Electronics Today

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January 1985

Electronics Today Index

Canada's Magazine for Electronics & Computing Enthusiasts

Reviews!

ECS6 Portable 6502 • ACNAP Circuit Design Software • Tech Sketch Light Pen • EMP 1200A Modem

RS232 Breakout Project

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Our Cover

The ECS6 portable 6502 accompanies the products reviewed in this issue: a plotter, a light pen, circuit software, and a modem; photos by Bill Markwick.

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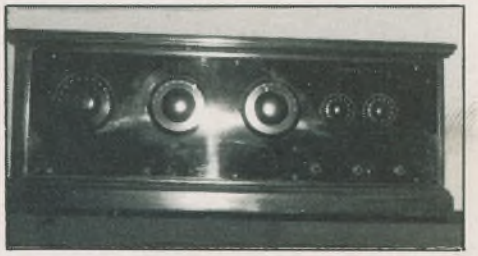

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Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for 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 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6F = 5p6 and 0.5pF = 0p5.

Resistors are treated similarly: 1.8Mohms is 1M8, 56k ohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.60hms is 5R6.

PCB Suppliers
ETI magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs, Contact the following companies when ordering boards.

Please note we do not keep track of what is available from who so please don't contact us for information PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

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New CMOS/NMOS Special Functions Data Manual

Motorola Logic and Special Functions Division announces the new CMOS/NMOS Special Functions Data Manual. A complete compilation of product specification and application information, this comprehensive book covers more than 60 Special Function VLSI integrated circuits offered by Motorola. It consists of eleven detailed chapters, including separate chapters for each family of devices: CMOS ADCs/DACs, CMOS Decoders/Display Drivers, CMOS Operational Amplifiers/Comparators, CMOS/NMOS PLLs/Frequency Synthesizers, CMOS Remote Control Functions, CMOS Smoke Detectors and Miscellaneous Functions.

Pricing for the new Motorola CMOS/NMOS Special Functions Data Manual is $1.60 each in quantities of 1-9; $1.35 each for 10-24; and $1,20 each for 25 or more. Copies of this data book can be obtained by calling the nearest Motorola components dealer, or by sending the appropriate payment to Motorola's Literature Distribution Center, Broadway Building #1, 616 W. 24th St., Tempe, AZ 85282. Request book number DL130.

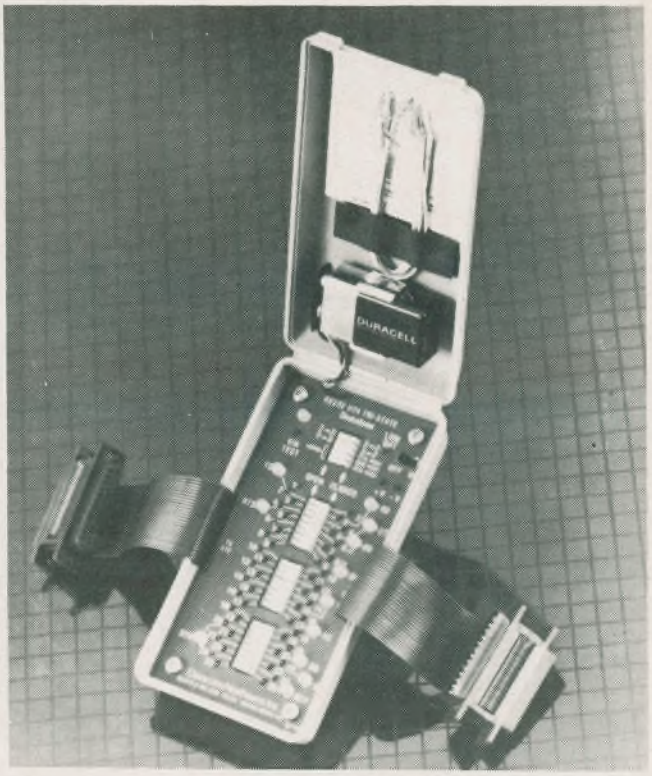
Sony Tokyo announced that it will market in Japan, starting October 21, a high-density digital television system, which incorporates double-speed non-interlace scanning, and a multi-functional digital television receiver called the Digital Canvas.

The DSC-10 is a non-interlace scanning unit which doubles the number of scanning lines (NTSC 525 lines) by means of digital interpolation to reproduce a bright and fine-grained picture without line flickers. This digital scan converter converts video and RGB signals into RGB double-speed non-interlace signals (31.5kHz).

The KX-14HD1 multi-scan color monitor is so designed to reproduce the signal information supplied from the digital scan converter in double-speed non-interlace scanning. Its newly-developed Auto Tracking Scan System makes it possible to monitor a wide range of scanning frequencies (from 15 to 34kHz). This color monitor thus can be used not only with a videotape recorder and a videodisc player but also with a personal computer (24kHz) and a CAPTAIN terminal (31.5kHz), just to name a few types of visual equipment.

Also, in the Test Equipment review, the photographs of the Sony/Tek scope and the Hameg HM208 scope were interchanged. Our apologies to the distributors.

Tri-State Databox



Ideal for data equipment users, communications companies, service organizations, equipment manufacturers and hobbyists, the pocket-size self-contained Tri-State Databox simply plugs in between the data terminal equipment and either the modem or communicaitons equipment.

Dual-in-line switches permit interruption of any of 24 interface signals for fast and simple locations of the source of trouble. Tri-state LED's show RED for positive signals, GREEN for negative signals, and OFF for invalid signals. A separate 5-position dip switch allows lines 2 and 3 to be swapped for modem reversal, or to apply positive voltage for test applications.

The Datacom Tri-State Databox is battery operated and includes a low battery indicator. Units are available in stock at authorized ACA distributors across Canada. Contact: Ms. Kelly Widdes, Allan Crawford Associates Ltd., Test & Measurement Division, 6503 Northam Drive, Mississauga, Ontario L4V 1J2, (416) 678-1500.

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The new BH1000 single cell batery holder from Memory Protection Devices Inc. will accept most 3-volt lithium coin cells up to 24mm x 3.0mm in size. The holder may be permanently soldered on a PC board for reliable memory protection.

The coin cell clips right in for easy installation and maintenance. BH1000 is made of tough, high temperature molded Valox with spring-tempered, stainless steel, nickel plated contacts that are designed to ensure correct polarity. It is also low profile for high density packaing.

For a sample and complete sepcification on the new MPD BH1000 single-cell battery holder, contact: Memory Protection Devices Inc., 320 Broad Hollow Road, Farmingdale, NY 11735. (516) 454-0340.

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Electro Corporation is represented and stocked by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, Ontario.

Branch sales offices are in Montreal, Ottawa, Winnipeg, Calgary, and Vancouver, with distributors located across Canada. For further information please contact, Bruce Petty at (416) 789-7761.

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After two years, we have an issue with no Roger Allan science articles other than the Electronics in Action column. After doing an excellent job of covering science for us, Roger has accepted the job of editor of Computers in Education, another Moorshead publication. Our best wishes to Roger in his new career.

The editor would like to point out that the review of the Psion Organiser in last month's issue was written and typeset before the publisher decided to sell the Psion as a limited-time reader offer. Too bad, he adds, I could have held out for thousands of dollars.

After 21 years of faithful service an old war horse is being put out to pasture. This Canadian record achieved at Chalk River Nuclear Laboratories by their PDP-1 computer, one of the first computers to be used in Canada on-line with experiments.

The PDP-1 was purchased from Digital Equipment of Canada Limited, and in its time it processed raw data from the EN-1, the world's first tandem accelerator or "atom smasher," which was delivered to Chalk River in the summer of 1958. Then, five years later PDP-1 came aboard, to be added to the Laboratories' research facilities.

In 1966 EN-1 was dismantled and sold for one dollar to the University of Montreal. It was replaced by the powerful new MP tandem accelerator, originally capable of operating at 10 million volts, later upgraded to 13 MV. The PDP-1 was hooked up to the new accelerator, and it provided faithful service from that time.

The computer was replaced because maintenance became a problem. In the fast-paced world of computers the normal servicing lifetime is 5-10 years. The PDP-1 used germanium transistors, which are now not available, and it became more and more difficult to keep it operating.

The PDP-1 had a memory of 32,000 18-bit words and a memory cycle time of 5 microseconds. It cost $439,000 21 years ago, but computers have since developed to the stage where even a $300 home computer has the same memory capacity and a shorter 1 microsecond cycle time.

The contrast as to size between the PDP-1 and the Perkin-Elmer 3230 which replaces it is even more striking than this cost comparison. The PDP-1 takes up about as much space as a half a dozen home freezer units. The central processor and memory boards of the 3230 are about the size of an AM/FM tuner.

The mighty mite, however, has a memory of a million 32-bit words, and can support four million in totoal. The 3230 computer will be part of the new tandem accelerator superconducting cyclotron complex, reading data from new experiments which will be possible with the vastly improved research facility.

In its long and useful service, says CHALK TALK, the CRNL newsletter, the PDP-1 has played its part in many contributions to scientific knowledge, ranging from physics experiments to those of interest to environmental scientists, archaeologists and engineers. Of immediate practical importance have been radiation damage studies, the development of new radiation detectors and the pioneering of on-line and automatic data analysis systems.

A generation of physicists at Chalk River and in universities who have used the tandem accelerator will perhaps mourn the passing of a link with the past, but its successor will be an enormous improvement capable of playing an expanded role in discoveries yet to be made with exciting new faciliaties about to come into operation.

By David P. Dempster

Aerosol PCB Cleaning Solvent

Micro Care aerosol cleaning solvents remove flux from printed circuit boards thoroughly by combining soaking, scrubbing and flushing in the same operation.

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For more information about Micro Care aerosol solvents, contact: Larry H. Heisler, GENESOLV Solvent Systems Group, Allied Corporation, P.O. Box 1139R, Morristown, New Jersey 07960, or call (201) 455-6751.

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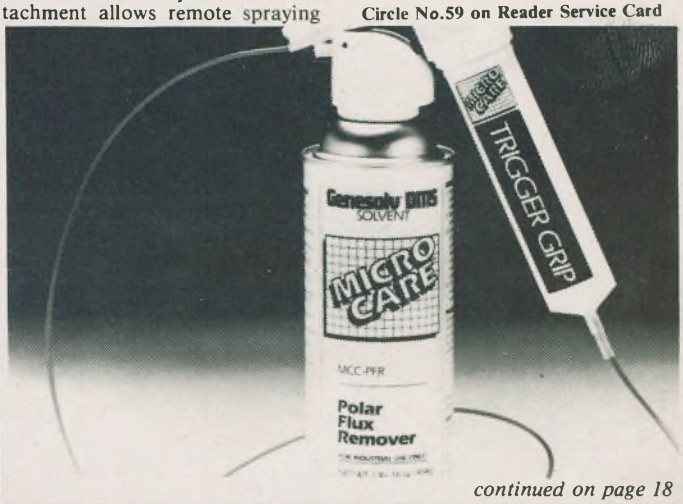

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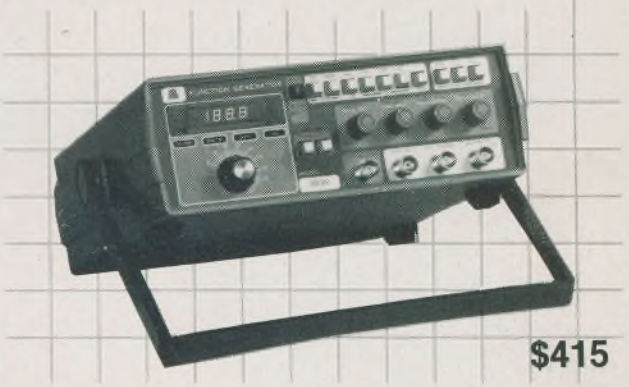

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New—Sinclair QL

*** 32-bit processor**
*** 128K memory**
*** two built-in microdrives**
*** high resolution colour**
Includes software:
word-processing
database management
spreadsheet
graphics

The Sinclair QL revolutionizes the computer revolution. It offers the utmost in performance, speed and power at the remarkably low price of only $799.95.

The QL is a full-size computer designed around the most powerful and advanced microprocessor yet created for the personal computer: the Motorola 68008. With 128K RAM, expandable to 640K. Two built-in Microdrives. Networking. A full-sized QWERTY keyboard. And its own operation system — QDOS — which accomodates windows and even multi-tasking. High resolution colour or black and white display, on either monitor or TV. Two RS-232C serial interfaces. Joystick cursor control.

That's just the hardware. The QL also comes with all the software you need to get started right away doing useful work. Word processing. Spreadsheet. Graphics. Database management. A powerful set of programs as sophisticated and as easy to use as any on the market.

Powerful Processors

The 68008 is already the favourite choice of software designers for its speed and flexibility. Its 32-bit architecture virtually gurantees the QL will never become outdated, and that wide software choices will be available in the future.

A second processor, an Intel 8049, controls the keyboard, generates the sound, and acts as an RS-232 receiver.

New Operating System

QDOS resides within the QL's 32K ROM. It is a single-user multi-tasking, time-sliced system using Sinclair SuperBASIC as a command language. Multi-tasking allows you to run several programmes individually and simultaneously, a feature normally found on computers costing at least 10 times as much as the QL.

128K Memory Expandable

The QL comes with a generous 128K of internal RAM, more than enough for the largest programmes you'll want under ordinary circumstances. An optional expansion board can turn your 128K into 640K simply and inexpensively.

Professional Keyboard

The QL keyboard is designed for fast, accurate input of data and programmes. It is a full-size QWERTY keyboard, with 64 keys, including shift keys, five function keys, and four separate cursor control keys. Key action is positive and precise.

The Microdrives

The QL's cartridge tape storage system is very much a part of the Sinclair revolution. For the first time floppy disk performance has been matched in a compact medium far less expensive to own. Depending on programme length, load time is 10 to 20 times faster than cassette. The rate of data transfer is actually a little faster than floppy disk. You can store up to 50 files, or 100K, per cartridge. Microdrive maintains an index so you can see exactly what's on any cartridge.

The QL has two built-in Microdrives, with expansion of up to six more.

A New Basic

The Sinclair SuperBASIC combines the familiarity of BASIC with a number of major developments which allows the QL's full power to be exploited. Procedure facility allows code to be written in clearly-defined blocks. Extendability allows new procedures to be added which will work in exactly the same way as the command procedure built into the ROM with which you're already familiar. Constant execution speed means SuperBASIC won't get slower as your programmes get larger. Instead, long programmes run much faster than with other Basics.

Incredible Extra Features

The QL features built-in networking capability for up to 64 QL computers. Set up local area networks of QL computers to swap information, ideas and programmes, shared over the network at 100K baud.

High resolution graphics? Up to 512 x 256 pixels (4 colour), 256 x 256 (8 colour). ROM expansion? The QL will accept an additional 32K ROM cartridge.

Included — QL Pro

Four fully-interactive programmes designed especially for the QL. Data from one programme can be transported to another. For example,

Word-processing

QL Quill word-processing gives an exact screen display of how your printed work will appear. Helpful prompts are available on-screen to step you through every word-processing task. Features include automatic word-wrap and paragraph indentation. Delete text by character, word, line or by block. Search and replace. Cut and paste, set tabs, margins, line spacing, headers and footers, view wide document. Combine data from other QL programmes. Boldface, superscript, subscripts, underline, hyphenate, overwrite. And more!

Spreadsheet

QL Abacus makes simultaneous calculations and "what if" model-construction easier than they have ever been. Refer to rows, columns, and cells by names, not just letters and numbers. Function keys can be assigned calculations with a single key-stroke. On screen prompts and Help menus simplify operations. You can link spreadsheets, use multiple windows, vary column width and justification of text. Scroll windows jointly or separately horizontally or vertically. There are many more features!

only $799.95 Including Professional Software

32-bit processor architecture 128K RAM, and QDOS combine to give the QL the performance of a mini-computer for the price of a micro.

fessional Software!

figures from the spreadsheet can be transferred to the Graphics programme for an instant visual presentation!

Database management

QL Archive is an extremely sophisticated yet easy to use filing system using a language even simpler than BASIC. You can define relationships, extract data and reorganize it, do statistical and accounting calculations and more. Screen editor allows you to design your own screen and format reports. Procedure and programmes may be written and saved for repeated use. Choose from 84 command words for queries, cross-reference entries, and search any number of files. Easy-to-use since everything is performed within the framework of familiar information prompts and Help menus.

Graphics

Spectacular colour graphs are easy to create with single key-stroke commands. QL Easel does not require you to format display before entering data; it handles design and scaling automatically or under your control. There are nine graph styles. Text can be added or altered as simply as data. QL Easel can also manipulate and evaluate data using a series of command math functions and formulas.

Getting the most from your QL

Your QL is supplied with a comprehensive set of manuals that make learning not only painless, but truly enjoyable. The QL manual includes a SuperBASIC reference manual, programming tutorial, and complete guides to the software. The manual also contains details of QL's comprehensive 90-day warranty, and service information.

Here is what you get:

Your QL comes complete with power supply, cables, manual, software and blank Microdrive cartridges. You will also receive information on the Canadian QL Users Club — available only to purchasers within Canada. Please remember as well that only QL's purchased in Canada can be serviced under the terms of the warranty. All orders will be acknowledged by return mail. Due to anticipated heavy demand please allow 4-6 weeks for delivery.

EDG offers a **7-day money back guarantee** on QLs purchased directly from us. The QL may also be available through local dealers in 1985.

Future Developments

Future QL products under development include a "C" compiler. 68000 assembler. Terminal emulator (that will allow you to tie your QL into a mini or even a mainframe computer). A 0.5Mb memory expansion board. Analogue-to-digital converter that could turn your QL into a home sound studio. Winchester hard disk interface. Parallel printer interface. IEEE-48 interface for engineering and scientific applications.

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Circle No. 34 on Reader Service Card

Cosmic CMP-9022 Plotter Printer

A new compact four-colour plotter/ printer with some impressive qualities and a low $249.95 price-tag has landed on our shores.

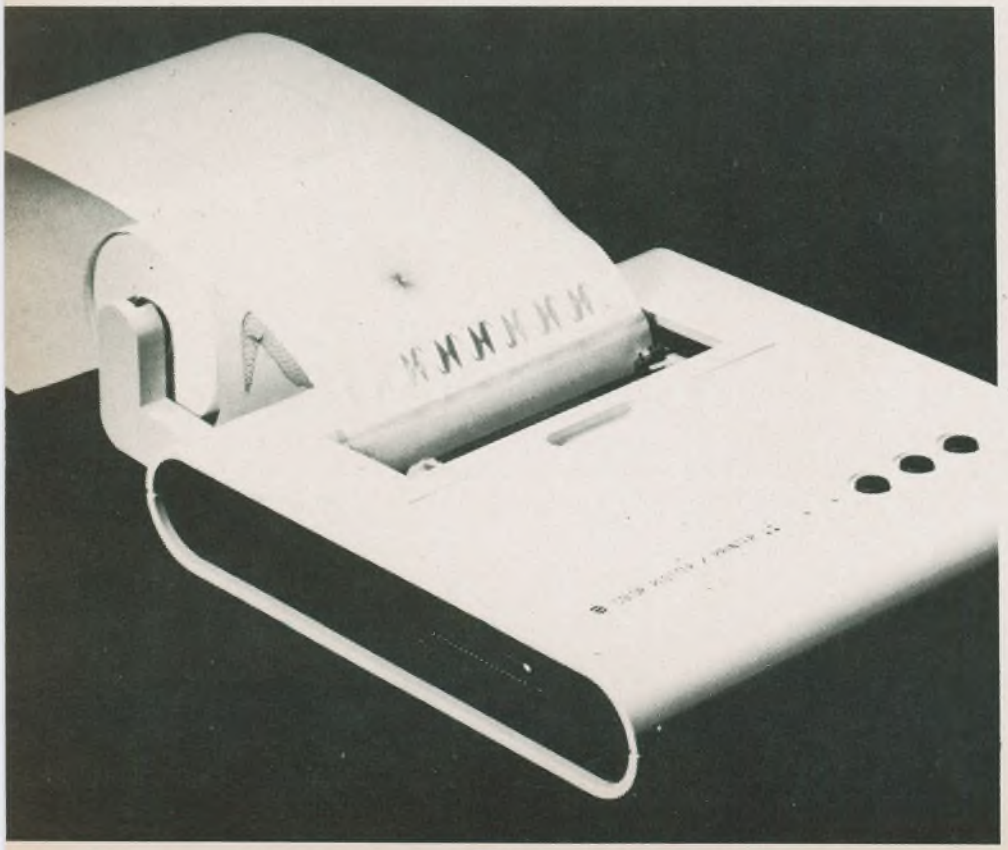
By Edward Zapletal

There was a time when things such as plotters, as well as printers, were luxuries that only the higher computing gods could well afford. The years have passed and the age of miniaturization has changed all of that. Not looking much bigger than a printing desktop calculator, the CMP-9022 four-colour plotter/printer is proof positive that good things come in small packages.

At First Glance

Setting up the 9022 is no big deal. You will need a Centronics parallel interface and cable for making the necessary connections to your favourite micro. One minor problem encountered was a lack of locking clips for the interface cable on the plotter itself. Each time we tried to insert the cable into the plotter it would pop back out. A call to Gladstone Electronics solved the problem in a flash. The particular unit which we were in the possession of had been dismantled earlier and a spacer was left out upon reassembly. We rectified the problem with masking tape.

A definite plus for this machine is its use of regular paper as opposed to thermal. The 114cm-wide by 55m-long paper fed easily into the back of the unit, but the holder containing the roll seemed to be a bit shakey when in position. An attempt to turn the unit over for a look at the underside resulted in the quick departure of the holder from the plotter.



On the top of the 9022 you will find the usual printer-like button switches: line feed, colour select, and pen change as well as paper end and power indicator lights. The underside reveals three slide switches for controlling carriage return, 40/80 character width, and ASCII/Japanese character sets. The Centronics cable fits into the side as does the power cord.

The pen holder, which contains the four 2.5cm-long ballpoint cartridges, is surprisingly small. Changing the pens is a snap and above all there is no mess. The colours are sharp and there didn't appear to be any skipping as some ballpoints tend to do.

Powering up the unit caused it to go into its self-test routine; printing four coloured squares across the paper. If you keep the line feed button depressed while administering the power switch the 9022 will etch out the four squares as well as its entire set of 96 ASCII characters.

BASICally Speaking

The unit is capable of operating in either text or graphics mode and the quality of both is superb. The smallest letter produced was approximately 1mm in height and it was very readable. The resolution of the graphics is 0.2mm per step according to the specifications; I'd hesitate to argue that point because a circle produced by the 9022 actually looked like a circle.

Programming is no problem since all commands are incorporated into standard BASIC. There are four standard control codes used in the text mode: backspace, paper reverse, switch to graphics, and next colour. The CHR$ function is used to activate these, and there are others which you can get by experimenting (or by looking at the ASCII chart in the back of the manual).

The graphics mode contains 13 graphics commands which include: colour change, pen movements (with or without drawing), character size, and rotation of printing. Depending on the version of BASIC you happen to be using, the print statement used to initiate the commands may be either PRINT or LPRINT. On the Apple version a PR#1 is necessary to activate the interface before any printing or plotting is attempted.

The following is an example of a simple program which moves the pen to a specific starting location on the paper, sets the origin (0,0) of the X and Y axes using the I command, and proceeds to draw a triangle using the "D" command.

```
10 REM *** I-Command ***
20 PR#1
30 PRINT CHR$(18)
40 PRINT "M100,-240"
50 PRINT "I"
60 PRINT
"D100,170,200,0,0,0"
```

Line 20 of the program activates the plotter (Apple ver.) and line 30 turns on the graphics mode. The print statement in line 40 tells the plotter to move the pen to a location 100 units to the right of the left paper edge and 240 units down. This will appear as a diagonal motion when the program is executed. The "I" command sets the current pen location to the point 0,0 (origin) in preparation for drawing. The numbers following the "D" command are actually grouped in pairs (coordinates) from left to right and are the destinations to which the pen will draw. For instance: 100,170 signals the pen to draw a line to a location 100 units to the right and 170 units up from the starting point and so on.

If you're not quite familiar with all this X and Y axis stuff then you might have to read up on your geometry. Don't panic though, if this all sounds too complicated the best way to get acquainted with the 9022 is by playing with it.

The Manual

Just a word about the instruction manual. The benefits from owning this dandy little plotter are actually two-fold. First, you become proficient in creating great graphics, and second, you will be completely fluent in Taiwenglish. Taiwenglish? This is not a new phenomenon but one which has been around as long as imported goods from the Far East. It's actually a cross between Taiwanese and English resulting from direct translation to the latter. It seems as though the good folks over there are determined to write instruction manuals this way. They are very entertaining to read, but it may be difficult to understand what it is that they're trying to tell you. Enough said.

Wrap It Up Please

The 9022 really has to be seen to be appreciated. Its sleek compact design and low price make it ideal for anyone wanting to get into computer graphics. The $1000 dot matrix graphics printer is no longer the only route to go for the home computing enthusiast who wants to generate simple graphics, in colour to boot!

