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August 1984

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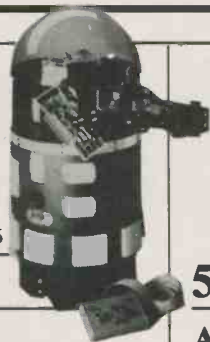

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The Heath HERO robot symbolizes what may be a new era in home robotics, page 16. The Acorn BBC computer is reviewed on page 26.

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Editorial Queries
Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letter ETI Query. *We cannot answer telephone queries.*

Binders
Binders made especially for ETI are available for $9.25 including postage and handling. Ontario residents please add provincial sales tax.

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Previous issues of ETI Canada are available direct from our office for $4.00 each; please specify by month, not by feature you require. See order card for issue available.

We can supply photocopies of any article published in ETI Canada; the charge is $2.00 per article, regardless of length. Please specify both issue and article.

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 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms 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 on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

K.S.K. Associates, P.O. Box 266, Milton, Ont. L9T 4N9.
B—C—D Electronics, P.O. Box 6326, Stn. F, Hamilton, Ont. L9C 6L9.
Wentworth Electronics, R.R. No. 1 Waterdown, Ont. L0R 2H0.
Danocinths Inc., P.O. Box 261, Westland MI 48185, USA.
Arkon Electronics Ltd., 409 Queen Street W., Toronto, Ont., M5V 2A5.
Beyer & Martin Electronic Ltd., 2 Jodi Ave., Unit C, Downsview, Ontario M3N 1H1.
Spectrum Electronics, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.

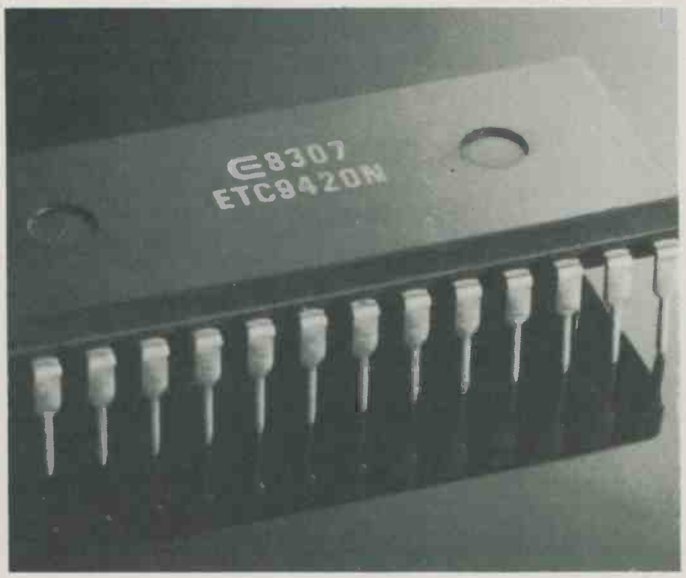
Rugged TSE Cases

TSE Inc. announced the introduction of a patented line of exceptionally rugged cases for shipping or carrying tools, components, and sensitive equipment. Molded of Lexan® resin, the virtually indestructible cases protect their contents from shock, dirt, moisture, and theft. TSE cases are ideal for shipment and storage — both in-plant and between-plant.

The water-resistant cases are remarkably lightweight yet considerably stronger than formed metal cases. They have the added advantage of being nonconductive and far more resistant to denting and cracking. Cutting tools, measuring devices, chucks, dies, and collets are among the objects protected in transit by polycarbonate TSE cases.

For further information on TS protective cases and TSE Custom-Pack system, contact TSE, Inc., 541 East Hector St., Conshohocken, PA 19428; phone (215) 825-8202.

Circle No.60 on Reader Service Card



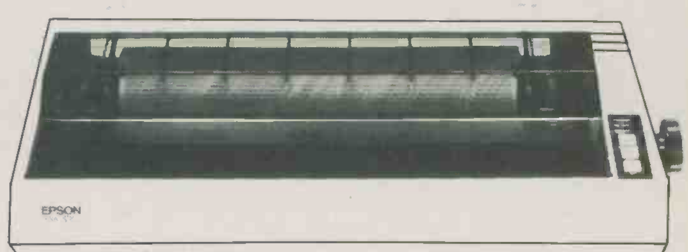
National's COP-420C

Thomson Semiconductor recently announced availability of its ETC-9420, a fully compatible equivalent of National Semiconductor's (Controller-Oriented Processor) COP-420C — a semi-custom, 4-bit microcontroller.

Thomson's P² CMOS device contains all system timing, internal logic, ROM, RAM, and I/O for a wide variety of applications including telephone sets, automobiles, toys and other dedicated control functions. Prices and technical information are available from Thomson Semiconductor's MOS marketing group, 6660 Variel Ave., Canoga Park, CA 91303, (818) 887-1010.

Circle No.59 on Reader Service Card

New Epson RX-100 Printer



Epson Canada recently introduced the RX-100 upgraded printer based upon the proven technology of the MX series. The upper-compatible RX-100 offers many features of the MX-100 such as a 9 x 9 print matrix structure and bidirectional with logic-seeking printhead motion. Both friction and tractor feed are provided for maximum paper handling convenience.

Two full 96 ASCII character sets plus 11 international characters sets offer a versatile printing capability. A total of 128 typestyles are offered including emphasized, doublestrike, pica, elite, italics, subscript and superscipt.

In addition to the RX-series, Epson Canada markets the FX-LQ- series dot matrix printers, HX-20 Notebook Computer and the QX-10 Personal Business Computer. All products carry a one year warranty under contract with E.S.S.N.A. Services Limited. For more information contact: Epson Canada Ltd., 21 Progress Court, Unit 18, Scarborough, Ont., M1G 3V4. Phone (416)431-5588 Telex 065-25415.

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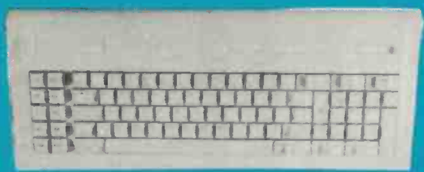

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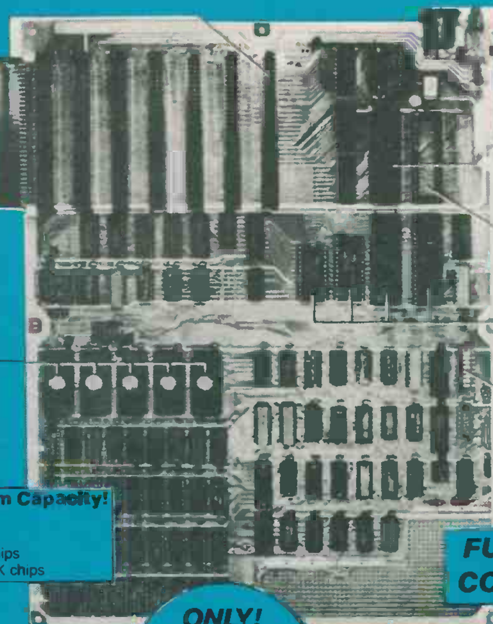

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New GRiDS

GRiD Systems Canada Inc. has announced a major expansion of its COMPASS Computer family with the introduction of three new portable computers, enhancements to its networking system, and several new software products. GRiD's networking system now integrates both IBM PCs and GRiD products in a remote area network. The GRiD COMPASS family now includes seven computer models, starting in price at $5,195 for the GRiD Server Workstation. GRiD introduced two models of its new COMPASS II computer. Both models offer plug-in software modules for operating systems and applications programs. Each COMPASS II will accommodate up to 512 kilobytes of read only memory (ROM) in the form of easily exchanged pre-programmed ROM packs which allow users to conveniently load different programs into the computer. Contact GRiD Systems Canada Inc., 2 Park Centre, 110-895 Don Mills Road, Don Mills, Ont. M3C 1W3 (416) 446-1555.

Circle No.53 on Reader Service Card

If you've ever considered turning your technical expertise into money through consulting, Michael A. Neighbours has recently published "How To Become A Consultant In Your Own Technical Field". The author believes that any engineer or technologist with about six years experience or more is probably qualified to work full- or part-time as a consultant; the book offers advice on marketing your services to the technical public. The book is priced at $25 U.S. from ATC Books, Rt. 2, Box 448, Estill Springs, TN 37330.

Circle No.52 on Reader Service Card

Computer bits: IBM Canada has lowered the prices of the PC and XT micros by 15 to 18 per cent; they have also followed the US firm's lead in lowering the price of the PCjr. Commodore has introduced the 8296 business computer with two drives and 128K for about $4,000, and Radio Shack in the US plans to start a door-to-door sales campaign for their colour computer.

Microtel Limited is now the official name of the company formerly known as AEL Microtel Limited. The amendment to the company's name, dropping the designation "AEL", became effective on June 1, 1984.

Selected Addresses:

Robotics Age, The Journal of Intelligent Machines, Box 358, Peterborough, New Hampshire, 03458, USA

(also Robotics Age Product Guide)

Designatronics Inc., Stock Drive Products Division, 54 South Denton Ave, New Hyde Park, New York 11040 USA

Feedback Inc., 620 Springfield Ave, Box 247, Berkely Heights, New Jersey, 07922, USA

RB Robots:
R.A. Hubbell and Assoc.,
298 Dundas St.,
London, Ont. N6B 1T6

Cybernetic Micro Systems,
PO Box 3000, San Gregorio, California, 94074, USA

HHS Microcontrollers, 5876 Old State Road, Edonboro, Pennsylvania, 16412, USA

Votrax, Inc., 1394 Rankin, Troy, Michigan, 48083, USA,

Votan, 4487 Technolgy Drive, Fremont, California, 94538, USA

Ezra C. Lundahl, Inc., 710 N. 600 West, PO Box 268, Logan, Utah, 84321, USA

Hobby Robot Co. Inc., P.O. Box 887, Hazelhurst, Georgia, 31359, USA

MACK Corporation, 3695 E. Industrial Drive, Flagstaff, Arizona, 86001, USA.

Valinco Automation Ltd., Custom Production Equipment, Unit 4, 2465 Dunwin Dr., Mississauga, Ont. L5L 1J9 (416) 828-7411

continued on page 64

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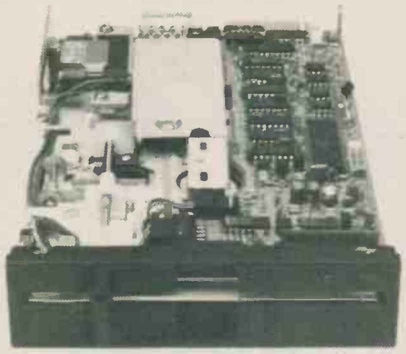

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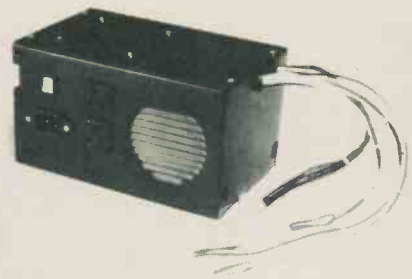

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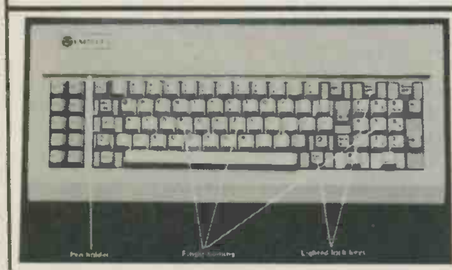
SPS-1130	130 W	15A	4.5A	0.5A	0.5A



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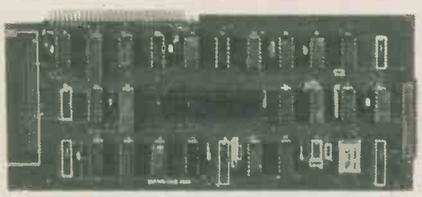

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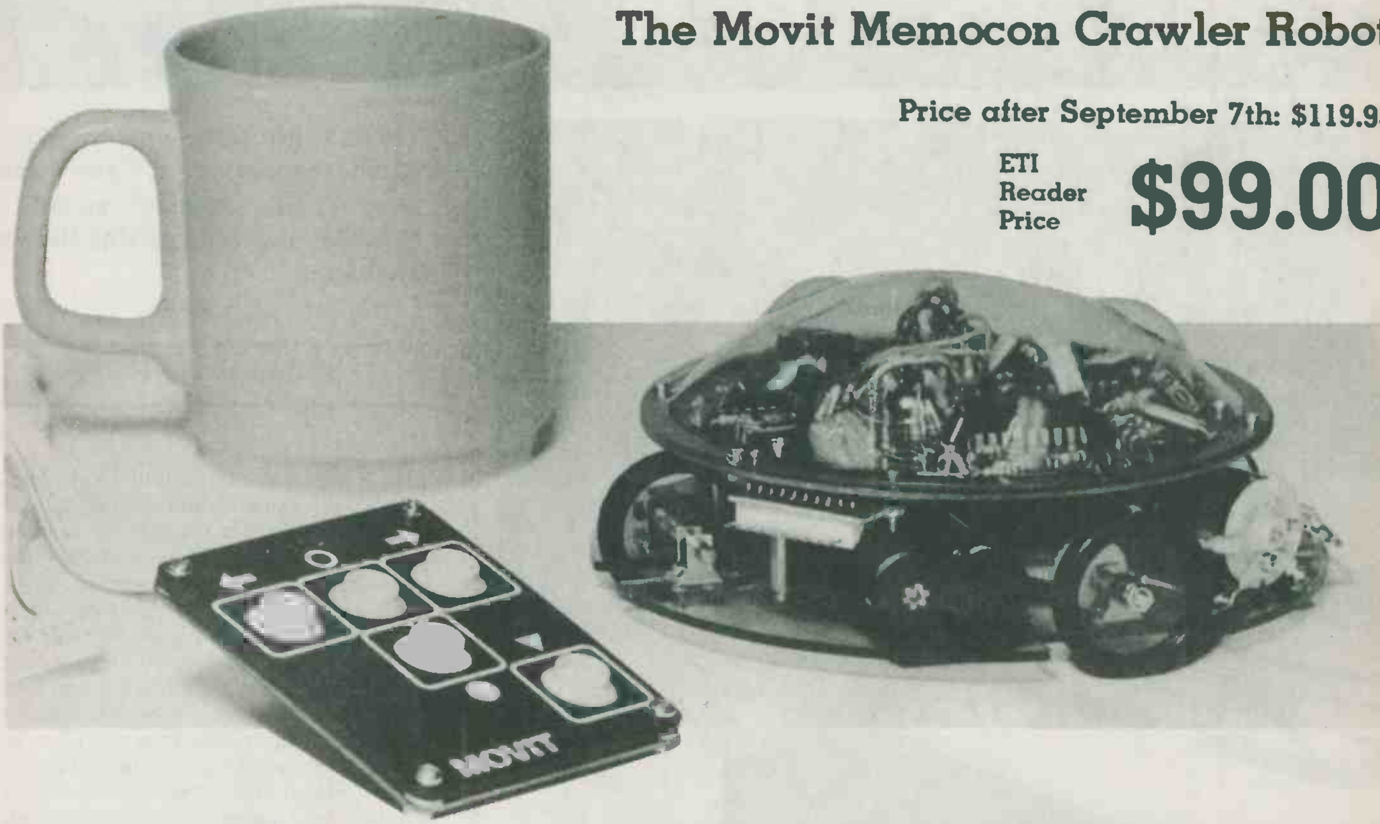
ETI READER OFFER

The Movit Memocon Crawler Robot

Price after September 7th: $119.95

ETI Reader Price $99.00



In researching our article on non-industrial robotics in this issue of **ETI**, we came across the **Movit Memocon Crawler MV-918 Kit** which will shortly become available in Canada through dealers – at the moment it is not on sale.

We had a lot of fun with it and have made special arrangements with the distributor to supply it directly to readers at a **special introductory price** prior to its launch in early September. The price will be $119.00, but we have arranged a strictly-limited-time offer at **$99.00 only for ETI readers using this offer.**

Fill out the coupon to get your kit now. The kit portion is purely mechanical – the electronics on the circuit board are already built; it takes from one to two hours to complete.

The Robot is controlled through a keyboard during the input stage; you then disconnect the keyboard and the **Memocon Crawler** duplicates the programmed instructions.

There are five modes: forward, left, right, sound a "beeper", and light an LED; a pause step can also be built into the program. The robot uses a sequence function static RAM 256 X 4 bit memory. The inputted program repeats itself once it has completed its routine. Up to 256 steps can be put in, each step representing a preset motion forward or a segment of a turn.

There are three wheels and two motors. The robot needs a 9V battery and two AA alkaline cells.

No instructions are given for connection to a larger computer but the operation and connections should present few difficulties.

This special ETI Reader Offer must close on September 7th and will not be extended. **Order now and save yourself a genuine $23.**

Yes. I'd like a Memocon Crawler and enclose payment of $99.00 plus $3.00 for shipping. Ontario Residents please add 7% PST.

☐ **Cheque or Money Order.**

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Mail to: Robot Offer, Moorshead Publications, 25 Overlea Blvd., Suite 601, Toronto, Ontario M4H 1B1

Please allow four weeks for delivery.

Offer Expires September 7th, 1984.

Alignment by Test Pattern

The Toronto control room at TV Ontario. Photos courtesy of Gord Kent, TV Ontario.

There's no need for a cross-hatch generator if you can receive TV Ontario; spend a Saturday morning getting the set in shape.

by James W. Essex

THE RAPID development of TV now has authorities talking about stereo sound and a separate additional channel for audio in another language. This is okay for language buffs, but all I wanted was a good old-fashioned "cross-hatch" pattern that would allow me to converge my triad-type picture tube on an Electrohome Chassis, vintage 1977, which I'd nurtured since my retirement. When I had to replace the picture tube recently, I was in trouble. I got a picture all right, but one in red, green and blue halos. The three guns required converging all over again with the new tube.

When I was with Electrohome, of course they had their own "in-house" convergence signal which included a "cross-hatch" pattern alternating with a "colour-bar" pattern. But they also had their own "in-house" rules and only bona fide repairs were allowed entrance. Even when employed there, you couldn't have taken a test generator home, although most technicians would have liked to have kept their own sets "up to snuff'. I recall one foreman who attemped to get around this by asking the local TV station outlet to broadcast a "cross-hatch" to facilitate his technicians' checking out of their own sets at home. But all we received from the TV station was a big yawn. After all, to get good "whites" and no "halos", the three guns have to cover off — exactly. But without a "cross-hatch" pattern, it's virtually impossible to get a good picture. I valiantly tried "lining-up" the three guns for the brief spell when a Tide commercial was on, but all I got was T-I-D-E in red, green and blue. I never did get my washing white. What to do?

Then I remembered TV Ontario — the Ontario Educational Authority. Why, only recently they ran a complete course in computers. Would they offer the same help with TV?

As it turned out, Gord Kent, Supervisor of Master Control for TVO, was already thinking the same thing. Kent wrote the following:

"For a long time, I have felt that there might exist the need among our viewers for this type of test signal, or at least something other than colour bars. It was your original letter forwarded to me that gave me the needed 'push' to do something about it.

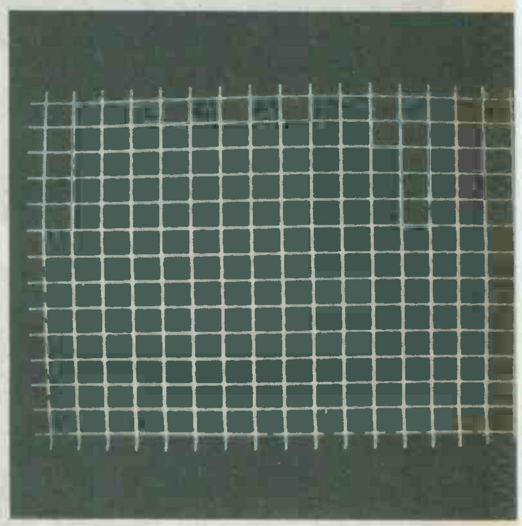
Following the first transmission on Saturday, January 14th, I arbitrarily decided to continue the transmission on a trial basis on Saturday mornings for an indefinite period awaiting any feedback, positive or negative, that might be forthcoming. I assume that Saturday (and possibly Sunday) would be the best day for most handymen and part-time technicians."

Kent of course, was referring to the help TVO already had given me when Doug Hanley of the same genial TVO staff, had already phoned me to "stand-by" that first Saturday morning in now distant January, in response to my call for help. This was followed by another from Dennis Roy, also with Master Control of TVO, that a "cross-hatch" was being transmitted for a half-hour beginning at 8 a.m., January 14th, 1984. I'm sure the pattern has been helping hundreds like myself since. This has been reinforced by Kent's subsequent comments:

"As indicated above, I recognize that the colour bar has limited usefulness to a viewer or anyone not having a vectorscope at his disposal. It certainly cannot be used for convergence adjustment or linearity. The colour bar has another disadvantage too. If left on for an extended period, the white chip will burn in, leaving a permanent dark square on the screen. For that reason, we transmit a 50% grey signal during non-program hours since we have a number of low power transmitters scattered across the province which operate 24-yours per day."

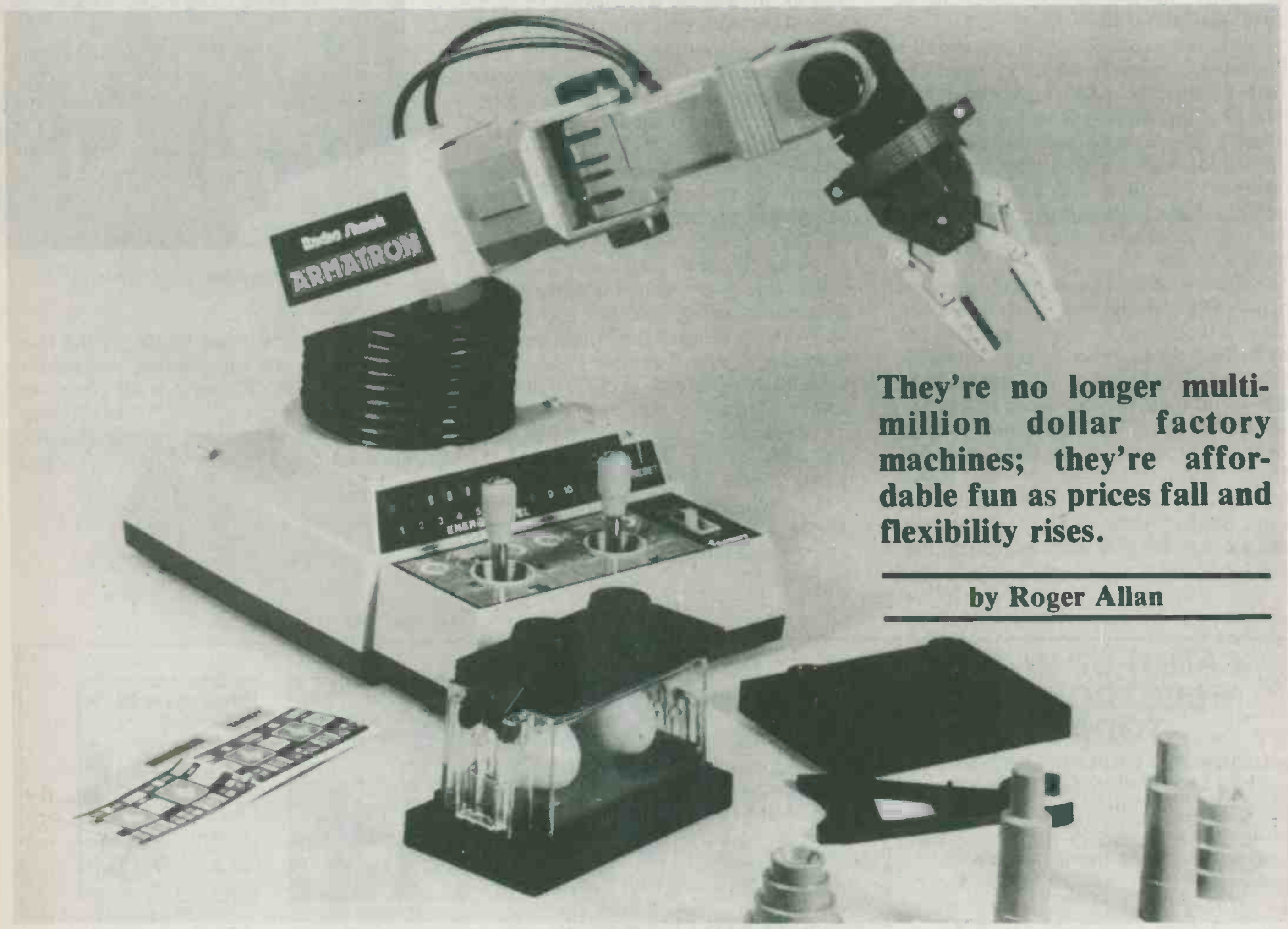
All of which means I don't get a "burn" on my picture tube and I can now converge to my heart's content. And while it's true that those with TVs having Trinitron picture tubes don't have to worry (the convergence is integral with each picture tube), there are many, many triad picture tubes extant which need convergence checks and/or converging. Without TVO's test signal, you might never have the opportunity to correct this.

