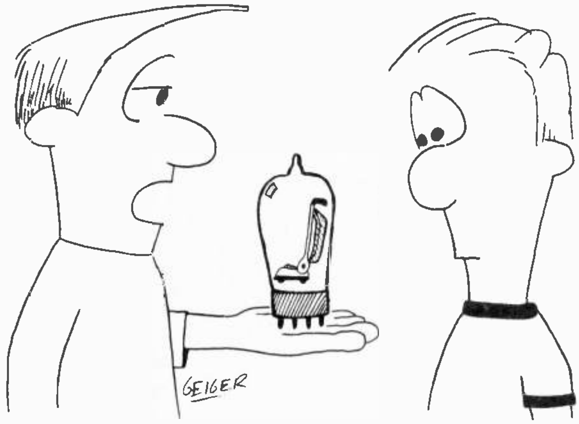
YES SIR, FRED, THIS IS A QUALITY PRODUCT YOU'VE GOT HERE: THE BREAKDOWN VOLTAGE LISTED IN THE MANUAL IS DEAD-ON.



I BELIEVE WE'RE IN TROUBLE, SIR: THE LATEST RESEARCH FIGURES SHOW THAT IT TAKES 10 MONTHS TO DEVELOP A NEW PRODUCT, AND ONLY 6 MONTHS FOR THAT PRODUCT TO BECOME OBSOLETE.



I SHALL BE CERTAIN TO GIVE YOUR CALCULATOR AN A+, JONES. YOU, HOWEVER, WILL BE RECEIVING AN F.



WHAT'S THE MATTER, HAVEN'T YOU EVER SEEN A VACUUM TUBE BEFORE?

# INFORMATION

## COMPONENT NOTATIONS AND UNITS

We normally specify components using the recently agreed International Standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be used by everyone sooner or later. ETI has opted for sooner!

Firstly decimal points are dropped and substituted with the multiplier, thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100n, 5600pF is 5n6. Other examples are 5.6pF = 5p6, 0.5pF = 0p5.

Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is 56k, 4.7kohms is 4k7, 100ohms is 100R, 5.6ohms is 5R6.

## BACK ISSUES

Previous issues of ETI-Canada are available direct from our office for $2.00 each. Please specify issue by the month, not by the features you require.

## EDITORIAL QUERIES

Written queries can only be answered when accompanied by a self-addressed, stamped envelope, and the reply can take up to three weeks. These must relate to recent articles and not involve ETI staff in any research. Mark your letter ETI Query.

## NON-FUNCTIONING PROJECTS

We cannot solve the problems faced by individual readers building our projects unless they are concerning interpretation of our articles. When we know of any error we shall print a correction as soon as possible at the end of News Digest. Any useful addenda to a project will be similarly dealt with. We cannot advise readers on modifications to our projects.

## COMPONENT STORES

ETI is available for resale by component stores. We can offer a good discount and quite a big bonus, the chances are customers buying the magazine will come back to you to buy their components.

## PRICES

All prices quoted in the editorial of ETI are in Canadian dollars, except where stated. Advertisers in U.S. may give U.S. dollar prices. Where we only know an overseas price, e.g. in U.K. pounds, we convert approximately to Canadian dollars, erring on the conservative side, where possible.

## COMPONENT SUPPLY

We do not supply components for our projects and are unable to supply advanced information on components used in any projects. However to enable readers to obtain printed circuit boards without undue delay we will be supplying retailers and manufacturers with certain p.c. board designs. Any company interested in receiving such designs should write to us on their headed note paper requesting details.

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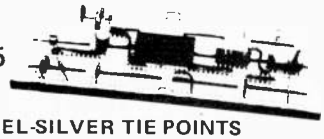

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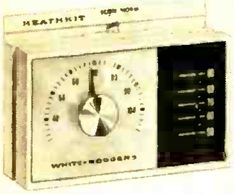

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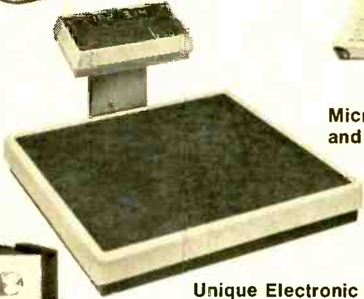

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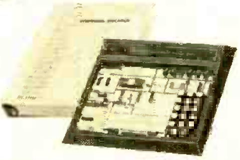

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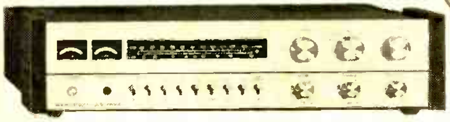

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