Quick Index

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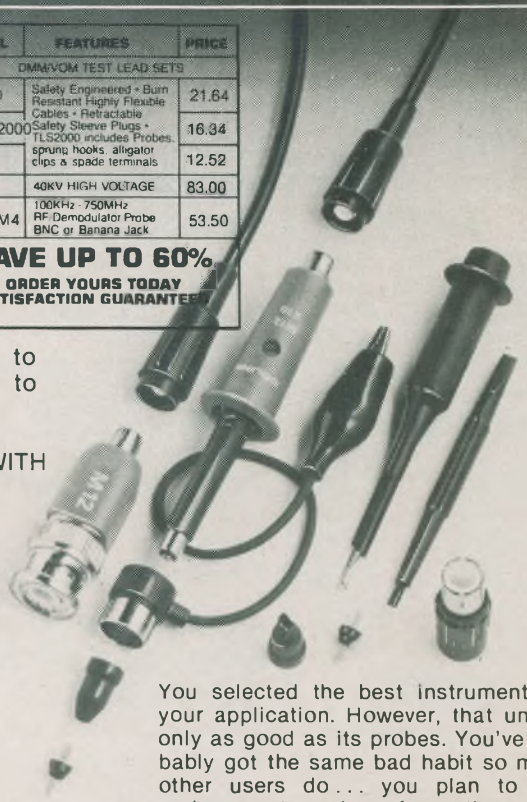

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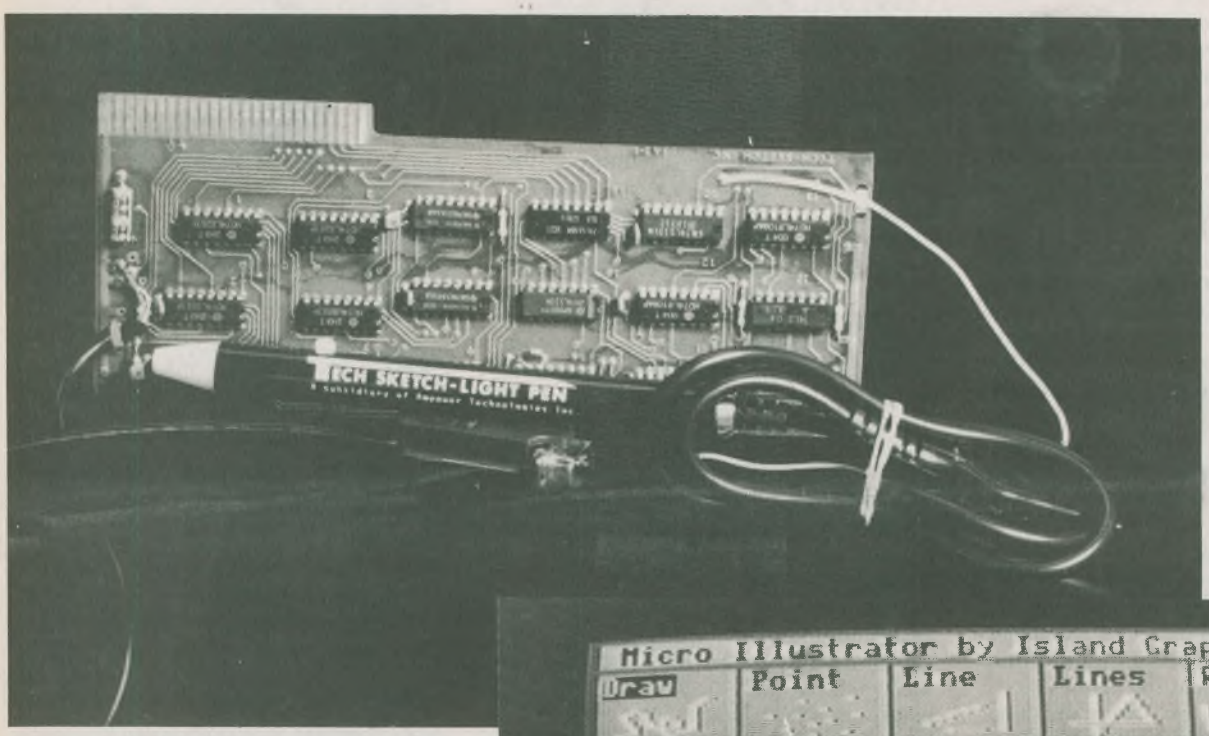

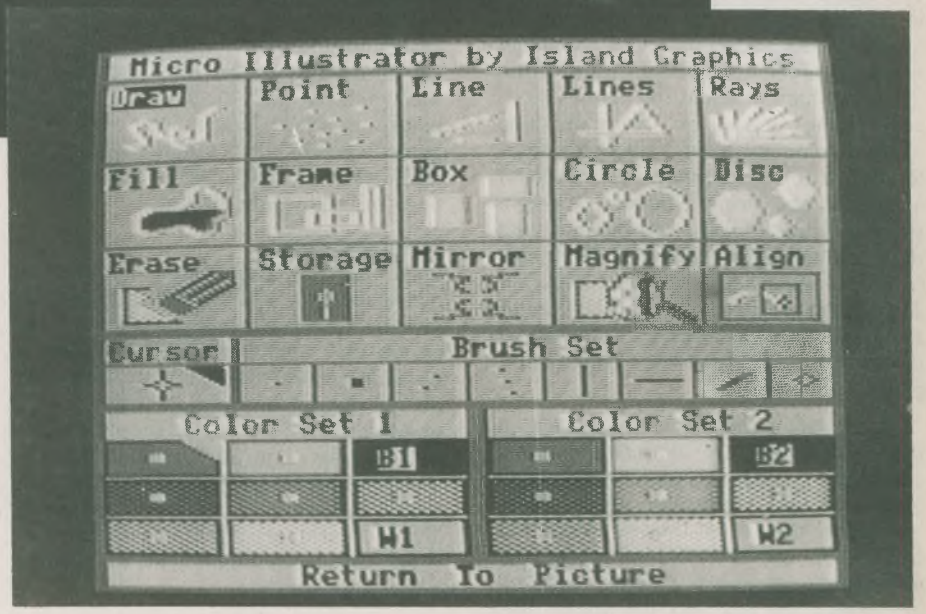

Turn your TV into a video canvas and keep the kids from drawing on your freshly-painted walls.

By Edward Zapletal

LIGHT PEN technology is certainly not new in the world of computing; design engineers have been using them to create prototype drawings of everything from cars to integrated circuits. Lately, though, with the declining cost of peripherals for microcomputers , the light pen is finding a place in the home computer graphics market. The latest entry into that market is the Tech-Sketch Light Pen from Tech Sketch Inc.

To be perfectly honest, there really isn't much to a light pen except a cable, push-button switch, and a photocell. The real guts behind the whole thing is the software. The Tech-Sketch comes packaged with the Micro Illustrator software from Island Graphics in formats for: the Apple IIe, II+, II, (and compatibles?), Commodore 64, and Atari computers. We were fortunate enough that the Tech Sketch people bestowed us with an Apple version for this review.

Plugging In

Upon its arrival, we eagerly unpacked the necessary hard and software which included the light pen, diskette, and interface card complete with an attached jumper clip. By the way, the card is required only for the Apple versions and is considered an optional extra.

There is a choice of two slot locations for the insertion of the light pen interface. This is for Apple and clone users alike who have few vacancies in the ol' slot motel. The recommended location is in slot 5 with the jumper clip connected to resistor R8 (2k ohms) for the II or II+, and R5 on the IIe. These resistors are located near the game IO sockets and care should be taken when connecting up to them. If slot five is occupied, slot seven will do just fine, and the jumper is ignored in this case. The reason for using the jumper clip, according to the Tech Sketch people, is because there is no direct connection to the video synch from slot five.

Micro Illustrator

As mentioned previously, the driving software for the pen is the Micro Illustrator. This is the same Micro Illustrator used in conjunction with the popular Koala Pad graphics tablet. For the purposes of putting the light pen and software through their paces, I opted for an Apple II + more out of necessity than availability. I had originally planned, at this point, to describe the difficulty encountered in making the whole thing work on an Apple compatible, but to be fair I will tackle the light pen first. Technical difficulties will be covered further on.

On booting the Micro Illustrator disk you are first greeted with the usual title and copyright information, in technicolour of course. After you've satisfied the computer's request for the slot location, some minor housekeeping details are in order in the way of calibrating the light pen's accuracy and speed of response. Once complete, you're on your way to becoming another Van Gogh.

The Menu Please

The Micro Illustrator's menu is divided into three main sections: commands, brush set, and color sets. The command section contains 15 functions for drawing the basic shapes such as lines, boxes, circles, frames and so on. There are nine brushes to select from, and there are a total of 18 colours arranged in two sets of nine. Strange things happen, though, when mixing colours from one set with those of another. Drawing a white line (colour set 1) on a powder-blue (colour set 2) background produced a red shadow around the line. According to the manual this is to be expected on the Apple computer.

One of the more interesting features of the Micro Illustrator is its *rubber banding* capability. Similar to Apple's Macintosh elastic software, this feature allows you to manipulate the size of frames, boxes, circles, discs, and rays for previewing purposes. By selecting the circle function, positioning the pen over the screen, and depressing the button, you create a centre point for a circle. Moving the pen away from that point causes a rubber band-like circle to appear on the screen. When you've decided that your circle is just right, depressing the button freezes your masterpiece.

Other features include ERASE, STORAGE, MAGNIFY, and ALIGN. The alignment command is used in the event that the cursor no longer appears to be directly under the tip of the pen. This is actually the same alignment function which sets up the Micro Illustrator at boot time.

The STORAGE command dumps you into yet another menu where the CATALOG, DISK FILE UTILITIES, LOADing, and SAVEing routines are stashed. The disk utilities include the usual such as format, lock, unlock etc. Pictures can be saved or loaded to or from any DOS 3.3 disk.

Compatibility?

Clone (klon), n. *Biol.* a group of organisms derived from a single individual by various types of asexual reproduction. That's the Random House Dictionary definition of something that is supposed to be identical in every way to the original.

After powering down a number of the trusty Unitron 6502s here at the office, we proceeded to follow the instructions for connecting up to an Apple compatible computer. The software loaded without a hitch and everything looked rosey except for the fact that the light pen just wouldn't work. With the card in slot five and the jumper connected to the equivalent of the R8 resistor on the II and II + versions, there was no action. Slot seven also proved to be a hopeless exercise. Meanwhile, the Tech Sketch people phoned to check on how things were progressing. After explaining the lack of success, we were instructed to return the pen for a replacement.

Our worst fears were realized when the new pen arrived and yielded the same results as before. There was no way in the world that this or any other Apple *clone* was going to give in. The Tech Sketch people in New Jersey were very sympathetic and did their best to assist us, but they were not able to offer any explanation for the incompatibility.

Incompatibility

It should be noted here that the problem is not necessarily with the Pen and/or interface, but rather with the type of machine to which they are connected. After all, it worked as promised on the real Apple. My overall impression of the package is quite good, although I question the usefulness of light pens in the home market. Affordable software limits most people to tinkering with colourful graphics on the family TV set and more expensive design software is left to the higher gods in the manufacturing world.

Quick Reference

Price:	$139.95 Apple version (incl. interface) $49.95 Commodore, Atari
Software:	Micro Illustrator included
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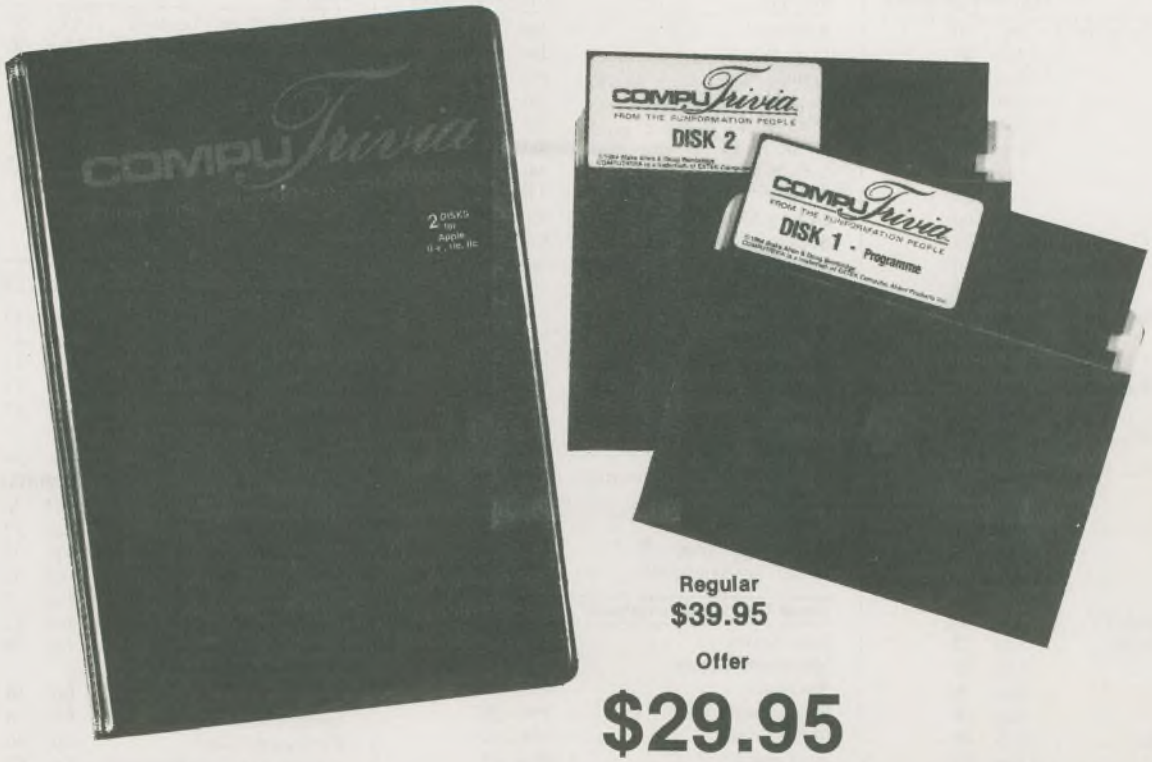

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For Your Information

Clamp-On Ammeter

Providing a large easy to read liquid crystal display the KYORITSU 2001 digital clamp-on ammeter will provide current measurements to 1000A. The voltage and current ranges are well protected by discharge tube, are extinguishing fuse and diode and the withstand voltage is 3000v. Accurate readings are possible because of the dual integral measurement system, while peak hold and data hold are incorporated features. This auto ranging clamp-on also provides measurements to 750VAc and 2000 ohms. The unit weights 500 grams and comes complete with carrying case. For more information please write to: OMINTRONIX LTD., 2410 Dunwin Dr. #4, Mississauga, Ont., L5L 1J9, (416) 828-6221.

Circle No.50 on Reader Service Card

Microtel Limited of Burnaby, British Columbia has been awarded a $1.6-million contract by the British Columbia Hydro & Power Authority for analog multiplex, order wire and supervisory equipment to be installed along parts of the microwave network linking the utility's power grid.

The equipment will be used to upgrade voice and data microwave service channels at 49 sites mainly between the Peace River Dam in B.C.'s far north and Vancouver.

The contract includes the purchase of Microtel's 46A3-SC Analog Multiplex, 353A Order Wire and PCM (Pulse Code Modulation) Digital Multiplex equipment for intstallation at sites along the network.

26-Mbyte Half-Height Winchester

Shugart Corp. has expanded its line of half-height 5.25-inch Winchesters with the introduction of a 26-Mbyte unit featuring a closed-loop servo system.

In addition to offering higher capacity, the Shugart 724 incorporates such data protection features as high-damping four-point shock mounts, a dynamic spindle brake and an actuator which automatically retracts the read/write heads to a dedicated head landing/shipping zone when the drive is powered down.

The 724, offering 20 Mbytes of formatted capacity, is designed for desktop computers requiring Winchester performance in a low-cost, compact unit.

For more information on the 724 contact Shugart in Markham, Ontario, (416) 475-2655,

Circle No. 43 on Reader Service Card.

Centronics Canada Inc. of Mississauga, Ont. has announced two new Long Distance Service Hot lines for improved customer convenience.

One Hot Line is linked directly to Centronics Calgary for service centres in B.C. and Alberta, and the other is linked directly to Centronics Toronto for service centres in Ontario and Hull, Que. Customers in B.C. and Alberta can call toll free 1-800-661-8129. Customers in Ontario and Hull, Que., can telephone 1-800-268-0432. Calgary and Toronto clients may continue to contact their service centres directly at the local number.

Control Data Canada, Ltd. has announced the establishment of the Women's Training Centre to train female students in computer career-entry skills.

The Centre will be part of the company's Toronto Control Data Institute and will offer courses in skills required to operate in an automated office environment. In addition, courses in computer programming, computer operations and computer maintenance and repair will be available. The courses will be offered at Control Data's 20 Hallcrown Place offices in Willowdale Ontario. For more infomation call (416) 826-8640.

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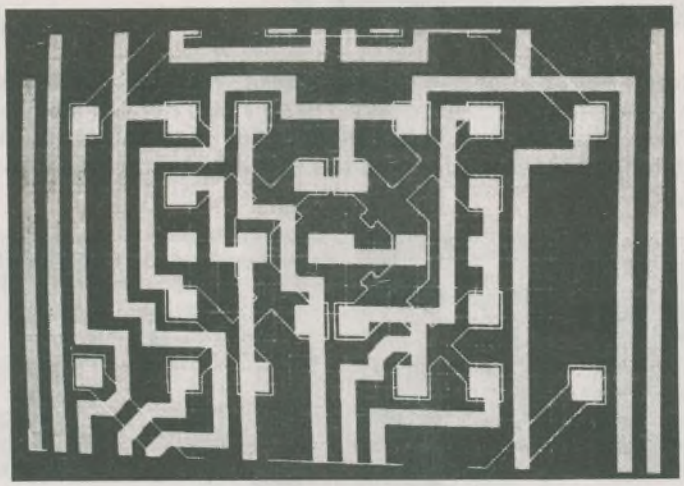


Fig. 1 Metal tracks laid out on a ULA, as seen on a VDU during design. The filled-in white area are metal tracks, the thin white lines outline transistors and diffused cross-unders, while the fain grey lines mark allowed track placements.

Customised ICs are catching on as fast as customised license plates. An explanation on how PLAs and ULAs have brought down the price.

By S.M. Smith

IN THE PAST ten years or so the complexity and density of circuits integrated onto one chip has increased dramatically. This trend is continuing for the following reasons:

Size: usually, one chip is smaller than twenty. Smaller circuits fit into smaller boxes, which are cheaper to manufacture and transport than large heavy ones. If several PCBs can become one, inter-PCB connections are saved.

Power consumption: in general a single device consumes less power than several. The consequent drop in heat dissipation may allow natural instead of fan-assisted cooling, or reduction of heatsink sizes, or both. Also a less bulky power supply is needed. The whole equipment may then reduce in size and weight by far more than the initial amount caused directly by integration.

Speed: devices on large scale ICs tend to be smaller than those in medium or small-scale ICs. The switching speed of small devices is usually faster than that of large devices, so the single chip is faster than several.

Reliability: one chip is more reliable than several. Reducing the chip count in equipment reduces the number of interconnections and hence the probability of a faulty connection. More reliable equipment means cheaper equipment, as less money has to be allocated for fixing faults arising during and after production.

Security: a board full of TTL ICs is easily copied by unscrupulous competitors. An anonymous black plastic block can only be copied with a lot of effort.

There are several ways of putting a logic system on a chip, ranging from the full custom IC down to the familiar PROM. A fully custom integrated circuit is a complicated device that takes months to design and develop, and requires massive investment in plant to manufacture. To recoup the cost of this requires sales of either a huge number of devices at reasonable prices, or a few sales at ridiculous prices, the latter being luxury indulged in only by the aerospace and defence industries. To understand why an IC costs so much to develop, it is necessary first of all to have an idea of the manufacturing process.

Integrated circuits are fabricated on thin sheets of silicon 2" to 5" in diameter, called wafers. The silicon used for IC fabrication has to be extremely pure — 99.99999% pure. It must also be moncrystalline, with the atoms laid out in a regular three-dimensional pattern and no defects. Since the wafer is polycrystalline silicon, a near-perfect layer of single-crystal silicon must be grown on the wafer surface, using a process called epitaxy.

Making Transistors

Transistors and resistors are made by *doping* the silicon with minute quantities of other elements, such as boron, gold, phosphor and indium. Obviously, a single transistor 3" in diameter is of little use, so the doping is introduced only to selected areas of the silicon surface. Areas to be doped are defined by holes in a layer of silicon dioxide on the wafer; the oxide prevents dopant reaching the silicon.

The shape and location of the holes in the oxide layer are ultimately determined by a pattern held in a computer. This pattern is converted into a 400 X full size master print which is photographically reduced in two or three stages onto a chrome-coated glass plate, the 'mask'. Several hundred patterns are repeated across the mask in a precise regular array, so one wafer will yield several hundred chips (see Fig. 1).

The wafer is coated with a photo-resistive polymer, which reacts to ultra-violet light (a similar process is used in PCB production). The mask is then placed over the wafer, in precise alignment with previous processing steps, and then the wafer is exposed to UV. The mask is

removed and the unexposed resist is rinsed off with a solvent — the exposed resist, hardened under the ultraviolet, does not rinse away. Now the un-covered section of the oxide can be etched away with acid, leaving silicon exposed for doping.

The final mask defines the metallisation layer, which is a thin network of aluminium tracks interconnecting devices on the chip. There may be several metal layers, separated by insulating oxide layers.

There are around seven processing stages for each mask, and an IC design may require 5 to 12 masks. this makes the process long, expensive and error-prone.

The Expertise Gap

There are few engineers capable of designing an integrated circuit at this level of complexity, with control over doping levels, transistor sizes and so on. Fortunately, many applications do not require minute control over the electrical charateristics of the devices on the chip. Semi-custom logic design allows an ordinary logic designer to design an integrated circuit.

The most complex semi-custom approach is the standard cell. Here the designer has access to a computer database containing mask layouts for often-used devices and functions up to the complexity of, perhaps, a full adder. The designer extracts from the database the devices and functions needed; he or she may have some control over electrical performance if layouts are held for different versions of the same device.

This is still an expensive method; although design data has been previously calculated for each function required, new masks have to be made for each IC. To be cost effective, large returns on sales must be certain. The advantage over full custom is the lower expertise required of the designer and faster design time, with only a small loss in performance.

Uncommitted Logic

The next level down in terms of cost/time is the gate array, or uncommitted logic array (ULA), to which the bulk of this article is devoted. In the ULA the devices and some inbuilt interconnection are ready-fabricated. The devices are laid out in a regular array with channels between groups of devices for interconnection routing (Fig. 1). The designer's job is to complete the interconnection by specifying a metallisation mask layout.

Although the designer has no control over electrical performance of the devices, and some waste of silicon area is inevitable due to the fixed form of the array, the ULA is attractive because of its fast design time (5 to 12 weeks) and lower production costs (only one or possibly three new masks have to be produced). It is therefore suitable for projects expecting relatively low sales volume.

Fuse Programming

Next comes the fuse-programmable logic array (FPLA; some versions are called PAL or PLA). These come in a number of different versions, but basically consist of a set of AND gates feeding on a set of OR gates. Fusible links control which of the chip inputs go to which AND input, and which AND output to which OR input. Some FPLA's incorporate D-types, registers and optional feedback loops to allow sequential circuits to be burnt in.

FPLAs have the advantage of very fast design time (a few minutes from specification of the logic function to production of the program for blowing the array). They tend to lack versatility compared with a ULA and make inefficient use of silicon. They have the advantage of inhouse programming (no need to send them away to the manufacturer, with the attendant delays) and can be very cost-effective in some applications.

And PROMs Too!

The final option is to use the PROM (Programmable Read Only Memory). This has the advantage again of on-the-spot programming and may implement more complex logic functions than the FPLA. The required truth-table is programmed into the PROM; the address lines are used as the logical inputs, and the data lines are the required outputs. However, the PROM is a comparatively slow device, and its use may often be a waste of silicon; as an extreme example, an octal inverter (16 transistors in CMOS) implemented on a PROM requires 256 words by 8 bits — a 2K memory!

Because of the reasons above, the ULA is the most important of the routes to a semi-custom logic IC at present. It is likely to become more so in the future as the pace of technology quickens, demanding new designs in shorter timescales, and as the software tools for ULA design improve, allowing more fully automated design and design of larger chips.

CMOS is the fastest-growing gate array technology at the moment, due to it's combination of speed, power and consumption, packing density and ease of design.

Designing A ULA

It would be almost impossible to design a ULA without the help of a computer. People are slow, they find checking boring and they make mistakes. Fortunately, computers are not yet intelligent enough to get bored.

The design starts, usually, with a 'breadboard' model of the circuit, in TTL or CMOS or whatever is the most suitable. This stage is used to check if the ideas are correct; it may be considered unnecessary if a well-known design is being implemented. The design is then translated into a form suitable for putting on a ULA. There will be some differences between the breadboard and ULA version of the circuit because in CMOS arrays some logic structures are more easily implemented than in bipolar technology or 4000-series CMOS.

One basic unit, fundamental to CMOS gate array design, is the transmission gate, a pair of P and N channel transistors with their sources and drains tied together, with complementary gate signals, Fig. 2. When CONTROL is high the N-channel transistor is turned on, and since CONTROL is low, the P-channel transistor is turned on too. Thus a signal can pass from A to B.

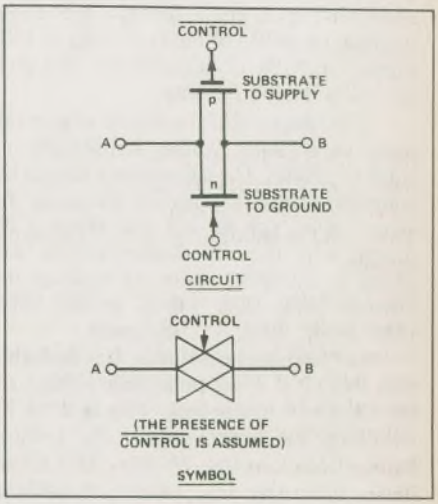


Fig. 2 The transmission gate.

Using this construct, a D-type flip-flop, for instance can be made with just 16 transistors, Fig. 3. An even economical D-type can be implemented using only

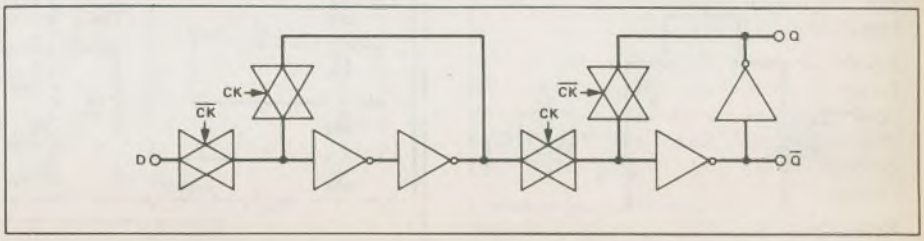


Fig. 3 D-type flip-flop (positive edge triggered) using 16 tranisistors (two per transmission gate, two per inverter — circuit not shown for inverter, but assumed very simple)

continued on page 53

Analog Capacitance Meter

A simple, low-cost capacitance meter for the test bench.

By John Linsley Hood

ONE of the simplest ways of measuring capacitance is to connect the component under test to a suitable (low voltage) source of AC, and then measure the current which flows through it. For small values of capacitance, this is obviously not going to be very big, so some kind of electronic amplifier will be needed.

A suitable arrangement is shown in outline form in Fig. 1. The only specific requirement is that Rx must be very small in value in comparison with the impedance of the capacitor under test.

The Circuit

The actual circuit used in the instrument is shown in Fig. 2, and is simply a high input impedance milli-voltmeter having a FSD input sensitivity of about 27mV and built around a TL071 op-amp.

The range switch is chosen to give full scale capacitance value indications of 10pF to 100uF. The capacitance ranges increment in steps of 1:10:100, etc, using the given values for R1-R9, but there is no reason why the constructor should not adopt a 1:3:10:30 series by making the resistor bank have values in the 3M3, 1M0, 330K, 100K . . . sequence.

For testing electrolytics, it is desirable that there is a small polarising voltage on the capacitor under test. This is done by switching the lower end of the resistor bank of SW1 to the -5V line. This effectively puts the DC supply smoothing capacitor of this line in series with the capacitor under test, so it is advisable to make these large with respect to the 100uF maximum instrument range.

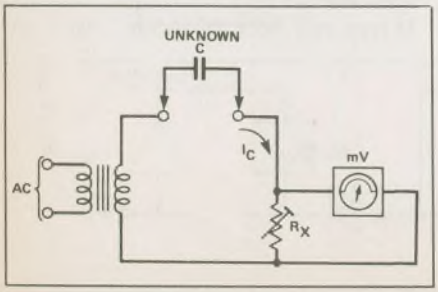


Fig. 1 A simple method of measuring capacitance.

Construction

Virtually all of the low-voltage circuitry is mounted on the PCB, including the meter and the range-setting switch with its associated resistors. However, neither the transformer nor the fuse are mounted on the board because of the risk of AC pick-up from them.

Assembling the PCB shouldn't present any problems provided the overlay is followed carefully. Begin by soldering SW1 into place and then move on to the resistors and capacitors, taking care with C2, 3 and 4 which are electrolytic and must be inserted the right way around. Finally install the diodes and the op-amp, again taking note of polarity. The op-amp is a bi-FET device and requires no special handling precautions; some constructors may prefer to use a socket for it but this is not essential.

Because of the susceptibility of the high impedance input to AC pick-up, it is recommended that the instrument be housed in a die-cast box. No particular type is specified, but you should choose one which is large enough to accommodate the PCB plus the off-board controls and which has sufficient depth to allow the transformer to be placed well away from sensitive parts of the circuit.

The test terminals should be positioned close to the appropriate pads on the PCB and then connected up using very short lengths of wire. These two leads should not, of course, be twisted together since this would introduce a certain amount of capacitance and thus affect the accuracy of the unit. SW2 presents no such problems and can be wired up in the normal way.