Now, if you have any qualms about why JR's cowboy hat has peculiar red, green, or blue lines outlined on his otherwise picture-white hat, you have only to tune to TVO any Saturday morning at 8 a.m. to check it out. With judicious settings of three knurled knobs on the convergence board surrounding the picture tube, you too can make it all come out right, and those big, bold "T-I-D-E" letters in that ubiquitous commercial will once more be "picture white". **ETI**



The alignment cross-hatch test pattern.

Robotics:
Home and Educational



They're no longer multi-million dollar factory machines; they're affordable fun as prices fall and flexibility rises.

by Roger Allan

THE DEVELOPMENT of robots has its roots in the Middle Ages, and is concurrent with the increase in man's ability to manipulate things mechanically. The greatest degree of sophistication, and the area in which the greatest amount of work and thought was placed, occurred in the development of clocks — the intricacy of their internal structures stretching engineering abilities to their limits. After all, to pick something up requires a high degree of mechanical sophistication (unless one is prepared to have it alternately crushed by too much force or dropped on one's toe from too little), an engineering ability derived from a knowledge of gears, torques and smooth movements — knowledge predicated, at least until recently, in the construction of clocks.

Bits of History

But what actually is a 'robot'? In Gothic, there is a word akin to robot which means 'inheritance', and in German, 'to work'. An old Slavic word, and near equivalent, is 'rabota'. In Czech and Polish 'robota' means 'servitude' or 'forced labour'. It was first used in its contemporary context in 1921, in the title for the stage play *R.U.R.* (Rossom's Universal Robots) by the Czech playwright Karel Capek; the play was a self-styled 'fantastic melodrama' in which robots, constructed without any feelings or soul ("God hasn't the slightest notion of modern engineering") do all the world's work, wage all the world's wars and finally rebel and destroy their makers. After all, as the leader of the robot rebels tells the General Manager of the factory that produced him (it?), "You are neither as strong nor as skillful as we robots. I want to be master."

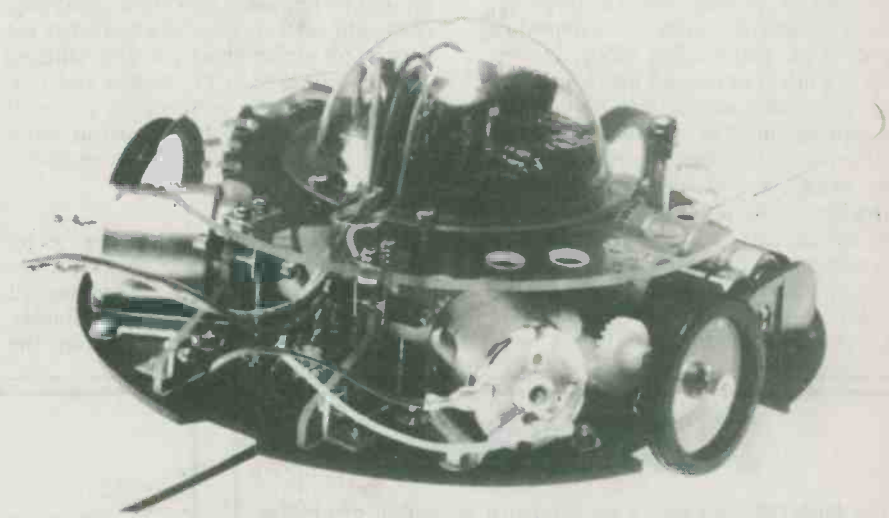
But despite the mere 60-year age of the word 'robot', and their technical basis in watch and clock making, robots have been cropping up in history for quite some time. In about 375 BC Archytas of Tarentum built a robot bird which flew (or so he records). *De Automattis* written by Hero of Alexandria in the 2nd century BC, tells of a theatre in which robot figures danced at temple ceremonies. In the 1490s, Leonardo da Vinci constructed a robotic duck which walked and flapped its wings (powered by a coiled spring — shades of clocks). In 1750, Jacques de Vaucanson constructed another duck robot. It stretched, took grain from the hand, swallowed and seemingly digested its food, leaving deposits behind. Johan Nepomuk Maelzel, in the early 1800s, built a robot orchestra of some seven instruments, for which he commissioned Beethoven to compose his *Vittoria Symphony*. Regretfully, Maelzel's other robot, this one a robotic chess player, was taken on a grand tour through Europe and North America and turned out to be more circus carney than robot. It was actually operated from the inside by a hunchbacked Alsatian dwarf named Schlumberger. But giving credit where credit is due, Maelzel's Panharmonium did work. There are many other examples of descriptions of robots in history. In the realm of mythology, the first humans were robots formed out of clay by the Titan Prometheus. In the realm of literature, perhaps the most noted example, courtesy of the fertile mind of Mary Shelley, is Dr. Victor Frankenstein's triumph in creating The Monster.

Definitions

Technically therefore, a home robot can be any one of a number of things: a device to play music, flap its wings, pour drinks, whatever. However, with the rise of automated industry and a concomitant rise in logic circuitry capabilities, robots 'took off' as it were, and in all sorts of directions, so much so that it is difficult to find a definition that can be agreed upon (see 'Industrial Robots," ETI, Feb. 1982). Its taking off was no longer dependent upon the abilities of watch makers, but upon the rise of the nuclear industry (requiring sophisticated manipulators to work in hazardous environments), war casualties (and the research into artificial limbs), and the rise of the computer industry (logic processing). Putting them all together, robots today are in a state of "expectant euphoria" according to one industry source, somewhat akin to the first microcomputer introduced in 1976 — a development without a stated purpose. By this, one doesn't mean that the massive robots employed in industry do not have a purpose: spray painting car bodies, lifting heavy objects out of furnaces, or even as at the Fujitsu Farroke plant in Japan, manufacturing other robots — quite obviously they do. But rather, the smaller robots, the ones one can find around the home or schools or light industry, have a purpose which is ill-defined and in a state of flux.

Perhaps the best coalescence of the problem (if it is a problem) is to repeat the quote by Douglas Bonham, U.S. director of educational applications for the Heath Company during the introduction of the HERO I robot. He stated that what they are good for, other than to teach people what robots can do, isn't really apparent, but that, "we hope the backyard tinkerers and inventors will come up with applications for it." In other words, it's similar to the introduction of the home computer offered to the electronic hobbyist market without any definite use, but computers have blossomed into a billion-dollar a year industry with applications cropping up in some of the unlikeliest places.

Such is the industry feeling about the home robot. At the moment, it's really only just 'fun', but the backyard tinkerers and the industry as a whole are beginning to find applications for it. Whether the industry takes off as did the microcomputer, remains to be seen, but the indications are that it very well may. The oft repeated question, "But will they do windows?" is rapidly becoming a question that can be answered in the affirmative.



The MOVIT Line Tracer is similar in design to the crawler, but its main function in life is to follow a black line with its infra-red sensing device.

The groundwork is in place. While this author has been unable to locate any true home robot manufacturers in Canada, there are more than 100 companies in the U.S. manufacturing complete robots, robot kits, peripherals, vision systems, software languages and addendums (and they *can* do the vacuuming — more later). There is a national magazine (glossy, subscriptions high) entitled *Robotics Age*, which recently published a sourcebook for educators and experimentalists in robotics. The first International Personal Robotics Conference was held in Albuquerque, New Mexico, two months ago, and had delegates from around the world.

State Of The Industry

But what actually is the state of the industry, ranging from the minor to just shy of the industrial grade machines? Is the potential for a $2 billion a year industry in home robots by 1990 fact or fiction? After all, home computer companies, such as Atari, Coleco, etc., have almost fallen flat on their faces with the home microcomputers (Atari lost $560 million U.S. last year), though it was only a year ago that their industry spokespersons were projecting that their manufacturers would not be able to keep up with demand. And what of the experimentalists of the backyard variety, upon whose shoulders rest the development of robotics applications around the house? Will they rise to the occasion as did the microcomputer hackers? One cannot say, other than that the potential is there.

Lets' start at the bottom-of-the-line machines, those just a fraction ahead of wind-up clockwork toys. There are any number of manufacturers, all extolling the virtues and humour derived from their machines. There are all sorts of models, far too many to catalogue in an article of this length. A few examples: perhaps the best to start with are those manufactured by the MOVIT company of Japan and widely sold in Canada, primarily through toy shops. They have eleven inexpensive models all in kit form. An example is the MOVIT Monkey MV-919 (assembled and ready to run) or the MV-929K (in kit form); Essentially cylindrical in shape, with what looks like a miniature elephant's trunk sticking up and out from the front of the body (containing a microphone at its end), with two plastic arms reaching up and in. One ties a piece of rope across the room and hangs the device from it. Loudly crying "Move!" or clapping one's hands results in the robot beginning to swing itself along the line hand over hand, just like a monkey. After a while it stops. Its movements are via two alternately moving gripper arms driven by crank motions, while its control is via a sound sensor which includes a condenser microphone. Its power is via two 1.5 volt "N" type batteries. Sophisticated? Not really; it's more of a novelty than anything else.

Slightly up the line is one manufactured by the TOMY company, marketed in Canada, which sells for about $20. Called DING-BOT, it looks like a little robot and is battery powered. It's a bit more complex than the Monkey, in that it moves forward until it encounters and object. It then stops, turns it head from side to side, chatters away with a chirping sound, then turns right and goes off. Battery powered, it comes with its own 'map' that only it can follow. A somewhat upmarket robot, also sold by TOMY is the VER-BOT. Looking a bit like R2D2, it possesses a memory with eight separate functions. It is voice activated and can, when activated this way, perform simple tasks such as moving forward, stopping, moving backward, retrieving an item via a gripper arm, and smiling (with flashing lights). While it cannot adjust to a changing environment, such as the DING-BOT, it is reprogrammable via voice activation while moving. In other words, the owner is the brains, and the device is the slave, analogous to the industrial robots which enter the hot cells in nuclear reactors; they have to be told what to do and when they are to do it.

An example of the top-of-the-line of this sort of robot is the OMNI-BOT, also manufactured by TOMY. Looking like a largish version of the VER-BOT, it is radio controlled, as well as being able to repeat a series of commands. It can repeat these programmed functions at a later time through an on-board clock/tape memory. It can speak or deliver messages via an on-board computer and a tape cassette, enabling it to carry on a dialogue with humans and to carry items like slippers, drinks and snacks. Real time programming is possible via the radio control hand held device. It retails for about $300 Canadian.

Essentially therefore, the first category of home robots are really nothing more than novelties. With the exception of the voice activation capability, one could perform all of the tasks they are capable of doing mechanically, utilizing switches rather than PC boards and ICs. As mentioned above, there are many of them manufactured by numerous companies, all primarily for the toy market.

Turtles

The next level of home robots come under the general umbrella heading of turtles. Generically, a turtle is simply an inverted bowl shaped plexiglass housing, with three wheels in a triangular configuration, the two on either side being power driven, usually by battery operated DC motors. Again, there are a number of manufacturers and types (even MOVIT, mentioned above, markets several versions), but they are a distinct progression towards what is customarily considered a true robot. Three examples:

The Line Tracer II, manufactured by Stock Model Parts and part of the MOVIT series, utilizes an infrared light sensor to guide it along any drawn black line pathway. A black felt-tipped marker or cap, can be used to create the straight or curved pathway, providing that the line is at least 3/8 of an inch wide and is on white paper or a white floor area. Sold in kit form (retail $44.95 U.S) and taking about 2 hours to build, the Line Tracer II is primarily designed for school science projects and introductory robotics courses which teach how infrared sensors work.

A second example, also sold by Stock Model Parts, is a programmable robot controlled through a seven function teaching pendant (one disconnects the pendants after having entered the program) or via a microcomputer having a parallel interface. Called the Memocon Crawler, and sold as a kit, the robot includes an on-board CMOS static RAM

256X4 sequencer. If the teaching pendant alone is used, a program can be entered to the robot's memory for it to go forward, right, left, pause, sound a buzzer, or light up an LED lamp. It repeats the program continuously.

A third example of a turtle is the ARMADILLO model EMR 1020 manufactured by the Feedback Company. It represents the middle ground between robots as toys (above) and robots as educational devices (though most manufacturers insist that their robots, no matter how simple in construction, represent an educational tool). This device requires connection to a computer, either a ZX81 (Timex Cinclair 1000), and AIM 65, or similar. The ARMADILLO has LED eyes that blink, and a beeper in two tones. When directed by the computer, it will press down a pen and 'draw' or chart its programmed progress on paper. Under computer control, it will run around forward, backward and to the right or left. Each of its three wheels is independently controlled. The difference between this turtle and those mentioned above is that it's 'environmentally sensitive', that is, touch sensors attached to the ARMADILLO's shell send data back to the computer whenever the robot encounters an object. The reprogrammed computer then directs either evasive or exploratory action. Its interface with the computer consists of four circuit blocks. The first is address and address decoder operating on the top ten address lines to produce an output only for a certain bit-pattern corresponding to a particular address (specifically, the ARMADILLO itself). The control circuitry determines, in conjunction with the output from the address decoder, whether the computer is writing data to the robot, or reading data from it. The latch accepts data from the computer at specific times and stores it until the next time data is sent to the machine. The buffer transmits data from the robot when the computer is ready to accept it. As such, the circuitry enable the robot to be treated as a memory-mapped I/O device; in other words, data can be sent to and from the robot as if it were another memory location in RAM or ROM.

Essentially, then, in the realm of turtles there is a spectrum of capabilities, ranging from glorified toys to devices that are capable of interfacing with the environment and reacting to it. The major drawback of this type of robot is that they just move around the floor.

Adding Grippers

The next generic classification of home robots runs the spectrum from near toys to light industrial grade devices under the umbrella title of 'grippers'. Grippers are essentially arms which are analogous to the human arm and hand; they can extend, twist, roll and grip through a variety of axes and motions. There are at least a dozen manufacturers of such devices in North America, each manufacturer having a variety of models. Only three will be discussed here, along with an addendum.

An example of a bottom-of-the-line device is a $44.95 item manufactured by the Tandy Corporation (Radio Shack) and called the Armatron Robot Arm. All command functions are via two joysticks that guide all of the robot arm motions. The arm can be controlled to rotate left or right, move up or down, and bend at the elbow. The hand assembly can also be raised or lowered. Turning the joystick levers, opens the grippers up to two inches for girpping, picking up, moving and releasing objects. It is provided with rubber-coated pinchers for gripping. Essentially, as a toy it can be used to play games (placing it alongside a chess set and having it move the pieces, for instance) or as an educational device to teach robotic arm movements, what they entail and how to think through motions.

Two examples of up-scale grippers, from the many available, are taken from the Feedback Company's product line. The first is the ARMSORT Model PPR

The Armover SSA 1040, an instructional robotic arm designed for control by an external computer.

1030. It was designed to illustrate the method of controlling stepper motors, solenoids and other robotic functions by using a properly programmed microcomputer. It comes with a magazine and a variety of resistors. Under computer control, this device moves its end of arm tool to the magazine and extracts a resistor. The value of the resistor is measured, converted to digital data and presented to the computer. The control program allows the the computer to search for up to 10 resistance values in preset tolerance bands. Each specified value of a resistor can be automatically placed in a predetermined storage location. Out-of-range resistors are rejected. When the magazine is empty, the robot halts and requests further instructions. It can continue to sort a refilled magazine or print out a summary of resistor sorts to date. Its 'personality pack' contains a software cassette or diskette, printout program (BASIC), flowchart program, and interface card and an interconnection lead to be placed between the robot and the microcomputer. Linear and rotary movement are provided through stepper motors, with resolution of 48 steps per revolution. They are geared to permit accurate positioning of the gripper. The two-fingered gripper is solenoid operated. When it picks up a resistor out of the magazine, a constant current circuit is completed. The voltage drop across the resistor is measured. The analogue value is converted to digital form and presented to the external computer.

The BASIC program attached to this device is quite straightforward. The ARMSORT introduces itself to the computer screen with, "Hi! I am an intelligent robot! I can perform a useful function by sorting mixed resistors into a number of stations in accordance with your instructions. My working resistance range has been set to 0-750 ohms. Above 750 ohms I make mistakes. First, drive my arm to the magazine, using the keyboard."

The device then asks the operator to select up to 10 stations, to select a choice of resistor values, and to give the resistor value and drive it to each station in turn. Then when the robot fails to pick up a resistor, it will request further instructions and/or give a summary of those selected.

Another example of a gripper is also taken from the FEEDBACK line, specifically the ARMOVER. It simulates full-scale industrial robots via interfaces with an Apple II (or clone). They simulate the actual production situations through waist rotation, shoulder bend, elbow bend, wrist pitch and wrist roll. The 'intelligent' gripper senses if it is holding an object or not, and can judge the size of an object to within 1/6 of an inch. Through parallel fingers, the versatility of the robot is increased over that of pincer-grip models lower down the model line. Low force levels forgive operator error, unlike full-scale industrial robots with which accidents can result in product damage. Its movements are via tendon technology, that is, the type of cable control used in aircraft. It is an educational device, or for the serious hobbyist. Another gripper arm is the device Armdroid 1, from Valinco Automation. It can be controlled by an apple computer, and includes software.

In the range of grippers, one now starts to bump into industrial production devices, such as those manufactured by the MACK Corporation in their B.A.S.E. line of robots, and as such are beyond the scope of this article.

Essentially, then, grippers are "set in place" devices reminiscent of industrial robots. They cannot move. Turtles move, but cannot grip. It is in the combination of these two generic types of capabilities that the true home robot emerges. There are not many such devices on the market as yet, but two give a good indication of what's available: Heathkit's HERO I and RB Robot Corporation's RB5X.

HERO

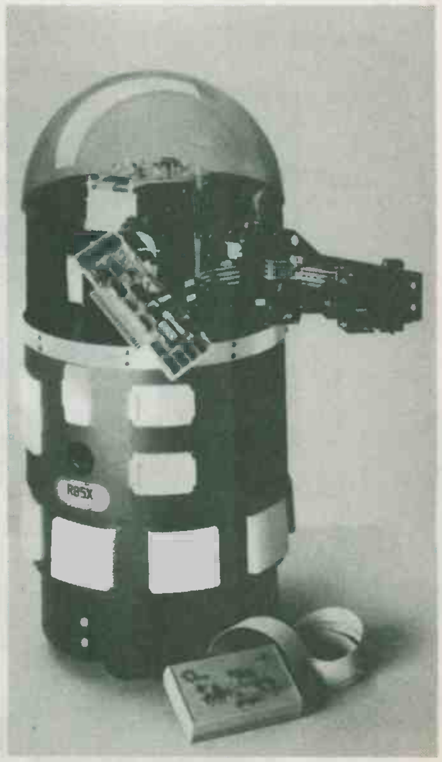
HERO I has been around for a while, and is perhaps the best known of such devices. It comes either in a kit ($1779) or assembled ($3395). It is an intelligent, mobile robot, incorporating the generic qualities of the turtles with those of the grippers. Reminiscent of R2D2, it stands about 20 inches tall, weighing in at 39 pounds. It is self-contained, operating on an electromechanical control foundation. It is controlled by its own on-board programmable computer and carries electronic sensors to detect and qualify light (1 part in 256, 30° angle), sound (resolution 1 part in 256, approximately omnidirectional), range (pulsed ultrasonics, resolution 0.42 inches at maximum range of 8 feet, horizontal and vertical beam width approximately 30°), motion (continuous wave ultrasonics, sensitivity resolution of a human at 15 feet), speech (synthesized phoneme-based system, 64 phonemes and time measurement. It moves on three wheels, has a head that rotates, and an arm with a gripper on the end which can pick up an object weighing a maximum of 225 grams. Its microprocessor (4K memory) is a 6808 which interfaces with all sensors, on-board real-time clock, experimental circuit board and drive motor. It is programmable through a hexadecimal multi-function keyboard mounted in its head, an external teaching pendant, or through directions carried on a standard cassette tape recorder pre-programmed via a computer. The microprocessor has seven operating modes: executive, utility, program, repeat, manual, learn and sleep. It therefore incorporates all the basic systems found in contemporary industrial robots, with the added ability of mobility. While classed as an 'intelligent' robot, it cannot in fact learn from its environment.

The top of the line device currently being massed-manufactured is RB Robots' RB5X which comes as close to the lay persons' idea of what a home robot can do.

RB5X

The RB5X stands about 23 inches high and weighs in at 25 pounds. It can do everything that the HERO I can do, and then some. The 'then some' is'quite some'.

Its biggest difference (in part due to it having a later design than the HERO I and having a 64 K memory on-board as opposed to HERO's 4 K) is that it is the first of the truly intelligent home robots. It learns from its own experience, progressing from simple random responses to an ability to generalize about the features of its environment and to make predictions about its environment. For example, when the RB5X, equipped with its standard sonar and tactile sensors, encounters an object in its path for the first time, it chooses from a table of random responses — turn left, turn right, whatever. When one of these responses proves successful in allowing the RB5X to continue moving, the robot stores that information in memory (either in RAM,



RB Robot Corporation's RB5X. This one will vacuum your rug, put out your fire, fetch your paper, and walk your dog, not to mention countless other possibilities. It doesn't do windows, though.