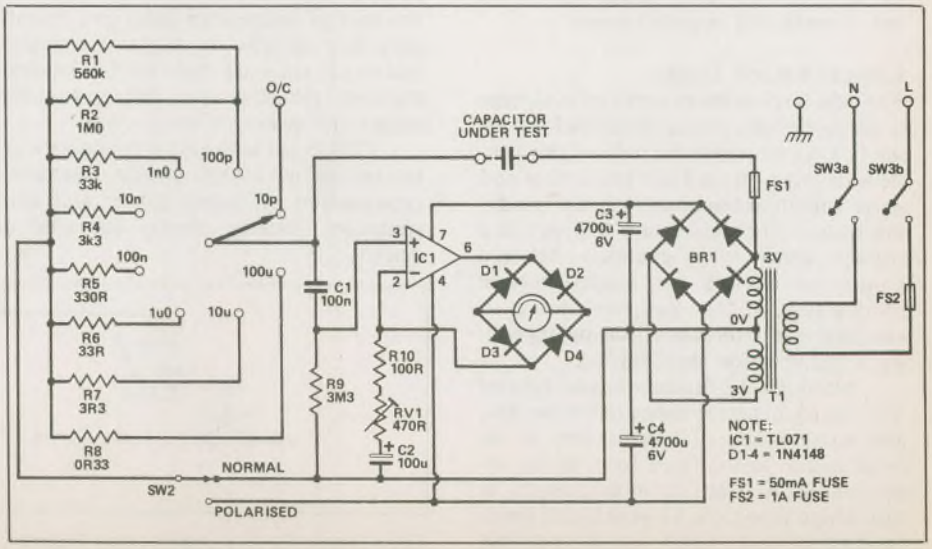


Fig. 2 Circuit diagram of the direct-reading capacitance meter.

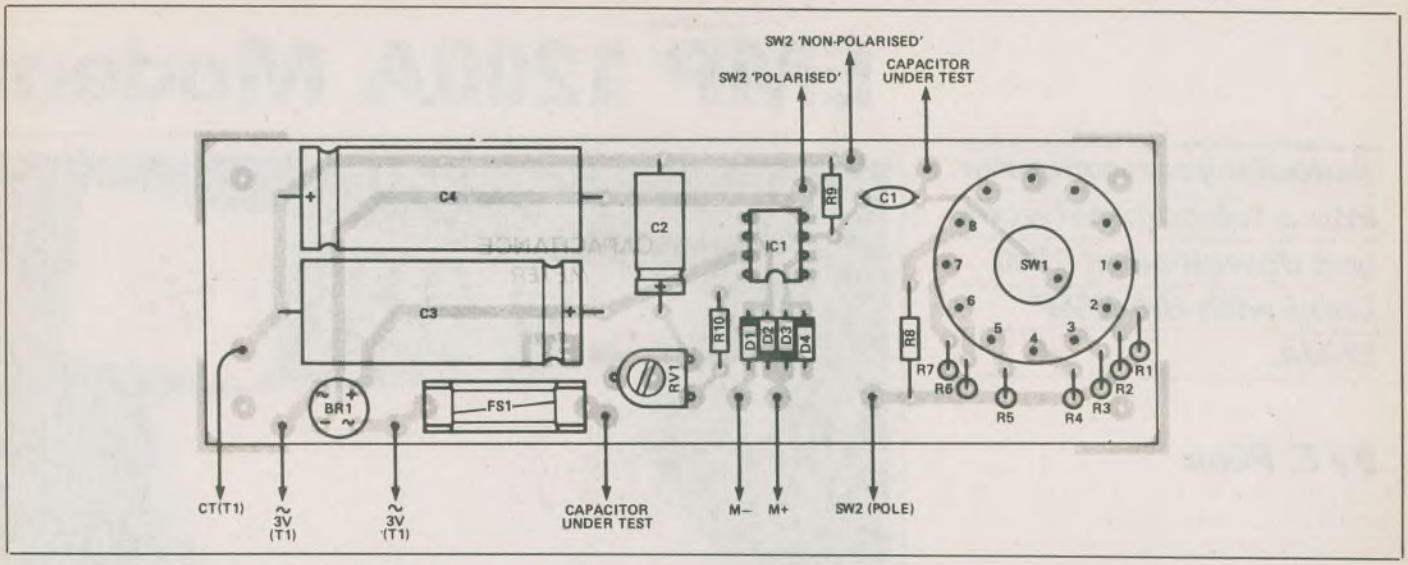


Fig. 3 Component overlay of the PCB.

PARTS LIST

Resistors

R1	560k
R2	1M0
R3	33k
R4	3k3
R5	330R
R6	33R
R7	3R3
R8	R33
R9	3M3
R10	100R
RV1	470R

Capacitors

C1	100n
C2	100u 16V electrolytic
C3, 4	4700u 6v electrolytic

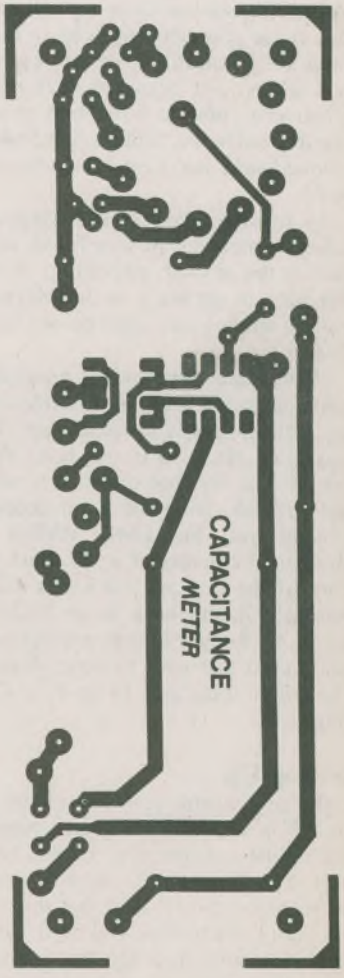
Semiconductors

IC1	TL071
D1-4	1N4148
BR1	W005

Miscellaneous

M1	100u moving coil meter
SW1	1 pole 8 way rotary switch
SW2	SPDT toggle switch
SW3	DPDT mains toggle switch
T1	3-0-3V 3VA chassis mounting transformer
F1	50mA 20mm fuse and chassis mounting holder
F2	loudspeaker-type twin spring terminals

PCB; diecast box; mains cable and strain relief bush; knob for SW1; spacers, nuts and bolts for mounting PCB and T1; screening material.



The transformer, power switch and fuse should all be positioned well away from the op-amp and the test terminals, particularly the terminal which connects to the wiper of SW1 since this point is at high impedance and therefore very sensitive to AC pick-up. The leads from the secondary of the transformer to the PCB should be tightly twisted together since this will reduce the magnetic field around them and hence the risk of pick-up. It may also be necessary to screen the op-amp and the high impedance terminal completely if the meter is to operate correctly on its two most sensitive ranges.

Setting up the instrument, on completion, requires the availability of a few good quality capacitors of which the capacitance is known to an adequate degree of accuracy. The value of RV1 can then be adjusted to give the best fit over several ranges.

It is possible to attach a pair of leads to the test terminals and use them to test capacitors in situ, but AC pick-up on the high impedance lead will introduce errors and this method can therefore only be used with large values of capacitance. In all other circumstances it is advisable to place the capacitor under test directly across the test terminals. If the size or construction of a capacitor prevents its being connected in this way, attach a flying lead to the low impedance test terminal (the one from the secondary of the transformer) and use this to connect one side of the capacitor while the other side is inserted directly into the high impedance terminal. ■

EMP 1200A Modem

Autodial your computer into a telecom network and download at 1200 baud with the EMP 1200A.

By E. Penn

WORKING computer bulletin boards with a 300 baud modem isn't all that bad, dig, cause you can only read so fast, you know? It's helpful to let the text dribble past when your eyes are little red slits. When you come to download good stuff like free software, though, it's Snail City: *"Download Time: Come Back Next Weekend"*.

So, naturally we need something hi-tech to free up more leisure time for us, and 1200 baud is the answer, providing, of course, that we can get back to 300 anytime for leaving strange messages on our favourite BBS.

Now, there are terminal programs and autodialers and various modems happening, but who really needs all that? What if you could get it all in one box? What if, indeed. The very box exists. It is called the EMP 1200A, from the good people who brought you the EMP MM101 Mini-Modem. It consists of a, ah, box. On the front of the box are red LEDs and three buttons. On the back is an RS232 connector, an 8-lever switch, a telephone jack and a cord that goes to your phone jack. The whole thing gets lit up by a 12 VAC plug pack.

Setting Up

In the next world, you won't have to. 32-bit CPUs will fathom what's happening and adjust accordingly. In this life, yer beat. You'll have to — aggh! — *read the instructions*. You'll find that this modem has pretty much what you need: 300/1200 baud selectable from the front panel, rear switch selection of parameters such as number of bits, and self-test. It has auto-dialing and automatic disconnect. It has auto or manual answer and originate. What more could you ask? You could ask for a manual which explains all these things, is what you could ask for, but you don't get one. However, if you follow all the advice in the little booklet ("Press switch 1 down and leave switch 2 up") everything will work and the LEDs will flash satisfyingly, even if their functions aren't explained.

And how does all this blend with the many wires of your computer? With an RS232 output and cable. Without you don't got no RS232, you don't get no telecom. Help is at hand, adapters are available, see your friendly neighbourhood computer dealer.

Using It

Activate your RS232 output by performing the necessary voodoo required by your computer. Be sure the modem is plugged into the wall and your telephone plugged into the modem. All set? Here we go.

The phone will ring. It will be your mother-in-law asking why the line is always busy. She will talk for three hours. Tell her the house has just caught fire and hang up. Check the computer screen for a right-arrow symbol; this symbolizes peace and harmony between the computer and the modem. Type "D" and the number you wish to call, including area codes if you like. A tiny relay will chatter inside the modem. If the number isn't answered within 30 seconds, the word "disconnect" will appear on the screen. You can then change numbers, or else type "R" for redialing. It's not quite as slick as having it all done for you robotically with auto-recall, but it beats wearing out your fingers on a rotary dial.

For working the digital conversation the other way, just leave it to the modem. When the phone rings, the "RI" LED will light and the modem answers. If it detects a carrier, it will begin receiving after automatically figuring out the proper baud rate. If it detects your mother-in-law, it hangs up. If it loses the carrier, it also hangs up.

Other

There are various testing modes available to verify that everything is getting along with everything else before you place that call to Hawaii. The "Loopback" mode, for instance, is selected from the rear switch, and takes in any data transmitted by the terminal (your computer) and sends it back to the computer for verification.

During me strolls through various BBSs at both 300 and 1200 baud, the EMP performed flawlessly as a good box should. The built-in dialer saves having to have a terminal program in software; only an RS232 port is required. Very flexible, very nice, and when you can't think of anything else to write, quote specs, I always say.

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Dialer: keyboard controlled, 10 pps
Interface: RS232
Phone Interface: Modular jacks
Regular Price: $539.00

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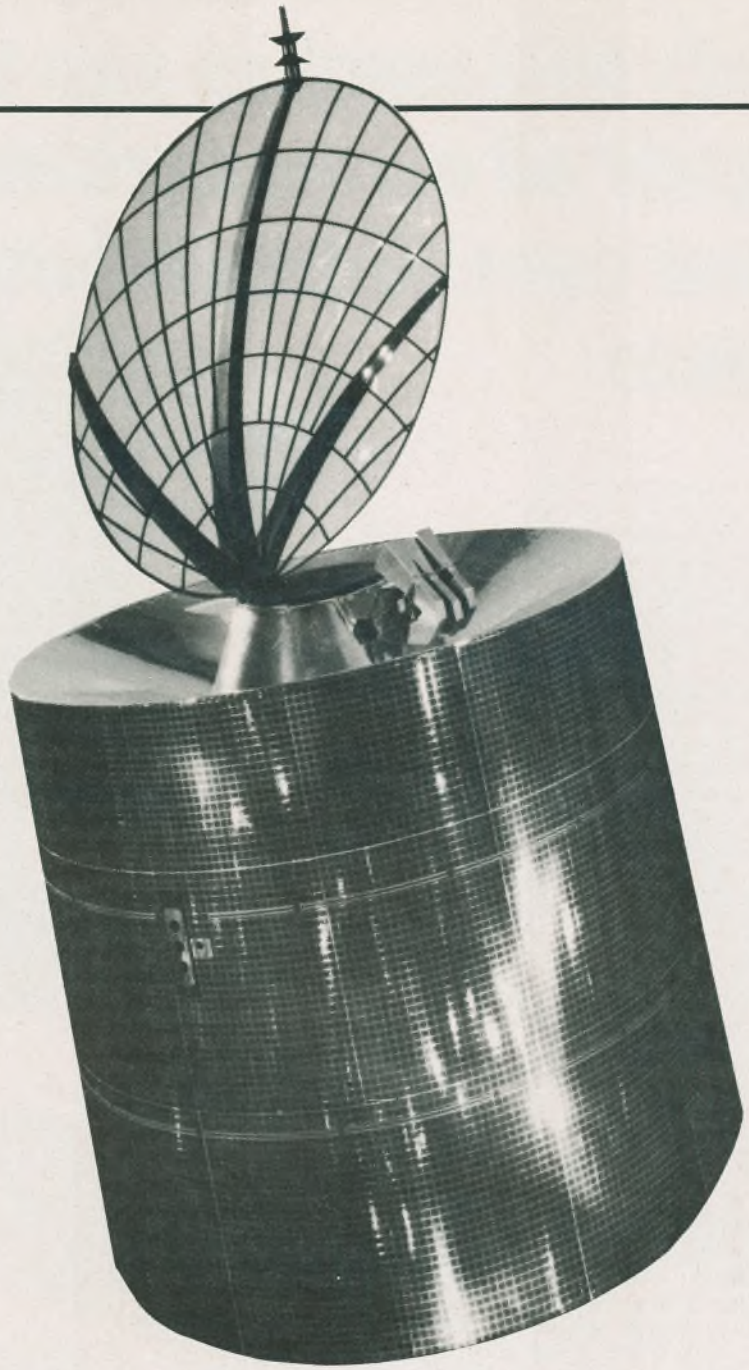
Plasmons: Solar Cell Research

Research into high-efficiency solar cells could change the approach to solar energy conversion; efficiencies as high as 50 percent may be possible.

By David Dempster



HAVE you ever heard of a surface plasmon? If the basic research in solar cell technology now being conducted at NASA's Lewis Research Centre in Cleveland is successful, surface plasmons could become a household word in the energy lexicon of the future. Surface plasmon research is one of several fronts on which the centre is seeking to advance the state-of-the-art of systems to provide electric power in space.

Solar cells are devices that produce electric current when exposed to sunlight, and the most advanced field of solar cell investigation at Lewis today involves the production of electricity without the use of semiconductor material.

The surface plasmon cell represents such an approach, and some day it could achieve very high levels of efficiency. It captures the energy in a broad spectrum of lightwaves as they strike a rough metallic surface, are converted into high speed plasma waves and are then collected and converted into power. Efficiency near 50 percent may be feasible, according to Americo F. Forestieri, head of Lewis' Photovoltaic Technology Section. (This contrasts with less than 10 percent for conventional cells.)

"We are just beginning to make devices that show the feasibility of the various aspects of this totally new energy conversion technique," Forestieri said. "The challenge will be to incorporate all aspects into one practical device. By the early 1990's we hope to have accomplished the goal.

"All of our solar cell technology work currently is focused on space uses," said Forestieri, "but the efficiency and other gains from these efforts will lead to improvements in solar cells designed for terrestrial purposes as well.

"For example, if we can increase the efficiency of solar cells by, say, a factor of three, this would substantially reduce the area of an array and also reduce the balance of systems cost for photovoltaic systems. By doing that, photovoltaic systems could then be competitive with other power sources such as the utilities."

Uses in Space

A large United States space station, orbiting the earth and requiring high power levels, may benefit from such improved technology, but near-term application possibilities include more sophisticated satellites for communications, weather forecasting, reconnaissance of earth resources and similar services.

One of the most promising near-term semiconductor approaches to improved power generation systems for space involves the gallium aresenide solar cell. When perfected, this cell, made by mixing gallium and arsenic or so-called III-V compounds, would equip builders of spacecraft with a more efficient solar cell array able to convert 18 percent of the energy it receives from the sun into electricity. Future efficiency may be as high as 22 percent.

Dr. Irving Weinberg, scientific consultant in photovoltaics at Lewis, ticks off some basic advantages: "Gallium arse-

nide cells lose power under extreme heat at only half the rate of the tried and true silicon cells, are less susceptible to space radiation damage, can recover their energy-producing potential after radiation at a much lower 'healing' temperature than silicon, and can be thinner and hence lighter than a typical silicon cell.

"Added to these benefits is the cell's ability to be used under concentrated sunlight, and we hope to exploit this to produce greater amounts of power at a lower unit cost from a smaller area of cells."

"One example is a gallium arsenide cell only a fraction of the size of a silicon cell that can be placed at the focal point of a small 5 centimeter (2 inch) diameter Cassegrainian mirror concentrator. The Cassegrainian mirror concentrator collects and focuses 100 times more light per unit area on the cell to produce larger amounts of power. Because cell efficiency increases with sunlight intensity, more power can be produced from a given area of cells. This permits the use of smaller arrays. Temperatures on the cell in the concentrator remain remarkably low and long life can be expected."

Lewis is already producing some of the new gallium arsenide cells for experimental purposes. The ultimate goal is to make an ultrathin gallium arsenide cell that will be more efficient and radiation resistant than present silicon cells and comparable in price.

The Cascade Cell

Forestieri and his staff are also working on what they call the ultimate semiconductor solar cell: the Cascade cell. This differs from any others in that it can generate maximum power from each of the colours that compose "white sunlight."

Other cells composed of only one semiconducting substance generate peak performance at one wavelength or colour only. The Cascade cell will employ layers of semiconductors that each produce peak power from a preferred colour of light. As light cascades through each layer, one colour is filtered out to generate power and the others are passed through to be used by the layers below.

Lewis researchers are using a vapour deposition process that can lay down a chemical film a fraction the thickness of a human hair across a substrate to build the Cascade cell. The total Cascade layer cake is about half the thickness of a human hair.

"The Cascade cell should achieve efficiencies up to 30 percent and enable us to reduce the size and weight of structures required to hold solar cell arrays," said Forestieri. "That will be a big advantage in space where smaller solar wings will reduce weight and permit greater payload aboard spacecraft. It will also be of advantage to builders of terrestrial units."

Welding the Cells

Another area of study at Lewis is to develop a practical welding technique for solar cell arrays to replace the use of solder in wiring the cells together to provide practical voltage and current levels. Intense heat, like that encountered by planetary probes sent into the near-sun environment, would melt the solder connections, causing a loss of power.

Temperature cycles of intense heat and cold as encountered by satellites moving from the sun side of a planet to the dark side may cause solder to become brittle and eventually break. A welded array that will be able to withstand greater temperature extremes and cycles is a goal of Lewis scientists. ■

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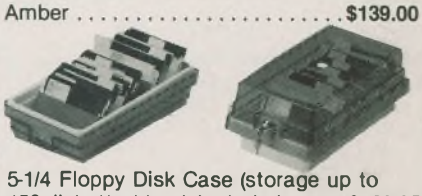

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The VEP-46 programmer programs 16K to 128K EPROMS four at a time, with each bit programmable via the host computer. Will also erase up to 10 EPROMS at a time. Ideal for small production runs or EPROM development work. Specify Apple or IBM host adaptor $449.00

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Circle No. 10 on Reader Service Card

continued from page 18

For Your Information

New Office Software for Apples and Franklins

The Magic Office System by Artsci is a giant step ahead. The power, simplicity and ease-of-use of windowing technology is now available for Apple IIe, IIc and Franklin users. The Magic Office System combines:

- A greatly enhanced version of Magic Window II, the popular "see what you get" word processor
- An electronic spreadsheet faster and more powerful than Visicalc, with variable width columns and output formatting
- A business graphics package for pie charts and multiple bar graphs.
- An automatic spelling checker

Also of note: Lisa-type file folders & documents; on-screen text justificiation; menu & function key driven; single key copy/back-up; restores original file from disk; does Mail Merge and supports many printers and interfaces. In comparison AppleWorks, a similar integrated software package from Apple Computer Inc. is not capable of any of these functions. The entire program is on one disk and each program is fully integrated with the other.

The Magic Office System is distributed by Micron Distributing, 409 Queen Street West, Toronto, Ontario 1-800-268-9052/ (416) 593-9862 and is available at your local computer store. Suggested retail is $399.95.

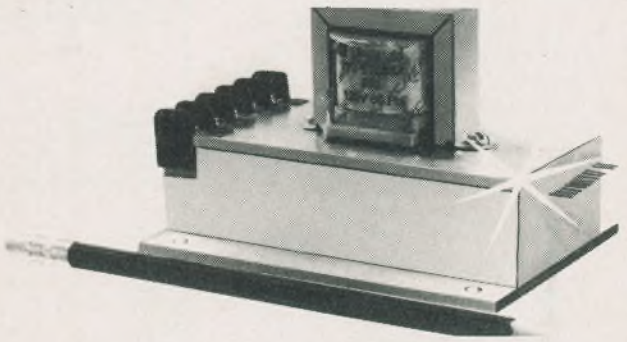
Circle No.51 on Reader Service Card

IC Lotion

Lotion for your chapped chips? Not yet. R&R Lotion, of 1220 North Statem, Tempe, Arizona 85281, are offering a hand lotion for those in the printed circuit repair or manufacturing trades. If you work with solvents and use a hand lotion to prevent sandpaper skin, chance are you're getting silicone, lanolin, or mineral oil on any PCBs that you handle. Solder flux can't be relied on to remove these contaminants. R&R's lotion is said to contain no contaminants that would affect solderability or cause corrosion. You can contact them at the above address, or call (602) 968-7787.

Circle No. 45 on Reader Service Card.

Servo-amp



Servo-Amplifiers Inc. has announced a new and more powerful addition to its line of digital interfaced DC motor speed controls. This new Model 14-25A is for computer controlled DC motor applications, providing up to 3000 watts of true servo power. The computer user is able to attach a standard 90 Volt DC motor through the Model 14-25A to a parallel port without causing any electrical interference in the microprocessor. This outstanding feature is achieved through the use of opto-isolators. A further cost and space saving advantage of the Model 14-25A is the ability to attach it directly to a 110 Volt line without expensive use of power supply or transformers. Contact: Servo-Amplifiers Inc., 2 Bloor St. W., Suite 100-265, Toronto, Ontario, M4W 3E2.

Circle No.55 on Reader Service Card

Over 500 software programs for manufacturing are described in the 1985 Handbook of Manufacturing Software. Programs include inventory control, CAD/CAM, robotics, and process control software. The handbook also covers the fundamentals of applying computers to the manufacturing environment. The handbook is available from: SEAI Technical Publications, P.O. Box 590, Madison, GA 30650. (404) 342-9638.

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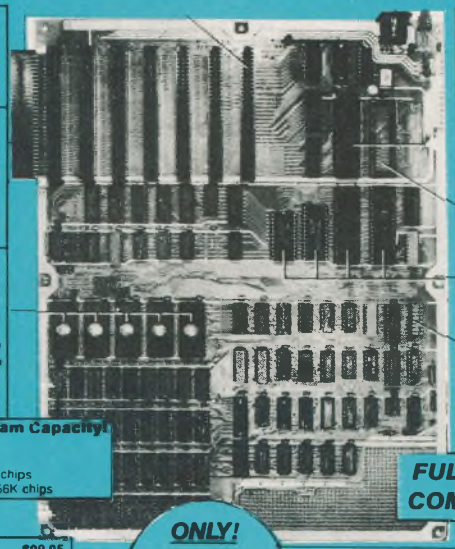

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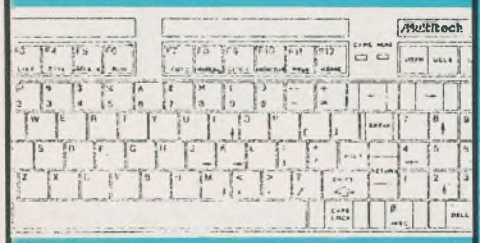

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(G) Printer Card $14.95
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MBE-XT $49.95

Here it is, a 256K XT compatible 8088 machine that works like an IBM. Note has 8 slots on 0.8" spacing to use modern XT peripherals, unlike the BEST which has only 5 on 1" spacing. The MBE-XT will hold any legal or illegal BIOS or BASIC. We suggest the MEGABIOS, one of the better ones available.
(A) MBE-XT with assembly data and parts list $49.95
(B) Complete schematics and manual $4.95
(C) Wave soldered MBE-XT board without any IC's, all sockets, edge con. R.C. Etchwith manual and full schematics. You just add IC's $225.00
(D) As above but fully stuffed with all IC's and 64K of RAM on board with BIOS and M&S $450.00

MEGABOARD/MBE-XT PARTS

A) INTEL/AMD IC set	$ 99.00	N) 62 pin edge conn.	$2.50
B) 8253-5	$ 8.95	O) 5 PIN DIN	$1.50
C) 8259A	$ 8.95	P) Power connector	$1.50
D) 8237A-5	$ 19.95	Q) 4.7K x 6 sip	$0.60
E) 8255A-5	$ 11.95	R) 4.7K x 15 ntwk	$1.00
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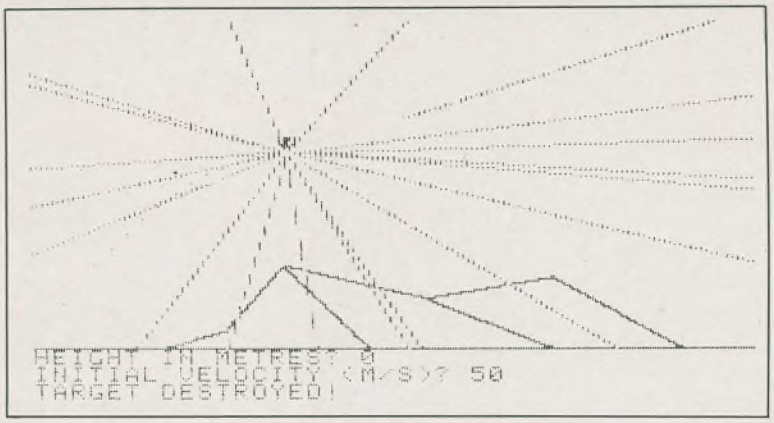
M) 50 pf trimcap	$ 1.00		

Circle No. 18 on Reader Service Card

By Yin H. Pun



Computing Today

Projectile Motion

Learn something about the physics of trajectories, or just play a diverting game; a discussion and a Applesoft listing.

PROJECTILE motion is often a difficult concept to grasp at first. Why do objects, ranging from a small baseball to a gigantic rocket move in such predictable paths after being launched?

Simple projectile motion is easily simulated in real-time on the Apple II's high resolution graphics screen using this program. If you want to do it analytically, the game requires a knowledge of parabolic or projectile motion governed by the law of gravity; if you'd rather just play the game, it's just as much fun as blasting your average aliens. The object is to fire a projectile after calculating its angle and initial velocity to destroy a target suspended in mid-air.

Entering the Program

First boot a DOS 3.3 or a ProDOS 1.0.1 disk and get into Applesoft BASIC. Type in the Applesoft program listing. Save it every now and then (to protect against crashes) by typing "SAVE PROJECTILE.MOTION". Type "RUN" to execute it.

Playing the Game

This game is quite educational in teaching the simple laws of projectile motion. First enter the acceleration due to gravity of the system. If only the "RETURN" key is pressed the acceleration will default to 10 m/s/s, the approximate value on Earth. Use the default value at first. Then experiment with some absurd values. Here are some accelerations due to gravity for some of the planets:

Celestial Body	g, m/s/s
The Sun	285
The Moon	1.62
Mercury	3.76
Venus	8.77
Earth	9.81
Mars	3.80
Jupiter	24.9
A Black Hole	1000

Fig. 1 A few values for g, the gravitational constant.

After you have entered the necessary information, a suspended target resembling a balloon is randomly placed on the screen. It may be as high as 160 metres in the air or as far away as 280 metres. You can enter the angle of your gun from 0 to 90 degrees. The height of your gun may be 0-160 metres high. The speed of your projectile can only be positive. With trial and error, you can usually destroy your target in less than ten shots. But, if you are bold enough, you may make precise calculations to destroy the target.

A projectile on the moon with low gravity requires a low velocity to escape the gravitational pull. A projectile in a black hole (g 1000 m/s/s) requires more than the speed of light (300,000 km/s) to escape. However, in accordance with Einstein's Special Theory of Relativity, the speed of light can be approached infinitesimally but never be attained or exceeded by any material object; therefore, this is impossible. Not even light can escape the pull of a black hole's gravitational field. (That's why they're "black").

The Physics Involved

The velocity of a projectile is a vector consisting of a magnitude (speed) and a direction (the angle). This vector is broken down into two rectangular components, the horizontal and the vertical. The horizontal component of the velocity always stays constant from the time of firing (neglecting any air friction) since no external forces act upon the object horizontally. The vertical component, however, is acted upon by the force of gravity, which is 9.8 m/s/s on Earth. This force produces an acceleration towards the surface (Newton's second law). By considering the motion of the projectile as two independent vectors, its position (or displacement from its initial point) can be calculated. The resultant motion takes the shape of a conic section, the parabola.

The velocity of the object at any instant is the general integral.

$v = \int -a\,dt$ is

$v = -at + K$; K is a constant. It is the initial vertical velocity of the object.

The displacement of the object is the integral of the velocity:

$d = \int -at + K\,dt$ is

$d = -0.5at^2 + Kt + H$; H is a constant. It is the initial height from which the object was launched.

Fig. 2 The equations involved in calculating the ballistic path if you're keen. Consider "a" to be negative as upward directions are positive.

By deleting line 570, the projectile will leave its locus of points on the screen as if the projectile had been photographed with a strobe light and a camera with its shutter open.

The Math

The position of the projectile is simply calculated by two formulas as functions of time, T.

The horizontal position, X, is calculated by line 540.

X = XV * T

where XV is the horizontal component of the initial velocity. T is the time. Since there are no external forces acting in the horizontal direction, the horizontal velocity remains constant (we neglect wind resistance). Therefore, the displacement is directly proportional to the time.

The vertical position, Y, requires more calculations since it is acted upon by the force of gravity. However, you may derive it by simple integral calculus. Displacement, velocity and acceleration are functions of time so you differentiate and integrate with respect to time. The change in displacement, called velocity, is the derivative of the displacement called velocity. The change in velocity, acceleration, is the derivative of the velocity. Working backwards, in other words, the velocity is the anti-derivative or integral of the acceleration and displacement is the integral of the velocity. The acceleration due to gravity which is constant is "a" downward on Earth.

The vertical position, Y, is calculated by line 550.

Y = YV * T - (.5 * G * T^2) + H, where YV is the vertical component of the initial velocity. G is the acceleration due to gravity and H is the initial height of the gun. As T increases, the position of the projectile changes. The equation, of course, is quadratic and a parabola would be plotted on a rectangular T vs. Y graph. Hence, this projectile motion can also be called parabolic motion.

Limitations

Of course, this program only provides a simulation of the real world by natural laws of physics. However, it does prove to be a pretty good approximation.

This program does not consider atmospheric friction of the flying object. Wind and the density of the atmosphere deviate the object from its ideal path. The coefficient due to air friction of the projectile would have to be considered. The faster the object goes, the more friction would act upon it. Wind would create a horizontal force, you can replace line 540 with:

540 X = XV * T + .5 * HX * T * T

where HX is a constant (the value of the horizontal acceleration)

to consider a horizontal acceleration. With this horizontal acceleration, the resultant acceleration vector would no longer be straight down; it would be oblique.

I will leave it to some physicist to destroy the target in one shot by calculation. The hint is to formulate a parabola whose locus coincides with the location of the target.

The applesoft listing appears overleaf

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I-103	512K RAM card (OK on board)	$ 150.00	I-103-8	Flip case 8 slot	$ 75.00
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I-111B	XT mother bare board	$ 48.00	Game I/O	XT joy stick interface card	$ 79.95
I-112A	Power supply (130 watts)	$ 149.00	Drive	DSDD Hitachi drive	$ 219.00

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```
10  REM ************************
    ******
20  REM *      PROJECTILE MOTION
    *
30  REM *
    *
40  REM *       BY YIN H. PUN
    *
50  REM *
    *
60  REM *     COPYRIGHT (C) 1984
    *
70  REM *  BY MOORSHEAD PUBLICATI
    ONS  *
80  REM *       TORONTO, ONTARIO
    *
90  REM ************************
    ******

100 :
110  TEXT : RESTORE : SPEED= 255
120  HOME : INVERSE : PRINT "PARA
    BOLIC MOTION OF A PROJECTILE
    ": NORMAL
130  PRINT
140  PRINT "BY YIN H. PUN"
150  PRINT "COPYRIGHT 1984": PRINT

160  PRINT "The object is to dest
    roy a target by a": PRINT "l
    aunched projectile.": PRINT

170  PRINT "INPUT ACCELERATION DU
    E TO": INPUT "GRAVITY IN m/s
    2? ";G$
180 G =  VAL (G$)
190  IF G$ = "" THEN  VTAB ( PEEK
    (37)): HTAB 19: PRINT "10":G
     = 10
200  POKE 230,64: POKE 28,255: CALL
    62454
210  HCOLOR= 3
220  HGR
230  REM Randomize position of ta
    rget
240 YA =  RND ( PEEK (78)): REM S
    eed random number generator

250 YA =  INT ( RND (1) * 159)
260 XA =  INT ( RND (1) * 269) +
    10
270  GOSUB 1080
280 YT = YA:YS = 159 - YA
290  HPLOT 0,159 TO 279,159
300  HPLOT 50,159 TO 75,150 TO 97
    ,120 TO 150,135 TO 200,125 TO
    250,159
310  HPLOT 97,120 TO 130,159
320  HPLOT 150,135 TO 200,159
330  REM MAIN ROUTINE
340 SL =  - 16336
350 EN = 10
360 ST = .25
370 VE = 100
380  HOME
390  VTAB 21
400  PRINT "Your gun is at the bo
    ttom left."
410  PRINT "g is "G"m/s2"
420  PRINT "The target is "XA"m a
    way and "YA"m up."
430  INPUT "ANGLE IN DEGREES? ";D
    :TH = D *  ATN (1) * 4 / 180

440  IF D   0 OR D   90 THEN  PRINT
    "ANGLE MUST BE BETWEEN 0 AND
     90 DEGREES.": GOTO 430
450  INPUT "HEIGHT IN METRES? ";H

460  IF H   0 OR H   160 THEN  PRINT
    "THE HEIGHT MUST BE   160 AN
    D   0.": GOTO 450
470  INPUT "INITIAL VELOCITY (M/S
    )? ";V
480  IF V   0 THEN  PRINT "VELOCI
    TY MUST BE POSITIVE.": GOTO
    470
490  REM Remember that the 'x' ve
    locity component stays const
    ant.
500 XV = V *  COS (TH)
510 YV = V *  SIN (TH)
520  REM MAIN LOOP OF PROJECTILE
    MOTION
530 T = 0
540 X = XV * T
550 Y = YV * T - (.5 * G * T  2)
     * H
560 SO =  PEEK (SL)
570  HCOLOR= 0
580  HPLOT XL,159 - YL
590  IF X   279 THEN  GOSUB 1200:
     GOTO 330
600  IF Y   159 THEN 660
610  IF  ABS (XA - X)   5 AND  ABS
    (YA - Y)   7 GOTO 680
620  IF Y   0 THEN T = 3: GOSUB 8
    30: GOSUB 1200: GOTO 330
630  HCOLOR= 3
640  HPLOT X,159 - Y
650 XL = X:YL = Y
660 T = T + ST: GOTO 540
670  REM TARGET DESTROYED!
680  HOME : VTAB 24: PRINT "TARGE
    T DESTROYED!"
690  FOR A = 1 TO 100
700 SO =  PEEK (SL):SO =  PEEK (S
    L)
710  POKE 49234,0: POKE 49237,0
720 SO =  PEEK (SL):SO =  PEEK (S
    L)
730  POKE 49236,0: POKE 49235,0
740 SO =  PEEK (SL):SO =  PEEK (S
    L)
750  NEXT :T = 0: GOSUB 950
760  POKE 49234,0: POKE 49237,0
770  FOR T = 1 TO 100: NEXT
780  POKE 49236,0: POKE 49235,0
790  FOR SO = 1 TO 25:T =  PEEK (
    SL): FOR T = 1 TO SO: NEXT T
    ,SO
800  FOR T = 1 TO 3000: NEXT
810  GOTO 110
820  REM THIS ROUTINE PLOTS EXPLO
    SION OF BULLET
830  HCOLOR= 3: IF X   269 OR X
    10 THEN  RETURN
840  FOR EN = 1 TO 2
850 YF = 158: HPLOT X,YF TO X + 1
    0,YF - 15: HPLOT X,YF TO X -
    10,YF + 10: HPLOT X,YF TO X -
    5,YF - 7: HPLOT X,YF TO X +
    5,YF - 7
860 SO =  PEEK (SL)
870  HPLOT X,YF TO X - 7,YF - 4: HPLOT
    X,YF TO X + 7,YF - 4
880  HPLOT X,YF TO X,YF - 10: HPLOT
    X,YF TO X - 10,YF: HPLOT X,Y
    F TO X + 10,YF
890 SO =  PEEK (SL)
900  HCOLOR= 0: NEXT
910  HCOLOR= T
920 SO =  PEEK (SL)
930  GOSUB 1080
940  RETURN
950 : HCOLOR= 2:YA = YS: FOR EN =
    1 TO 2
960 SO =  PEEK (SL)
970  HPLOT XA,YA TO 0,0: HPLOT XA
    ,YA TO 0,159: HPLOT XA,YA TO
    279,159: HPLOT XA,YA TO 279,
    0
980  HPLOT XA,YA TO 150,0: HPLOT
    XA,YA TO 75,0: HPLOT XA,YA TO
    0,75: HPLOT XA,YA TO 279,80
990  HPLOT XA,YA TO 0,35: HPLOT X
    A,YA TO 0,115: HPLOT XA,YA TO
    279,119: HPLOT XA,YA TO 279,
    40
1000  HPLOT XA,YA TO 0,30: HPLOT
    XA,YA TO 0,93: HPLOT XA,YA TO
    279,85: HPLOT XA,YA TO 279,6
    0
1010 : HPLOT XA,YA TO 75,159: HPLOT
    XA,YA TO 150,159: HPLOT XA,Y
    A TO 225,159
1020  HPLOT XA,YA TO 40,159: HPLOT
    XA,YA TO 110,159: HPLOT XA,Y
    A TO 145,159
1030 SO =  PEEK (SL)
1040  HCOLOR= 0: NEXT
1050 YA = YT
1060  POKE  - 16300,0
1070  GOTO 910
1080 YK = 159 - YA
1090  HPLOT XA,YK TO XA,YK - 7 TO
    XA + 1,YK - 7 TO XA - 1,YK -
    7 TO XA + 1,YK - 6 TO XA - 1
    ,YK - 6
1100  HPLOT XA - 4,YK - 1 TO XA -
    4,YK TO XA + 4,YK TO XA + 4,
    YK - 1
1110  HPLOT XA - 1,YK TO XA - 1,Y
    K - 3 TO XA + 1,YK - 3 TO XA
     + 1,YK
1120  HPLOT XA + 1,YK - 3 TO XA +
    3,YK - 5 TO XA + 3,YK - 7: HPLOT
    XA - 1,YK - 3 TO XA - 3,YK -
    5 TO XA - 3,YK - 7
1130  RETURN
1140  HCOLOR= E:E = ((T * 20) AND
    3) * 3
1150  PRINT T,E
1160  HPLOT XA + 1,YK - 3 TO XA +
    3,YK - 5 TO XA + 3,YK - 7: HPLOT
    XA - 1,YK - 3 TO XA - 3,YK -
    5 TO XA - 3,YK - 7
1170  HPLOT XA - 4,YK - 3 TO XA +
    4,YK - 3
1180  RETURN
1190  REM THIS ROUTINE SIMULATES
    A GET STATEMENT
1200  PRINT "PRESS ANY KEY TO CON
    TINUE...";
1210  IF  PEEK ( - 16384)       14
    1 THEN 1210
1220  POKE  - 16368,0
1230  RETURN