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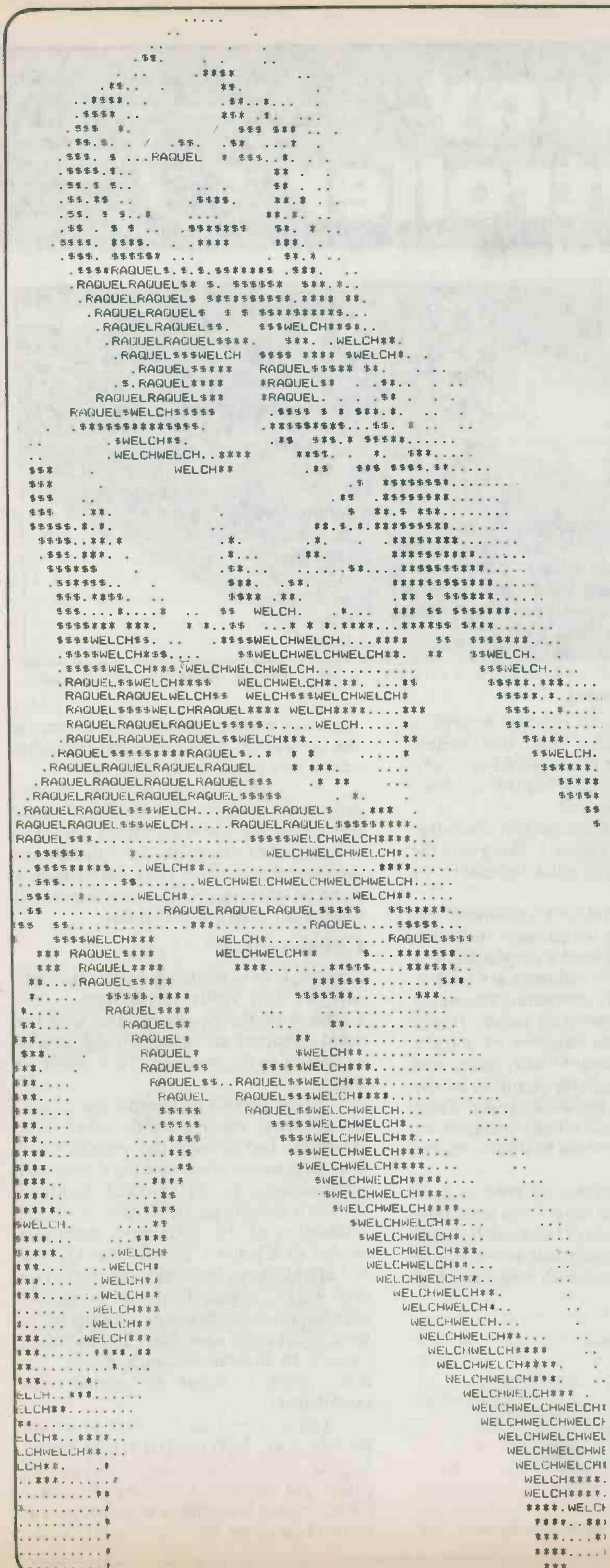

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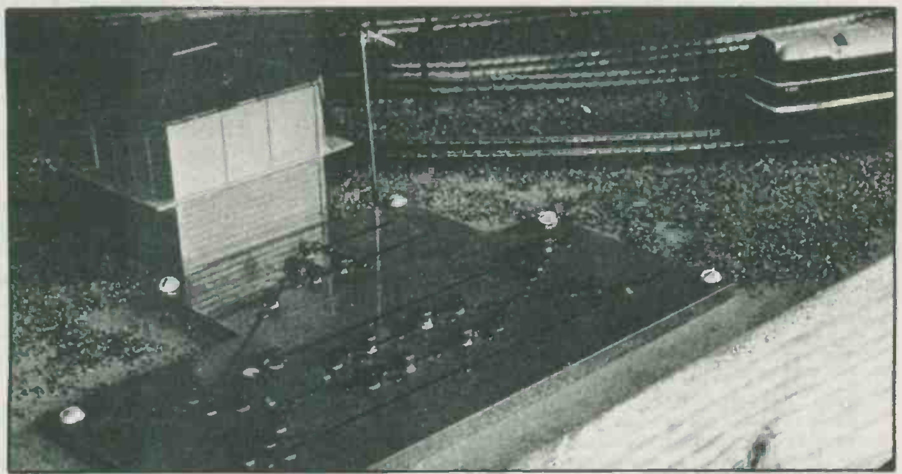
Model Railway Switch Controller

This project employs a capacitive discharge type power supply to drive the solenoid actuators in model railway turnout switchers. An add-on indicator unit can be used in conjunction with it to show which way turnouts are switched at any time.

by Jonathan Scott



Signal map. This shows a view of one of my signal maps with the switch pushbuttons and indicator LEDs installed.

THE IDEA of using a capacitive discharge supply to drive the solenoids in model railway turnout switchers is not new. Indeed, you can buy these at hobby shops for $20 or so, if you are not inclined to build one for yourself. However, this project incorporates refinements you may not have seen, along with a system of indicating the state of turnouts modelled after the fashion of the 'professional' signal box lighted map.

The capacitive discharge supplies bought 'over the counter', generally charge a capacitor of one to two thousand microfarads via a current limiting resistor from a rectifier and an AC source. This is quite adequate, but can be refined. If you charge the capacitor from a constant current source, it charges somewhat faster and one can provide an 'unready' indication while it's charging. The little extra speed one gains in charging is handy as several switches often need to be changed in a short space of time and one's fingers dance from button to button when doing so.

With either system, the current limiting arrangement protects the solenoids against burnout if the supply happens to be accidentally connected indefinitely. The simpler system almost invariably incinerates something if you get a short somewhere.

The idea behind the capacitive discharge method is simply that the switch changes in the first hundred milliseconds or so; any other power delivered is wasted. The high momentary current capability of a capacitor means that the solenoid always moves quickly. When you connect the charged capacitor to the switch solenoid, it will deliver a very high current which rapidly subsides to nothing or, at worst, the charge current which can be much less than the current required to actuate the solenoid. Thus, the solenoid remains cool even if connected (by some accident or other) indefinitely, avoiding burnout of the solenoid.

The outline of a capacitive discharge supply is shown in Figure 1, along with the outline of a 'remote point indicator', or 'remoter'.

The remoter is simply a 'memory' circuit which records which way the switch was last changed. I used a simple flip-flop for this. Two LEDs or lamps are used to indicate the switch's condition. These may be built into a signal map panel. This is basically just a line diagram of a track layout, or part thereof, with lights and switches in the symbollic positions of the actual switches on the track layout. Train signal lights are also usually included on the map along with train position sensors, if used.

There is, of course, no need to have remoters. They are purely conveniences, rather than necessary functional items. Remoters are primarily important if you wish to have a layout which is as much like the 'real' thing as possible. However, for the few dollars or so extra cost each, they add a very pleasing touch of realism.

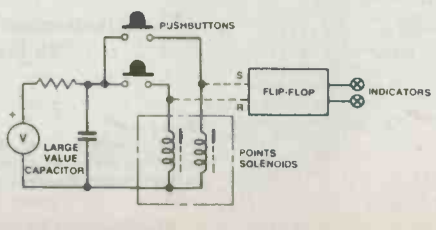


Fig. 1 The controller indicators scheme.

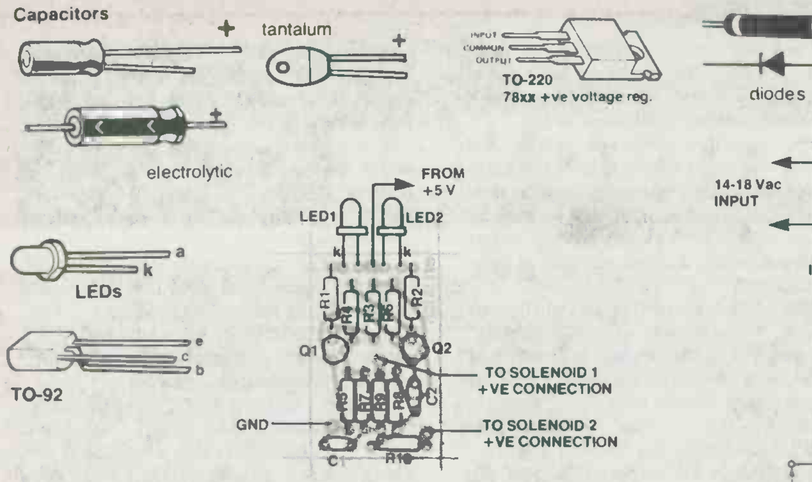
You can have any number of turnouts in your layout and you'll only need one capacitive discharge supply unit. The one described can easily drive three turnouts simultaneously if you need to operate some of them together. One remoter is needed for each set of turnouts.

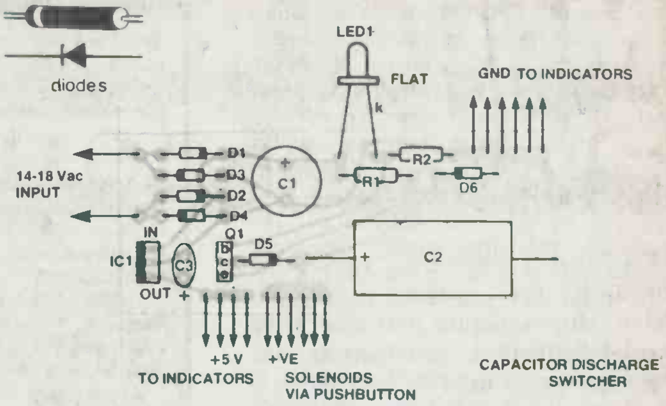
Construction

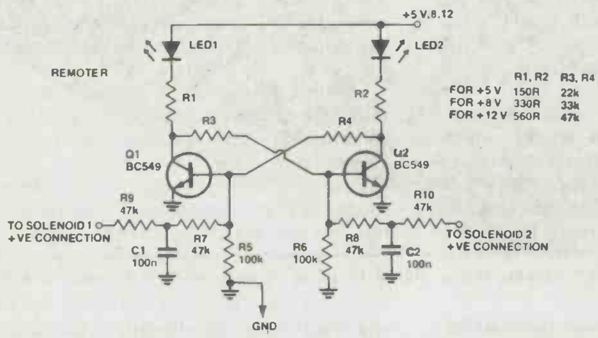
Construction is relatively brief. The only part we can really cover here is the assembly of the pc boards and with the usual exhortation "assemble the boards according to the overlays," it's nearly all over!

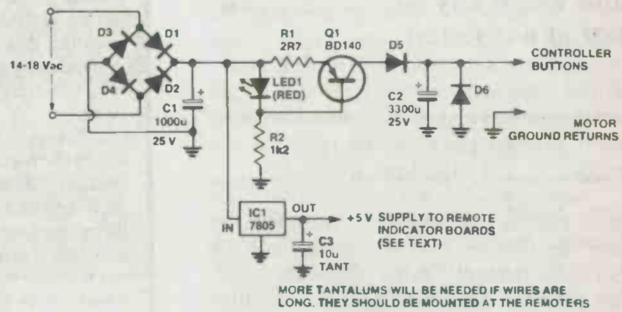
There are two pc boards: the capacitive discharge supply, and the other is for remoters. Let us take the supply board first. It is easiest to mount the diodes and resistors first, then Q1 and IC1, followed by the capacitors. Take care with the orientation of the diodes and transistors as well as C1 and C2. Note that Q1 and IC1 should have heatsinks attached. You can make these from a scrap of aluminum; each heatsink should be at least 25 sq. cm in area. They can be bolted straight to the face of each device, but don't forget to smear on thermal compound first.

You may or may not wish to mount the 'charging' LED (LED1) off the board; such as on the front panel of your controller, for example. This is a good idea if other perople are using your layout, as it helps them allow for the necessary delay









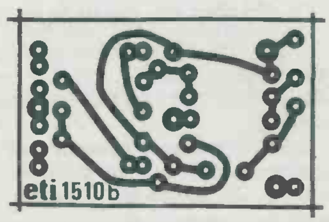
REMOTERS PARTS LIST

Resistors	
R1,R2	see text, circuit
R3,R4	see text, circuit
R5,R6	100k
R7,8,9,10	47k
Capacitors	
C1,C2	100n
Semiconductors	
LED1	TIL220Y yellow LED
LED2	TIL220G green LED
Q1,Q2	2N3904 or equiv.
Miscellaneous	
pc board; hookup wire, etc.	

between switching operation of about half a second or so. Make sure you wire in LED1 the right way around.

The remoter board is quite straightforward. Best way to tackle this one is to mount the resistors and capacitors first. Then mount the two transistors making sure you get them the right way around. Finally, mount the two LEDs. Leave their leads long as the board can actually 'hang' from them. Alternatively, the LEDs may be mounted off the board and the board mounted somewhere conveniently nearby.

I secured my board to the underside of the model railway baseboard with staples from a staple gun holding down the wires to and from the units. The capacitive discharge supply was actually mounted at right angles to the baseboard. The remoters were held flat on the baseboard by stapling the wires fairly



close to the pc board. This arrangement has proved entirely satisfactory.

Trying Out

The supply board can be tried out first. Hook up the input to an AC source of between 14 and 18 volts. On switch-on, LED1 should light, then extinguish about a second later. If not, check that it's connected the right way around. If that's OK, check that you're getting about 1½ times the AC input voltage across C1 (between 20 and 25 V DC or so should appear across it). If not, switch off and check the diodes D1 to D4 are all correctly oriented. Correct any faults as you go. When you've got LED1 to light on switch-on, then check that the output of IC1 is +5 V. Measure the voltage across C2. It should be equal, or nearly so, to the voltage on Q1. If LED1 won't go out, or there's less than one volt across C2, odds are you've got D6 the wrong way round.

Temporarily hook up the supply to a switch solenoid and see that it operates as expected.

You can check out the remoter(s) by temporarily connecting it to the +5 V

SUPPLY PARTS LIST

Resistors (all ½W, 5%)	
R1	2R7
R2	1k2
Capacitors	
C1	1000u/25 V electro.
C2	3300u/25 V axial electro.
C3	10u/6 V tant.
Semiconductors	
D1-D6	1N4001/2/3/4 etc.
LED1	TIL220R red LED or equiv.
IC1	7805
Q1	1A 50 V PNP, 2N4920 or equiv.
Miscellaneous	
pc board; hookup wire, etc.	

from the supply board. One or other of the LEDs will light. Say, LED2 on the remoter lights. Connect the 'SOLENOID 1' input momentarily to the positive terminal of C2 on the supply, LED1 should light and LED2 should extinguish. If not, check transistor and LED orientations. If this works, then temporarily connect the 'SOLENOID 2' input to the positive terminal of C2 and the LEDs should swap over.

When wiring in the remoters, it may be necessary to add some extra supply bypassing to prevent random toggling of the LED indicators. Add a tantalum with a value between 4u7 and 10u. You'll need one of these per extra metre of cable length if the cable is a metre long or more.

Wiring Multiple Switches

Invariably, you will want to install multiple sets of switches, some of which operate alone, some of which may need to operate together. There are two wiring options which exist and which may prove useful if you have not seen them before.

It often happens that two switches will always need to be switched together. These can be wired directly in parallel and operated by only two pushbuttons. The capacitive discharge supply described, should drive such an arrangement easily, without the need to increase the value of the discharge capacitor (C2). The 3300u capacitor specified would easily and reliably operate three parallel switches in my layout. If you need to drive more, then the capacitor's value can be increased (try 4700u). Conversely, you can decrease the capacitor's value if you find your solenoids are light ones and/or don't have parallel operated switches. Don't forget that if you increase the capacitor's value, you'll increase the charging time. If you decrease it, charging time speeds up.

Sometimes there is a need to have one set of switches 'slaved' from another, but have the first set operated independently also. This is readily achieved by the inclusion of some simple diode logic. A diode with its anode connected to one solenoid and its cathode connected to another, will leave the first turnout unaffected by the second when switched, but will ensure that when the first is switched, the second also operates. This can be implemented with ordinary silicon rectifier diodes such as EM401s, 1N4001s, etc.

The various wiring arrangements are illustrated in Figure 2.

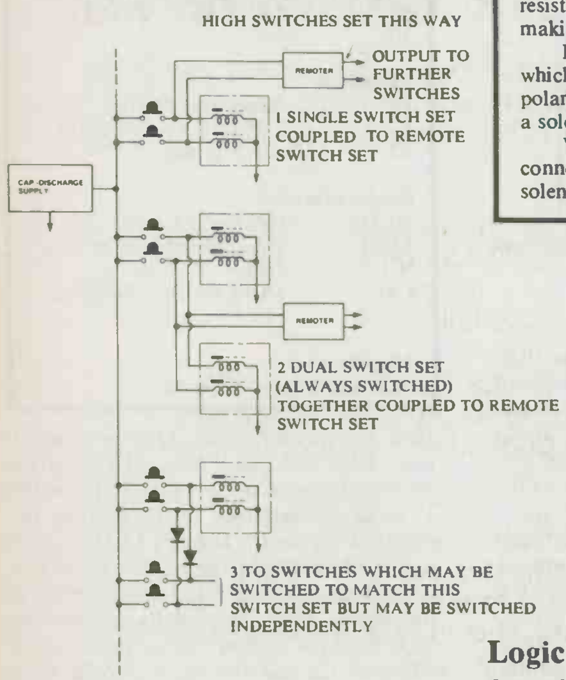


Fig. 2. Showing the three fundamental schemes for wiring switches.

HOW IT WORKS

There are two distinct parts to the project: the first is a capacitor discharge supply used to operate the switch solenoids, the second is a remote indicator unit.

The capacitor discharge supply unit charges a capacitor which is then discharged into the switch solenoid, which then operates the switches. This unit is capable of changing one switch every half second or so, and can power a larger number of switches together.

The remote indicator unit, or 'remoter', has the job of 'remembering' which way the switch set was last switched and indicates the direction with a pair of LEDs mounted as part of a signal map.

Consider the capacitor discharge unit. Diodes D1-D4 rectify the 14-18 volt AC input to provide a DC supply capacitor C1 smooths this for IC1, which regulates the voltage supply for the remoters. Up to fifteen remoters can be run off the output of IC1.

Transistor Q1 and surrounding components form a current source which charges C2 via D5. LED1 forms the voltage reference and doubles as an indicator which illuminates for the time when the capacitor is being recharged after use. Diode D5 prevents reverse biasing of the transistor when C2 is charged and C1 is below the peak input voltage value.

Using a current source for the charging element, removes the need for a large series resistor and speeds up recharging as well as making the system short-circuit proof.

Diode D6 is a "freewheel" diode which prevents possible reversing of the polarization of C2 by the flyback voltage of a solenoid.

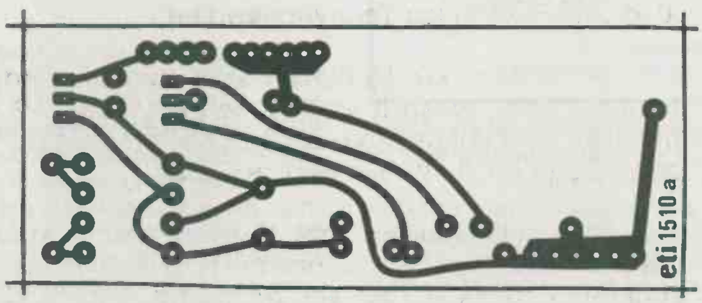
When a button is pressed, making a connection from the output of the unit to a solenoid, C2 discharges into the coil, changing the switch. After C2 is discharged, the only current flowing through the coil is the recharge current of about 375 mA. When the button isolates the solenoid, the current is free to charge C2, which takes about a quarter of a second. When C2 reaches the input voltage, Q1 saturates, LED1 goes out, and the unit is ready to operate again.

The 375 mA charging current is insufficient to harm a solenoid if it is left connected for any reason. As the controller can withstand indefinite shorting itself, the whole system is protected against abuse and failure of switches, etc.

Each remoter consists of an R/S type flip-flop formed by two transistors. Assume initially that Q1 is on, and Q2 off. The collector current of Q1, via R1, illuminates LED1, and the saturation collector voltage of Q1 ensures that Q2 remains off.

When a solenoid is activated by the discharge of the capacitor, a large voltage spike appears across it. Suppose that the voltage across the coil appears on R10. Capacitor C2 filters out brief induced spikes, so that no signal other than the correct one can affect the circuit. When the longer duration discharge pulses appear on R10, some current reaches the base of Q2, turning it on. This turns on LED2 via R2 and removes the base drive from Q1, and it turns off. Thus LED1 goes out, and the collector voltage on Q1 keeps Q2 turned on via R3. The reverse operation occurs when a pulse appears on R9.

Transistors are used rather than an IC as they have a higher output drive, are less intolerant of supply voltages, and ICs normally have more than one flip-flop in each package and you waste the rest.

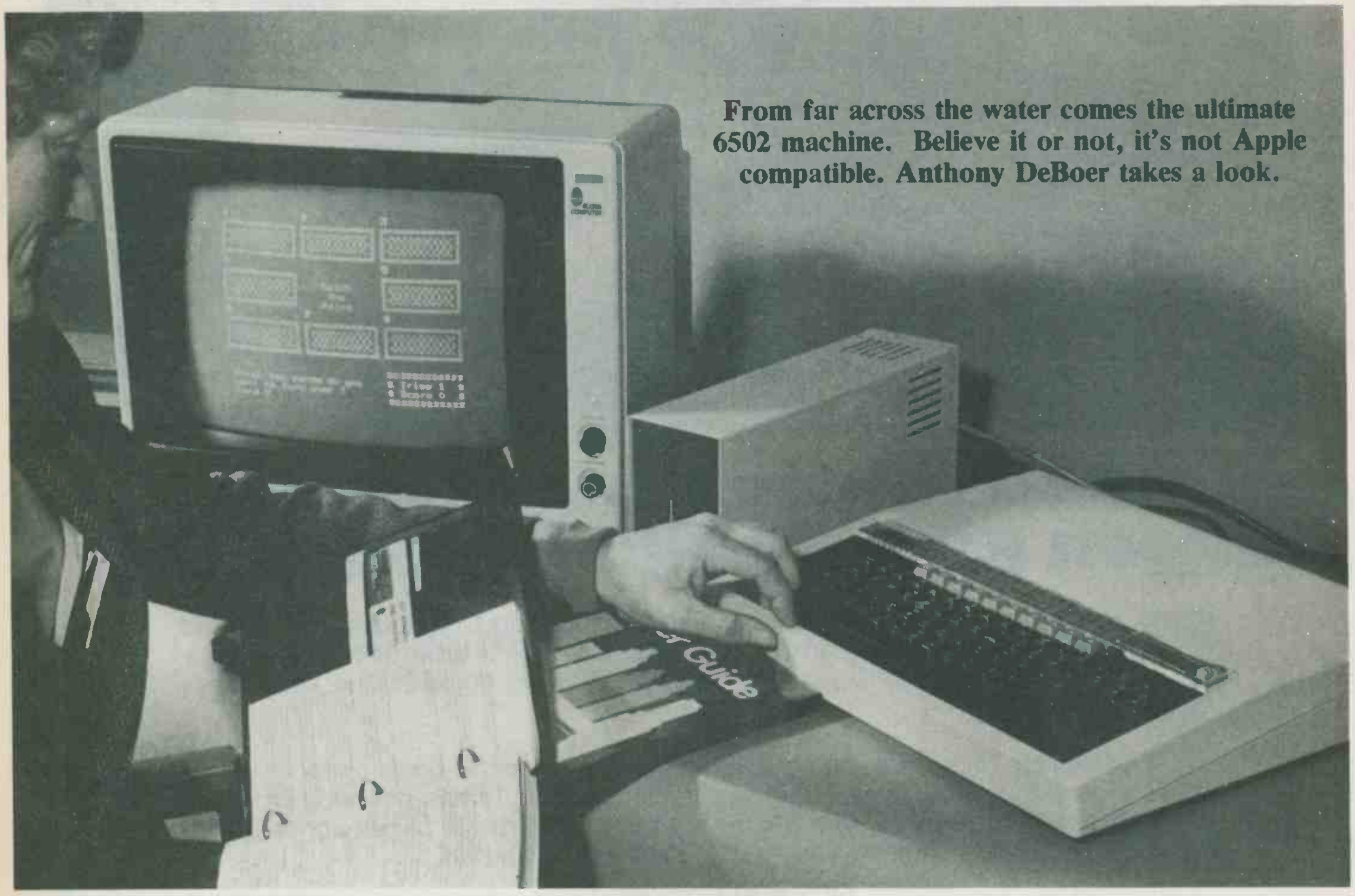


Logic Output

One advantage of remoters is that they can output the state of a switch set as logic levels for feeding into a digital system or computer. Astute readers will have noticed a certain provision in these model railway projects for a computer interface. The collectors of the transistors in each remoter circuit give a 'low' voltage when the respective side is that one carrying the traffic. For a 5 V supply, the levels are TTL. This is the main reason that the remoters are run from a carefully regulated supply, apart from a desire to keep LED illumination level fairly constant. For those needing CMOS or other levels, the resistor values for 8 V and 12 V supplies are shown on the diagrams. (R1-2 and R3-4 will vary.)

Coupled with position sensing systems, the remoters can allow a simple anticrash logic system to be hardware implemented! **ETI**

Acorn BBC Review



From far across the water comes the ultimate 6502 machine. Believe it or not, it's not Apple compatible. Anthony DeBoer takes a look.

FROM THE foggy isles that brought us the Queen, the Beatles, and the ZX-81, not to mention the language most of us speak, comes the computer we're reviewing this month. Like the Multitech computer that came from a sunny island halfway around the other side of the world for the June review, it also uses a 6502, but unlike it, the Acorn BBC microcomputer bears no further resemblance to the Apple.

Like Ontario's Cemcorp Icon (a.k.a. the Bionic Beaver), the BBC micro was designed as an educational machine. The British Broadcasting Corporation (BBC) decided they wanted a machine to use as part of an educational television show they were doing, called "Making the Most of Your Micro". Meanwhile, Acorn Computers was working on a successor to their Atom microcomputer, a fairly popular machine in Britain that never really took off in the Canadian market. Eventually, the two lines of effort became one, and the Acorn BBC micro was born. The computer has since been phenomenally successful in the British market, and is now available in Canada.

Hardware

Internally, the BBC consists of a 2 MHz 6502 (twice the speed your ordinary garden variety 6502 runs at) addressing 32k of RAM and somewhat more than 32k of ROM. The upper 16k of ROM contains the "Machine Operating System" — all on one chip — which does all the I/O and selects one of up to four other such chips to occupy the other half of ROM space. BASIC occupies one such ROM, leaving the other sockets free for things like the disk operating system and the word processor ROM.

Externally, the machine consists mainly of a flat box with a keyboard on the front upper part, as pictured in the photos accompanying the article. The back side has, besides the usual power cord and switch, video connectors for your choice of monitor, modulated RF, or RGB signals, along with connectors for cassette, analog input, RS423 (which is similar to good old RS232), and Econet (a network system Acorn offers). The remaining connections are on the bottom of the machine, a rather unusual place for this kind of thing, although this apparently puts them along the front edge of the main printed circuit board. They include the connector for the disk drives, a user port, a printer port, a "1 MHz bus", and another one marked "tube", which we'll get to later.

The keyboard on the BBC, while having a feel to it that is quite unlike anything but the earlier Atom keyboard, is still quite usable. It has real keys that go up and down properly, unlike the other major British micro, which shall at this point go unnamed. What more could you ask for?

The keyboard generates the full ASCII set, with the exception that the reversed quote (CHR$(96)) comes out as a British pound sign. In addition, there are ten programmable function keys, giving 30 possible codes depending on the shift and control keys. There are also four arrow keys and both a regular caps lock key and a shift lock key.

The disk drives that came with the computer were double-sided 80-track machines, storing a reputed 400k per disk. Despite the high capacity, they gave no trouble at all. The cable connecting the drives to the computer was a fairly heavy beast, being ribbon cable in a copper mesh interference shield encased in heavy-duty vinyl.

Looking at it

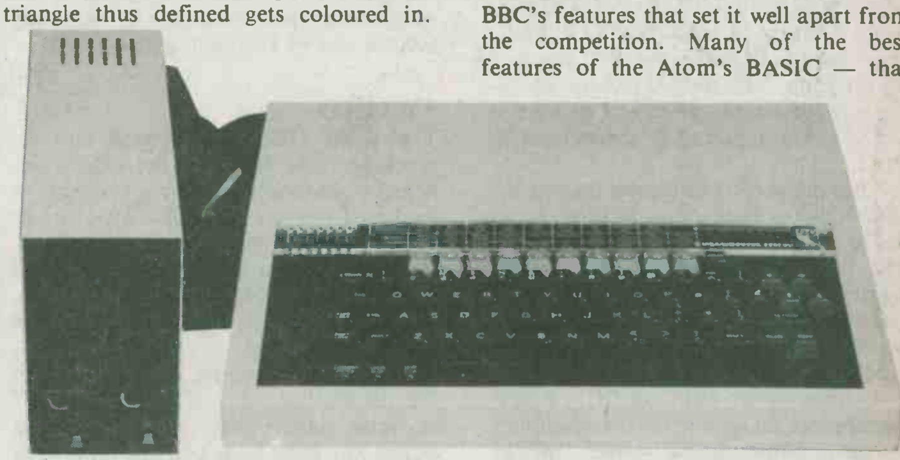
The BBC's graphics compare quite well with those of the much more expensive IBM compatibles, both in resolution and, more surprisingly, in drawing speed. For a humble 6502, it certainly moves like greased icecubes on a hot summer's day. In the highest resolution mode, there are 640 by 200 pixels (and/or 80 by 25 characters of text), although only monochrome is offered in this mode. That is, you can select one of the machine's sixteen basic colours for the background and another for the foreground. The first eight are the basic black, white, red, blue, green, yellow, cyan, and magenta, while the other eight are various flashing pairs of these colours. You can, for example, set things up so that the screen will flash back and forth between green letters on a red screen and magenta letters on a cyan screen. They flash back and forth *ad nauseum*, or at least until your eyes give up trying to watch them and fall from their sockets to the floor.

The most colourful mode offers all sixteen colours, but at only 160 by 200 resolution. A bit grainy, but it has possibilities. Since the sixteen display colours are not tied one-to-one to the sixteen actual colours, you can do some really neat pseudo-animation here. For example, you can declare all sixteen colours to be black, and then draw something. Nothing will appear until you selectively tell colours that they're visible. Since declaring a colour takes only a tiny fraction of the time it takes to actually draw something, you can make things appear, disappear, reappear, or seem to move very quickly.

One nice feature is that the BBC uses standard graphics coordinates. In all modes, the screen appears to your program to be the same size. Coordinates go from 0,0 at the lower left-hand corner to 1279,799 at the upper right, regardless of how many pixels there actually are. Rounding off to the actual coordinates is done internally. This means that if you write a program to work in one graphics mode, you don't have to rewrite it to work in another one.

Another nice feature is that text and graphics can be mixed freely, since the character generator plots the characters directly on the graphics screen. Anyone who's ever tried labelling a graph on an Apple or similar machine will appreciate this.

At this point, maybe the reason why the BBC does graphics as quickly as a much more powerful 16-bit IBM should be explained. Even though an 8088 is faster than a 6502 ten times out of ten, the software being run can make a world of difference. IBM BASIC, to do solid coloured areas, uses a PAINT statement. You outline the area you want and then PAINT it. Flexible though this is, it requires masses of CPU power to examine each point, find your outline, and stay within the lines. The BBC, on the other hand, uses a much simpler triangle routine. You feed it three points, and the triangle thus defined gets coloured in.



Two triangles give you a square or a rectangle, and a number of "pie slices" will give you a circle.

There's only one complaint to be made about the BBC's colour graphics capability. You'd expect this machine, the epitome of all British hardware, to hold strongly to the Queen's English in its choice of BASIC keywords. Yet it has, for the purpose of setting text colours, a COLOR statement. Yes, you heard it right — the "U" is missing. Must be a Yankee on the design team.

Bells and Whistles

Among the high-tech hardware the BBC mounts under its plastic exterior is a speech synthesizer. Yes, the machine can talk to you. Although it limits you to the 206 words in its ROM (unless you can figure out the instructions on how to code your own words), you can be quite creative with what you have. Video games can say things like "INTRUDER ALERT", "GO LEFT", and "GET OFF THE MACHINE". The choice of words is rather interesting, including "QUEBEC" but not "ONTARIO". *Eh bien*, but you can still accomplish things here.

To the left of the keyboard is a little plastic plate which, when pried up, reveals a pair of sockets. Rumour has it that what goes here are extra ROM cartridges for the speech synthesizer, giving it a larger vocabulary.

More conventional sound synthesis is also included. Although the hardware itself looks very similar to the Commodore 64's sound chip, with three music channels and one effects channel, the BASIC interface is vastly different. On the 64, you use masses of utterly incomprehensible POKEs to make sound. The BBC has a SOUND statement in BASIC to cause sound and an ENVELOPE statement to manipulate the sound envelope. This seems much more civilized.

BASICally Better

The BBC's BASIC is another of the BBC's features that set it well apart from the competition. Many of the best features of the Atom's BASIC — that wild, wonderful, non-Microsoft language — have been retained, but this new BASIC is much more like the standard versions of BASIC most North American programmers are used to. It's still non-Microsoft, but in many ways it's better.

The big feature is proper functions and procedures. No more of bad old BASIC, where you would write a routine to GOSUB, and then have to remember the line number (heaven help you if you renumber the program...) and be sure the variables you used in the subroutine didn't cause any problems with the rest of the program. Instead, the procedure gets a proper name, and the variables you use in it can be local, completely separate from the rest of the program. For example:

```
10 MODE 0
20 PROCsquare(640,400,300)
30 FOR X=100 TO 200
40 PROCsquare(600,400,X)
50 NEXT:END
100 DEF PROCsquare(X,Y,R)
110 MOVE X-R,Y-R
120 DRAW X-R,Y+R
130 DRAW X+R,Y+R
140 DRAW X+R,Y-R
150 DRAW X-R,Y-R
150 ENDPROC
```

As you can see, this makes programming a whole lot easier and more structured. The variable X in the main program is completely separate from the X in the procedure. Functions can be similarly defined, with multiple lines including IFs and so on.

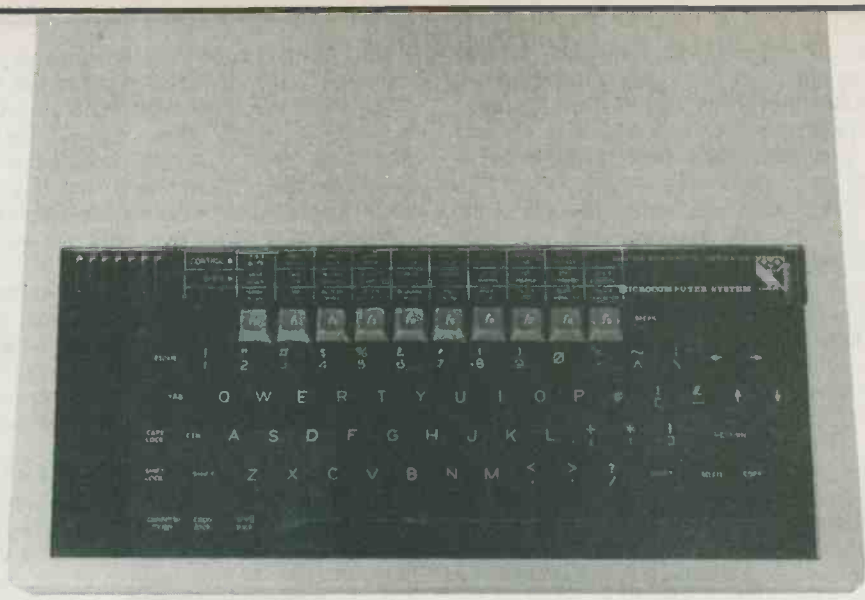
This procedure capability, together with REPEAT ... UNTIL and IF ... THEN ... ELSE, makes BBC BASIC a structured language. You can write programs having a clear and logical flow of execution, with the subroutines properly isolated from each other and from the main program.

This BASIC has other neat tricks, too. There's an EVAL function that evaluates expressions. For example, if A$ were equal to "2+2", then EVAL(A$) would return 4. EVAL("COS(PI)") comes back as negative one. You can even use program variables as part of an expression for EVAL. If X is 7 and A$ is "X*X", then EVAL(A$) comes back as 49.

The inline 6502 assembler that set the Atom apart is back in an improved version in the BBC. What this lets you do is write 6502 microprocessor code in the middle of your BASIC programs. Most programmers won't need this at all, but it does let you write code that runs at the speed of the machine (typically a hundred or so times faster than BASIC) or that does obscure things deep in the machine's internals. Most BASIC-based micros make it difficult to do machine code at all, or if they do allow it, they make it difficult to write and assemble the code, but the BBC makes 6502 code accessible and almost easy to use. It's still not for beginners, but it's a big step in the right direction.

The BBC employs a unique program statement editing system. When you use the arrow keys on the keyboard, a second cursor appears. You move this to the statement you want to edit, and then use the COPY key to copy characters from there. The copied characters, along with any others you might hit, appear back at the main cursor. The system, while a bit strange at first, actually does work quite well.

Another way in which this BASIC differs from almost every other BASIC on the planet is in what it says when it doesn't understand what you're typing in. Most others say "Syntax error", which is obstruse and technical, but this one is much more direct and to the point. It says "Mistake". You can save face and blame the computer when you get a syntax error, but it's hard to do anything but admit you were wrong when the computer cheerfully accuses you of keying in garbage.



*WORD

Typing the *WORD command into the computer gets you into the BBC's onboard word processor. There's nothing to load in from the disk; just type in the command and bang, the computer switches ROM chips and you're into word processing. Considering how long a program like WordStar can take to load, this is a real advantage.

Once you're going, you can pull in files off the disk, edit, reformat, type stuff in, print, save things, and so on. The escape key pops back and forth between command mode, where you can key in commands, and editing mode, which lets you type in and edit text. The function keys, together with shift and control, are used to do things like move blocks, reformat, etc. It is a very good word processor, easily adapted to by anyone used to WordStar or a similar system, or easily learned.

CP/M

Part of the BBC's design is that it can mount a second microprocessor via a connector on the bottom of the computer called "the tube". In this configuration, the second processor runs whatever language you're using while the 6502 in the computer handles I/O.

The first choice offered for a second processor is a second 6502 with 64k of RAM, which makes the computer faster and capable of handling more data, especially since you no longer need to share the computer's memory with the screen graphics area.

Second is a Z-80, again with 64k, with which one can run CP/M on one's machine. Acorn claims that a BBC running CP/M is better than a more conventional CP/M machine, since I/O is all handled by the 6502 in the main machine, leaving more time and memory space to the Z-80.

Third is a 16-bit National Semiconductor 16032 chip with up to 16 megabytes of RAM. This might not be enough to knock Cray out of business, but it is probably more than enough computer for any expansion needs.

Software

The introductory disk that comes with the computer includes, besides the disk formatting program and a verify routine, a series of demo programs and games. There's one that draws a desert island and then animates the waves in the ocean around it. There's also a sketch program that lets you make simple drawings. And then there's Mars Lander. You can try to land your lander gently, as the rules call for, or you can play by the Computing Now! rules, which involve attaining the greatest possible velocity prior to impact. The record so far is well over a kilometre per second.

The BBC started out as an educational computer, however, and an educational computer needs educational software. Unto this end, Acorn markets a line of such software. The titles we got to review with the machine included Gas Diffusion, Gas Laws, Speed, Density, Gravitational Fields, and Venn Diagrams. Each comes in a plastic case, with a book and a disk inside.

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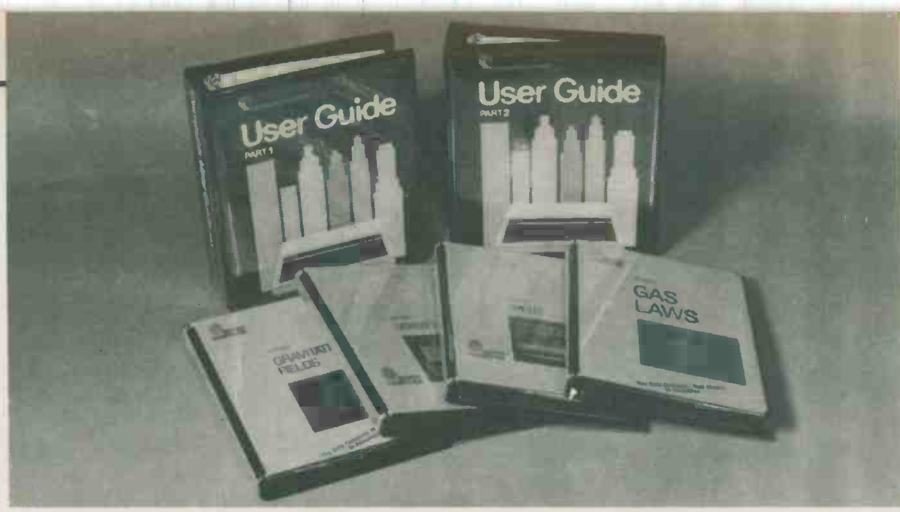

There is quite a difference between the elementary and the secondary level software. Taking the Density package as an example, it uses bright colours and large letters to attract the children's attention. One gets to play a game against the computer involving the guessing of densities for a number of common substances. At the end, after telling you who got the best score so far, it says to "Tell your teacher you have finished".

The highschool level software is much more highbrow, being command driven rather than prompted along, allowing you to set up problems and watch them get solved, graph the results, and so on.

For some reason only the elementary level programs were protected, having a character embedded in the first filename on the disk that disables the video driver, preventing you from seeing what was on the disk. Break and Escape didn't work either. Is this supposed to say something about the state of the educational software market and the illegal copying therein? Are highschool teachers more honest than elementary school teachers? Maybe it's just that the different packages were written by different people, some of whom were more trusting than others.

Conclusions

The BBC is a very impressive computer, having excellent graphics and BASIC, along with all the features you could ask for. Over in Britain, it's allegedly selling at four hundred pounds for the basic machine, although once it gets to Canada the price finds its way into the vicinity of fourteen hundred dollars. This may be a bit steep, but computers generally tend to come down in price after their introduction. Even so, it is easily the most impressive computer to come across this reviewer's desk to date. Highly recommended.

Quick Reference

Mfg:	Acorn
CPU:	6502
RAM:	32k
Screen	80 x 25
Graphics:	640 x 200
Colours:	8
Sound:	Yes
Video:	RGB
Price:	$1495
	$1495 for dual drives.

Acorn Computers Corp., 14 Woodborough Rd., Guelph, Ont. (519) 837-2022. **ETI**

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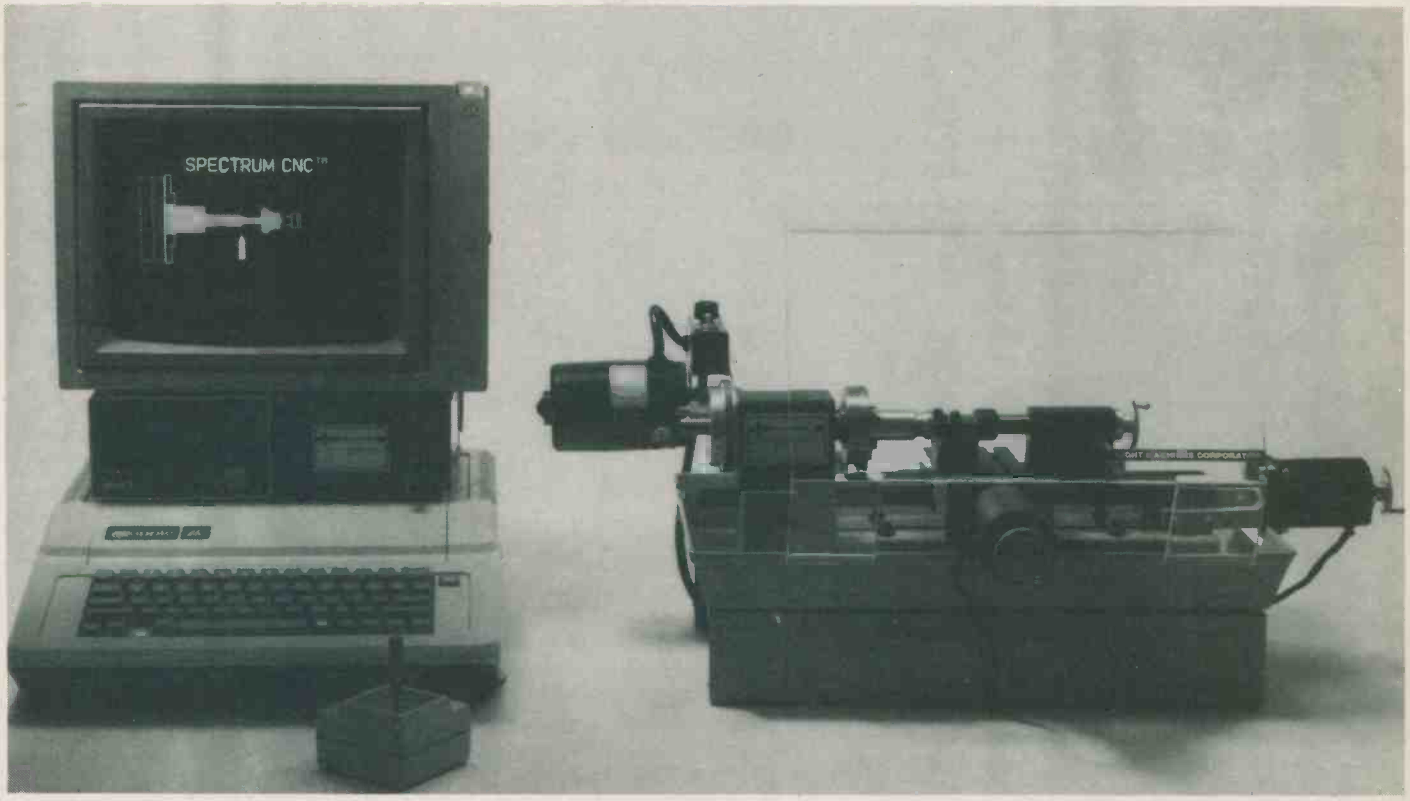
Electronics in Action



In a new series, Roger Allan looks at some of the many applications of electronic technology in home and industry.

The Cottage Lathe

HISTORICALLY, MACHINE shop systems have been enormously expensive due to the demand for high performance and reliability. This has tended to preclude their utilization by schools for training purposes and further, prevented their use by small craftsmen, such as those involved in the cottage industries of wood and metal working. They cannot expand due to the high set-up costs involved. The fundamental major portion of these machines' cost is in the lathe's mechanical precision requirements.