]
```

■

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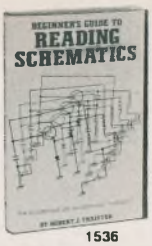

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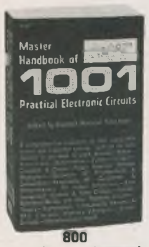

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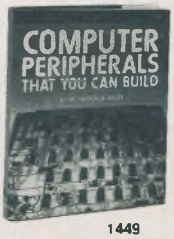

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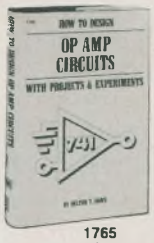

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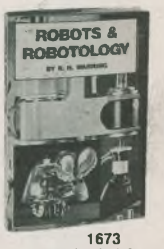

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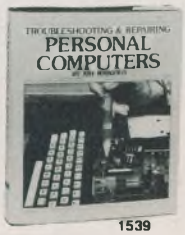

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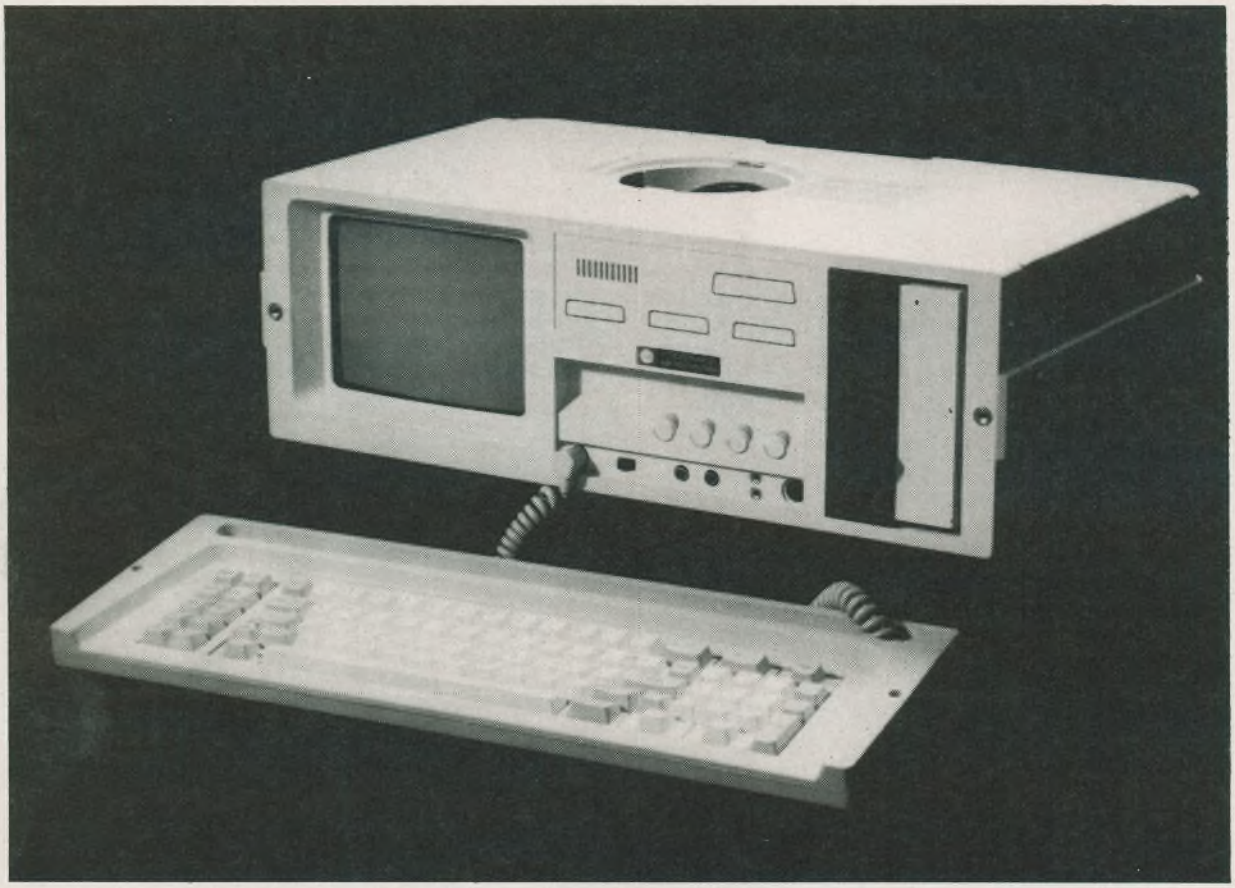


An Apple/CPM-compatible in a portable case complete with disk drive and monitor; some good ideas and some bugs.

by Bill Markwick

OCCASIONALLY I take a 6502 computer home so I can do a bit of word processing without the *Computing Now* staff throwing paper airplanes at me. The computer, monitor, fan, and two disk drives balanced on top of each other make an interesting jiggly tower and an adventure of every doorway. And of course, the trailing power cords wind themselves around every table leg like boa constrictors, pulling disk drives to the floor and scattering bits and bytes everywhere.

To my knowledge, the ECS6 is the first Apple-compatible computer in a truly portable case; the Apple IIc, while transportable, isn't quite the same idea because it has a separate monitor and power supply.

Opening It Up

The computer in its shut state looks somewhat like a portable sewing machine and is about the same size. Unscrewing two knobs lets the bottom come off and reveal its new personality as a keyboard. It's vaguely like an IBM type, but with a few of key legends altered. The function keys have specific uses rather than being programmable, the Alt key now says PWR (although it doesn't actually do anything), the Print Screen is now another Control key, and so on.

On the front panel you'll find a nine-inch amber monitor, one half-height disk drive mounted vertically, jacks for video and cassettes, and knockout slots which will accept three 25-pin D connectors and

one 50-pin. There's a switch marked 40/80 and the usual monitor adjustment controls for horizontal and vertical.

On top is a round plastic cover which unlatches to reveal the power cord. If you pull out the power cord holder, you'll be holding the mounting panel for the fan while peering into the innards of the computer. Inside you'll see a conventional-looking motherboard with eight slots for peripheral cards. In Slot 0 is the small card which holds the ROMs, and in Slot 6 lives the disk controller; the 80-column card for Slot 3 is optional, and requires figuring out the unmarked video cables. Eventually, you'll stumble onto which one goes to the 80-column card and which one to the 40-column output. At the rear is a standard switching power supply and beside it the switching regulator for the monitor. There's 64K of RAM in 4164-type ICs tucked under the monitor tube.

Although you can get cards in and out nicely through the fan opening, the workings are easier to examine with the case top off; this requires removing six screws. A few drawbacks reveal themselves. One is that the front panel cassette jacks have cables which are supposed to plug into the motherboard and can't; the disk drive mounting panel is in the way. Another is that the disk ribbon cable is folded and secured with a metal loop; this loop tinkled unnervingly against the controller card. The power cord for the fan wiggled loosely in space as well.

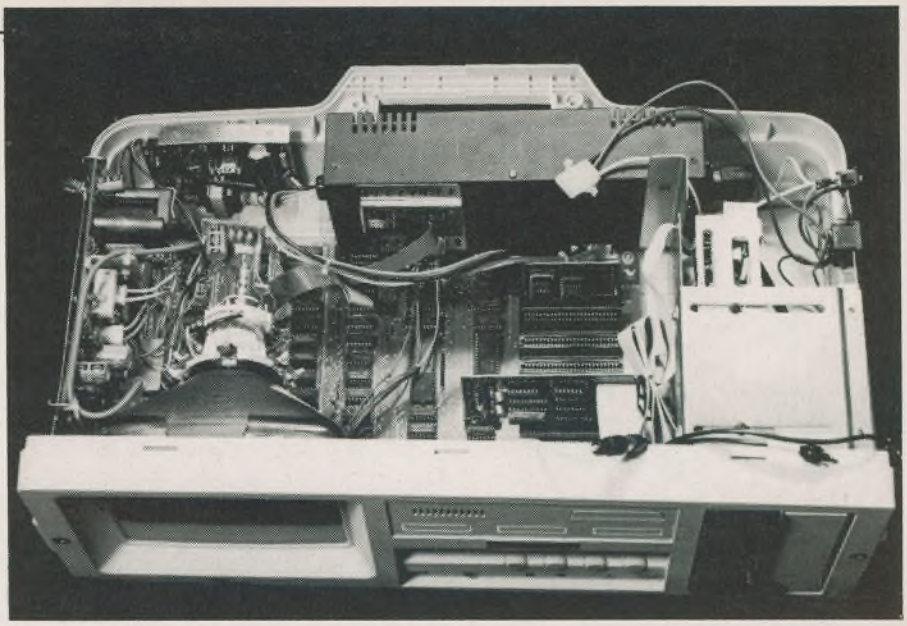
None of these wandering wires caused any immediate problems, but the main and monitor power switches come loose if you take the top off because they're a friction fit between the case halves. Again, this didn't cause anything but annoyance, but I'm thinking of the trusting soul who gives his ECS6 to the airline freight handlers. No doubt he jets off, blissfully unaware that his power switches have either been poked into the case or torn out by the roots.

Lastly, the threaded knobs which hold the keyboard can be inserted into holes in the bottom of the main case to tilt it up for viewing. They don't thread in, however, but sit rather insecurely.

Testing It Out

Remove the coil-cord from its groove in the keyboard and plug in the DIN connector to the front panel. Switch on, and you'll see a sharp, easy-to-read image on the amber screen. Insert a DOS disk and press Boot; PR-6 will automatically appear on the screen and DOS loads itself in.

Working with BASIC was convenient; most of the often-used commands appear at a single keystroke. The CLR/EOL key remains a mystery; though it returned



The interior of the ECS6. The cords at the front edge are for the optional 80-column card; the one at the rear is for the fan.

ASCII 27 (Escape), it didn't seem to affect anything. There are two Control keys on opposite sides since the IBM-style has more keys than an Apple-compatible needs, and I found this very nice for WordStar and its many control functions. The Tab key doesn't actually tab, but prints the word on the screen for use with HTAB and VTAB.

Function Keys

On the left side of the keyboard are BASIC commands such as Run, List, Save, Load, etc. In addition, lots of things

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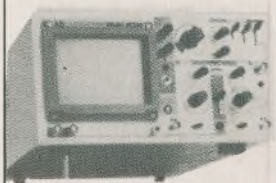

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are stored away in ROM and can be activated via Control/Shift and one other key. The numerals, for instance, will load in little graphics demonstration programs and run them; Control-Shift-7 loads in a simple arithmetic game. The most useful feature would be the string buffers assigned to 12 of the letter keys. To use this, you would type Control-Shift-A, for instance, and then a string of up to 40 characters. This string will now appear whenever you type Control-Shift-A again; very useful for inserting phrases and BASIC statements that you use a lot. As an example, if you need a delay loop to allow time for reading text in a program, you could insert a FOR-NEXT loop in buffer A and recall it as needed.

The next letter up in the alphabet clears the buffer below it; for instance, Control-Shift-B clears buffer A. If you can't keep them all straight, Control-Shift-Z displays all the buffers and their contents.

CP/M

If you insert a CP/M disk and press Boot, you're away. Beside the 6502 on the motherboard lives a Z80; add the optional 80-column card and the world of CP/M software is yours. Word processors are surprisingly comfortable to use on the small screen; the text is about the width of a paperback book. It was a treat to have the 40/80-column switch on the front panel; dual- processor fans will welcome the relief from having to reach around the computer and fumble the video cord into another jack.

As I was doodling away, I heard a clunk from within. I opened the fan door and found that the tiny speaker had come loose from its double-sided tape and was adrift amongst the RAM. *Gasp!* Nothing shorted out, but I'd certainly prefer a better mounting method, especially for a portable computer.

If you'd like a bigger screen, you can power down the monitor separately and connect a bigger one to the front panel jack. If you do a lot of telecommunications and have a serial card, you can easily fit an RS232 jack to the front panel; there are mounting posts on the inside. You can also fit a DIN-type jack if you prefer. Space and jacks are provided for an optional RF modulator should you decide (for some reason) to run the computer into a TV. The modulator fastens to the inside of the front panel with double-sided tape.

More Operating

There's another leftover key on the IBM-style keyboard: FUNC. This didn't func. It didn't seem to have any use at all, though it returned an ASCII value of 31. There's also a HOME key, which is nice for clearing the screen quickly.

I set the keyboard down on top of the computer and went over to another desk. Suddenly there sounded a loud peeping from the ECS6; when I returned to see if ghosts were typing at it, the screen had filled up with gibberish. Turned out that both the monitor and the keyboard are unshielded, and the flyback pulses from the tube just drove the system crazy. It didn't cause any harm, but you have to be careful where you set the keyboard.

The fan was nice and quiet, but I found that the disk drive ribbon cable (that pesky thing *again*) could lazily coil upwards and stop the prop from turning. This could have been easily cured with cable ties.

Summary

Would I buy an ECS6? Yes, but with a few minor reservations. The BASIC and disk drive appear to be fully Apple-compatible, the keyboard has some nice function keys, it's a great looking box with a first-rate monitor, and best of all, it's truly portable. On the other side of the coin, it's obviously been rushed into production without much care being taken with little things. The factory should:

1. Tie back the ribbon cables with plastic ties.
2. Protect the exposed power switches.
3. Label all internal cables.
4. Shield the keyboard or the monitor.
5. Fasten the speaker mechanically.

These are minor problems, but annoying nonetheless. Since our test version was one of the early models, it's entirely possible that by now everything has been corrected on retail models. The cost of the unit at $1295 is a tad higher than buying the equivalent computing power in separate boxes; it generally costs more to have things in nice packages.

Quick Reference

ECS6 Apple-compatible portable

CPU:	dual, 6502, Z80A
RAM:	64K
Monitor:	9 inch amber
Disk Drive:	5-1/4 half-height, includes controller
Options:	80-columns, second drive, etc.
Weight:	11.3 kg.
Other:	80 column switch on front panel, external monitor output, IBM-style keyboard
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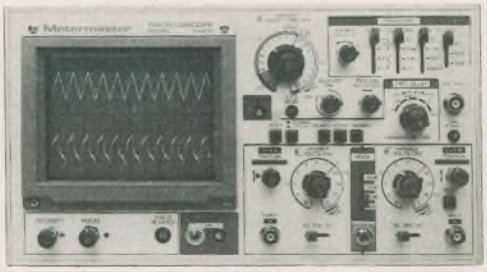

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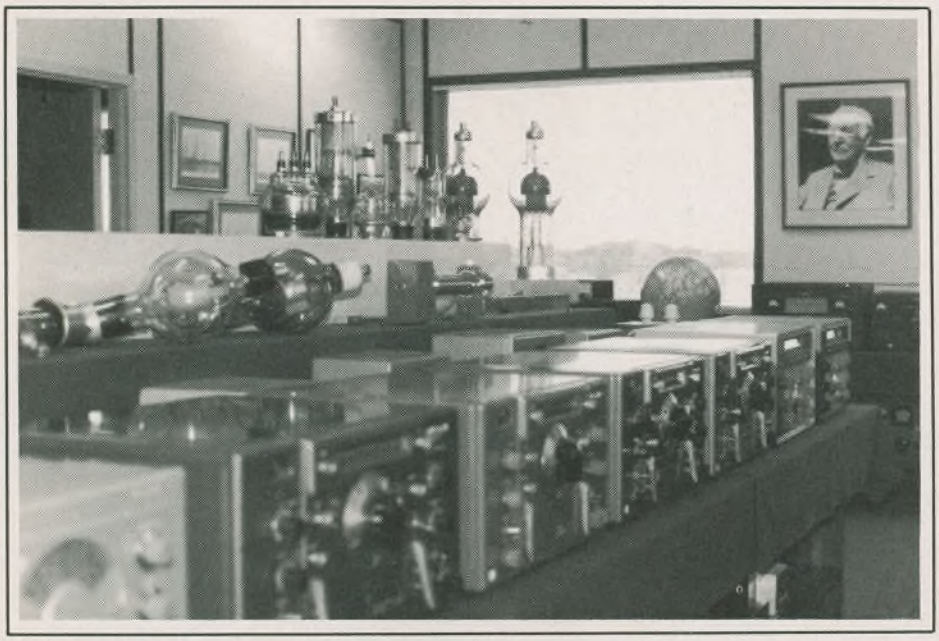
Hammond Radio Museum



The radio equipment of yesteryear is preserved in Hammond's Guelph museum; here are some nostalgic memories.

By James W. Essex

QUICK now! What's the single most important development which enabled us to get to the Moon? Electronics: it also launched many careers, specifically Radio, long before that momentous event. And Fred Hammond of Guelph, Ontario has recorded "radio's long walk" in a recently-enlarged Radio Museum on the top floor of the parent company's sprawling electronics Plant on the north-west edge of Guelph, Ontario. Located on Highway #7 about 48 km north of the telephone city, Brantford, the Museum is in good company, for telephone and radio because synonymous with the spoken word since the early 1900's.

Most of us knew Fred through Hammond transformers, found everywhere since the early days of radio. Fred Hammond, with three brothers, helped it all happen then, and though now semi-retired and the surviving brother of the triumvirate, Fred's determined that we remember the first halting steps of radio with a "Radio Museum".

I first met Fred after I'd assumed charge of a radio station near Guelph. CJCS Stratford was my first job on "civvy street" after stowing the Navy uniform of 1945 and giving a fond farewell to the King's coin. My frustrations were similar to Fred's, however, for he had to comb store-rooms and attics where vintage radios were left long forgotten while I faced the prospect of a transmission-less Christmas because an equally antiquated transmitter which failed on the most lucrative business day of the year, Christmas 1945.

"I'll see what I can do to get you back on the air," replied Fred in response to my cry for help. Remember, this was the day of entrepreneurs like Roy Thomson where baling wire and a few tubes constituted a transmitter, and anyone with more nerve than common sense could set up shop. In fact, Thomson, along with Jack Kent Cooke (who went on to become a top sports promoter in Los Angeles), got Stratford its first commercial radio license in 1937 after another set of brothers named Higgins built 10 A K Stratford about 1933. This was my inheritance; much like Fred Hammond's radio memorabilia is today. And Thomson has his "Roy Thomson Hall" in downtown Toronto.

The museum contains everything you always wanted to know about radio but were afraid to ask. How many, for example, recall the famous "Scott" radio containing a nickel-plated chassis? Even tube shields were plated, the Cadillacs of the trade. Or the opposite extreme, the humble crystal-set which provided the glue which held the fledgling industry together in the early years, but which tried the patience of the most tender souls trying to find the "hot-spot" so he could listen to *Amos 'n Andy*.

Hammond has a radio from every decade, including the type which received the first Presidential returns from pioneer Radio Station KDKA Pittsburg. When "Harding Wins" burst forth over the air waves the night of November 2nd, 1920, it marked a new era in radio beating the newspapers to the punch, and instant communications was begun.

Perhaps about a hundred homes possessed receiving sets then. By 1929, U.S. radio sales totalled nearly $950 million as Americans paid upwards of $118. (fantastic then) for elaborate console models with up to 14 tubes and a loud-speaker, of which Fred has two, still in their shiny, hardwood hand-rubbed walnut cabinets. Motorola invented the car radio that year and Fred has some of these, too. The loudspeaker was mounted under the all wood floor-boards then in vogue while the radio itself was twice the size of a sportsman's tackle box. Despite size, this new concept became firmly established as the forerunner of the sleek, miniaturized radio and tape players commonplace today in autos. Even the stock crash of that year couldn't stifle radio. People may have been short of money in "the Hungry Thirties" after the Market Crash of 1929, but they always seemed to find money for entertainment, as the wide range of taste reflected in Fred Hammond's equally huge display of the best from that era testifies.

In the Museum today you'll find radios heard only by earphones to huge ones driving loud-speakers following the advent of the push-pull triode circuits using the type 45 triode tube which radiated enough heat to warm the living-room wall. (It's interesting to note that today's kids have brought us full circle as they walk the streets, headphones clamped tightly to their ears. Early pioneers did the same thing then, only in the living-rooms of the nation.) Loudspeakers which followed brought families together again. Fred has many early examples of this development, from the early classic horns symbolized by the puppy-dog and RCA's "His Master's Voice" to the huge dynamic speakers which eventually went into Movie Houses, and which made Al Jolson's "Sonny Boy" synonymous with magic.

To see Hammond's Museum is to enjoy a commentary on the social mores of yesteryear. That noble experiment of the

Some of Fred Hammond's DX cards confirming long-distance reception. Below is a Stromberg-Carlson receiver of the 1920's; the three RF stages had to be tuned exactly with each other. All photos by Dave and J.W. Essex.

1920's, Prohibition, is here also when radio complemented President Hoover's idea. Prohibition was not much of a success and, after 13 years, it was abandoned in favour of a new morality. Prohibition was at last cancelled with the Twenty-First Amendment, ironically announced via Radio, of course to an expectant public which had had enough.

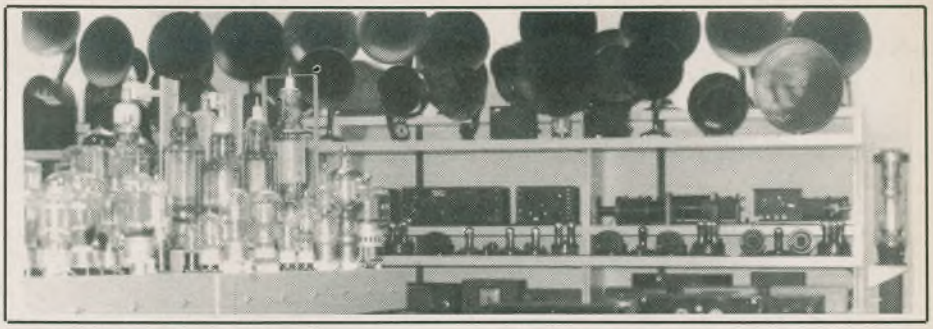
One buff even had his picture taken sitting with a pair of headphones clapped tightly upon his ears with a bottle of "illegal" whiskey at his side, ready to consume as soon as the repeal was flashed across the nation. Colourful reports continued over Radio, attracting still more listeners captured by the sheer excitement engendered by news "greats" like Lowell Thomas, as Al Capone and rival gangs in Chicago vied for power. The times ushered in a new era of comedy with Jack Benny and Fred Allen and a public grown tired of violence. A peculiar appendage of that age was the proliferation of violins carried in the streets of Chicago which led many to remark "it was a musical city". Many types of radios, like the radios which carried the action then, are in the Museum today, while popular songs such as "I'll see you in My Dreams" lent an air of unreality to the wonder of the age which could bring the world into your living room without wires.

Fred points with pride to an early wireless, built by a Canadian, Colin B. Kennedy of Teeswater, Ontario, who preceded Hammond's own flirtation with making radio receivers and who also failed to survive in a rapidly competitive market. Hammond continued in component manufacture and today is one of the larger producers of power transformers for electronics, while the Kennedy is heard no more except in the Museum; it shares the fate of the crack International Limited, the huge steam-drawn train which raced between Montreal and Toronto, equipped with radio (*Electronics Today*, December, 1981). Now both steam and that form of radio are gone but artifacts of that era can be seen today in the Museum. (An actual steam engine too of that era rests by the CNR tracks at Guelph's VIA Rail Station — a brief ride from the Museum). Not forgotten is the tremendous advance in the vacuum tube which Fred has lovingly displayed to advantage in huge racks. There are the UV200's, the 227's and the 2A5's, the 6L6's which opened our eyes by showing what a pentode power stage in a radio could achieve in loudness, up to the larger transmitter tubes like the 810's, 812's and the air-cooled 6066's by Western Electric, only one of the many type of transmitter tubes which helped make it all possible. Decorating the door frame is a huge water-cooled transmitter tube which stands as high as the door, a symbol of the epitome of power of Radio's heyday.

The Museum hasn't forgotten the early "radio pioneers extraordinaire": the Radio Amateur. Fred has his own high-powered short-wave transmitter which he still uses to contact world listeners, evidenced by DX cards from all over the globe. Amateur radio receivers including the famous Hallicrafters are here, as well as an AR-88 built by RCA which were used widely in World War Two by the Air Force, Navy, and some Army units. The Museum has early turntables used when radio consisted mainly of a phonograph and a microphone, epitomized by men like "Doc" Cruikshanks of CKNX Wingham. Something resembling protec-

tionism today was evidenced in early radio too; if you wanted a Western Electric microphone, for example, you had to buy a whole transmitter (theirs, of course).

Diversity receivers are also displayed. They were the set-ups whereby several receivers at varying locations were phased to a common listening post in order to reduce "fading", the characteristic "wave sound" of overseas broadcasters. These of course have been phased out too, made obsolete by the satellite where steady-signal strength from overseas is not just a hope but a fact. Communications from the Moon itself proved you didn't need gobs of power to get distance, nor for that matter knowledge of the vagaries of the Kennelly-Heaviside Layer, which is what the "Diversity Receiver" tried to compensate for.



A sampling of various loudspeakers along with various types of radio sets.

Today, Fred and I laugh about how we got that recalcitrant long-ago transmitter in Stratford back "on the air": he, by sending me a box full of miscellaneous spare parts on the next train; me, by picking over them judiciously until I found just the right combination of capacitors to replace the shorted Final which popped because of an ice storm shorting the antenna lead-in on the hotel roof where our 50 watt transmitter was located.

To see the Museum, go to the reception area in the office on Curtis St., Guelph during business hours and request "to see the Museum". Memorabilia of men not only like Lee De Forest, but Edison, Marconi, Fessenden and others are here.

And as Fred locked the Museum door behind us, the darkness which had descended emphasized a brilliant moon which hung in the sky outside. "Isn't it beautiful," said Fred, looking up but not taking into account a new generation had already began a museum of their own up there. For on that heavenly body lay the remnants of man's "greatest step" and a plaque marking the event; perhaps one day younger minds will tour much as I had done embracing the yesteryear of Radio in Hammond's Museum, today. Such has been the "leap" of Radio. ■

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Software Now!

The difference between we humans and the other inhabitants of the planet, is our capacity for making tools. Civilization is often measured by its grasp of technology . . . it's through his use of tools that man has come to be able to manipulate his environment.

The computer is the ultimate tool . . . it is, like man himself, unspecific, and thus adaptable to virtually any task. The same computer can be a bookkeeper, a game, an artist's palette, a composer's amanuensis, a word processor or a programmer's development station.

The computer itself is simply a box full of chips. The power of computers lie in the software that runs on them.

Software Now! is the magazine for people harnessing the power of the microcomputer. In its pages, you will find the information which you will need to choose and apply the software that will dedicate your computer to your tasks. It will help you make sense of the miriad of similar software packages, translate the intricate complexities of software claims, understand the watershed breakthroughs in software development . . . and even have a bit of time left over to dematerialize a few aliens.

Perhaps most exciting, however, is that the pages of **Software Now!** contains news about software for applications you've never even considered running on your computer. Imagine having an overview of the work of the world's most gifted program developers . . . and you'll have a good idea as to what **Software Now!** is about.

Software Now! deals with a broad range of systems and applications, encompassing eight, sixteen and thirty-two bit machines, and software as diverse as video games, drafting systems and spreadsheets.

Features In The Queue

Here's some of the editorial line up for the next few issues of **Software Now!** You can expect it to change a bit . . . new software springs up almost daily, and **Software Now!** is always featuring the most important developments in this dynamic field.

Computer Aided Drafting On a Micro ● Techniques in MacPaint ● How to choose a Spreadsheet ● Apple Software Crate ● Getting to the Root of UNIX ● The Digital Research Pantry ● A Thousand and One Word Processors ● IBM's Productivity Family ● Can Mac Write? ● Professional Software Roundup ● Power Programs for the 64 ● Approaching the C ● Word Processing Support Programs ● dBASE II Enhancements ● Will it Run Multiuser? ● Concurrent CP/M

Reviews (typically 10 each issue): 10 Base ● Mighty Mail ● WORDBASE ● Easy Script ● Computer Chef ● Electronic Circuit Analysis Program ● Superex Retailer ● MAI Basic Four ● The Print Shop ● TK!Solver ● Microsoft BASIC for the Macintosh ● Sundog ● Turbo PASCAL for the IBM ● AutoCAD ● MultiMate ● Lexicheck and Word Juggler ● Dataflex ● Symphony ● Omniterm 2 ● DB Master ● Paint Magic

In addition to this, look for these regular features:

The Library	(Monthly survey of books)
By The Board	(Public domain software)
Arcade	(A look at the latest games)
Short File	(An overview of new releases)

We've reached a level of development in microcomputer software wherein one needn't be a computer genius to apply a computer. In fact, one can operate a computer with only a bit more expertise than one needs to successfully make toast. The key that will unlock the power of your computer is the software you plug into it.

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Computers in Education is Canada's only dedicated magazine for the educator involved with microcomputers. There are articles on the latest developments and technology, others on beginners guides to languages etc., but the emphasis is on software.