To help overcome this problem, *Light Machines Corporation* now markets the spectraLIGHT CNC Lathe which uses machine intelligence to replace the expense of mechanical precision.

Originally designed as an industrial grade machine for short-run small-part fabrication, this lathe has the same capabilities as machines costing 20 times as much, retailing for about the price of an Apple. It can create any surface of revolution in wood, plastic or metal up to 8 inches in length and up to 3½ inches in diameter.

The lathe uses an Apple II+ or IIe computer (or clone) as its programmable controller. In conventional numerical-control code, this device duplicates most of the same operations performed on any full sized CNC lathe. Using BASIC, the user may add special functions such as polynomial-fit curve cuts, mouse or graphic table programming; the software and operator's manual guides the user through each step. Graphic part verification allows the user to view animations of part programs on the screen before any material is cut.

This device may also be operated with the manual handwheels, directly through the keyboard, or with an optional joystick. The system offers a basic resolution of .0025 inches in both axes, with positioning repeatability to plus or minus .0005 inches. Backlash can be removed by software and adjusted by keyboard command. A single floppy disk can store several thousand NC blocks, thereby permitting cottage craftsmen to produce small numbers drawn from a very wide assortment of items without necessitating any reprogramming.

Electronic Tape Measure

Determining range by means of ultrasonic echo ranging is a relatively simple process. A short burst of ultrasonic energy is generated electronically, amplified and transmitted by a transducer. The signal travels through the medium (in this case air), reflects from the target object and returns to the transducer. The signal is received, amplified and processed by the system electronics. The time for the round trip can then be determined, and knowing the correct speed of sound in air, the distance to the object may be calculated.

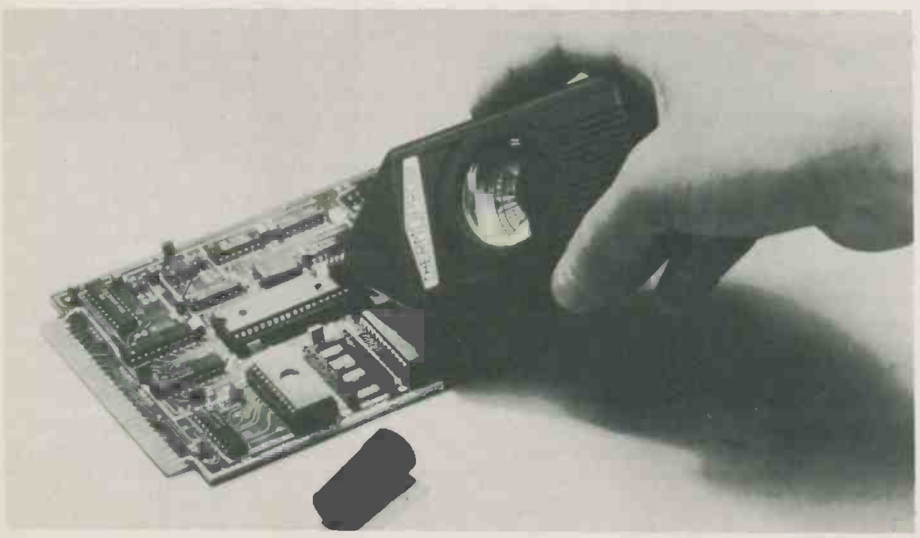
A simple ultrasonic echo ranging system was initially developed by Polaroid for use in their Sonar Auto Focus Camera. It is composed of only two parts: the transducer and the electronics module. The transducer is an electrostatic type which is used to transmit the signal and

The Electronic Tape Measure

receive the echo. The module contains all of the circuitry needed to generate the transmit signal, drive the transducer, receive the echo and process the information received by the transducer. The distance from the transducer to the target can then be computed with additional circuitry, knowing the speed of sound in air and the time interval between the transmit signal and the received echo as provided by the ranging module. The Polaroid system operates over a distance range of 0.26 to 10.7 meters (0.9 to 35 feet), increasing the receiver amplifier gain and decreasing the bandwidth with time to compensate for signal losses over the distance range. Then, to minimize the system's susceptibility to noise pick-up, a signal integration scheme is employed before the system locks onto an echo. Once the threshold level of the integrator is reached, a signal is generated to indicate a received echo. The logic level outputs for the transmit signal and received echo can be used to perform control functions or calculate distance to the object with a minimum of additional circuitry.

A number of companies have taken Polaroid's development and applied it to uses other than home photography. One of them is the Exergen Corporation which sells a pocket-sized ultrasonic tape measure known as the *Rangescanner*. Accurate to within 1% over the thirty-five foot range, the device is the smallest instrument available offering instant dimensioning.

Looking at bit like a packet of cigarettes, the Rangescanner offers a 3-digit LED display showing the distance in either feet or operated by a measurement selector switch (the third digit in the LED display is the decimal). It has the added feature of a mode selector: either "lock" or "scan". In the lock mode, the range of the object being measure is recorded on the LED display. In the scan mode, the device measures the distance 3 times a second, displaying the distance each time. This mode is useful in locating positions; eg., the user presses the deadman operating switch, and walks backwards or forwards until the correct measurement shows.



The PC Board Tester

Originally designed for real estate people to measure rooms, this device is now used by contractors, builders, engineers and architects, allowing them to walk through take-offs and surveys.

PC Board Tester

The Metrifast company recently introduced a low cost electronic test instrument called a *Thermoprobe* which is designed to quickly identify dead components on printed circuit boards without direct contact and thereby without using a voltmeter.

Essentially, the solid-state device consists of a thermistor probe connected to a modified wheatstone bridge circuit. It is designed to measure minute temperature changes of 1/25 of a degree Fahrenheit (1/45 °C). Since dead resistors, transformers, diodes or ICs do not emit heat, they can be quickly identified by the unit's built-in meter as the thermistor probe is moved in close proiximity to them.

The six-inch long unit is operated by removing the protective front cap and pointing the thermistor probe with 1/16 of an inch of the PC board surface. A nulling wheel at the side of the unit is then turned clockwise until the meter indicator reads "normal". Then, as the thermistor probe is moved slowly at approximately 1/16 of an inch above the components on the PC board, the meter indicator will move to the right or "warm" area of the dial each time the unit is passed over an operational active component. The dial indicator will move back to the nulled position if the active component being tested is dead and therefore not emitting any heat. Utilizing a 9-volt battery, the unit is about the size of a large packet of cigarettes and is designed for field service applications in computers, electronic instrumentation, video and hi-fi repair as well as the home experimentalist.

Seiko TV Watch

The RT10A TV watch marketed by Seiko involves a new advance in video display pictography.

In the Liquid Crystal Video Display (LVD) developed by Seiko and utilized in the watch TV, two types of liquid crystal are enclosed between a sheet of glass and a transistorized silicon base to create 31,920 screen dots similar to the ink dots that make a newspaper photograph. As electrical pressure is applied in the silicon base, the liquid crystals 'stand' or 'lie down', reflecting or absorbing light in accordance with their position, to produce light and dark (blue) dots, thereby making up a picture. Because the liquid crystals reflect light to create the picture, the LVD screen operates best in good light, unlike the traditional cathode ray picture tube. Further, the LVD does not require high

voltages. In fact, the television screen in the Seiko watch (measuring 30 mm (1.2 in.) diagonally) is powered by two AA batteries in the receiver unit (possessing about 5 hours worth of continuous viewing power), or may be connected to an electrical outlet with an AC adapter.

The receiver for the watch, for which a headphone cord acts as an antenna, will pick up UHF (14-83 ch.), VHF (2-13 ch) or FM (88-108 MHz) as effectively as most portable televisions or TV sets using 'rabbit ear' antennae. Reception is dependent on broadcast electrical waves and will therefore be poor where the signal is weak or blocked by buildings or mountains. The watch has insufficient sensitivity to receive signals underground, even in the basement of a building. However, if the FM signal is weak or distorted by high levels of static interference, switching from the stereo to the mono mode of reception improves the sound quality.

The TV receiver for the watch is designed to operate in Canada and the U.S., and will not decipher signals in overseas countries using different broadcasting systems and frequency ranges. The headphone band size is adjustable by rotating the speakers on the headset.

Seiko's TV watch.

However, as the cord also serves as an antenna, the user has to keep the cord as straight as possible.

In addition to the video and FM reception capability, this watch also tells the time in the customary fashion, but has the added feature of being able to tell it either in 12 (a.m./p.m.) or 24 hour display modes, accurate to plus or minus 10 seconds a month. The day/date calendar adjusts automatically for odd and even months with the exception of February in leap years. Its chronograph has a split time capability in hours, minutes and seconds with an accuracy of up to 1/100 second over 12 hours. And finally, an alarm may be set to ring for hourly or daily time signals. **ETI**

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Features In The Queue

This is some of the editorial we have lined up for the first few issues of Software Now! You can expect it to change a bit . . . new software springs up almost daily, and Software Now! will always feature the most important developments in this dynamic field. Articles being developed during the preparation for the magazine include:

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 •.

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In addition to this look for these regular features:

The Library	(Our monthly survey of books)
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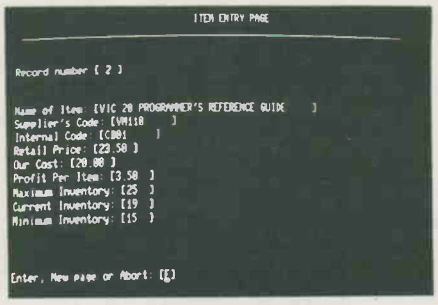

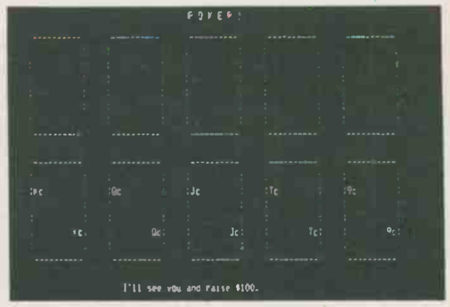

CalcNow

CalcNow is a fully capable spreadsheet package. It can manage a sheet sixteen columns across by twenty six rows deep. It allows for automatic and manual recalculation, full cursor movement, formulae, constants and labels, disk storage of your sheets and a full hard copy reporting function. Its syntax and behavior is very much like that of the popular packages and for models of the size usually used in small business and personal financial planning it's equivalent to professional . . . and very much more expensive . . . spreadsheet packages.

Phone Jack

Most computers have telecommunications hardware built into them . . . it's a shame that they don't all have software available to drive it. This program does basic telecommunications and, while its features do vary a bit from system to system . . . based on what the operating systems allowed us to impliment . . . it does provide for the basic requirements of calling computer bulletin boards and dial up mainframes.

Utility Pack

Most revisions of the disk will also have a choice selection of utility programs. These vary a lot from system to system so it's a bit difficult to describe them all here. However, these are the little routines that make life so much easier when you sit down at the keyboard and switch on.

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Machine Code Programming Part 3

In this month's installment, Bob Bennet looks at a few methods of addressing using different CPUs.

LAST MONTH I gave a couple of CPU addresing mode examples, but before I give any more I would like to explain a couple of things. First, whenever possible, I will give other CPU direct equivalents to the Z80 instructions, but I can't possibly mention every CPU. What I hope to do is make it possible for you to recognize your own particular CPU instructions. To help you do this, don't pay too much attention to the *name* of the addressing mode, but rather what *happens* because of the instruction; different manufacturers have, at times, used slightly different terminology to describe similar actions. The second point is, that in every example I will give the hex code first followed by the mnemonic thus, 00h — **NOP.**

Although machine code doesn't use line numbers, the BASIC statement GO TO 100 has a very near equivalent in machine code, but the comparison cannot be taken too literally. These equivalents are the *jump* or *branch* instructions, part of which form the relative addressing mode. In this mode the instructions are two bytes long, the first byte is the function, and the second is the offset. In the Z80 instruction set, the straightforward jump instruction code is 18h — **JR,e**, or jump relative by the amount of the offset byte e. Why relative? Well, the value of the offset byte indicates a destination for the jump, relative to the current program position.

Because the offset is only one byte, the maximum jump is 255d (d = decimal) or FFh locations, but in which direction? The numbers 0 to 255d are positive, so a forward direction is indicated; this leaves the problem of going backwards. No sweat, the answer lies in the use of the 2's complement. Never heard of it? Don't worry, all will become clear.

Take the maximum range of a byte, 0 to 255d, and split it; the first section, 0 to 127d (7Fh) are the forward or positive range. The second step is where it might get confusing so watch it carefully; the numbers that are left from 128 to 255d or 80 to FFh, but, because we need a backwards, or negative, direction, the decimal numbers now range from -128 to -1.

Remember that I said you would need a knowledge of the binary system? This is where it comes in handy. The binary equivalents of the decimal numbers 0 to 127 and 128 to 255 are 0000 0000 to 0111 1111 and 1000 0000 to 1111 1111 respectively. A closer examination shows that, throughout the first set of numbers, but 7, the leftmost bit, is 0; and throughout the second set, but 7 is 1.

This makes it possible for bit 7 to be used as a sign bit: reset, or 0,. for positive; and set, or 1, for negative. To get the value of the offset byte is easy. Counting the byte after the offset byte in the program as zero, count backwards or forwards until you reach the destination for the jump, as shown in Fig. 6. Another method would be to take the destination address, and the zero address, take the lower from the higher, and add the sign accordingly.

Assume that you have counted 100 places backwards; Fig. 7 shows what happens next. Alternatively, if you subtract the

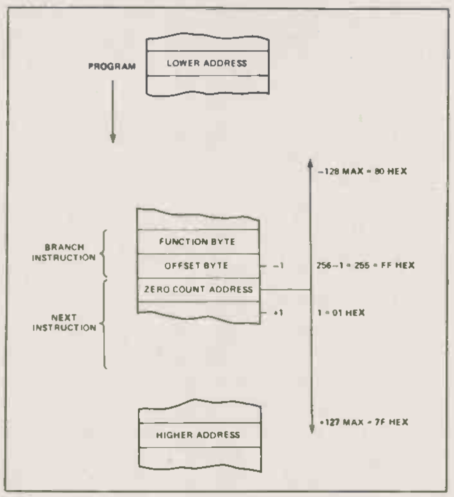

Fig. 6 Counting the value of the offset byte.

backwards count from 256d, the answer is a decimal number equal to the 2s complement, which you then convert to hex.

Some CPUs do not have a straightforward relative jump/branch in the instruction set, but some do support the conditional relative jumps/branches. This is similar to the BASIC IF X = 0 THEN GO TO 100. The Z80 instruction 28h — **JR Z,e** means jump relative if the zero flag is set, by the amoung of the offset e. The 6502 code is F0h — **BEQ** which means branch when zero flag set. Usually most of the

```
Binary
0110 0100 = 100 decimal (ignore sign)
1001 1011 = 1s complement i.e. change is 1 s to 0 and vice versa
          1  add 1
1001 1100 = 156 d or 9C hex, which is the offset byte value
└──────────▶ Bit 7 is set which means a negative count
```

Fig. 7 2's complementing a backwards (negative) count.

flags can be used in the set or reset condition for relative jump or branch instructions.

Absolutely So

Although the relative jumps and branches are sometimes of great help in a program, their range is rather limited as I have shown. To get further afield requires slightly different techniques, and different instructions of course. This set of instructions requires an absolute destination, or address, to be specified in the instruction. For those of you who like analogies, relative addressing is like saying 'go to the third house past the church' and the absolute equivalent is 'go to 31 Church Street'. This type of jump or branch is only a part of the absolute addressing mode instructions, but for now I'll deal with jumps.

Because, in theory, the whole of our 64K memory is reachable, the addresses will have to be in two bytes, so the total bytes for absolute addressing is at least three. There are special cases that require just one byte, and some that need four, but I'll cover them later. Let's assume for now that we need to jump unconditionally to address 30,000d; Fig. 8 shows how to convert the decimal number into the two byte hex number we need.

The Z80 instruction C3 — **JP pq,** where pq are the address bytes, and the 6502 instruction, 4C — **JMP** are box examples of jump in the absolute mode. Fig. 9 shows how both examples would be used in a program, when the destination was address 30,000d. Note that the low byte of the address goes straight after the code for jump; please accept that this is so for now, and I'll explain more later on.

In some of the instruction sets the flags status, or condition, can be used just as in the relative jumps.

Leaving the jump/branch instructions let's have a look at some more absolute instructions. The Z80 instruction 3A — **LD A, (pq)** means load the A register with the contents of the address pq. Note the use of brackets in the mnemonic; without them

continued on page 59

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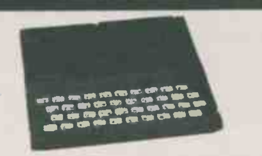

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Advanced 6502 Programming

Using the instructions of the 6502 in a non-standard way, you can write quick and efficient machine language programs for the Apple or other computers.

by Yin H. Pun

THERE ARE A FEW programming techniques which you cannot find in most machine language programming books, but they are commonly used by programmers and crackers alike. These techniques use instructions of the 6502 microprocessor in a non-standard way; they are quite useful in writing quick and efficient machine language (even though its structure may be harder for someone else to understand!). I will use the Apple 6502 to explain these techniques, although they can be easily implemented on other 6502 machines.

Self-Modifying Code

Self-modifying code is not a new instruction. Self-modifying code uses immediate or absolute addressing and can easily replace indirect addressing. Briefly, the operand is changed into another value. For example, you may simulate an indirect JMP instruction with an absolute "JMP" instruction if you simply change the operand to other instruction. The advantage of self-modifying code is its ease of use and 30% faster execution speed. Best of all, self-modifying code uses no zero-page locations like indirect addressing to work.

Try this little gem:

```
BEG  JMP OUT
BEG2 LDA #$69
     STA OUT + 1
     LDA #$FF
     STA OUT + 2
OUT  JMP BEG2
```

This routine will first "jump" to "OUT" and then "jump" back to the code where it changes itself. The operand of "JMP" at "OUT" will be modified and then executed. The program will jump to address $FF69, the monitor program of the Apple.

Self-modifying code lends itself useful in quickly storing or retrieving values in a loop.

```
* PROGRAM TO POKE $00 INTO $2000 to $3FFF
* AND USES SELF-MODIFYING CODE
       LDA   #$00     ;Initialize the
                      operand of the
                      "STOre A" in-
                      structionn
       STA   STO + 1
       LDA   #$20
       STA   STO + 2
LOOP   LDA   #$00
STO    STA   $0000    ;self modifying
                      code
       INC   STO + 1  ;increment operand
       BNE   NEXT
       INC   STO +2
NEXT   LDA   STO + 2
       CMP   #$40     ;finished?
       BNE   LOOP     ;no, Loop again
       RTS            ;Yes, and quit
```

The only problem with self-modifying code is that the program becomes quite messy when it is overused. Operands must be initialized back to their original values if the routine is to be used again. It cannot be programmed into ROM for obvious reasons.

Playing With The Stack

The stack of the 6502 is located in page 1 of the memory map ($100-$1FF). It is like a piece of notepaper which the 6502 uses to keep track of subroutine and interrupt return addresses. Also, it may be used to temporarily save an accumulator value.

The "JSR", "jump to subroutine" instruction, analogous to the BASIC "GOSUB", stores the program counter into the stack and loads its 2-byte operand into the program counter. The program flow is thus routed to the subroutine. An "RTS", "return from subroutine" fetches the program counter from the stack and thus returns control to the main program. You may manipulate the stack and the stack pointer to "pop" a return address to fool the microprocessor and make it forget that it had ever jumped to a subroutine. You may alter the return address so that the program will jump to a location other than its return address.

To retrieve the return address during a subroutine and make the microprocessor "forget" the return address, pull the accumulator from the stack twice. The first pull should return the high order byte and the second pull should return the low order byte of the return address.

```
SUBR PLA
     STA HIGH  ;store high order byte in
               memory
     PLA
     STA LOW   ;store low order byte in
               memory
```

```
* BUT DO NOT DO AN RTS INSTRUCTION
*BECAUSE THE INTENDED RETURN ADDRESS
*WILL NOT BE THERE AND THE ADDRESS,
*ONE BEFORE THE INTENDED, WILL BE
*CONSIDERED.
```

To place back the return address, push the values back into the stack just before executing the RTS.

```
LDA LOW
PHA        ;push low order byte of return
           address into stack
LDA HIGH
PHA        ;push high order byte of return
           address into stack
RTS
```

Of course, you may execute an "RTS" instruction to simulate a "JMP" by simply pushing an address into the stack. However, you need the address which is always one less than the intended one, so subtract one from the address before pushing it into the stack. This is because the program counter (another register in the 6502) increments the return address before executing it.

For example:

```
LDA #$68
PHA
LDA #$FF
PHA
RTS
```

is the same as:

```
JMP $FF69  ($FF68 + 1)
```

the program may see what location it is running at by jumping to a subroutine, returning and pulling the address from the stack. Peripheral cards use this type of routine to determine what slot the card is in. Here you must use the stack pointer. For example:

```
JSR  $FF58  ;$FF58 simply contains a dum-
            my subroutine; it only contains
            an "RTS"
TSX         ;transfer stack pointer to X
LDA $100,X  ;fetch high order byte
STA HIGH    ;store high order bye in
            memory
DEX
LDA $100,X  ;fetch low order byte
STA LOW     ;store low order byte in
            memory
```

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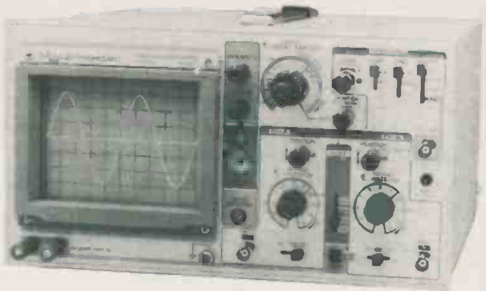

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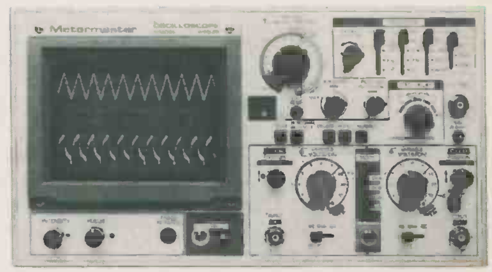

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Simulating a BASIC "PRINT" Instruction

The code below simulates a BASIC "PRINT" instruction by altering the stack. The actual ASCII text to be printed is located immediately after the JSR instruction. The program flow will not return to the code immediately after the JSR instruction, but will skip the next real instruction after text. If the stack were not modified, the routine would return and try to execute the text codes which are garbage. Use a macro-assembler such as TOOLKIT ASSEMBLER or LISA to enter this code.

```
*MANIPULATING THE STACK PRINT ROUTINE
PROINT  EQZ  $FE
COUT    EQU  $FDED        ;$FDED is character output routine for Apple
        ORD  $800
        JSR  PRINT        ;call print routine to print text below
        ASC  "MODIFYING THE STACK."
        HEX  8D           ;must terminate text with a carriage return
                          ($8D = CR)
        JSR  PRINT
        ASC  "MAL ALEGNA SKANHT! IT WORKS!"
        HEX  8D
        BRK               ;stop this! or put "RTS" to exit safely
* THIS IS THE ACTUAL PRINT ROUTINE
PRINT   PLA               ;fetch JSR address low order byte
        STA  PROINT       ;store program pointer in memory
        PLA               ;fetch JSR address high order byte
        STA  PROINT+1
PRINT2  INC  PROINT       ;increment JSR address
        BNE  PRINT3
        INC  PROINT+1
PRINT3  LDX  #$0
        LDA  (PROINT,X)   ;get character
        JSR  COUT         ;output character
        CMP  #$8D         ;is it a carriage return?
        BEQ  EXIT         ;exit if it is
BACK    CLC
        BCC  PRINT2
EXIT    LDA  PROINT+1     ;modify stack to restore return address
        PHA
        LDA  PROINT
        PHA
        RTS               ;execute modified return address
```

"BIT" As A "Reference" Instruction

The "BIT" instruction is used to test bits 6 and 7 of a memory location, so that appropriate action may be taken because of the status of these bits. Usually, a conditional branch (a "BMI" or "BPL" for example) follows this instruction; however, there is another quite uncommon use of this instruction.

Sometimes to save program space, you must introduce dummy instructions to act as spacers to mask other instructions as data. Dummy instructions also are used to activate I/O locations which need only be referenced, such as the speaker and the video mode soft switches. The "BIT" instruction is best suited for a dummy instruction. It is a read instruction which only affects the bit 6 and bit 7 of the status register. Instead of using "LDA $C030", to toggle the speaker, use "BIT $C030". "Bit $C030" does not load the accumulator with garbage and thus keeps it free to do other things for example, keep count of a loop.

A routine to beep the speaker:

```
        LDX  #$30         ;number of speaker toggles or "clicks"
LOOP    BIT  $C030
        LDA  #$10
        JSR  $FCA8        ;wait routine (wait half the period of the
                          wave)
        DEX
        BNE  LOOP
```

The "BIT" can be used to activate or test other I/O locations.

```
        BIT  $C010        ;clears the keyboard strobe
NO      BIT  $C000        ;check if keyboard is pressed
        BPL  NO           ;if keyboard location is greater than 128, go
                          test keyboard again
        RTS               ;otherwise continue
```

or turn on the hi-res screen without affecting other registers:

```
HI      BIT  $C051        ;select graphics mode
        BIT  $C057        ;select hi-res graphics
        BIT  $C054        ;select primary graphics page ($2000-$3FFF)
        BIT  $C052        ;select whole graphics page (no text at bot-
                          tom)
```

The "BIT" instruction can be interchanged with the "LDA" instruction, but using "LDA" destroys your data in the accumulator. Therefore, "BIT" makes a good instruction to simply "reference' a certain address where the data passed to or from the address is irrelevant.

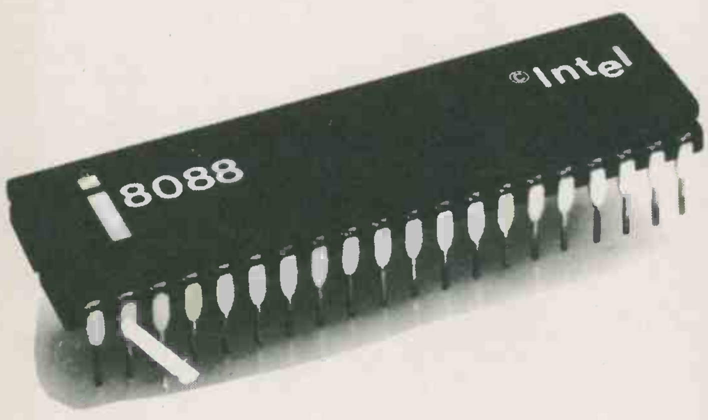
To use the "BIT" as a dummy instruction to mask other instructions, use absolute addressing.

For example:

```
ZERO LDA #$00
FF      BIT $A9FF ;the data $A9FF actually means
                  LDA #$FF if you disassemble it
                  starting from FF+1
```

This routine when entered at "ZERO" would load the accumulator with $00 and execute the "BIT $A9FF" instruction which is meaningless and does nothing practical. However, if you disassemble the code at FF'1, skipping the "BIT" instruction, you interpret the operand, "A9FF" as an instruction, "LDA #$FF". This effectively loads the accumulator with $FF instead. This type of routine is especially useful in conditional branching where you have to load a parameter with a certain value depending on the condition, before it jumps to a subroutine as in the following example.

```
COND CMP #$00         ;is accumulator a zero?
     BEQ FF + 1       ;if it is, then load accumulator with $FF
ZERO LDA #$00         ;load accumulator with zero if it is not.
FF   BIT $A9FF        ;the data $A9FF actually means LDA #$FF
                       if it is disassembled starting from FF+1
```



Conclusion

These advanced techniques perhaps stretch the limits of the 6502 microprocessor, but should give some insight into some of tis hidden capacities. The 6502 is alive and well! **ETI**

CIRCUIT IDEAS

Tone Control

Last month our circuit feature showed the block diagram of a tone circuit. Here's the complete circuit.

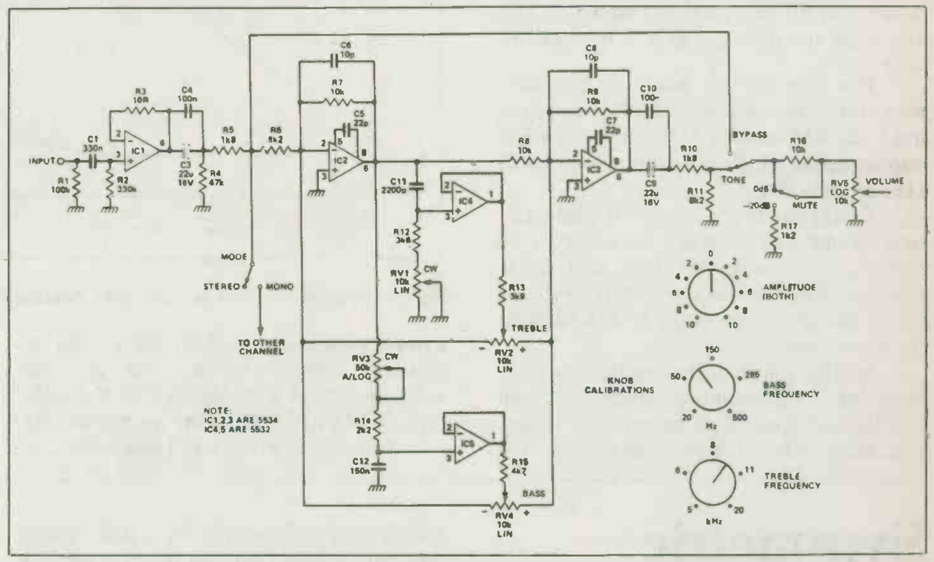


Fig. 2. Circuit diagram of the tone control module.

ALTHOUGH fully paid-up members of the Flat Earth Society would have us believe that any form of signal processing is guaranteed to make a pig's ear of the emotional experience of listening to a group of musical morons twanging guitars and wailing, it should be remembered that most recordings are subject to considerable amounts of 'equalization', usually to satisfy the producer's requirement for a particular type of sound. No allowance is made for the introduction of random phase shifts, or that the the intricate relationship of harmonics is sent on a one-way trip to the cleaners. The object is to change the sound to make it more satisfactory, and if tone controls are used in the replay process for exactly the same purpose, surely no-one has the right to complain?

The type of tone control fitted to most hi-fi equipment is far from ideal, usually being much too dramatic in operation — for example, if it is required to lift frequencies below about 100 Hz, the effect is usually to lift, by varying amounts, everything up to at least 1 kHz, and even higher.

The circuit shown in Figures 1 and 2 is somewhat more sophisticated than usual, possessing in addition to the normal lift and cut controls, adjustment of the turnover frequencies of the two sections.

Operation of the circuit is quite straightforward. IC1 acts as an input buffer, presenting an input impedance of approximately 100k ohms to the line inputs of the preamplifier. The input of IC1 is AC coupled by C1, which together with R2 fixes the -3 DB point at about 1.5 Hz — low enough to prevent objectionable low frequency phase shift. The output of IC1 drives the pair of inverting stages formed by IC2 and IC3, the input resistor to IC2 being split to allow mono summing of the two channels. The signal path is maintained at unity gian by the equal input and feedback resistors of the two stages.

The output of IC2 feeds two single-pole filters which are buffered by IC4 and

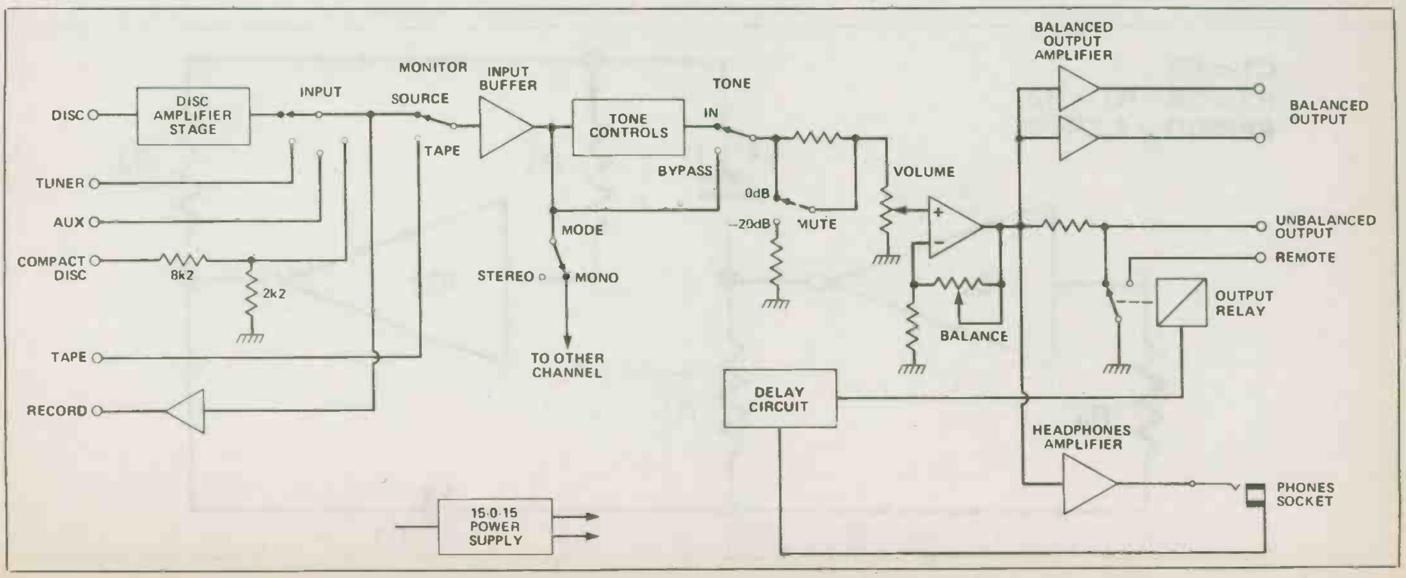


Fig. 1. Block diagram of the extended preamp.

IC5. The filter formed by C11, R12 and RV1 has a high pass characteristic with its -3 DB point adjustable by VR1 from 5.3 kHz to 20 kHz. Operation of the treble control, RV2, decides the destination of the high frequencies that emerge from the output of IC4 — in the "Cut" position, they are applied as negative feedback to IC2, and in the "lift' position, they bypass R8 giving additional gain to IC3. The amount of lift and cut is controlled by R13, the value specified giving a ± 10 dB variation.

The bass control works in the same way except that a low pass filter comprising C12, R14 and RV3 selects the low frequency range which is variable between 20 Hz and 480 Hz.

This type of tone control is characterized by shelving response curves with no interaction between the bass and treble sections. The curves are shown in Fig. 3 which illustrates the range of the variable frequency controls.

As the tone control section is non-inverting from input to output, it can readily be bypassed as shown. To ensure that there is no change in level when the bypass switch is operated, the 2.9 dB attenuator formed by R5, R6 and the volume control is duplicated by the addition of R10 and R11 at the output of IC3.

The mute switch has been added, as much for convenience as anything. When changing records or when the phone rings, it is very useful to be able to reduce the overall gain without disturbing the volume control setting.

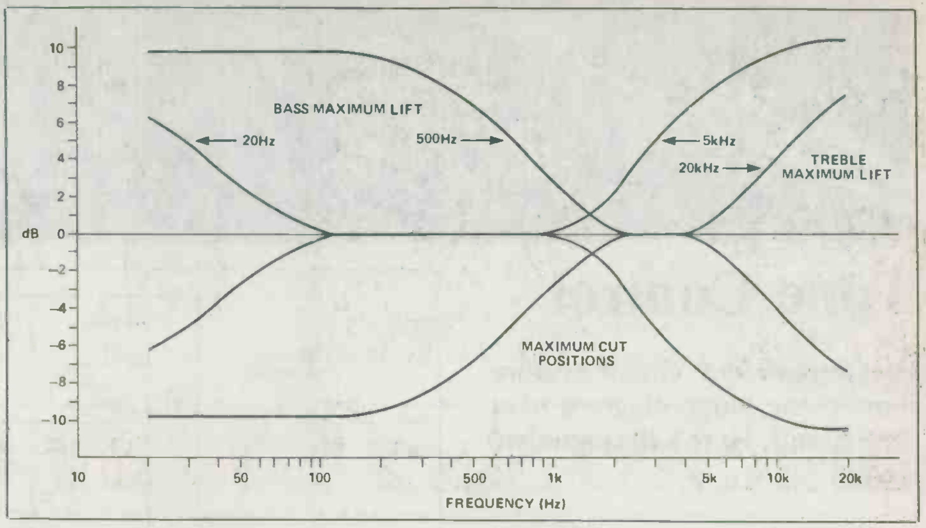


Fig. 3. Response curves for the tone control module.

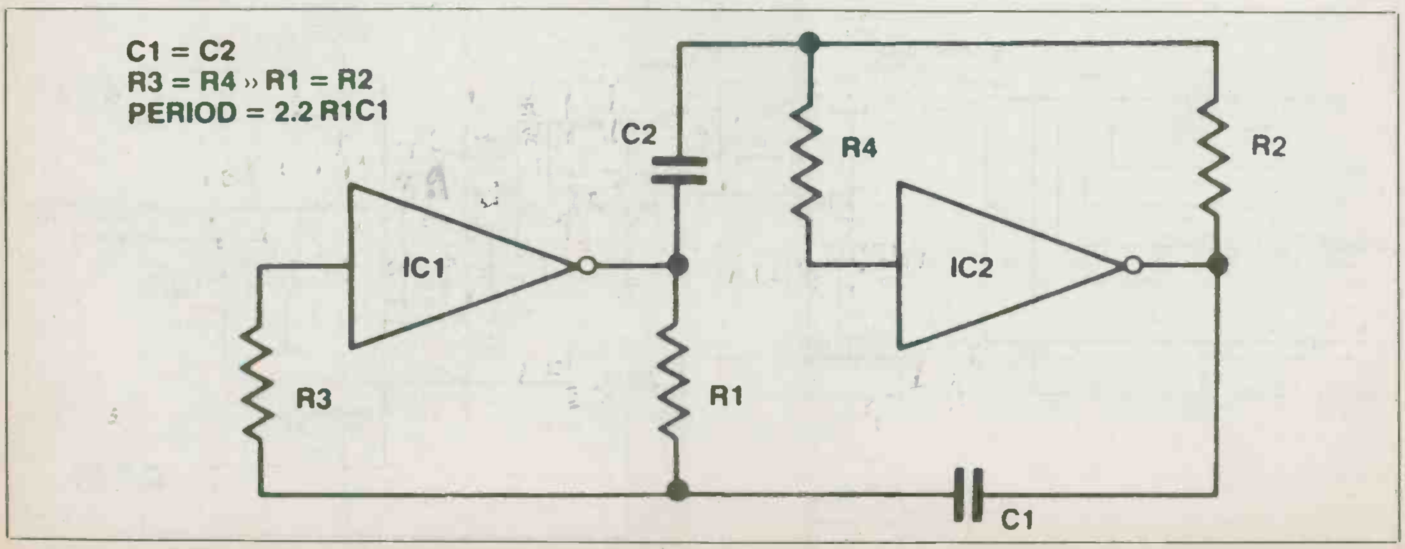
Symmetric Multivibrator

Dr. Ton Trancong

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

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

Resistors R3 and R4 should have a value of more than three times that of R1 and R2 for the RC relaxation circuits to behave as if R3 and R4 were infinite. However, too high values of R3 and R4 may affect the operation of the circuit as the voltages at the inputs of the inverters may then fail to follow the relaxation voltages. The only requirements for proper operation are the IC1 and IC2 must be sections of the same physical integrated circuit chip, and that corresponding components of the dual circuits must have the same nominal values. A 4009 CMOS hex-inverter chip with R1 = R2 = 300K (20%), R3 = R4 = 1M (20%), C1 = C2 = 680p (10%) should produce acceptable results. The frequency obtained is fairly stable (with 33% variation when the supply voltage varies between 3.3 V and 15 V) and its duty cycle is almost a perfect 1:1 over the whole permissible range of supply voltage.



continued on page 52

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F.G. RAYER, T.Eng.(CEI), Assoc.IERE
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics, will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts, to aid the beginner.

Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

221: 28 TESTED TRANSISTOR PROJECTS
R.TORRENS $5.00
Mr. Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

BP71: ELECTRONIC HOUSEHOLD PROJECTS $7.20
R. A. PENFOLD
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

Electronics Today Bookshelf

BP49: POPULAR ELECTRONIC PROJECTS $7.75
R.A. PENFOLD
Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS
R.A. PENFOLD $7.60
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

BP95: MODEL RAILWAY PROJECTS $7.60
Electronic projects for model railways are fairly recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects: striboard layouts are provided for each project.

BP93: ELECTRONIC TIMER PROJECTS $7.60
F.G. RAYER
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

BP113: 30 Solderless Breadboard Projects-Book 2
R.A. Penfold $8.85
A companion to BP107. Describes a variety of projects that can be built on plug-in breadboards using CMOS logic IC's. Each project contains a schematic, parts list and operational notes.

BP104: Electronic Science Projects
Owen Bishop $8.85
Contains 12 electronic projects with a strong scientific flavour. Includes Simple Colour Temperature Meter, Infra-Red Laser, Electronic clock regulated by a resonating spring, a 'Scope with a solid state display, pH meter and electrocardiograph.

BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING $7.60
R.A. PENFOLD
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

BP84: DIGITAL IC PROJECTS $7.60
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS $7.05
F.G. RAYER, T.Eng.(CEI), Assoc. IERE
Numeral indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.
In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

BP99: MINI—MATRIX BOARD PROJECTS $7.60
R.A. PENFOLD
Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

BP103: MULTI-CIRCUIT BOARD PROJECTS $7.60
R.A. PENFOLD
This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 $8.85
R.A. PENFOLD
A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP106: MODERN OP-AMP PROJECTS $7.60
R.A. PENFOLD
Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

How to Design Electronic Projects
BP127 $8.95
Although information on standard circuit blocks is available, there is less information on combing these circuit parts together. This title does just that. Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

Audio Amplifier Construction
BP122 $8.95
A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

Electronic Circuits for Model Railways
BP213 $4.50
Lots of circuits including three types of controllers including one with simulated inertia and one with high power. Signalling and lighting systems are discussed at length and the superession of RF interference. There are also 4 "steam whistle" and "chuffer" circuits.

BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 $7.75
R.A. PENFOLD
Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 $8.85
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS $6.75
F.G. RAYER, T.Eng.(CEI),Assoc.IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.
This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

BP87: SIMPLE L.E.D. CIRCUITS $5.40
R.N. SOAR
Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

BP42: 50 SIMPLE L.E.D. CIRCUITS $5.75
R.N. SOAR
The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

THE ACTIVE FILTER HANDBOOK
TAB No.1133 $13.95
Whatever your field — computing, communications, audio, electronic music or whatever — you will find this book the ideal reference for active filter design.
The book introduces filters and their uses. The basic math is discussed so that the reader can tell where all design equations come from. The book also presents many practical circuits including a graphic equalizer, computer tape interface and more.

MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS
TAB No.800 $ 26.50
MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS
TAB No.804 $23.95
Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

BP88: HOW TO USE OP AMPS $8.85
E.A. PARR
A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

BP65: SINGLE IC PROJECTS $6.05
R.A.PENFOLD
There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 $7.60
Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.
This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.
The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

223: 50 PROJECTS USING IC CA3130 $5.00
R.A.PENFOLD
In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

224: 50 CMOS IC PROJECTS $5.25
R.A. PENFOLD
CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.
Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories: I — Multivibrators II — Amplifiers and Oscillators III — Trigger Devices IV — Special Devices.

THE MASTER IC COOKBOOK
TAB No.1199 $17.95
If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - Book 2
R.A. PENFOLD $7.60
This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP24: 50 PROJECTS USING IC741 $6.75
RUDI & UWE REDMER
This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics.

BP83: VMOS PROJECTS $7.70
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

BP50: IC LM3900 PROJECTS $5.40
H.KYBETT,B.Sc., C.Eng.
The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.
Simple basic working circuits are used to introduce this IC. The LM3900 can do much more than is shown here, this is just an introduction. Imagination is the only limitation with this useful and versatile device. But first the reader must know the basics and that is what this book is all about.

ELECTRONIC DESING WITH OFF THE SHELF INTEGRATED CIRCUITS
AB016 $12.95
This practical handbook enables you to take advantage of the vast range of applications made possible by integrated circuits. The book tells how, in step by step fashion, to select components and how to combine them into functional electronic systems. If you want to stop being a "cookbook hobbyist", then this is the book for you.

See order form in this issue.

Electronics Today Bookshelf

RADIO AND COMMUNICATIONS

BP96: CB PROJECTS $7.60
R.A. PENFOLD
Projects include speech processor, aerial booster, cordless mike, aerial and harmonic filters, field strength meter, power supply, CB receiver and more.

222: SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS $7.60
R.A. PENFOLD
In this book, R.A. Penfold has designed and developed several modern solid state short wave receiver circuits that will give a fairly high level of performance, despite the fact that they use only relatively few and inexpensive components.

BP91: AN INTRODUCTION TO RADIO DXing $7.60
This book is divided into two main sections one to amateur band reception, the other to broadcast bands. Advice is given to suitable equipment and techniques. A number of related constructional projects are described.

BP105: AERIAL PROJECTS $7.60
R.A. PENFOLD
The subject of aerials is vast but in this book the author has considered practical designs including active, loop and ferrite aerials, which give good performances and are reasonably simple and inexpensive to build. The complex theory and math of aerial design are avoided.

BP125: 25 Simple Amateur Band Aerials
E.M. Noll $7.60
Starting from simple dipoles through beam, triangle and even mini-rhombics (made from TV masts and 400ft of wire) this title describes several simple and inexpensive aerials to construct yourself. A complete set of dimension table are included.

BP46: RADIO CIRCUITS USING IC's $5.40
J.B. DANCE, M.Sc.
This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. The chapter on amplitude modulated (a.m.) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, while the chapter on frequency modulation (f.m.) receivers will appeal to those who desire high fidelity reception.

BP92: ELECTRONICS SIMPLIFIED—CRYSTAL SET CONSTRUCTION $6.80
F.A. WILSON
Aimed at those who want to get into construction without much theoretical study. Homewound coils are used and all projects are very inexpensive to build.