There are between 6,000 and 11,000 educational programs (so many that even we are not sure of the total) — some of them can only be described as junk, while others are superb. Sorting out the good from the bad is a horrendous task, but **Computers in Education** can help. Also there is a section on electronics with a build-it-yourself project, technical tips and more.

Features in recent issues have included: The ICON Computer, 10 Things to do if it Doesn't Boot, Beginners Terms Explained, Floppy Disks, Extra Ports for your Computer, Overview of Word Processing, Word Processing Mini-Survey, BASIC Tutorial, Microcomputer Buyers Guide, Canadian Computers and Courseware, Computers and the Handicapped, Computer Learning Systems, Logo: Opening Doors, Survey of School Computers in Canada, Computer Assisted Testing.

Software Reviews: Rocky's Boots, Coco, Touchtype, Golf Classic and Compubar, Report Card, Delta Drawing, Apple Writer, Magic Window.

Electronics Today
INTERNATIONAL

The world of electronics is changing, not year-by-year, but day-by-day. Our future depends heavily on the developments in the electronics field: computers to speed the flow of information and to remove the drudgery from our lives, control systems to improve productivity in our factories and offices and to reduce energy wastage. Entertainment is also now largely electronic: TV, VCR's, Hi-Fi and information systems such as Telidon.

Defence, communications, navigation . . . the list goes on and on.

We are living in an electronic world and **Electronics Today** reflects this, keeping you in touch with what is happening and what is changing. Each month **Electronics Today** reports on new products and applications as well as presenting circuits and state-of-the-art projects.

Features: A vast range of subjects are covered in the magazine, from microwave ovens to music synthesizers to satellite communications, but this gives only a glimpse at the true scope.

Projects: Each month **Electronics Today** describes at least two electronic projects, a high proportion of them designed, built and tested in ETI labs. Almost all build into attractive units using printed circuit boards available from several sources.

Circuits and Design: Most months **Electronics Today** carries a "Circuits" feature, which either describes a multitude of applications for a particular device, or different circuits for a given application. These are invariably written by professional circuit designers.

Microcomputers: Each issue of the magazine has a computer review as well as a regular column "Computing Today" plus several other articles and frequently projects for the advanced microcomputer user.

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You can't go outside any more without being inundated with advertisements for computers. In fact, even staying inside won't help very much, unless you unplug the TV and the radio and threaten the postman with violence so he'll stay away. Computers are becoming as much a part of our culture as are TV, cars and central heating. In five years, computer illiteracy may be as much of a handicap as print illiteracy was five years ago.

Despite the colourful advertisements that have turned up in the media for computer hardware, micros are still understandably forbidding for many people. In fact, though, most new computer owners are amazed at just how small the leap from unpacking the thing, to getting it to do what they want it to do really is.

A computer is an everything tool. It can do anything you can conceive of having it do, limited only by your own ingenuity in telling it how. This is the art of programming, an experience not unlike that of an artist with every colour of paint imaginable and a blank canvas the size of Australia. However, the canvas of a computer never gets full . . . the more you learn how to do, the more you'll realize it is possible to tackle.

Computing Now! magazine can be the most useful accessory you can buy for your system. Every issue is stuffed full of news about products which will enhance your system, programs to run on it, ideas and applications to give you new things to do with your machine, articles about programming techniques, and tricks to make your computer a better tool for realizing your ideas, and piles of other features to help you get the most out of your system.

Whether you are looking at a computer as a hobby or to run your business, **Computing Now!** can provide you with information and applications to make your system the most useful thing you've ever bought next to the can opener. The articles in **CN!** are written by people who are using computers daily, and are among the most experienced small computer users in the country.

Computing Now! is published and wholly owned in Canada. As such, the articles and advertisements in it relate specifically to products you can get North of the border. There is nothing more frustrating that finding something interesting in an American magazine, only to discover that it will take four months to drag it through customs.

We know microcomputers and we practise what we preach — in fact, we are probably one of the most computerized companies in Canada. Here are just some of the systems we currently own: Apple II and compatibles (15 systems); Apple Macintosh; IBM PC and compatibles (BEST; Corona, Columbia, JLS); Nelma Persona (2); TRS-80 Model II (2); Commodore 64; Vic-20; Commodore PET; ZX81; if800; Acorn Atom; Multiflex. These are just some of the systems we own and use ourselves; our contributing editor's systems are additional to this list.

With powerful computers becoming widely available, you can't afford not to be aware of the expanding universe of micros **Computing Now!** can provide you with an understandable, incisive and varied insight into this powerful new technology. It is written to be both understandable by the beginner and informative for the more experienced user with a depth and variety unequalled by any other contemporary computer publication.

Recent articles: Local Area Networks ● Hexes and How to Throw Them ● Interrupts on the IBM ● Review of Three IBM Clones ● Bandit (a game) ● What is MS-DOS? ● Rescuing Lost Data on the 64 ● Backing Up Protected Disks ● Stockboy (an inventory control program) ● Computer Aided Drawing ● Survey of Portables ● Infomart ● Digging up CP/M ● Drum Card Review for the Apple ● Review of the HP 150 ● Hacking Modem7 ● How to Use the Smartmodem ● CP/M MAC Macro Assembler ● Popular Business Software Directory ● Explaining the IBM Serial Interface ● Directory of Microcomputer Paraphernalia ● Xerox Service Centres ● CN!'s Most Asked Questions ● dBASE II Report Generator ● Dimension 68000 Review ● Review of Radio Shack's 2000 ● IBM Telecommunications ● Business On Line ● A Potful of BASIC Routines ●

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MDM730

MDM730 is one of the most powerful MODEM7 programs available . . . and the Computing Now! version of MDM730 incorporates features not available in the public domain editions. If you are into telecommunications, bulletin boards and downloading software your life will be full and meaningful with this code. For background on MDM730, see July 1984 Computing Now!. Consider the facilities.

- Terminal program which works at any baud rate.
- Ten programmable macro function keys.
- Thirty six number phone library.
- Christensen software transfer protocol.
- User settable toggles for line feeds, ON-XOFF and so on.
- Extensive help menus.
- Baud rate selection on the fly (or the spider).
- ASCII dump and capture.
- Status menu
- Many more features.

In addition to all this splendor, however, we've added dialing support for the Apple version. While the standard MDM730 cannot dial unless it's hooked to a Hayes Smartmodem, we've added patches to it to allow it to do pin twenty five pulse dialling and to dial through the Hayes Micromodem II and the SSM card. The Computing Now! MDM730 will also

- Select a number from the library and dial it
- Accept a hand entered number and dial it
- Wait for carrier
- Log you onto the remote system if it's free
- Optionally autodial if the remote board is busy.
- Count the number of attempts at dialling the remote BBS.

The Computing Now! MDM730 package is available for

- The Hayes Micromodem II.
- The SSM 300 Baud modem card.
- The PDA 232C serial card with external modem.

The PDA 232C package includes versions supporting both the Smartmodem and a dumb modem with pin twenty five line control, such as the Novation AutoCat.

Also included with each package are utilities to permit easy alteration of the phone number library and the function key macro strings plus an extensive documentation file.

The source code file for this program is over a hundred and fifty kilobytes long. It cannot be hacked on a standard Apple. We patched it on a larger machine and downloaded it. As such, we're pretty sure that MDM730 with these features is unavailable elsewhere.

Available for: Apple II + CP/M 2.2. systems

TRS-80 Model II (complete with the above applicable features)

Please specify modem version from above list. **$29.95**

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Fine Print:
The original MDM730 code is in the public domain. We are offering this part of the program without cost. The charges for this package are for the patches created by Computing Now! and to defer the cost of handling and postage.

This software is guaranteed to work correctly if properly applied. The serial cards on Apple and compatible systems must be installed in slot two with at least 48K of RAM running Microsoft CP/M 2.2. The PDA 232C version will require the availability of either a Hayes Smartmodem or a modem with pin twenty five line control to dial. Users of the SSM card version may experience some difficulty in detecting extremely faint carriers on older versions of this card.

Formats

Where **CP/M** is shown, the following formats are available:

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Access Matrix, Morrow Micro Decision, Superbrain, Xerox/Cromenco*, Epson QX-10VD, Sanyo MBC1000, Nelma Persona, Kaypro II, Osborne Single Density*, Osborne Double Density, Systel/Olympia, 3R Avatar, Attache, Televideo, Lobo Max-80*, DEC VT-180, Casio FP-1000, Micromate, Zorba, 8 inch SSSD*

*Software marked with an asterisk is the higher price quoted.

MDM730 for the Apple II + CP/M requires two disks and is at the higher price.

PC
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AppleDOS
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TRS-80 Model II CP/M
Will operate under either Lifeboat or Pickles and Trout CP/M.

Apple Wordstar Fixer

Apples and Wordstar are not entirely friendly. Apple compatible systems equipped with Videx type eighty-column cards do a number of unpleasant things to this popular word processor. While there are simple cures for this... they all involve some delicate code hacking.

The Fixer solves this problem. Place it on the same disk as your copy of WS.COM, type FIXER and after a suitable amount of disk noise version 3.0, you will have APWS.COM on there too. This version of Wordstar includes special patching and unhooking code which runs each time you boot Wordstar, and makes your fruit behave as it should. It releases the control K's, translates the left arrow key to a delete character, and patches Unitron keyboards.

In additional all of this, the fixer allows you to set some of the defaults of Wordstar which the MicroPro INSTALL Package doesn't really get to. All of these features are menu driven in English for absolute non-technical operation.

Fixed Wordstar will run in either 44K or 56K CP/M.

Available for:
Apple II + CP/M only. **$19.95**

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Steve's CP/M Wunderdisk! Volume the First

In the course of doing the last year or so of Computing Now! we've generated a lot of code. We've collected all the programs we've written... some of which have never been published in any of our magazines... and put 'em all on one disk. Included are things like STAR, the Gemini 10 printer setup, the Last Wordstar Unhook, CPMAP and the CP/M HOST program, complete with several unreleased support programs.

The Wunderdisk is the best collection of tricky CP/M routines on the planet, ideal for anyone who wants to get inside this powerful operating system and sing. It's also the best documented... the programs, for the most part, are written up in issues of Computing Now!

The Wunderdisk is available for: CP/M **$19.95**

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Gemini WordStar PRESS

The WordStar printing function is agonizingly slow. It's also not very obliging in regards to where it puts its page numbers and things like headers.

PRESS is a utility which handles the formatted printing of all sorts of text files, be they manuscripts, drafts, program listings . . . anything that you'd normally want printed out in page form. It installs the header of your choice at the top of each page and slaps the page number beside it.

It also gives you a running count of the number of characters, lines and pages having hit the printer as you go. It allows you to have your documents printed out in a variety of type size and style permutations, commensurate with the capabilities of your printer.

Most important, however, PRESS will send text to your printer, formatted and all, as fast as your printer can accept it. It will even adjust the high bits of WordStar files to avoid selecting the Sanskrit character set.

PRESS comes configured for the Gemini 10X and 15X printers. It will, in fact, be quite happy with most Epson compatible dot matrix printers. A version is also supplied for use with letter quality daisy wheel printers.

PRESS is a simple to use package which communicates with you in plain English.

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Moorshead Publications Almost Free Software

Almost Free Software #1

Modem7. Allows you to communicate with any CP/M based system and download files. Complete details were in Computing Now! November 1983.

PACMAN. You can actually play PAC-MAN without graphics, and it works pretty fast.

FORTH. A complete up-to-date version of FIG FORTH, complete with its own internal DOS.

DUU. The ultimate disk utility allowing you to recover accidentally erased disk files, fix gorched files, rebuild and modify your system. A real gem.

D. A sorted directory program that tells you how big your files are and how much space is left on the disk.

USQ/SQ. Lets you compress and uncompress files. You can pack about 40% more stuff on a disk with this system.

Finance. A fairly sophisticated financial package written in easily understandable, modifiable Microsoft BASIC.

BADLIM. Ever had to throw out a disk with a single bad sector? This isolates bad sectors into an invisible file, making the rest of the disk useable.

DISK. Allows you to move whole masses of files from disk to disk without having to do every one by hand, you can also view and erase files with little typing.

QUEST. A "Dungeons and Dragons" type game.

STOCKS. This is a complete stock management program in BASIC.

SEE. Also known as TYPE17, will TYPE any file, squeezed or not allowing you to keep documents in compressed form while still being able to read them.

Order as AFS #1 and specify system

Almost Free Software #2

BISHOW. Th ultimate file typer, BISHOW version 3.1 will type squeezed or unsqueezed files and allow you to type files which are in libraries (see **LU**, below). However, it also pages in both directions, so if you miss something, you can back up and see it again.

LU. Every CP/M file takes up unnecessary overhead. If you want to store lots of data in a small space, you'll want LU, the library utility. It permits any number of individual files to be stored in one big file and cracked apart again.

RACQUEL. Everyone should have one printer picture in their disk collection.

MORTGAGE. This is a very fancy mortgage amortization program which will produce a variety of amortization tables.

NSBASIC. Large disk BASIC packages, such as MBASIC, are great... and very expensive. This one, however, is free... and every bit as powerful as many commercial programs. It's compatible with North Star BASIC, so you'll have no problem finding a manual for it.

Z80ASM. This is a complete assembler package which uses true Zilog Z80 mnemonics. It has a rich vocabulary of pseudo-ops and will allow you to use the full power of your Z80 based machine... much of which can't be handled by ASM or MAC.

VFILE Easily the ultimate disk utility, VFILE shows you a full screen presentation of what's on your disk and allows you to mass move and delete files using a two-dimensional cursor. It has heaps of features, a built-in help file and works extremely fast.

ROMAN. This is a silly little program which figures out Roman numerals for you. However, silly programs are so much fun...

CATCHUM. If you like the fast pace and incredible realism of Pacman, you'll go quietly insane over Catchum... which plays basically the same game using ASCII characters. Watch little "C's" gobble periods while you try to avoid the deadly "A's"... It's a scream.

Order as AFS #2 and specify system

Almost Free Software #3

OIL. This is an interesting simulation of the workings of the oil industry. It can be approached as either a game or a fairly sophisticated model.

CHESS. This program really does play a mean game of chess. It has an on-screen display of the board, a choice of colours and selectable levels of look ahead.

DEBUG. The DDT debugger is good but this offers heaps of facilities that DDT can't and does symbolic debugging... it's almost like being able to step, trace and disassemble through your source listing.

DU87. The older DUU program does have some limitations. This version overcomes them all and adds some valuable capacities. It will adapt itself to any system. You can search, map and dump disk sectors or files. It's invaluable in recovering damaged files, too.

ELIZA. This classic program is a micro computer head shrinker... It runs under MBASIC, and, with very little imagination, you will be able to believe that you are conversing with a real psychiatrist.

LADDER. This is... this program is weird. It's Donkey Kong in ASCII. It's fast, bizarre and good for hours of eye strain.

QUIKKEY. Programmable function keys allow you to hit one key to issue a multi-character command. This tiny utility allows you to define as many functions as you want using infrequently used control codes and to change them at any time... even from within another program.

RESOURCE. While a debugger will allow you to disassemble small bits of code easily enough, only a true text based disassembler can take a COM file and make source out of it again. This is one of the best ones available.

Order as AFS #3 and specify system

Almost Free PC Software #1

For IBM PC's and genuine compatibles. Available in Double-Sided or two Single-Sided Disks.*

PCWRITE. While not quite Wordstar for nothing, this package comes extremely close to equalling the power of commercial word processors costing five or six bills. It has full screen editing, cursor movement with the cursor mover keypad, help screens and all the features of the expensive trolls.

SOLFE. This is a small BASIC program that plays baroque music. It's also a fabulous tutorial on how to use BASICA's sound statements.

PC-TALK. A Telecommunicatons package for the IBM PC which does file transfers in both ASCII dump and MODEM7/X-MODEM protocols and comes with... get this... 119424 bytes of documentation.

SD. This sorted directory program produces displays which are a lot more readable than those spewed out by typing DIR.

FORTH. This is a small FORTH in Microsoft BASIC. You can build on the primitives intregral with the language.

LIFE. An implementation of the classic ecology game written in 8088 assembler.

MAGDALEN This is another BASIC music program.

CASHACC. This is a fairly sophisticated cash acquisition and limited accounting package written in BASIC. It isn't exactly BPI, but it's a lot less expensive.

DATAFILE. This is a simple data base manager written in... yes, trusty Microsoft BASIC.

UNWS. Wordstar has this unusual propensity for setting the high order bits on some of the characters in the files it creates. Here's a utility to strip the bits and "unWordstar" the test. The assembler source for this one is provided.

HOST2. This is a package including the BASIC source and a DOC file to allow users with Smart-Modems to access their PC's remotely. It's a hacker's delight.

Order as AFPCS #1 Specify Double-Sided or 2x Single-Sided.*

Almost Free Software #1, #2 and #3 are for CP/M and are available in a variety of formats: Apple // + CP/M, 8 inch SSSD*, Access Matrix, Morrow Micro Decision, Superbrain, Xerox/Cromemco*, Epson QX-10VD, Sanyo MBC 1000, Nelma Persona, Kaypro II, Osborne Single* and double densities, Televideo, DEC VT-180, Casio FP-1000, Zorba.

***single density formats require two disks. The package cost for these formats is $19.95**

All of this software has been obtained from public access sources and is believed to be in the public domain. The prices of the disks defer the cost of reproducing them and mailing them, plus the cost of the medium. The software itself is offered without charge. A few items include messages imbedded in the code asking for voluntary donations on behalf of the authors.

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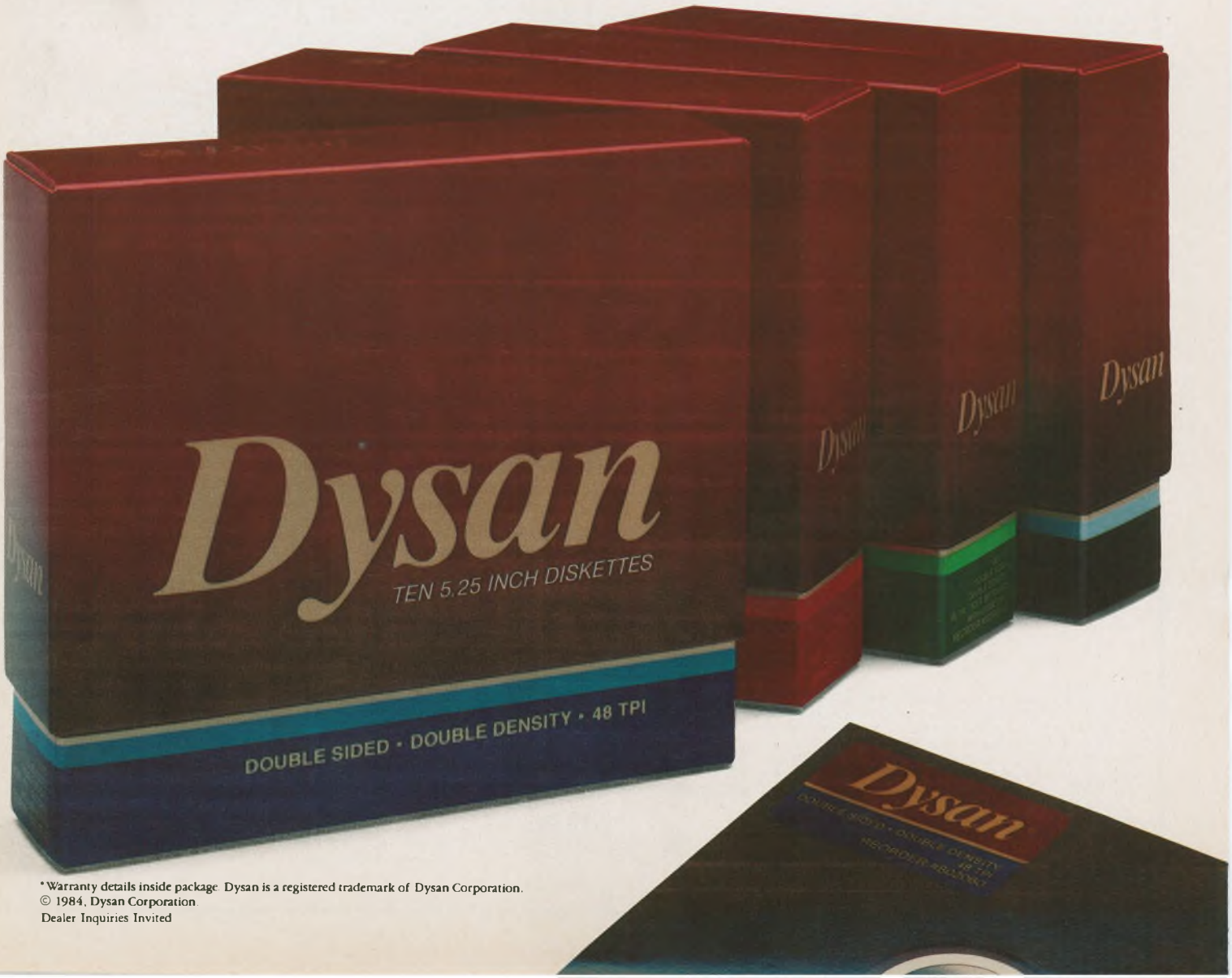

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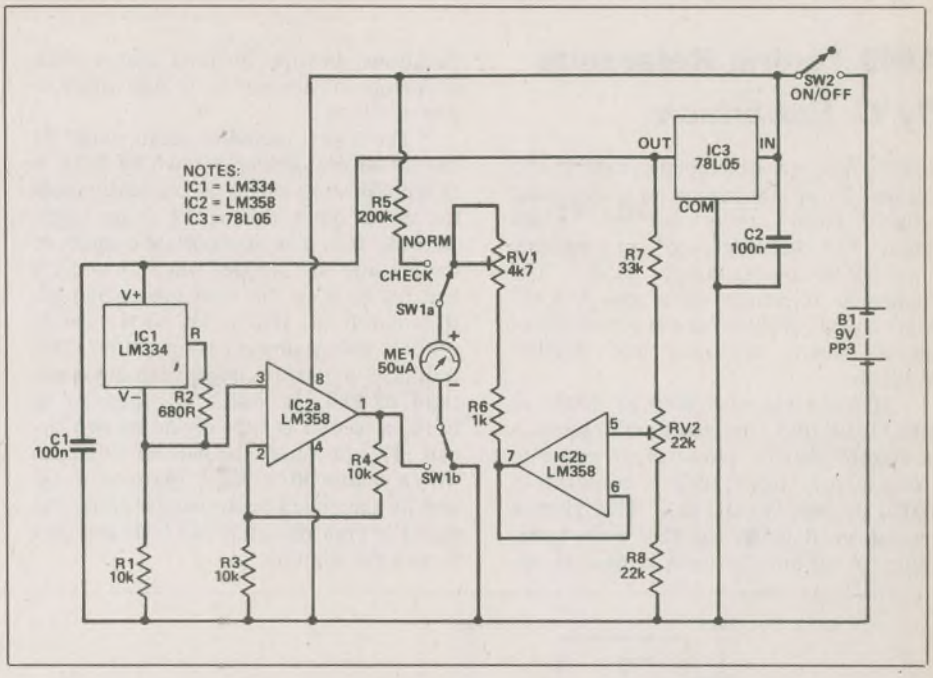
Analog Temperature Sensor



THE temperature sensor is an LM334 current regulator (IC1), and R1 is the load resistor. The output current of IC1 is controlled by a discrete resistor, which is R2 in this circuit. Output currents of between 1 microamp and 10 milliamps can be accommodated, and the output current is approximately equal to 0.0677 divided by the value of R2 in ohms. Using the specified value for R2 this gives a nominal output current of 100 microamps. This is low enough to ensure minimal dissipation and self heating of the sensor, but is large enough to avoid problems with noise pick-up in the lead to the sensor.

IC2a is used to amplify the output of the sensor, and it is a straightforward non-inverting mode operational amplifier circuit. It is *not* advisable to use a substitute for IC2 as most operational amplifiers have an output stage which cannot swing to a sufficiently low voltage to give correct operation in this circuit. IC1a provides a low output impedance, and this is important since there is not a great excess of output voltage swing available from the amplifier, and a medium or high output impedance would effectively reduce this voltage swing by a substantial amount due to the loading by the meter circuit.

On the other side of the bridge circuit IC3 provides a well stabilised 5 volt supply, RV2 taps off a suitable proportion of this to balance the circuit with the sensor at zero degrees, and IC2b acts as the buffer amplifier. Again, a low output impedance here is important, in order to avoid significant desensitising of the meter circuit. IC1 is powered from the stabilised 5 volt supply as this gives slightly improved long term stability and accuracy.

With SW1 in the "normal" position the meter is fed from the bridge circuit via R6 and RV1. The later is adjusted to give the unit the correct level of full scale sensitivity. With SW1 set to the "check" position the meter is connected across the battery via series resistor R5. This resistor gives the meter a full scale sensitivity of 10 volts so that it can be used to check the supply voltage. Accurate results are obtained with supply voltages of down to about 8 volts or a little less, but the battery should be replaced when its potential falls significantly below 8 volts. The current consumption of the circuit is only about 4 to 4.5 milliamps, incidently.

Hiss Reducer

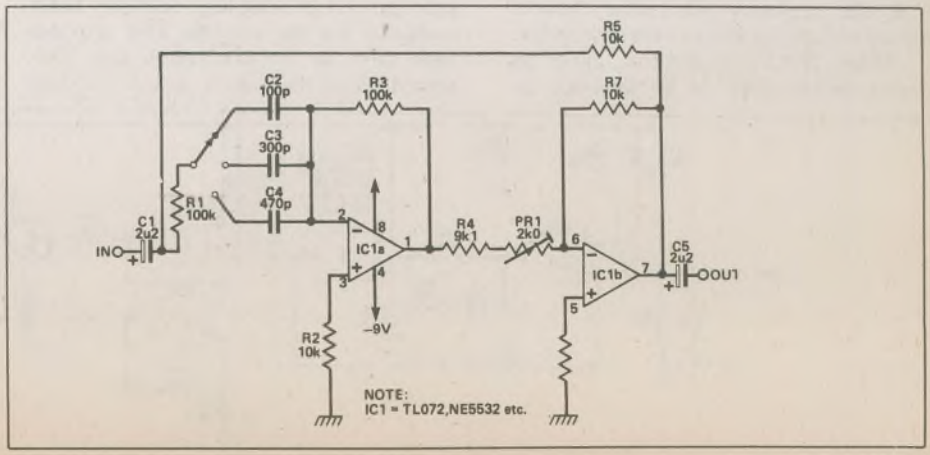
By S.P. Giles

THE circuit goes some ways towards offering a cheap reduction in the annoying hiss present on bad VHF reception signals and hissy tape recordings. It is based on the principle that two signals equal in all respects other than phase will cancel out when mixed together. If we create an out-of-phase version of the hiss and mix it with the original, it will cancel out.

The signal to be cleaned up is DC blocked by C1 and then fed into two separate paths, to mixer IC1b's inverting input via R5 and into IC1a. The latter is a unity gain inverting amp which inverts the high frequency content of the input signal passed through by C2, C3 or C4. The IC1 a output is then passed to mixer IC1b via R4 and PR1, which for best results should be a multiturn preset.