BP70: TRANSISTOR RADIO FAULT-FINDING CHART $2.50
CHAS. E. MILLER
Across the top of the chart will be found four rectangles containing brief descriptions of various faults; vis: — sound weak but undistorted; set dead; sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

AUDIO

205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES $3.75
B.B. BABANI
This book gives data for building most types of loudspeaker enclosure. Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH. . .
TAB No.1166 $15.95
The author, F. Alton Everest, has gotten studios together several times, and presents twelve complete, tested designs for a wide variety of applications. If all you own is a mono cassette recorder, you don't need this book. If you don't want your new four track to wind up sounding like one, though, you shouldn't be without it.

BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING $7.75
M.K. BERRY
Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator.

This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment. It then describes how the sounds are generated and how these may be recorded to build up the final composition.

BP81: ELECTRONIC SYNTHESISER PROJECTS $6.80
M.K. BERRY
One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesiser or effects generator. Although an electronic synthesiser is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

ELECTRONIC MUSIC SYNTHESIZERS
TAB No.1167 $10.95
If you're fascinated by the potential of electronics in the field of music, then this is the book for you. Included is data on synthesizers in general as well as particular models. There is also a chapter on the various accessories that are available.

TEST EQUIPMENT

BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION $6.80
F.G. RAYER, T.Eng. (CEI), Assoc. IERE
This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

THE POWER SUPPLY HANDBOOK
TAB No.806 $15.95
A complete one stop reference for hobbyists and engineers. Contains high and low voltage power supplies of every conceivable type as well mobile and portable units.

REFERENCE

BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE $11.75
ADRIAN MICHAELS
This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use. The Equivalents are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included. An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists. Fantastic value for the amount of information it contains.

BP108: INTERNATIONAL DIODE EQUIVALENTS GUIDE
ADRIAN MICHAELS $8.95
This book is designed to help the user in finding possible substitutes for a large user orientated selection of the many different types of semiconductor diodes that are available today. Besides simple rectifier diodes also included are Zener diodes, LEDs, Diacs Triacs, Thyristors, Photo diodes and Display diodes.

BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $5.75
B.B. BABANI
This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES $6.75
B.B. BABANI
The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

TOWER'S INTERNATIONAL OP-AMP LINEAR IC SELECTOR
TAB No.1216 $17.95
This book contains a wealth of useful data on over 5,000 Op-amps and linear ICs — both pinouts and essential characteristics. A comprehensive series of appendices contain information on specs, manufacturers, case outlines and so on.

CMOS DATABOOK
TAB No.984 $12.50
There are several books around with this title, but most are just collections of manufacturers' data sheets. This one, by Bill Hunter, explains all the intricacies of this useful family of logic devices . . . the missing link in getting your own designs working properly. Highly recommended to anyone working with digital circuits.

ROBOTICS

THE COMPLETE HANDBOOK OF ROBOTICS
TAB No.1071 $15.95
All the information you need to build a walking, talking mechanical friend appears in this book. Your robot can take many forms and various options — light, sound, and proximity sensors — are covered in depth.

HOW TO BUILD YOUR OWN SELF PROGRAMMING ROBOT
TAB No.1241 $13.95
A practical guide on how to build a robot capable of learning how to adapt to a changing enviroment. The creature developed in the book, Rodney, is fully self programming, can develop theories to deal with situations and apply those theories in future circumstances.

BUILD YOUR OWN WORKING ROBOT
TAB No.841 $10.95
Contains complete plans — mechanical, schematics, logic diagrams and wiring diagrams — for building Buster. Buster is a sophisticated experiment in cybernetics you can build in stages. There are two phases involved: first Buster is leash led, dependent on his creator for guidance; the second phase makes Buster more independent and able to get out of tough situations.

VIDEO

BP100: AN INTRODUCTION TO VIDEO
D.K. MATHEWSON $7.60
Presents in as non-technical a way as possible how a video recorder works and how to get the best out of it and its accessories. Among the items discussed are the pros and cons of the various systems, copying and editing, international tape exchange and understanding specifications.

Tab1519: ALL ABOUT HOME SATELLITE TELEVISION $22.95
Covers such aspects as where to buy, problems in setting up your TVRO station and how to solve them, antenna siting and equipment selection.

Tab1490: VIDEO CASSETTE RECORDERS: BUYING, USING AND MAINTAINING $14.95
A complete handbook for the video enthusiast. You'll learn about how the systems work and how to choose as well as take a technical look at the inside workings. There are also sections on making your own video recordings.

MISCELLANEOUS

PH255: COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS, 2nd Edition
J. DOUGLAS-YOUNG $11.95
Packed with scores of easy-to-understand diagram and invaluable troubleshooting tips as well as a circuit finder chart and a new section on logic circuits.

BP101: HOW TO IDENTIFY UNMARKED IC'S $2.75
K.H. RECORR
Originally published as a feature in 'Radio Electronics', this chart shows how to record the particular signature of an unmarked IC using a test meter, this Information can then be used with manufacturer's data to establish the application.

BASIC TELEPHONE SWITCHING SYSTEMS
TALLEY
HB27 $17.95
The Revised Second Edition of this book, for trainee and engineer alike, includes updated statistical data on telephone stations, and new and improved signaling methods and switching techniques. It also includes E & M signaling interface for electronic central offices and automatic number identification methods used in step-by-step, panel and crossbar central offices.

PH252: DIGITAL ICs: HOW THEY WORK AND HOW TO USE THEM
A. BARBER $10.95
The dozens of illustrations included in this essential reference book will help explain time-saving test procedures, interpreting values, performing voltage measurements, and much more!

AUDIO AND VIDEO INTERFERENCE CURES
KAHANER
HB21 $8.95
A practical work about interference causes and cures that affect TV, radio, hi-fi, CB, and other devices. Provides all the information needed to stop interference. Schematic wiring diagrams of filters for all types of receivers and transmitters are included. Also, it supplies simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, motors, etc.

BP121: How to Design and Make Your Own PCBs
R.A. Penfold $7.60
The emphasis is on practical rather than theoretical techniques. Starts by giving simple methods of copying from magazines, carries on with photographic methods of producing PCBs and continues with layout design.

See order form in this issue.

A Look At the Memotech 512

An impressive new computer from a company best known for ZX peripherals.

by David Norman

MEMOTECH HAS served a long apprenticeship in the field of microcomputers as a manufacturer of high quality ZX81 peripherals, and now they are set to take a slice of the home and business market with the MTX 512.

If first impressions are important, then Memotech has scored highly — their product comes beautifully packed and presented. The micro itself is cased in black anodised aluminum and carries a total of 79 keys which have a crisp and positive feel to them. The power supply is a separate unit, equally stylish, and rated at 1A. All the usual cables and documentation are also contained.

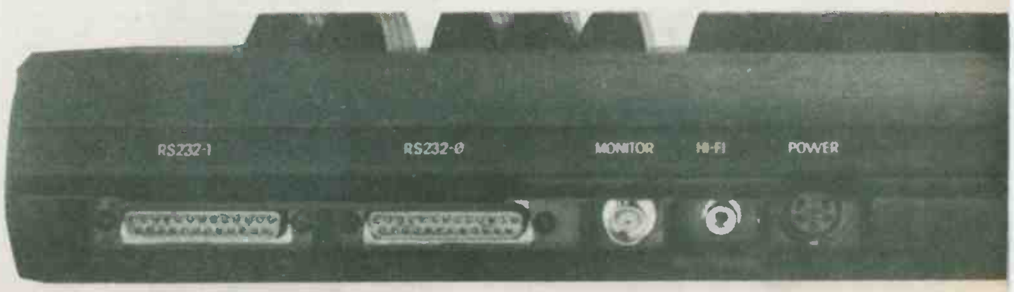
RAM

The MTX 512 is a 64K machine with expansion to 512K. There's no need to worry about shrinking user memory when you're in the graphics mode either; there's an extra 16K for the graphics alone and the graphics RAM is controlled by a separate video processor.

Plenty Of Ports

The MTX is a wide computer — about 19 inches — so there is plenty of room along the back for a multitude of connectors. They are generally high quality sockets, but deeply recessed and therefore difficult to get at, though this won't matter if the machine is going to stay in one place most of the time. There is a phono socket so that the sound output from the computer can be sent to a hi-fi. In normal use the sound channels, of which there are four, will pass through the television and can therefore be easily adjusted to the volume of your choice.

Monitor and printer outputs are present, as are two joystick ports which will accept the popular "Atari" type of joystick. All the important CPU signals are available on an edge connector, though this is normally blanked off in the interests of safety (the machine's safety by the way, not the user's!) and two RS232 interfaces are available as an optional extra. As if this wasn't enough, there is also an uncommitted 8-bit I/O port on the PCB itself, just sitting there as a 16-way IC socket and waiting for the home constructor to pop in a 16-pin header on some ribbon cable so that the micro can start controlling various gadgets around the home.



Up And Running

The DIN power supply connector was a *very* tight fit in its socket, but fortunately once it is in, there is no need to disconnect. Not only is there an illuminated switch on the power supply, but there is also a reset button on the computer to bring you out from all crashes, infinite loops and other software nightmares. It is just as well that there is a light on the power supply since the MTX runs silently, without hums or buzzes.

The display on a Hitachi 12 inch colour TV was steady and the colours true, though the TV did need retuning after a warm-up period of about half an hour. There was no "dot-crawl" on either stationary or moving characters. The format of the screen in character mode is 40 x 24 and in general the text is clear and of pleasing proportions. However, I didn't much care for the lower case 'g' so I used the GENPAT command to redefine it. Any character in the standard ASCII set (codes 32 to 127) can be redefined in this way, and you may also define 26 new characters (or graphics) for codes 128 to 154, *and* type most of them into the computer using the special function keys marked F1 to F8. In graphics mode there are 32 characters on a line, so there is more space between each character. You can use the keyboard to change the character set to Spanish or German, in which case the specialized European symbols occur in place of the English keyboard's square-brackets and so on.

All the video work is done by one chip, the Texas 9929. This is a standard Video Display Processing (VDP) chip capable of producing four display modes, 16 colours and up to 32 sprites, about which more will be said later. One possible source of complaint is that the leading character position in each line may be lost in the television margin. This is not noticeable at first, since the software places print statements a couple of spaces on from the beginning of a line. The general advice must be to try to buy a TV or monitor with a horizontal hold, accompanied by a plea to the manufacturers to start putting these controls back onto their television sets!

High Command

The MTX has 24K of ROM, so there is plenty of space for some powerful and sophisticated commands. The manual is a provisional version: it runs to 250 pages and contains a wealth of technical information, but even so it is evident that a more comprehensive manual or book will be necessary to enable the user to get the best out of this computer. The ROM contains the BASIC, an interactive language called NODDY and an Assembler/Disassembler with powerful debugging facilities. Also available are plug-in cartridges for the FORTH and Pascal languages. The MTX BASIC has extra commands to enable the user to handle colour, sound, graphics and sprites without recourse to PEEKs and POKEs (Commodore please note!) and it should please most people. You may be disappointed to see that PROCEDURES and DO . . . UNTIL constructions are missing, but on the other hand you should be pleased to find that syntax is checked at the time of entry, and that keywords may be entered in a shortened form.

Assemble, Please

The assembler is called from BASIC, and it assembles the code in situ, as part of the BASIC listing. The assembler itself is fairly basic, but it is easy to use and to edit. Numbers may be entered in either hex or decimal, and addresses are printed out in hex. Address labels are obviously accepted, but labels equated to numeric values are not supported. Define Space and Define Byte (incorporating Define String) can be used, but Define Word is absent.

Table 1

CIRCLE	DRAW	PLOT	ARC	LINE	ANGLE	VIEW
PHI.	SPRITE	MVSPR	ADJSPR	CTLSPR	GENPAT	

Table 1. The graphic and sprite group; powerful instructions for multi-level, highly mobile screen displays.

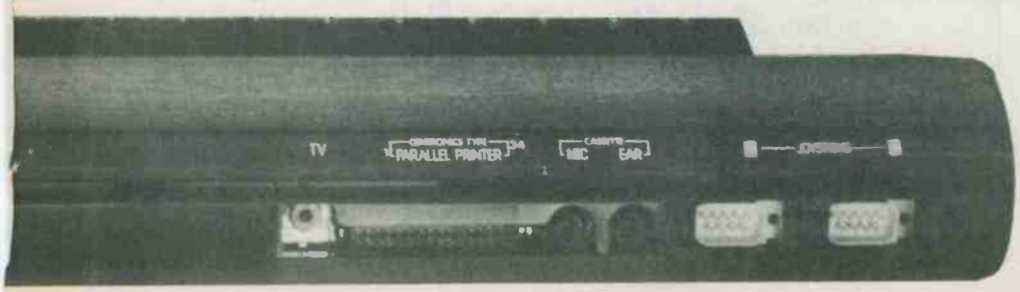
NODDY is a new language designed to simplfy text handling. It has only 11 commands, but can be incorporated into BASIC in such a way that the two languages work toegether. Coupled with the MTX editing keys, it should take the drudgery out of creating programs with a large textual content. Applications are obviously going to suggest themselves in areas of the school curriculum, in the fast-training of personnel in commerce, and in adventure-game writing. Time will tell how useful NODDY will be, and Memotech are to be congratualted for incorporating it into their computer — it's an experiment on their part and a challenge for the software writers to make something of it.

PANEL calls up the front panel display and puts the user directly in control of the MTX monitor at machine code level. Basically it is a window looking in at the registers and memory locations of the computer and it is an invaluable aid to all users intersted in writing and debugging program and control of I/O devices at machine code level.

Other interesting commands in this group are the COLOUR, PAPER, INK and ATTRibutes which set up the various colour and printing options: the CLOCK and TIMES which handle a real-time clock in hours, minutes and second format, and the SOUND command that passes either 3 or 7 parameters to the Texas 76489 sound chip.

Sprites And Things

The graphics screen has a resolution of 256 x 192 pixels and the graphic commands are listed in Table 1. PLOT, LINE and CIRCLE are fairly standard point and line drawing comands, but there is also ANGLE, PHI, DRAW and ARC and these are used together to determine the direction of lines and patterns drawn in the style of LOGO's TURTLE graphics. The provisional manual gives short examples of how to handle these advanced graphics, and it is to be hoped that further instructions will be provided in the final version of the manual.



Rear view showing the vast assortment of connectors on the MTX 512.

And so now to the Sprites: "Up to 32 independently controllable user definable sprites, plus pattern plane and backdrop plane" to quote the specifications, but what exactly does this mean? Think of the TV screen as a drawing board with a small piece of paper on it. The paper represents the physical size of the video screen, 256 x 192 pixels and can be a colour of your choice. This is the "backdrop-plane".

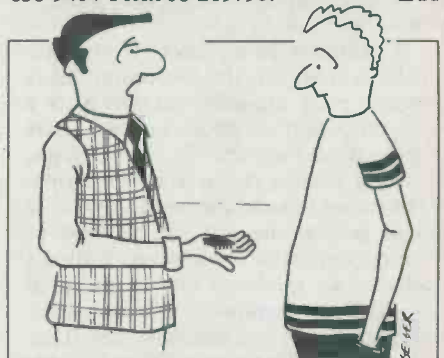
The Memotech power supply

Onto that paper, that screen, goes the text and/or graphics shapes in any ink colour you choose. This is the "pattern-plane". Consider the paper and the ink as a landscape. Now imagine a large piece of cellophane, 8192 x 8192 pixels in size, on which you have placed a small object called a sprite. The cellophane is your "sprite-place". You can see the landscape beneath the cellophane, except where the sprite obscures it. Furthermore, you can move the sprite across the cellophane (with sprite) relative to the landscape. Finally, imagine that you could have up to thirty-two seperate sheets of cellophane all piled on top of the landscape, and each with a moving sprite on it. That's how sprites help to achieve animation effects, and the commands such as MVSPR (move sprite) and CTLSPR (control sprite) help to set up the operating conditions. Once set, the sprites move around independently of the BASIC program, until such time as their parameters are altered. Collision between sprites are detected, and can be checked on by a PEEK to a register in the VDP chip.

Conclusion

The MTX 512 is a well designed and carefully constructed machine which is well worth the $945 asking price. It seems to be suitable for both the home and educational markets, as well as novices and experts alike.

The Memotech MTX 512 is available from Gladstone Electronics Supply Co., 1736 Avenue Rd., Toronto, Ontario M5M 3Y7 (416) 787-1448. The distributor for the MTX 512 is EDG Electronic Distributors Inc., 3950 Chesswood Ave., Toronto, Ontario, M3J 2W6 (416) 636-9404 Telex 06-219798. **ETI**



"It's a new type of memory chip, manufactured in California. It doesn't have a definite access time; it finds your data as soon as you stop hassling it and let it get its head together."

Circuit Ideas continued from page 46

DC Lamp Dimmer

The IC which controls the switching is the well known 555 timer, which is intended for monostable or oscillator applications.

Its main internal functions comprise a flip-flop, and two comparators, which can set the flip-flop (and hence the output) into either state. The comparators switch at one third and two thirds of the supply voltage, but this can be modified by the control voltage input, and thus in this application can change the mark to space ratio.

It can in fact be varied from full on to completely off — though being on for two thirds of the time seems to be a typical setting required.

The FET used requires less than 0V8 on its gate to guarantee turn off — no problem for the 555 IC which is guaranteed to pull down to 0V25.

The circuit can handle lamps up to about 10 watts in size.

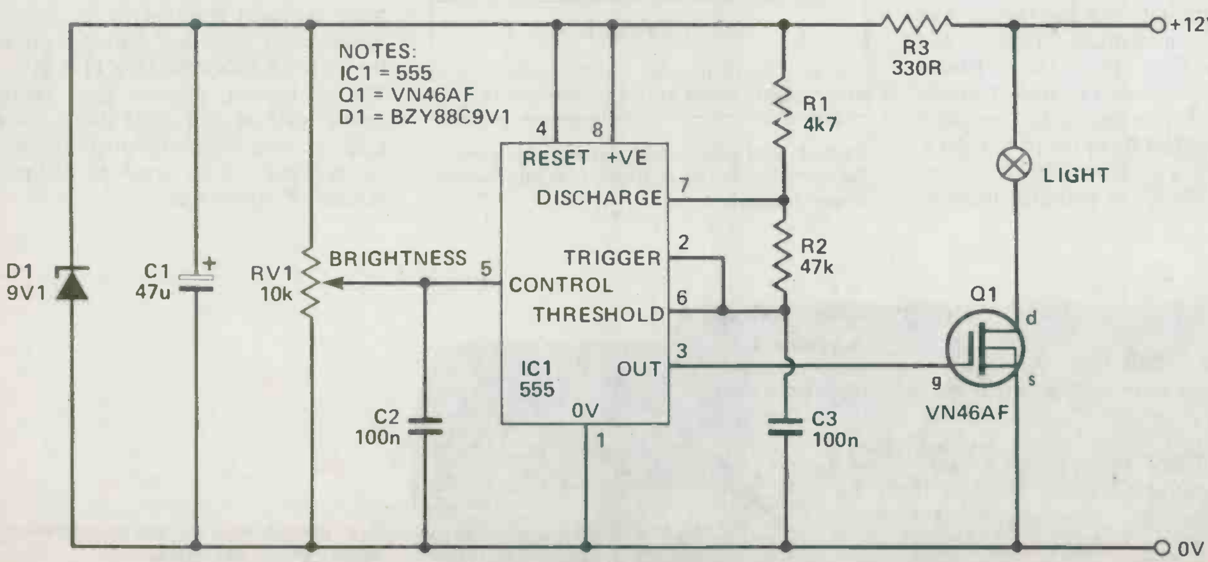


Fig. 1. The circuit. The dimming is obtained by a rapid switching of the lamp, controlled by the 555 timer.

ETI

which it loses when turned off, or on EPROM, so it can remember when it wakes up). As its experience grows, the RB5X develops rankings or levels of confidence in each of its possible responses. Eventually, the RB5X creates a range of appropriate learned responses to all of the circumstances it encounters in a room.

As well as moving and lifting and carrying, the RB5X has a number of capabilities that the other robots of the home variety can't do. For example, it has a fully resident voice recognition capability whereby the robot ban hear and understands your words and respond either with information or with an action. It has the ability for radio communications whereby it can communicate through a modem to a remote computer, to a computer in the same room, directly to another robot, or to a security device. That means that the robot can teach another robot what it has learned, or, it can be programmed to patrol an environment (one's home) and detect intruders or a fire, transmit the information to the police or fire department, and raise an alarm. In the realm of navigation, the robot can be provided with an on-board compass such that no matter what direction it faces it will know where it is, or alternatively, a rotating sonar sensor enables the robot to scan the environment, compare the readings with prior knowledge, determine where it is, and via the compass, determine in which direction it is to move. As a continuation of the security aspects of the robot, it can be fitted with a fire detector and extinguisher. It can sense both temperature and the rate of change of the temperature. For example, it can tell the difference between a person or an animal walking by (simple body warmth), a stove turned on for cooking (relatively hot but unchanging) or a fire (very hot and getting hotter). It then is capable of raising an alarm (siren, lights) and via a cartridge carried in a dolly pulled behind it, detect where the hottest portion of the fire is, point the nozzle and release a blast of pressurized C02 at the base of the fire. This either extinguishes it, or delays its spread until humans can show up and deal with it themselves. And lastly, it can do the vacuuming via a device mounted on a dolly pulled behind it. As for doing widows, have patience; they're working on it. (The problem is reach — RB5X is too short).

There are also programs to teach, via TinyBASIC, such things as physics (interaction of sensors, etc.) and mathematics (patterns and geometry); it can be programmed to bring one the mail, water the plants, take the kid for a ride in the dolly, and at least in one publicity photo, take the dog for a walk (though I don't think this author's 85 pound pooch would take too kindly to that idea).

Essentially, then, for an assembled base price of roughly $2,300, the RB5X comes about as close to a real life R2D2 as can currently be found.

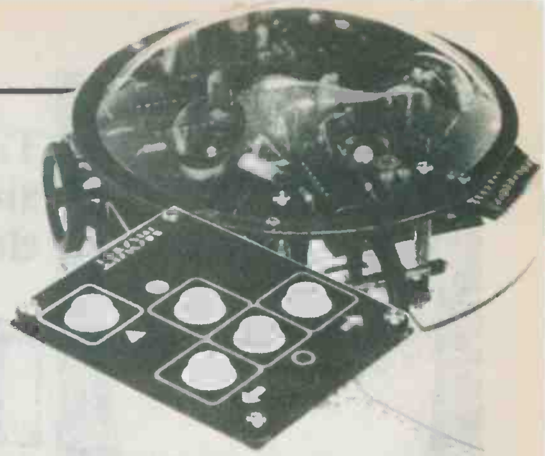
What then of the future? It's all well and good for companies like RB Robots to develop production models that can do things, but nonetheless home/hobby robotics are still firmly stuck in the position that microcomputers were six or seven years ago; the technology is there, but the uses still have to be developed by the home hobbyist. Fortuntely, there are a number of companies that directly or indirectly recognize this, and are attempting to provide the home robotics person with parts and systems that can be amalgamated into working devices. As such, there are a number of areas to be covered: information processing, sensing, mobility, grippers, and education.

In the realm of information processing, or controllers, there are a number of companies: Cybernetic Micro Systems with its CY500 Stored Program Stepper Motor Controller, HHS Microcontroller's R8E Microcontroller, and so on. To delve into their capabilities is redundant. Their addresses are found at the end of this article.