To set up, connect a temporary link between R1 and IC1a's inverting input, which will allow IC1a to pass all of the input. Hook up the input to a radio tuned to a hissy VHF station and the output to an amplifier. Adjust PR1 for minimum output — headphones would help here. Now remove the temporary link and make sure S1 is switch to position (a); you should hear the original signal with its hiss. Moving S1 to position (b), (c) and (d) will result in the hiss gradually becoming less audible with position (d) giving the most dramatic reduction at the expense of losing a little high frequency response.

The values of C2, C3 and C4 can be altered to suit the individual IC1, a dual op-amp, should of course be a low noise type such as NE5532 or TL072 and C2-4 should of course be polyester types.



A440 Tuning Reference

By C. Robertson

THIS circuit was developed as a result of a demand by several friends for a cheap and reliable A440 tuning reference which could be connected to an exisiting amplifier/studio talkback system. The frequency reference used was a 4.433 MHz crystal, this having the advantage of being cheap, accurate and readily available.

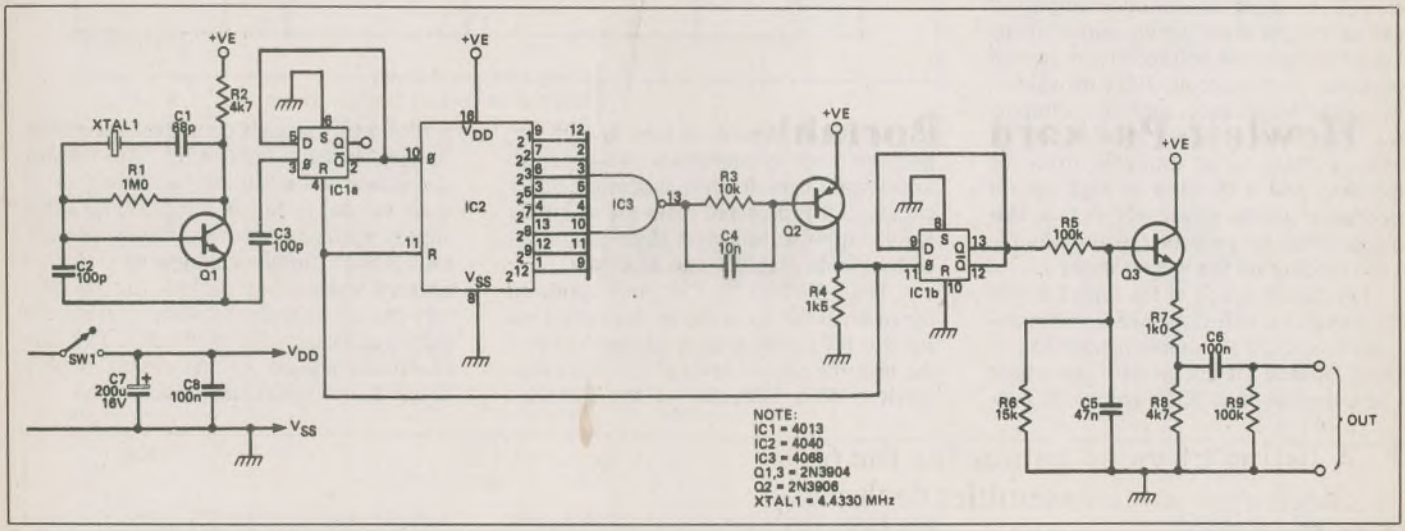
If 4.433 Hz is divided by 10075 or 10011101011011_2 the resultant frequency is exactly 440 Hz. However, in order to simplify the circuit, this is rounded to 10076 or 10011101011100_2. This gives a resolution of 0.5% which is quite sufficient for all but the most critical of applications, bearing in mind that a pitch difference of about 6% is equivalent to one semitone.

The crystal oscillator based round T1 has its output divided by two by IC1a, a D-type flip-flop which subsequently feeds the clock input of the 12 stage ripple counter, IC2. The appropriate outputs of the counter are ANDed via IC3 and Q2 and fed back to the reset inputs of both IC2 and IC1a, (Q2 is an NPN type in order to reduce power consumption). This produces a narrow negative-going pulse train of 880 Hz which is presented to IC1b, a second D-type divide by two circuit. This produces the 440 Hz reference with a precise 50/50 mark space ratio. Q3 and its associated components reduce the signal to approximately line level and perform wave shaping.

The power supply is a single 9V PP3 battery connected via a simple SPST switch with decoupling performed by C7 and C8. Current drain is typically 4mA.

The prototype was constructed on a small printed circuit board in an ABS box measuring 120 x 80x 30 mm. It should be noted that although the inputs to IC3 are arbitrary, the pin connections shown give the simplest PC layout if the chips are positioned side by side with the 4040 on the left, pin 1 top right.

Finally, although the unit was designed to run from a 9V battery, it will run equally well on supplies of up to 18V such as those found in many mixers and preamps although it is advisable to increase R2 and R7 accordingly.



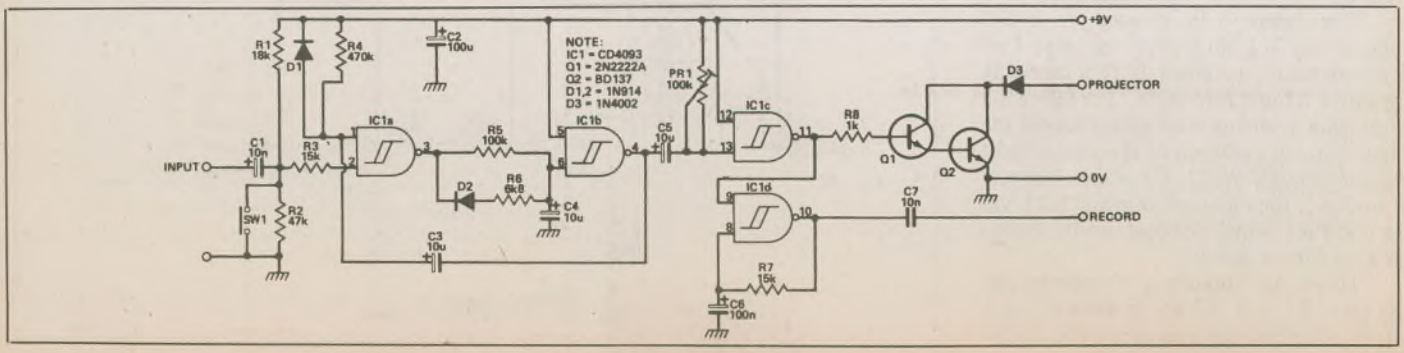
Slide Advance Unit

By Ian Lamb

THIS unit either encodes to or decodes from one channel of a stereo tape deck a 1kHz tone to activate the remote advance of a slide projector. The other channel utilised for commentary of the slide series.

When pin 2 is pulled low, either by closing switch SW1 or by applying an audio signal, the normally low output on pin 3 goes high, charging the capacitor on pin 6. This eventually causes pin 4 to switch low, which pulls pin 1 low for a period of 3 seconds and pin 13 low for a period controlled by the setting of the 100k potentiomenter. The output of this gate (pin 11) pulsing high activates 1kHz oscillator for the recorder and provides base drive to the Darlington pair connected across the remote jack of the slide projector. The 100k potentiometer is adjusted for the correct length of pulse to advance the slide tray.

At the end of the 3 second period, pin 1 is again high and if pin 2 has also returned high then the outputs on pin 3 going low discharges the capacitor on pin 6 which in turn switches the output on pin 4 to the a high, leaving the unit ready for the next negative going input signal. ■



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Hewlett-Packard Portable Review

Another lap computer; this one has over 600K bytes built in, including a word processor and Lotus 1-2-3.

Blort!

A listing of video games for the 6502; check out some assembler techniques or just blast at aliens.

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RS232 Breakout Box

Here's a handy project for all those computer hobbyists who've ever wrestled with RS232 cabling, 'sexing' and troubleshooting.

By A. Bendili

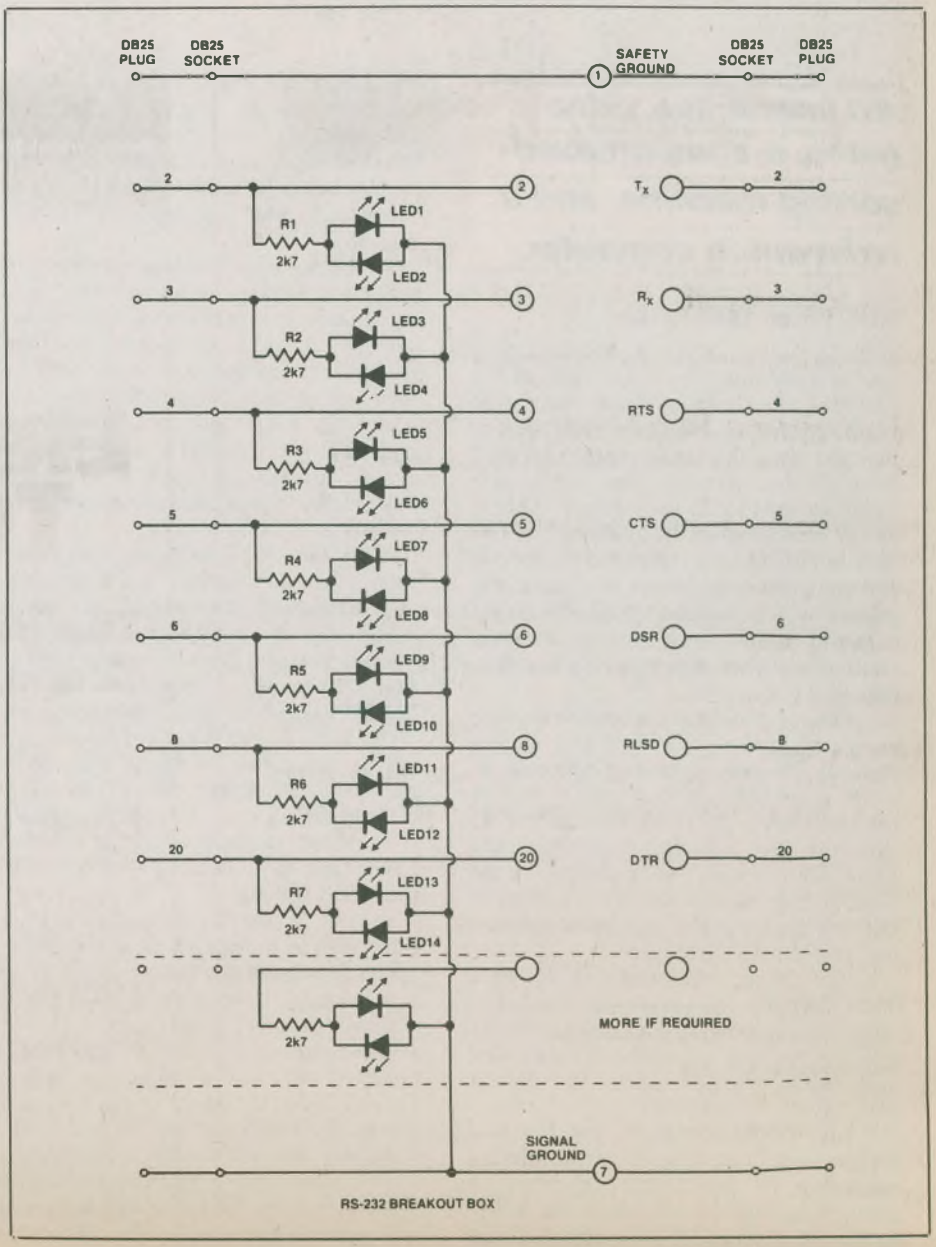
RECENTLY, there have been a number of articles describing troubleshooting aids for RS232 communication lines, e.g: *Electronics Today* last month. There are also commercially available breakout panels/monitors suitable for use with RS232 equipment. These units invariably require some form of external power either via a battery set or plugpack. It is quite probable that, with infrequent use, the battery will be flat when you least expect it, or you cannot get hold of a double adaptor or a long extension cable for your plugpack.

The recent availability of high efficiency LEDs (e.g: National NSL 6752) has eliminated the power supply problem. These high efficiency LEDs typically emit 40 mcd at 20 mA; as a result, only 2 mA is needed to obtain the same light output as a standard LED driven with 20 mA.

Description

To eliminate the power supply requirment, standard LEDs were not used since they would require at least 80 mA each. However, the high efficiency LEDs operating at 1 mA emit adequate light to indicate whether the signal line is mark/space or disconnected but also to provide reverse bias protection to each other. The 2k7 series limiting resistor is high enough not to adversely load the RS232 lines and low enough so that the LED is still visible (albeit dim) with a 3 V signal through a 500 Ohm combined line and line driver resistor. There is no circuit definition as to which end is the input or output. The input could logically be the side associated with the LEDs.

There are always two permanent connections to be made; these are the safety ground (pin 1) and signal ground (pin 7).



continued on page 52

By Roger Allan

RDI Video Disk Game

Electronics in Action

An interactive video game, a computerised sorting machine, and a wristwatch computer.

RDI Video Disk Game

SOME years ago, someone had the bright idea of using video for arcade type games. The idea took hold and soon there were video arcades in practically every shopping centre, much to innumerable parents' chagrin. More recently, there has been a slump in interest in such games. This is hardly surprising, as the quality of the images is limited and rudimentary at best, and the games themselves are linear and puerile in their banality. Even the lowest common denominator among us soon realized that their repetitiveness was boring.

One of the most successful of such games is known as "Dragon's Lair". Devised by Rick Dyer in California, it culled some $30 million in sales in its first three months. It is hardly surprising, therefore, that with the slump in arcade game interest, and Dyer's abilities in the field, that he should turn his attention to the next generation of such games involving interactive video disks.

The result, manufactured by RDI Video Systems, is known as the "Halcyon". Essentially, it is a combination of a computer and a laser-read video disk connected to one's television. The result is really quite extraordinary.

Like 'Dragon's Lair', the Halcyon system produces feature-movie quality animation or live action sequences to create a narrative world where the player makes the choices for the characters and the outcome is based on those decisions. In the course of the game, the player makes dozens of choices among hundreds of possibilities from thousands of possible combinations with the outcome being different each time that particular game is played.

The system employs artificial intelligence, speech synthesis and voice recognition to create a computerized personality. It speaks in its own voice and recognizes acquaintances by the sound of their voices, carries on rudimentary conversations with them, and understands and implements spoken commands. By simply speaking through a lightweight headset, the player controls the actions of the characters in the game.

So far, RDI produces five adventures, "Thayer's Quest" (an historic fantasy adventure), "Orpheus" (an educational Greek mythology adventure), "Shadow of the Stars" (a space exploration adventure), "Voyage to the New World" (an historical adventure), and "The Spirit of the Whittier Mansion", a horror adventure utilizing live action rather than animation. As well, the system can run the 800 or so video disks available from other manufacturers in standard Laser-format, as well as the new "B" music video disks.

More technically, according to Dyer, the system includes a 200 word vocabulary which is expandable and is capable, via networking, of voice recognition of 200 different peoples' voices, each one having a vocabulary of 200 words. It essentially operates on a voiceprint recognition system, with the disk being the mass storage R/O unit, and the external Level 3 computer providing the computational facility. Due to the artificial intelligence aspect, the more the player interfaces with the system over time, the more the machine learns about you and the more extensive is the development of its own personality.

Due to its abilities, this system is also being investigated by the Veterans Administration in the US for possible use by paraplegics. Due to the system's ability to learn foreign languages, the system is capable of learning the Vets' speech and undertaking actions on their behalf.

RDI Video Systems,
2261 Cosmos Court,
Palomar Airport Business Park,
Carslbad, California,
92008, USA

Circle No. 47 on Reader Service Card.

Electronically Sorted Fruit

With the ever-growing world population, the cost of fresh fruit and vegetables, so necessary for a healthy diet, tends to be a boom or bust situation. Either there is so much of it, or not enough, and when there is a lot, its quality tends to bounce all over the spectrum. The major, non-farming cost involved is not, surprisingly, transportation, but picking and sorting.

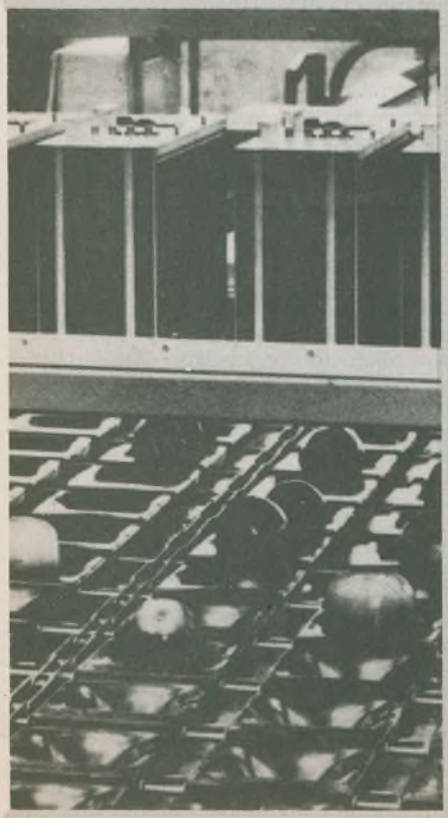
Recently, the French company, Materiel Arobriculture Fruitiere, commenced marketing a machine which significantly reduces the cost in the sorting stage of fruit by electronically dividing it according to its weight, diameter and colour. It is a high capacity machine operating 12 lines which check some 350 buckets a minute, and identifies the central diameter of the fruit through an analysis of its realtime image. The colour-measuring sorting system determines the degree of the fruit's ripeness and sorts them according to their different end destinations, with the ripest being reserved for the local market.

More specifically, one initially sets

the colour sorter by placing a well coloured fruit under the initial sensor and telling the terminal, via a keyboard, what the colour of the fruit is. The machine then takes the incoming fruit load and divides them into several groups of lanes (a maximum of four groupings) with every group working differently, eg. to divide the size into two outputs or to put the second quality on some specific lane, etc.

As the machine is running, a monochip microcomputer microprocessor system with a modular hierarchic structure comes into play. Every sorting lane is driven by a card using its own microprocessor with a communal card driving all the information exchanges between the lane cards, the colour sensors and the operator at the terminal. In the event of an error message, a software controlled system permits the operator to locate the fault, both as to what the fault is and where the fault is located. Adjustments may be made accordingly by the operator without leaving the terminal and while the machine's non-fault lines continue to run.

There are no optical elements, such as incandescent lamps. As such there are no dust problem. By using a microprocessor sensor, the machine permits the analysis of almost the total surface of the fruit thanks to four consecutive readings from different angles.



For handling different fruits, the machine stores no less than eight different programs, each of which may be recalled by the touch of a button, permitting easy change between crops. Further, new programs may be entered while the machine is running on another program. For record keeping, the machine uses a standard display terminal operating at 4800 baud, and a standard printer with a Centronics interface.

The machine received the Salon International du Machinisme Agricole 1984 Gold Medal in industrial design.

M.A.F.,
(Materiel Arobriculture Fruitiere),
546 Rue Gustave Jay,
82000 Montauban,
France

Circle No. 48 on Reader Service Card.

Seiko Data 2000

Currently, watches seem to be going through something akin to a metamorphosis. No longer content to merely present time with sufficient accuracy to get one to the court to hear all sorts of awful things entered into testimony by one's soon-to-be ex-wife, watch manufacturers have extended their vistas to embrace the briny deep or athletic events,including paper printouts, and have recently nudged their commercial noses into the realm of data memory.

The top of the line in this latter format is Seiko's Data 2000, a hybrid of a good watch and a mini-computer. But even the good people at Seiko have failed to overcome one difficulty: size. Hence it is in two parts, though the connection between the two is quite novel.

The first part looks a bit like an up-market watch, with all the appropriate functions. It has a 12-hour display, with day, date and month, which automatically adjusts for all years other than leap years. It has a chronograph with simultaneous split and total elapsed time displays, and measures up to 10 hours in hours, minutes, seconds and 1/100 seconds. It also has a display face, which can show an 8 digit display in each of four lines.

Then the interesting bit. One may insert the back of the watch into a face panel of what looks like a four function calculator with an alpha-numeric keyboard. Using the keyboard, one can enter up to 1000 characters in 100 lines contained in 2 separate memories. As such, one can enter all sorts of information: travel times, appointments, mathematical formula, business notes, memoranda, whatever. While connected to the watch portion, one may access and modify the information at any time, using a fast forward and back continuous scroll readout on the watch face.

The connection between the two portions is by low power radio transmission. In other words, the watch portion not only has a miniature short range radio transmitter, but a miniature receiver, as

does the calculator portion. They operate on slightly different frequencies, such that they don't interfere with each other. The keyboard section, being larger, has the circuitry to determine whether a message is incoming from the watch, and adjusts input/output accordingly. So minute is the power consumption that the watch battery will last for two years, and the keyboard for five.

Seiko Time Canada,
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Willowdale, Ontario,
M2H 3P3, Canada ■

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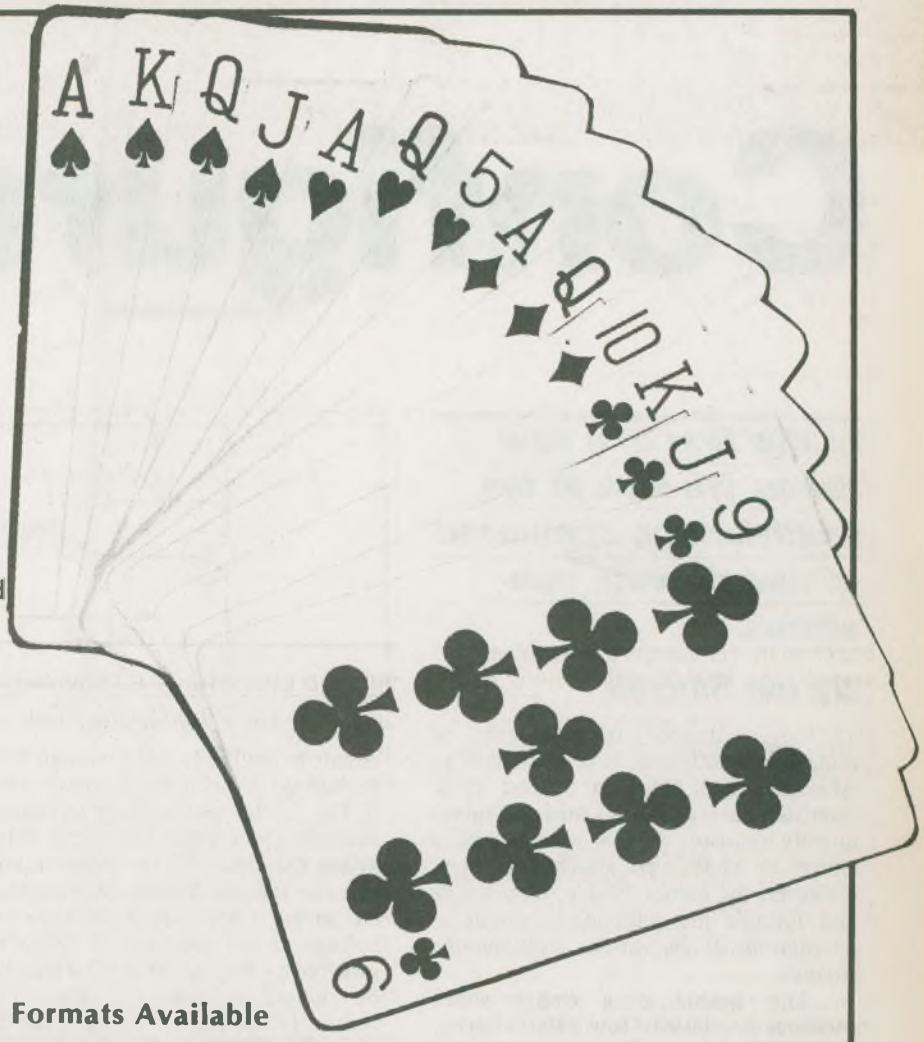

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ETI

Configurations

In this first of a new series, we look at the multivibrator, composed of two discrete transistors.

By Ian Sinclair

The multivibrator is a circuit of remarkable antiquity; it is attributed to Abrahams and Bloch at around 1918. Over the years, as various tube and subsequently transistor versions were devised, a variety of names were attached to them. However, the names astable, monostable and bistable are particularly useful as descriptions of the various multivibrator circuits.

The astable is a circuit which oscillates continually (no stable state — hence the name), producing steep-sided waveforms whose frequency can be adjusted by changing RC time constants. The monostable has only one stable state, and an input pulse will disturb this state for a time that depends on the time constant of the circuit, following which it returns to the stable waiting state. This circuit is widely used as a pulse generator, because ideally the duration of the pulse (the pulse-width) is independent of the repetition rate of the pulse, which is determined by the rate at which the monostable is triggered. The bistable circuit (two stable states) is the basis of digital circuitry, but is seldom used in discrete form nowadays because of the low cost of digital ICs. A source of confusion over names, incidentally, has been the use of 'flip-flop' by digital circuit designers, whereas the name was traditionally used to mean a monostable.

Astable Antics

Two varieties of astable exist, the parallel and the serial, of which the parallel is much the better known. The basic circuit is shown in Fig. 1, but unless your needs are very simple, the waveform from this

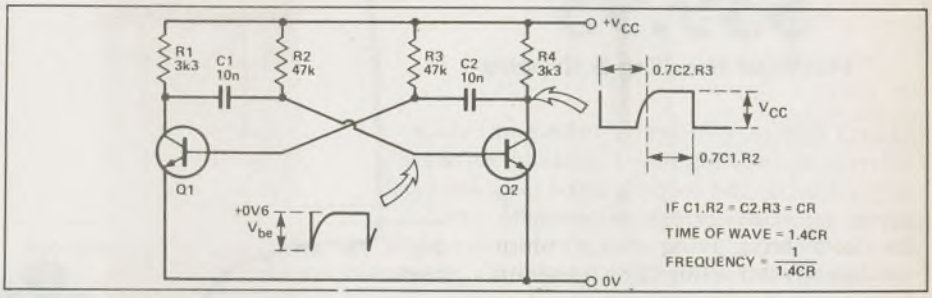


Fig. 1 The simple multivibrator astable, with period formula.

circuit is not really good enough without reshaping. A much better circuit is shown in Fig. 2; this uses a diode to isolate the collector from which the output is taken. When Q2 cuts off, its collector voltage can rise sharply, leaving D1 reverse biased. In the simple circuit, a sharp rise of voltage at the collector of Q2 is made possible by the capacitor C2 which has to be charged through the collector load resistor (R4 in Fig. 1). By using the diode, the collector voltage can rise sharply, and the charging of C2 is done at a slower rate by the additional resistor R5. This ensures a much sharper shape of waveform at the output.

Another problem of the simple circuit is that, contrary to theory, its frequency changes as the supply is changed. This is because of silicon planar transistors will conduct readily in the reverse direction when the base voltage is negative with respect to the emitter (for an NPN transistor). This is a form of zener breakdown, but it can be prevented by connecting silicon diodes with a higher reverse breakdown voltage in series with the base leads, as shown in Fig. 3, so greatly improving the frequency stability of the astable.

Formula For Success

The astable frequency is given by the formula shown in Fig. 1; it depends on the two sets of time constants. These should not be greatly different; don't be tempted to try to produce pulses with very large or very small values of mark-to-space ratio by using an astable with very different values of the two time constants. The wave form will probably be disappointing, and the circuit may not start oscillating reliably.

The frequency stability of an astable is generally poor compared with that of the LC type of oscillator, and this feature makes the astable particularly useful inasmuch as it can be easily synchronised to external pulses. Unless the 'natural' frequency of the astable is reasonably close to the incoming frequency, however, synchronisation cannot be relied on, and

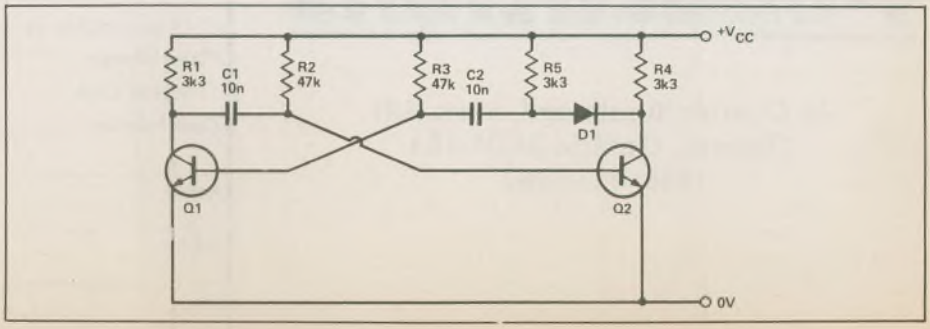


Fig. 2 Using an isolating diode to sharpen the leading edge.

slowly-changing waves such as sinewaves are not useful for synchronisation because the triggering point is liable to vary (or jitter) from one wave to the next. The astable can be synchronised by pulses at one base, and this can be done by pulsing a cut-off base into conduction or by pulsing a conducting base to cut-off.

Fig. 3 Using base-isolating diodes to prevent base-emitter breakdown.

Whichever method is used, the trigger pulse should be isolated from the astable by diodes to prevent the astable interfering with the action of the trigger circuit (Fig. 4). If the 'pulse-off' method is used, a catching diode must be included to prevent the transistor base-emitter junction from being reverse-biased which would cause zener action of each negative pulse.

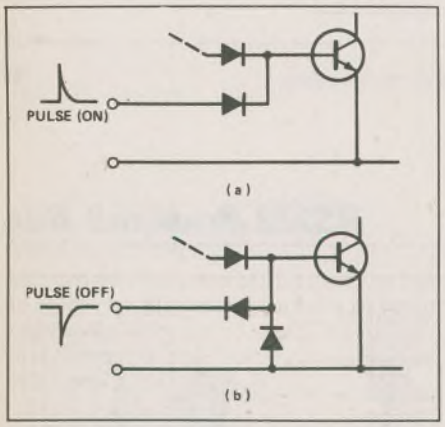


Fig. 4 Diodes are used in the synchronising circuits, too!

Breakfast Serial?

The other type of astable, much less well known, is the serial astable, which is a particularly good way of producing very short pulses which can pack a lot of energy. A circuit is shown in Fig. 5, and since the circuit is not so familiar as that of the parallel astable, a run through its action might be of interest. Note that only one time constant, R1.C1, is used, and that the transistors are complementary; one PNP, one NPN.

We can start by supposing R2 = R3 and V_{cc} = 10 V, with C1 discharged so that the emitter of Q1 is at a low voltage. Q1 will be cut off, and will stay that way until its base voltage is more negative than its emitter voltage, or to put it another way, until its emitter voltage fixed at ±5 V by R2 and R3, the capacitor will have to charge to around 5V6 before much will happen.

Meantime, because Q1 cut off, no current is reaching the base of Q2, and this transistor also is cut off. The circuit remains with neither transistor conducting until the charging capacitor reaches the voltage at which Q1 turns on. This also turns on Q2, because the collector current of Q1 goes to the base of Q2. This in turn drastically lowers the base voltage of Q1, and the emitter voltage will follow it, rapidly discharging C1. Once the emitter voltage of Q1 drops, however, the circuit recovers, and we're back where we started.

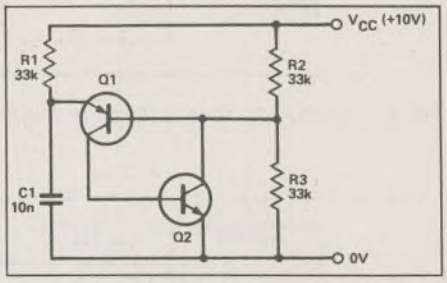


Fig. 5 The serial astable circuit using complementary transistors.

Unlike the parallel circuit, in which one transistor conducts while the other is cut off, the serial multivibrator spends most of its life with both transistors cut off, and only brief intervals with both turned on. The cut-off time is the time needed to charge C1 through R1 to about 0V6 above the voltage supplied by R2 and R3 — the formula for the time is shown in Fig. 5. The time for which both transistors are on is less easy to estimate because it depends on the effective resistance of the transistors at saturation; it is normally very short compared to the charging time.

Monostables

The classic monostable uses a parallel circuit with one DC coupling, as shown in Fig. 6. With no trigger-pulse input, Q2 is held on because of current flowing through R2. The collector voltage of Q2 is very low, and this ensures that Q1 is held off. This is the stable state of the circuit, and it will remain in this condition, with C1 charged, until a positive-going trigger pulse arrives, with enough amplitude to make Q1 conduct. This pulse causes current to flow in Q1, so that the collector voltage drops, and the drop in voltage at the base of Q2 cuts Q2 off. This condition lasts until C1 charges through R2 sufficiently to turn the base of Q2 on again, when the circuit switches back. The diode in the base lead of Q2 prevents base-emitter breakdown from affecting the timing.

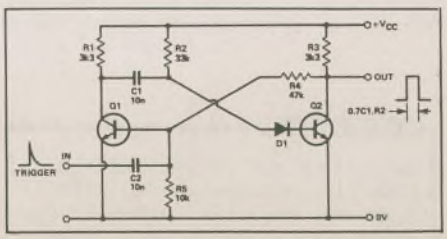


Fig. 6 The parallel monostable circuit.

As in all parallel circuits, there is always one transistor conducting and the other cut off. The serial version of the monostable (Fig. 7) uses complementary transistors, and will pass no current in its waiting state. When a trigger pulse arrives, Q2 switches on, and the voltage at its collector drops. This switches on Q1, via the capacitor C1, causing the base circuit of Q2 to be heavily forward biased. C1 now charges through R2 until the voltage at the base of Q1 rises to its cut-off value of around V_c—0V6. Both transistors then cut off.

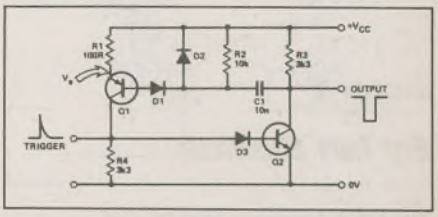


Fig. 7 A serial astable — a useful circuit which is seldom seen.

The pulse width of the output depends on the time constant of C1.R2, and will vary as the supply voltage varies. Diodes can be used to prevent base-emitter breakdown in the usual way.

Bistables, Two By Two

Figure 8 shows the classic bistable circuit using two NPN transistors. The circuit is stable with either Q1 on and Q2 off, or in the alternate condition of Q1 off and Q2 on. Switching is done by using the A or B inputs. With Q1 on, a negative pulse at A will switch the circuit over, and a negative pulse at B will switch it back. This action corresponds to that of the simple set-reset latch.

Counting action may be obtained if steering diodes are added to the basic circuit, as illustrated in Fig. 9. Suppose Q1 is conducting: its base voltage will be around OV6, and its collector voltage about OV1, so that D1 is almost conducting. D2 is cut off because its anode voltage will be about zero and its cathode voltage almost at supply voltage. C1 will carry virtually zero charge, while C2 will be charged to around supply voltage, V_{cc}. When a negative trigger pulse of amplitude around 1 V is applied D1 conducts, allowing Q1 to be cut off by the trigger pulse; however, D2 is held off by the charge on C2. The bistable then changes over so that Q2 is fully conducting and Q1 cut off. In this condition, it is D2 which is biased almost on and D1 com-

pletely off. When the next trigger pulse arrives, then, Q2 will be cut off by it, and the circuit will switch back to its original state. Hence, if the circuit is triggered regularly, either output will be a square wave with half the frequency of the trigger pulses.

The waveforms at the collectors of a bistable can be much closer to square than those from simple astable, so that one way of creating well shaped square waves is to drive a bistable from an astable (Fig. 10). In this circuit, the output from the bistable has the same frequency as the astable. Nowadays, the ready availability of bistables in integrated form discourages us from using the discrete variety — we'll look at IC types later in this series.

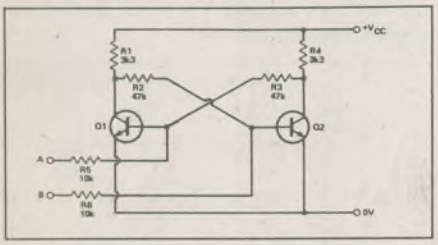


Fig. 8 The simple R-S type bistable.

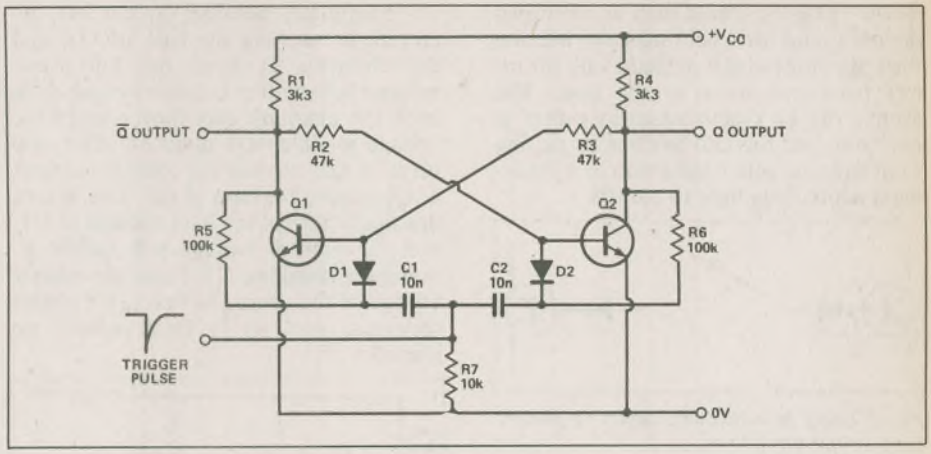


Fig. 9 A bistable with steering diodes to give the scale-of-two action.

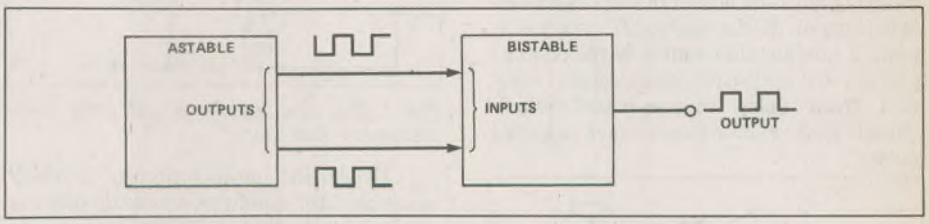


Fig. 10 Following an astable with a bistable to sharpen the waveform. ■

continued from page 45

RS232 Breakout Box

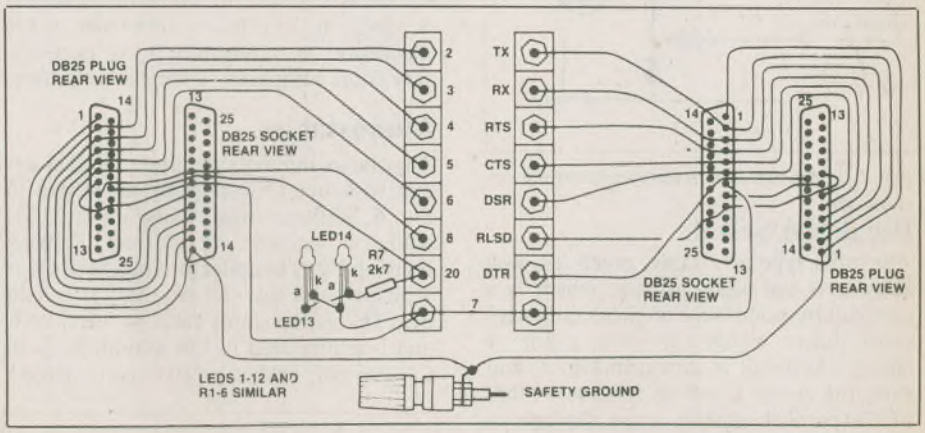
The other pins usually depend on the usage, e.g: Tx and Rx could be reversed: some peripherals use RTS instead of DTR.

A spare, unlabelled LED could be connected to any of the 4 mm sockets to monitor its status. I found that a set of eight leads consisting of a flexible wire about 100 mm long terminated at each end with a stackable 4 mm plug is sufficient to link, stack, strap, crossover, pull up and monitor.

A double row of 4 mm sockets allows the connecting of input to output according to the situation in hand.

Construction

As shown in the accompanying photograph, the unit was built in a diecast box. A connector pair consisting of a plug and socket on each side of the box allows for cables with either termination to be connected to the breakout box. A label between the two rows of sockets identifies the pin number and its conventional designation. As it is highly unlikely that all 21 RS232 signals will be monitored, the minimum set of signals shown on the circuit diagram would be adequate for nearly, if not all, situations. ■



HOW IT WORKS

Back-to-back high efficiency LED pairs, LEDs 1-14, are connected across the RS232 signal lines with a 2k7 current limiting resistor in series. The plug/socket pairs on the left and right can be linked via the central column of sockets, the LEDs indicating the presence or absence of signal and its polarity on the lines.

PARTS LIST

Resistors . . . . . all ½W, 5%
R1-7 . . . . . 2k7

Semiconductors
LED1-14 . . . . . National NSL 6752 or similar

Miscellaneous
Diecast box to suit; 16 x 4 mm 'banana' sockets; 1 x 'banana' socket-terminal; 2 x DB25 chassis-mount plugs; 2 x DB25 chassis-mount sockets; 5 mm LED clips; hookup wire, etc.

eight transistors, Fig. 4. This relies on the charge stored at X during CK lows. When CK goes high the signal propogates to Q. Of course, the gate capacitance at X will leak, so a minimum clock frequency of a few kHz must be guaranteed.

Because transistors in the ULA are individually accessible, composite gates can be built up using less silicon area than if a gate array really were an array of gates, rather than transistors, Fig. 5.

Once initial design is completed, some verification of the design will be required. At around —10,000 per fabrication run, the 'suck-it-and-see' approach is not popular. This is where CAD (Computer Aided Design) is used.

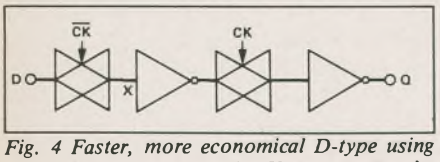


Fig. 4 Faster, more economical D-type using the gate capcitance at point X as a storage element.

Verification Procedure

Initially electrical characteristics, usually just propogation delay in logic design, are checked. Most common elements, inverters, AND gates, adders and so on will already have been simulated by the manufactuer, but a few special functions may require investigation.

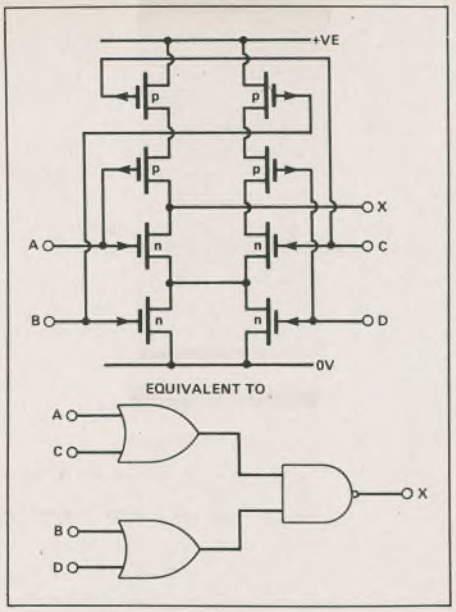


Fig. 5 Composite gate, where the gate function has been implemented directly rather than been broken down into individual elements.

To simulate a circuit at this level (device level) requires a program with device models incorporated, and a knowledge of the model parameters to use, things like channel length, oxide thickness and doping levels for very thorough simulations, or turn-on voltage and channel dimensions for more approx imate simulations. The program takes its information from a file containing the circuit description, and a set of instructions on what to do to the circuit.

For propogation delay analysis, the circuit is stimulated with a known input waveform, and the program instructed to give the input and output voltages at say, 1 ns intervals. The output can be plotted by another part of the program and delays read off, Fig. 6.

To simulate a whole circuit at device level is possible, but rather pointless; the detail is unnecessary and the program execution time too large. Other, circuit level simulators are employed, for which the parameters used are simply gate delays. The output from this simulation is used to detect hazards and glitches which may not have been present in the breadboard model due to its different layout, logic family or size.

A hazard exists when different delay

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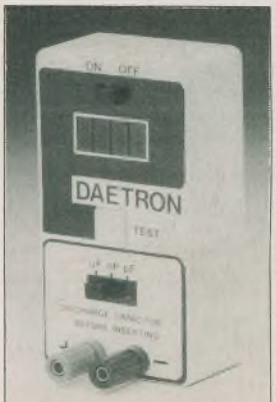

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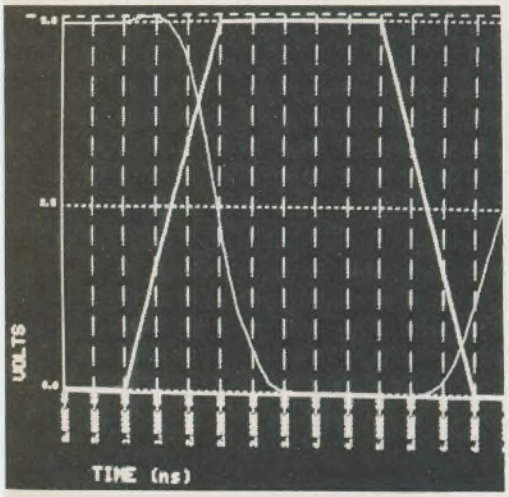

paths in a circuit cause the output to change state when it is not expected to. The output of Fig. 7 should be low only when ABC = 011. A transition of ABC from 001 to 111 should therefore have no effect on X — it will remain high. However it can be seen from the timing diagram that if the AND and NAND gates have different propogation delays as they often do in practice) there is an output change.

The presence of problems like this may mean the difference between success and failure of a design. Hazards can be eliminated by careful design, or made irrelevent by using fully synchronous (clocked) logic, essentially allowing the circuit plenty of time to settle between input changes.

Another important factor a designer must consider is testability. An IC may contain the equivalent of 2000 gates and yet have only 40 pins. It is not possible to put test probes inside an IC, as it is too small. Every test node must somehow be brought out to a pin, or at least a bonding pad.

Getting Stuck

The two most usual fault conditions in an IC are a gate input stuck at '1', and a gate input stuck at '0'. Consider the circuit of Fig. 9. If this circuit operated correctly, then input ABC = 0 would produce the output X = 0. However, if B is stuck at 1 the output will be 1. The pattern ABC = 100 is a test for the fault B S-A-1 (B stuck at 1).

The problem in an integrated circuit is that the circuit of Fig. 8 may be 'buried' deep in the IC, and it is difficult to get the required test patterns to it — perhaps other circuits have to go through several states before the values on ABC reach 100. One rather elegant solution to this problem is called *scan design*.

Most logic circuits have flip-flops and registers on them. By designing a few more and adding some extra steering gates, the on-chip registers can be connected as a long shift register, and the latches used to hold test patterns.

Three extra pins are needed: 'TEST', 'TEST DATA IN' and 'TEST DATA OUT'. When TEST is high, the circuit is in test mode, and test data is serially fed in to the flip-flop chain. After a number of clock pulses the required test pattern is in the circuit under test. TEST is taken low and the circuit operated normally. Test outputs are sent to the registers. Then TEST goes high again and the output values are clocked out along the shift register to TEST DATA OUT.

There are algorithms for finding test patterns for the possible faults in a circuit. Given the logic diagram, corrects software and sometime, the computer can generate test patterns for most faults. It can also detail those faults which are undetectable with the circuit as it stands; such faults often indicate some redundancy in the circuit.

The gate level simulator can be used to simulate a faulty circuit. This may seem unnecessary, but is useful to test the efficiency of test patterns.

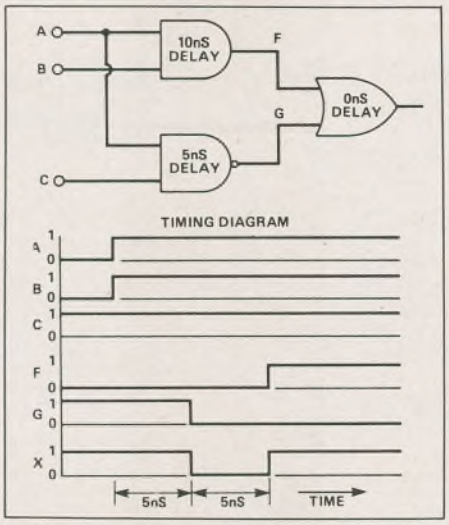

Fig. 7 An example of a timing hazard.

The Layout

The next stage is the circuit layout. The designer will probably start with a paper sketch showing roughly where each functional block will go, and proceed from there. He or she will try to interconnect the blocks along certain allowed lines (there will be a set of design rules, governed by the accuracy of the manufacturing process, which determine track minimum widths and spacings, etc). There are automatic connection routing programs, but they are usually for two or more metallisation layers, while most ULA's have only one. People produce more compact layouts than computers, especially when constricted to fixed channels allowing only a certain amount of interconnection tracks.

Finally, automatically, semi-automatically, or manually, a layout is produced. The likelihood of an error, especially with a manual layout, is high.

A piece of software called a *design rule checker* will look for tracks too close together, incomplete tracks and so on, reporting back to the designer, who can edit mistakes at an interactive graphics terminal. There is also the question of whether the circuit drawn actually performs the intended function, even if it complies with the rules for physical layout. A *circuit extractor* program can work out the function of the layout, simulate it, and compare the results against those expected from the circuit. This is a difficult and time-consuming task, even for a powerful computer. The need for this stage can be reduced by careful design, or eliminated completely by the use of automatic layout and interconnection.

Finally the data describing the complete, checked layout are fed to another program which generates instructions for a machine which produces the metallisation masks. Masks traditionally are made by photographic reduction of 400X full size master, cut by a computer-controlled knife. Nowadays electron-beam lithography is common; an electron beam scans the actual size mask, exposing electron-sensitive resist. This latter method is more accurate than the first, allowing higher circuit densities, and, because each chip pattern is individually written, it costs little extra to change the program halfway and write two, three or four different metallisation layouts onto one mask. This allows smaller than usual quantities to be economically committed.

The Future

What of future developments? Most predictions are based on company forecasts, and they obviously predict a rosier future for whatever semi-custom method or technology they are marketing that their competitors do not have. However it is possible to say some things with reasonable certainty.

Silicon-gate CMOS arrays are likely to dominate the market in most applications, due to their combination of speed, density and low power. Low power density is important with high levels of integration — chips which dissipate more than a watt or so require special packaging to keep them cool and the package may cost more than the chip it houses.

Sofware is still chasing hardware in sophistication — 20,000 gate arrays are announced but no CAD system can adequately handle them yet. 30,000 gate arrays have been predicted for 1985. Array

manufacturers are becoming aware of these difficulties, and are employing software writers to produce product-specific CAD tools at the same time as hardware designers work on the physical design of the array.

Most ULA sales are in the 300-1,000 gate range, the very large arrays tending to be purchased by the computer industry. A recent FPLA chip (the AmPAL22V10 from Advanced Micro Devices) claims to offer the versatility of a 500 to 1,000 gate array be of clever design and the provision of over 5,800 fuses. Perhaps we shall see FPLAs making headway into markets previously the domain of the gate array.

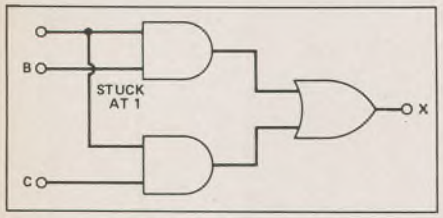

Fig. 8 Fault testing: suppose the input B is stuck at 1.

By the end of this decade CAD software may have advanced to the level where the standard cell will exceed the gate array in popularity. This is because most systems are not composed only of logic circuits — they contain RAM, ROM, EPROM and linear devices like op-amps, analogue to digital converters and voltage references. There are arrays which have linear functions and memory areas on them (an ordinary array wired as a RAM is very wasteful of silicon) but the problem is always how much space to allocate to each function. If too many choices are offered none will sell in large numbers and the advantages of mass production are lost. With a standard cell IC there are no such problems — as much ROM, etc, as is needed is fabricated.

Increasing levels of integration bring problems of pinout too — 64 pins is the usual maximum in a DIL package. However a semi-custom IC may be replacing a whole PCB with over 80 connections. We are likely to see more and more exotic packages such as flatpacks and pin-grid arrays (which look like a bed of nails from the pin side).

In conclusion, then, it seems likely that more and more products will employ semi-custom ICs of one sort or another. These ICs will be designed by ordinary circuit designers, using powerful software tools running on mini-computers or special-purpose micro-computers. ■

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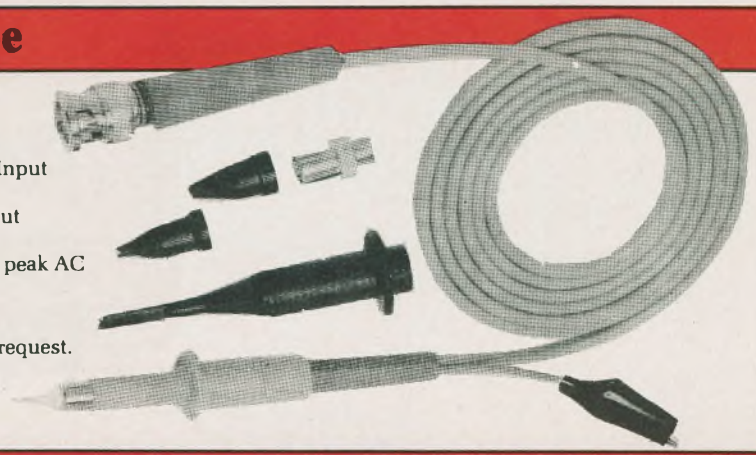

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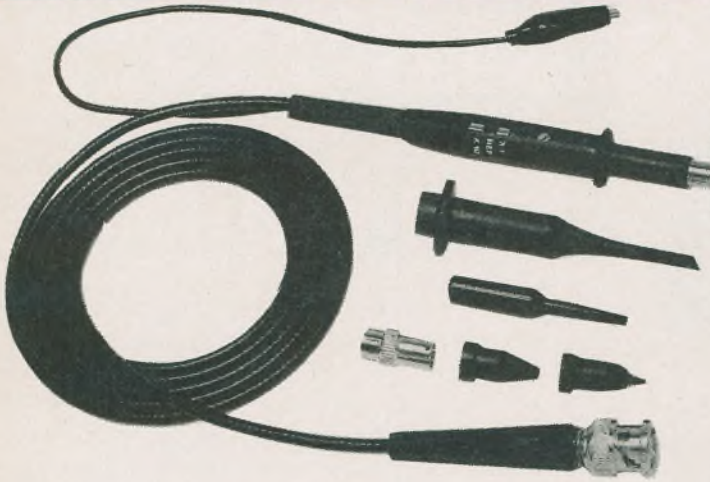

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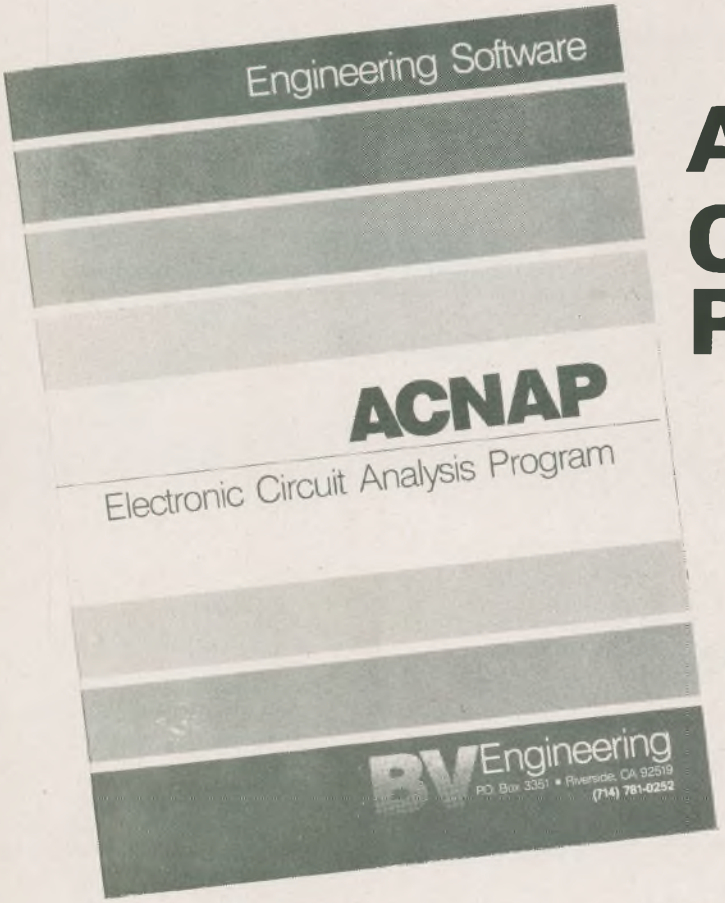

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By Bill Markwick

ACNAP is an AC electronic circuit analysis program written in Fortran, converted to machine code, and available for over 80 makes and models of microcomputers. It allows frequency response and phase measurements to be specified for any combination of up to 60 resistors, capacitors, inductors, and current sources (gain stages). It doesn't require complex engineering practices to operate, though it's assumed that you can manage simple models of amplifier circuits and can break amplifiers down into voltage- controlled current sources with input and output impedances in the right places (it's not as intimidating as it sounds).

After loading the program, you can either load in a previously saved circuit to tinker with it, or you can type in a new one. In the latter case, you'll see the main menu; its choices consist of functions like load, save, list components, change components, run the circuit, noise equivalent bandwidth and so on.

Entering a Circuit

Components are entered by specifying how they relate to their neighbours; this in turn is done by calling each junction of components a **node**. If you're not familiar with network theory, you'll soon get the hang of it; node 0 is always ground, node 1 is always the input, and if you wanted to show a 10K resistor from the input to ground, for instance, you would enter:

R1: 10K
+node: 1
-node: 0

An active filter is reprinted from the manual in **Fig. 1**, showing how the nodes work. It's cumbersome at first, but it soon flows along, and it's the best way to deal with components short of drawing the circuit with a light pen. After entering nodes, the component tolerance is listed. The same procedure is followed for all passive components; the final step is to specify the input and output resistances as well as the gain of the amplifier stage, if any. A 0.0 is typed in if a particular type of component is not in the circuit.

Testing and Running

Once all desired values are in, you can return to the main menu and list them. This will be your first surprise: ACNAP's one serious drawback is that it is *very* fussy about number formatting. Integers must look like 5.0 instead of 5, and prompts such as "number of nodes" must not, or else the program sets your value to zero in the first case or crashes in the second.

However, this was the only major problem I encountered, and to be fair to the publishers, they've included a form asking for your opinion on how the software could be improved. To continue: once the values are to your liking, you can then run the program, specifying the bandwidth and number of sample points. After a few seconds, depending on how many sample points there are, you'll be presented with the readout shown in **Fig. 2**, giving the magnitude in decibels and the phase angle in degrees.

One minor complaint was that there is no way to quickly find the centre frequency, which is usually what you want to check right away just to make sure you didn't slip a digit and put your audio filter up in the megahertz region. One way to find it, I discovered, was to watch for the general frequency of interest (in the example, it would show as maximum gain, or minimum loss) and then re-run the circuit with lots of samples clustered around the area of the centre frequency. This allowed me to find it within a fraction of a Hertz.

Monte Carlo

If you're designing an uncritical circuit such as a simple lowpass, you'll probably

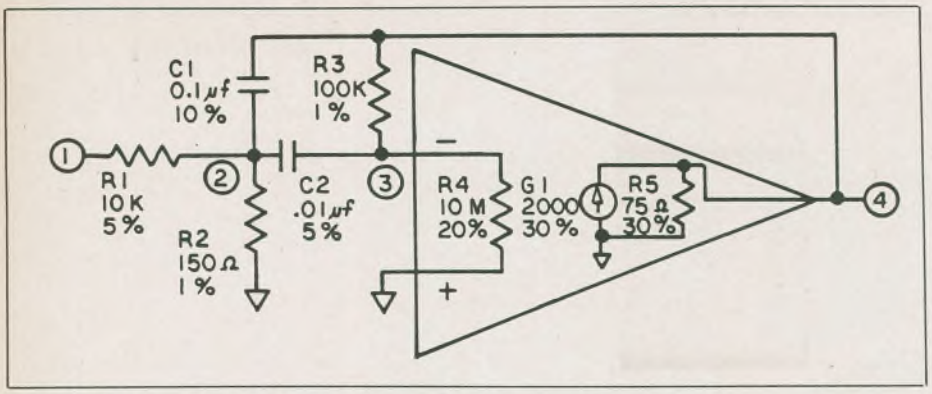

Fig. 1. The schematic of an active filter used as an ACNAP example.

be content with the expected variations due to component tolerances. However, if you're designing test gear, or very fussy active filters, component variations may cause effects far more serious than the percentage tolerance would indicate. ACNAP will "build" any number of circuits by computing magnitude and phase according to a random choice of component values within the specified tolerance.

As an example of how valuable this can be, I ran the test circuit shown for ten tries with 5 percent components. The variation in magnitude at 1300 Hertz from circuit to circuit was about 2.5 dB, not exactly precision performance. At this point, you might be tempted to stuff everything with .1 percent components, but there's a more efficient way:

Sensitivity

Return to the main menu, and you'll see "Compute Component Sensitivities". What you'll get is a list of magnitude and phase changes of the circuit over various frequencies as each component value is increased by 1 percent. Some components have a negligible effect; some cause the circuit performance to alter drastically.

Once you determine the culprit components, you can return to the main menu and change them to better tolerances and rerun the circuit, including the Monte Carlo.

Options and Others

ACNAP itself doesn't support graphics, but BV Engineering have other compatible software to do the job: PLOTPRO is a graph printing program for ACNAP, and generates graphs on any 80 or 132 column printer. It provides linear, semi-log, or logarithmic plots, including optional grid lines, and also labels anything on the graph. It costs $49.95 US plus $8.60 for airmail to Canada.

Another companion program (which we didn't have as we went to press) is the SPP, or Signal Processing Program. It gives the time domain response of the ACNAP circuit for any input waveform; it looks invaluable for transient response. It costs $59.95 US plus $8.60 for airmail to Canada.

Miscellaneous

Once the circuit data goes scrolling past you, there isn't any way to back up and review it; however, there's a printer toggle so you can record how you're doing as you change components.

We received ACNAP in the Apple 56K CP/M format; it occupied about 38K of space on the disk. Circuits were saved as normal CP/M files, and could be transferred or deleted as usual. ACNAP also generated two other ASCII data files for each circuit; these were for the companion programs mentioned above.

Incidentally, you can also use the program for simple passive circuits as well; I designed a ladder attenuator by entering all the resistors and then specifying the same frequency for the minimum and maximum. Out came the loss in dB. Of course, you could always stick in a few parallel capacitors to represent stray capacitance.

In conclusion, I have the feeling that if I'd had ACNAP ten years ago, I could have saved an enormous amount of time when I was a circuit designer, and best of all, I could have run lots of computer simulations for optimising the circuit. Unless you have an obsession for breadboards and bits of wire, ACNAP is a superb tool for circuit design.

For further information, contact: BV Engineering, PO Box 3351, Riverside, Cal. 92519 (714) 781-0252. ■

Frequency	Magnitude (dB)	Phase(Deg)
10.000	-60.643	-90.063
19.953	-54.642	-90.121
39.811	-48.636	-90.238
79.433	-42.612	-90.471
158.490	-36.517	-90.946
316.229	-30.127	-91.970
630.959	-22.379	-94.805
1258.929	-2.112	-149.656
2511.896	-21.250	95.473
5011.893	-29.356	92.152
10000.046	-35.815	91.025

<Enter 0 for main menu> 0

Fig. 2. A listing of the magnitude and phase response of the circuit in Fig. 1.

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Boeing Vertol Company has awarded a $2.9 million contract to Atlantis Flight Research of Downsview, Ontario, Canada. Atlantis will design and manufacture four maintenance trainer systems to help support Boeing Vertol-built U.S. Navy and Marine Corps H-46 Sea Knight helicopters.

During the 19 month contract, Atlantis will build two H-46 hydraulic systems simulators and two Automatic Flight Control System (AFCS) simulators. One of each will be used to train Navy/Marine helicopter maintenance technicians at the rework facilities in New River, North Carolina and Tustin, California.

"This contract to Atlantis Flight Research represents our continuing commitment to a productive relationship with the Canadian Aerospace Industry, one that yields competitively priced, high quality components, systems and subcontract work required to build and support our helicopters," said Joseph Mallen, president of Boeing Vertol. To date the Canadian dollar value of contracts awarded to 35 Canadian suppliers exceeds $170 million.

Torontel Technology Systems Limited, a newly-formed Canadian company specializing in high technology information systems and equipment, has been appointed eastern distributor for Robot Research Inc. of San Diego, California — world's largest manufacturer of phone-line video systems. Victor Pacione, president, also announced that the company will also design and manufacture custom systems for teleconferencing, tele-medicine, tele-education, security systems and other sophisticated software application systems. "Our objective is to provide business, government, industry and institutions with the latest innovative information resources cost-effectively and efficiently. Our appointment as distributor for Robot Research Inc. and our internal resource base, provides Canadian organizations with a single-source facility from design through to installation and after-service", states Mr. Pacione. Torontel Technology Systems Limited is located at: 205 Riviera Drive, Markham, Ontario, (416) 475-9455.

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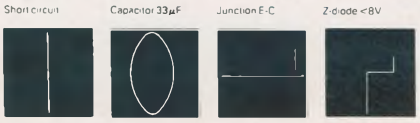

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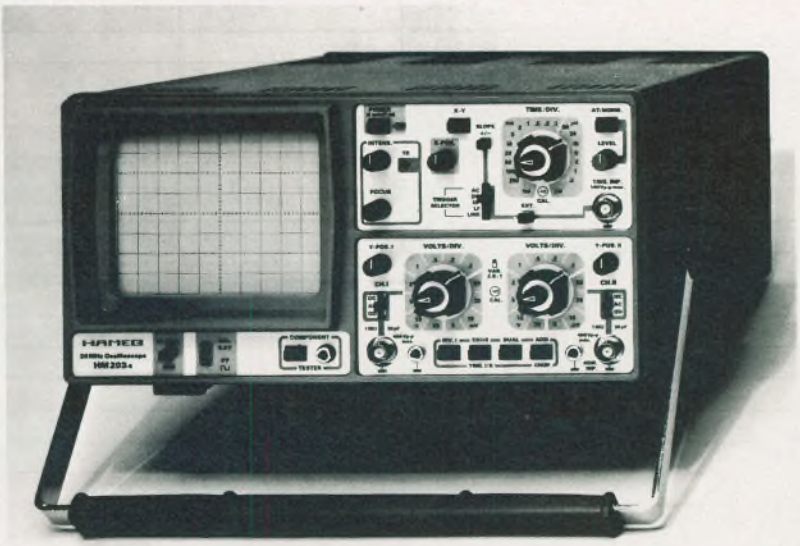

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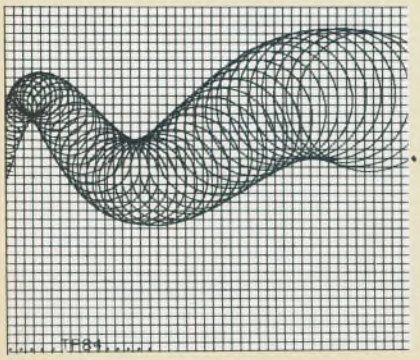

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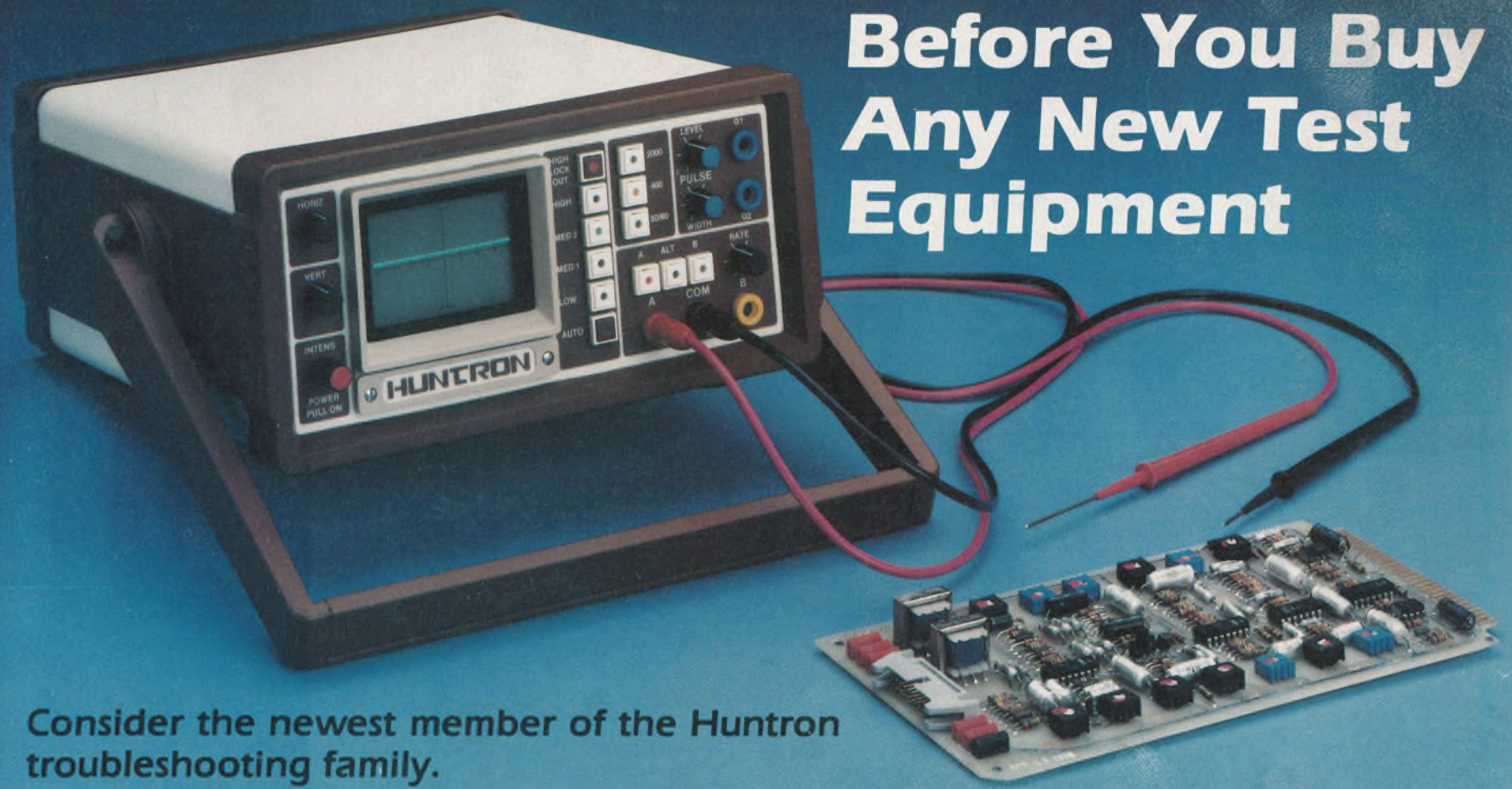

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