In the realm of sensing there are also a number of companies, though basically one three will be mentioned here. The Votrax Inc. company manufactures a personal speech system which is about as good as one gets. The Ezra C. Lundal Inc. Company manufactures a sonic ranging device designed as a distance sensing and control unit, as well as a distance monitor device about the size of a packet of cigarettes. Perhaps the most versatile ranging device is Polaroid's Ultrasonic Ranging System developed for one of their cameras, and now used in a variety of applications, particularly robotic sensing systems. A rundown on what it does and how it does it can be found in this issue of ETI under 'Electronics in Action'.

Do It Yourself

Mobility can be handled one of two ways. One can purchase an off-the-shelf base, such as Hobby Robots RBU-IIT unit which can carry up to 275 pounds over flat terrain at 3 feet per second, though at $1500 (US) a unit, it's a bit pricey. Far better to build one yourself. To that end Stock Drive Products in a veritable mother-lode for the robotics enthusiast via their *Handbook of Small Standardized Components* and their *Design and Application of Small Standarized Components,* which includes a 51 page robotics design section. This latter volume prefaces each section over the course of almost 800 pages with diagrams, descriptions and explanations dealing with small scale engineering; e.g., how to select the right gear, how many teeth should it have and why, etc. It's a superb quick course in small scale engineering with real life examples. It costs $7.95 US. In combination with the other volume (730 pages,



The Memocon Crawler from MOVIT, designed in the turtle fashion, can be programmed from a five function keypad to perform basic robotic actions.

$5.95 US) which contains every sort of little thing (24,000 different gears, bushings, pulleys, motors, whatever) this writer can safely say that no hobbyist dealing with matters mechanical could or even should try to design anything without possessing a copy.

In the realm of grippers, the MACK Corporation's low profile actuators are about as good as they come. Primarily designed for industry, the smaller ones have application in robotics.

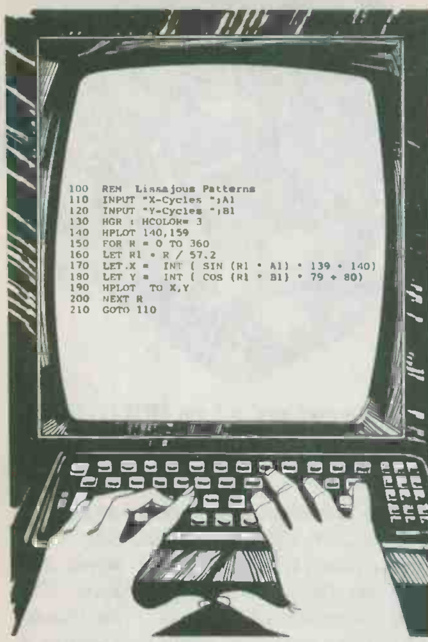
In the world of education, there are an increasing number of courses available for the would-be roboticist through community colleges and universities. However, they require attendance. Perhaps the best correspondence, self-tech program in robotics is the one offered by the Heathkit Company, costing $150 (an industrial applications course in Robotics cost another $150.) It covers almost everything and in combination with the Stock Drive Products' volumes, will set roboticists well on their way to success.

And finally, for those who want a quick taste of what the problems are and how to deal with them, the MACK Corporation has a free booklet, originally intended for internal use by their employees, entitled *Robotics . . . Start Simple.* It is a good introduction into what sort of problems the roboticist is likely to face and how to overcome them.

What then of the future? If the hobbyists get going, then perhaps the $2 billion a year industry by the end of the decade will come about, and the indications are good that it will. After all, the speech synthesis device used by the RB5X was originally designed by 17-year-old Arnold Tang of Honolulu, Hawaii, and the RB5X's fire extinguisher mechanism was developed by Mark Turner while a student at the Golden High School in Golden, Colorado, and entered into the school's science fair where it (not surprisingly) took first place in the Engineering Division.

Just like the developments in microcomputers six years ago.

For selected addresses see page 10.



Timekeeping: find Easter, print a calendar for any year, and try some graphics with an analog clock.

Computing Today

Apple Listings by Anthony DeBoer

THE THREE programs presented here are concerned with the subject of time. Computers, with their ability to do math and follow complicated sets of rules, are well suited to figuring out times and dates. Consider, for example, the rules for leap years: every fourth year is a leap year, but every hundredth (1800, 1900, etc.) is not, except for every four hundredth (2000, for example), which is. Keeping track of a seven-day week through 365 and/or 366 day years is another interesting trick.

Of course, if you think that's complicated, you ain't seen nothing yet. Check out the rules for when Easter occurs: "the Sunday which follows the full moon which occurs on, or next after, the day of the spring equinox." They don't figure these things out by throwing darts at a calendar, much as it may seem that way. You almost need a degree in astronomy to plan your spring vacation.

The Silicon Solution

Starting off, we have a program that prints out calendars for any year of the Gregorian calendar. Although written in Applesoft BASIC, it could probably, with a bit of programming knowledge, be adapted to just about any other BASIC. It asks for a year and a month — enter zero for the month to get all twelve — and then prints up the calendar(s). A hardcopy option lets you print out the results.

The second program figures out when Easter Sunday falls in any given year or years. It asks for a starting year and an ending year, and then prints up a list of the dates on which Easter will fall in those years.

Third, we have a clock program. While it doesn't keep accurate time, it does show off the Apple's animated graphics capability (using both high-res screens) fairly well. It even makes nice mechanical clicking sounds as it goes around. Of the three, this is the only one that probably isn't worth trying to translate to another computer's BASIC, since it uses so much that is Apple-specific.

Calendar

```
100 REM Calendar by Anthony DeBoer
110 DEF FN D(R) = (Y = (R * INT (Y / R)))
120 I$ = CHR$ (124) + "    "
130 DIM MN$(12): FOR N = 1 TO 12: READ MN$(N): NEXT
140 DATA JANUARY,FEBRUARY,MARCH,APRIL,MAY,JUNE,JULY,
    AUGUST,SEPTEMBER,OCTOBER,NOVEMBER,DECEMBER
150 TEXT : HOME : PRINT "Calendar": PRINT
160 INPUT "Year = ";Y: PRINT
170 INPUT "Month (0 for all year) = ";M
180 IF M < 0 OR M > 12 THEN 170
190 PRINT : PRINT "Hardcopy? ";
200 GET H$: IF H$ < > "Y" AND H$ < > "N" THEN 200
210 PRINT H$: IF H$ = "Y" THEN PRINT CHR$ (4);"PR#1"
220 IF M > 0 THEN GOSUB 260: GOTO 240
230 FOR M = 1 TO 12: GOSUB 260: NEXT
240 IF H$ = "Y" THEN PRINT CHR$ (4);"PR#0"
250 END
260 REM figure out what day the month starts on
270 D = Y:A = M - 2: IF A < 1 THEN A = A + 12:D = Y - 1
280 C = INT (D / 100):D = D - 100 * C
290 W = INT ((13 * A - 1) / 5)
300 Z = W + INT (C / 4) + INT (D / 4) + 1 + D - 2 * C
310 F = Z - 7 * INT (Z / 7)
320 REM figure out how many days in month
330 L = 28 + INT ((13 * A + 12) / 5) - W
340 IF M = 2 THEN L = 28 + FN D(4) - FN D(100) + FN D(400)
350 REM print calendar month
360 IF H$ = "N" THEN HOME
370 A$ = MN$(M) + " " + STR$ (Y): HTAB 20 - LEN (A$)
380 FOR N = 1 TO LEN (A$): PRINT MID$ (A$,N,1);" ";: NEXT
390 PRINT : PRINT
400 PRINT "  SUN  MON  TUE  WED  THU  FRI  SAT": GOSUB 520
410 I = 0: IF F > 0 THEN FOR N = 1 TO F: GOSUB 460: NEXT
420 FOR I = 1 TO L: GOSUB 460: NEXT
430 IF D > 0 THEN I = 0: GOSUB 460: GOTO 430
440 IF H$ = "N" THEN GET A$
450 PRINT : PRINT : RETURN
460 REM print calendar cell
470 PRINT LEFT$ (I$,5 - (I > 9) - (I > 0));
480 IF I > 0 THEN PRINT I;
490 D = D + 1: IF D < 7 THEN RETURN
500 PRINT LEFT$ (I$,1)
510 PRINT I$;I$;I$;I$;I$;I$;I$; LEFT$ (I$,1)
520 PRINT "+----+----+----+----+----+----+----+"
530 D = 0: RETURN
```

```
         D E C E M B E R   2 0 0 1

  SUN  MON  TUE  WED  THU  FRI  SAT
+----+----+----+----+----+----+----+
|    |    |    |    |    |    |   1|
|    |    |    |    |    |    |    |
+----+----+----+----+----+----+----+
|   2|   3|   4|   5|   6|   7|   8|
|    |    |    |    |    |    |    |
+----+----+----+----+----+----+----+
|   9|  10|  11|  12|  13|  14|  15|
|    |    |    |    |    |    |    |
+----+----+----+----+----+----+----+
|  16|  17|  18|  19|  20|  21|  22|
|    |    |    |    |    |    |    |
+----+----+----+----+----+----+----+
|  23|  24|  25|  26|  27|  28|  29|
|    |    |    |    |    |    |    |
+----+----+----+----+----+----+----+
|  30|  31|    |    |    |    |    |
|    |    |    |    |    |    |    |
+----+----+----+----+----+----+----+
```

Easter Sunday

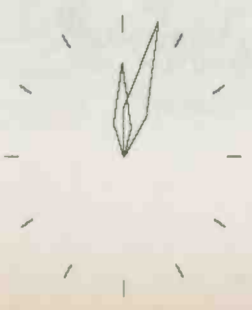
```
100 REM Easter Sunday
110 REM Adapted by Anthony DeBoer from a program by Noel Bailey
   from an algorithm by T. H. O'Beirne
120 PRINT
130 INPUT "FIRST YEAR = ";Y
140 INPUT "LAST YEAR = ";Z
150 PRINT
160 PRINT "EASTER SUNDAY"
170 PRINT "------ ------"
180 FOR X = Y TO Z
190 A = X - 19 * INT (X / 19):B = INT (X / 100):C = X - 100 * B:
   D = INT (B / 4):E = B - 4 * D:G = INT ((8 * B + 13) / 25)
200 Q = 19 * A + B - D - G + 15:H = Q - 30 * INT (Q / 30):
   I = INT (C / 4):K = C - 4 * I
210 Q = 2 * E + 2 * I - H - K + 32:L = Q - 7 * INT (Q / 7)
220 M = INT ((A + 11 * H + 19 * L) / 433):N = INT ((H + L - 7 * M
   + 90) / 25)
230 Q = H + L - 7 * M + 33 * N + 19:P = Q - 32 * INT (Q / 32)
240 M$ = " APRIL ": IF N = 3 THEN M$ = " MARCH "
250 PRINT P;M$;X
260 NEXT
```

```
FIRST YEAR = 1981
LAST YEAR = 1990

EASTER SUNDAY
------ ------
19 APRIL 1981
11 APRIL 1982
3 APRIL 1983
22 APRIL 1984
7 APRIL 1985
30 MARCH 1986
19 APRIL 1987
3 APRIL 1988
26 MARCH 1989
15 APRIL 1990
```

Clock

```
100 REM Clock by Anthony DeBoer
110 DIM C(59),S(59)
120 PI = 3.1415927
130 T = PI / 30: FOR N = 0 TO 59:X = N * T:C(N) = COS (X):
   S(N) = SIN (X): NEXT
140 HGR : HGR2 : HCOLOR= 3
150 TI = 1:TM = 0:TP = 60
160 TF = 3:NT = 9 / 10
170 SP = 49200:S = 0
180 POKE (49236 + S),0
190 POKE 230,(64 - 32 * S)
200 CALL - 3086
210 GOSUB 390
220 REM Do clock face
230 FOR T = 0 TO 59 STEP 5:R = 90: GOSUB 310: HPLOT X,Y:R = 80:
   GOSUB 310: HPLOT TO X,Y: NEXT
240 REM Do minute hand
250 HR = 90:HT = TM: GOSUB 340
260 REM Do hour hand
270 HR = 60:HT = INT (TM / 12): GOSUB 340
280 GOSUB 390
290 TM = TM + TI
300 S = 1 - S: GOTO 180
310 IF T > = TP THEN T = T - TP
320 IF T < 0 THEN T = T + TP
330 X = R * S(T) + 140:Y = 96 - R * C(T): RETURN
340 HPLOT 140,96:SR = HR / 3
350 R = SR:T = HT - TF: GOSUB 310: HPLOT TO X,Y
360 R = HR:T = HT: GOSUB 310: HPLOT TO X,Y
370 R = SR:T = HT + TF: GOSUB 310: HPLOT TO X,Y
380 HPLOT TO 140,96: RETURN
390 REM Click speaker
400 QV = PEEK (SP) + PEEK (SP): RETURN
```



The clock at 12:03

ETI

Servo Interface

Looking for something useful to do with those servos you threw in the back of the closet? Why not interface them to the ZX81 (or other favourite micro) and get them to do some work around the house.

by Rory Holmes

THE SERVO interface is built on a single-sided PCB. An additional double-sided PCB is used to make a lead-through type of edge connector plug, similar to that used on the ZX printer. The interface electronics are too bulky to be mounted directly on the Sinclair edge-connector, but our small Verobox-enclosed plug, wired to the main board via ribbon cable, puts less strain on the expansion connector. Although this interface has been designed for use on the ZX81, real adventurists can modify it for use on just about any other micro with accessible I/O ports.

Start construction with the main PCB, soldering in the links and resistors first (there should be eight links altogether), followed by the IC sockets and other components. Insert Veropin terminals at all the computer bus connections, since this makes wiring up to the ribbon cable easier. Veropins, or a five-way Molex connector socket should also be used at the servo output terminals as illustrated on the PCB overlay diagram of Fig. 1.

The double-sided board is really an extender to allow the use of peripheral connectors. If you don't need the peripherals, you can substitute a suitable connector and wire the ribbon cable to it. If you need the PCB, it's easy to make up with the paint-and-etch method, or you can use the self-adhesive foil patterns available commercially.

Adjust Your Address

The three DIL switches can be replaced by appropriate wire links if the address combination that you wish to use is going to be a permanent fixture. The address selection details given below should be studied to appreciate the possible configurations of the address decoder. Observe that the two switches corresponding to the Z80 control lines (those nearest C4), would always be set to logic low, i.e., closed. Also note that IC3 is positioned the other way round to the other ICs.

Pot Luck

The edge connector PCB is cut to exactly fit into the smallest Vero potting box. By a lucky coincidence, the 23-way Sinclair expansion bus will exactly fit the inside of this box. The solder tags on the edge socket are spaced wider apart than the PCB thickness and must be adjusted slightly — don't forget the keyway orientation shown in the wiring layout. One row of tags should first be soldered as they are to the 'underside' PCB terminals and then the other row can be bent down to reach the topside terminals, allowing the assembly to fit in the Verobox.

Figure 3 shows how slots should be cut in the box to house the edge connector plug and socket. Two large size stick-on rubber feet should be positioned on the inside of the lid to hold the board firmly in place as the lid is screwed down. If one of the feet is stuck above the ribbon cable entry point, it will act as a cable clamp. A very neat and solid connector system will result from this construction method.

Address Selection

With the ZX81, IC8 and 9 must be fitted while IC7 is optional, depending on the degree of address decoding required. Jumper links JB and JC should be fitted, but not link JA. The memory map given in part 1 showed the address line logic levels needed to decode different address ranges. These logic levels are set on the switches to decode the required addresses for the servo locations.

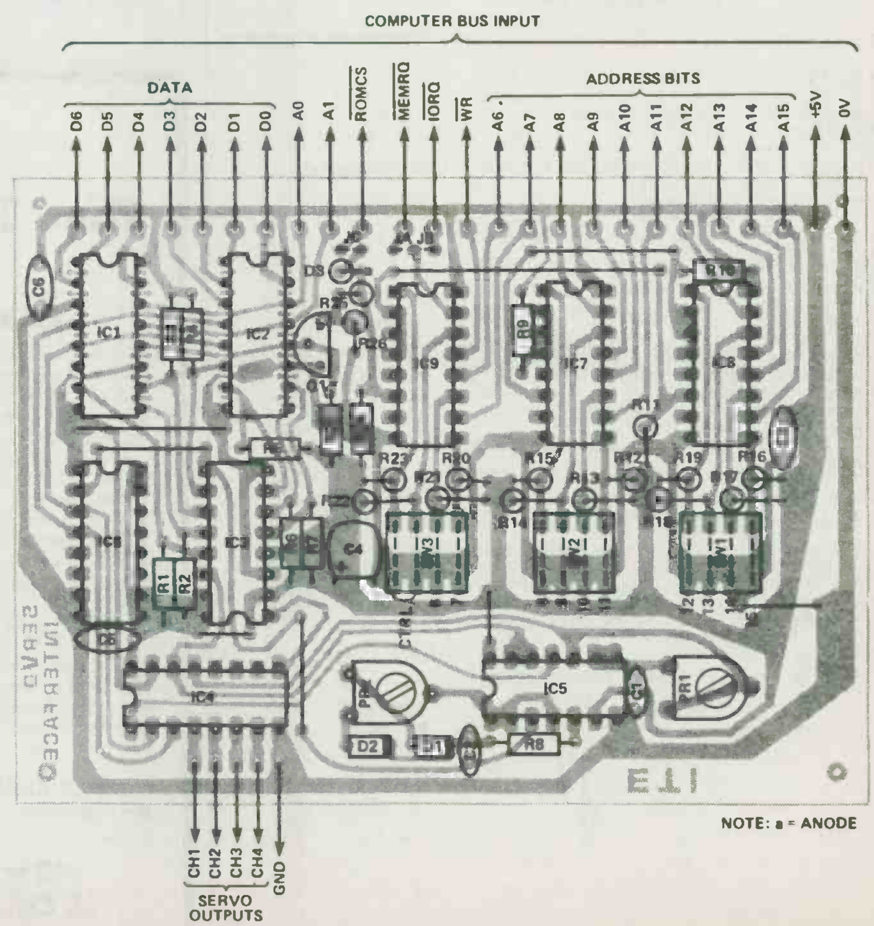


Fig. 1. Overlay for the servo arm interface board.

the instruction would mean: load the A register with the two byte number pq; two into one won't go! To get the number in the A register into the address pq, the instruction in the Z80 set is 32 — **LD (pq), A.**

This mode of addressing need not be restricted to a single register; a Z80 example is 2A — **LD HL, (pa),** where the byte is pq is loaded into L and the byte in pa + 1 is put into H. If you forget which byte goes where, just remember H for high (byte), and L for low; using the DE pair, the high byte will go into register D.

FIRST STEP: divide decimal address by 16

16 ⟌30,000 = 1,875 remainder 0 = 0 x units

SECOND STEP: divide this by 16

16 ⟌1,875 = 117 remainder 3 = 3 x 16

THIRD STEP: divide again by 16

16 ⟌117 = 7 remainder 5 = 5 x 16

As the result is less than 16, we stop therefore 30,000 decimal = 7530 hexadecimal

Fig. 8 One way of converting decimal to hex.

Those of you with Sinclair micros may have noticed, in the manual appendix dealing with the character set, the words 'after ED' or 'after CB' etc. This is where a four byte absolute instruction may be found and is explained as follows. The instruction 4B in the Z80 set means **LdC, E,** but after ED means **LD BC, (pq).** Fig. 10 shows how this is used in a program. The use of ED and CB, etc., is very similar in principle to the use of shift keys, where one key with shift has a different function to the unshifted version.

A Direct Extension

This section should explain, in part at least, some of the differences in terminology that I mentioned earlier. In one book I read, the author gave an example of absolute addressing, using 3A — **LD A, (pq)** for the Z80 set. He went on to say that this mode is sometimes called the direct or extended mode. As the 6800 set uses both of those modes I'll give a couple of examples.

In the direct mode, the instruction 96h is concerned with loading the accumulator with the byte held in an address, but there is only one byte used for the address. This is because the high byte of the address is supplied by the computer automatically and the byte is 00. So when the computer meets the instruction 96 FF, it interprets it as meaning **Ld A, (pq),** where pq is 00FF. An example of the extended form from the 6800 set is 87 — **LD (pq), A** where the two bytes pq must be put in by the programmer. As a last example, I'll use the 8085 set; in that set 3A — **Ld A, (pq)** is considered as being in the direct mode.

Now for a little bit more explanation of terminology. That 6800 direct mode example I gave above is sometimes called *zero page addressing,* or sometimes, *abbreviated absolute form.* No matter what it is called, it still works in the manner that I have described. Those of you with a 6502 can use zero page addressing, which simply means the first page (of RAM) runs from addresses 0000 to 00FF. All you have to do as a programmer is specify the low byte of the address from 00 to FF, and the computer adds the 00 automatically, as already explained. Now you can see that it does help to know how your computer has its memory mapped out. A computer that has ROM starting at address 0000 cannot use zero page addressing in the form **Ld (pq), A,** because you cannot write to ROM.

Pop Goes The Weasel

In the instructions that I've already covered, the two bytes, pq, have been used as an address. Later on I will be giving addressing mode using pq as numbers, but for now more explanations. These explanations concern not only what has gone before, but what is yet to come. Firstly, let us recall the stack pointer register, SP, as we'll be looking at this in rather more detail.

As you will recall, the stack is a portion of RAM which the computer reserves for its own use, and, like the variables area, the size can fluctuate. The stack is used to store two byte addresses or numbers, either at the command of the programmer, or as part of a computer controlled sequence. Curiously, the stack is sort of upside down, with the latest piece of information going on top of the one before, which makes for a last in, first out, situation.

To help you understand the stack and the manipulation of pq, I am going to use two single-byte instructions. These are the **PUSH** and **POP**, or **PUSH** and **PULL** instructions. Because pq takes up two bytes push and pop concern register pairs. The Z80 set allows the push and pop of every register pair (see part one of this series) and also allows the A register to be paired with the flags register, F, for this purpose.

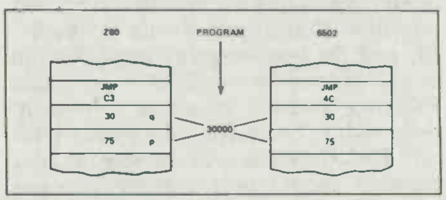


Fig. 9 Absolute jump instructions.

Don't be misled, though: the use of the AF pair allows only A to be loaded (with any number up to FFh), but you can't load the F register.

Using the HL pair to make things clear, the Z80 instruction EF — **PUSH HL** will store the contents of HL on the stack. See Fig. 10 while following the explanation. Supposing HL contained the number or address 30,000d or 7530h before the instruction E5 — **PUSH HL** was encountered by the program. On reaching E5 the stack pointer will be pointing to the next empty address available on the stack. First the low byte in L is copied into that address. The stack pointer, sp, is then decremented (by one) and the high byte in H is copied into the new address pointed to by SP. The register is decremented again so that it is now pointing to the next available address.

The reverse happens on the pop instruction which, in the Z80 set is E1 — **POP HL.** This instruction will increment SP (by 1), the byte in the new address is copied into H; SP is incremented again, and the next byte goes into L. Now SP is pointing to the next available address on the stack.

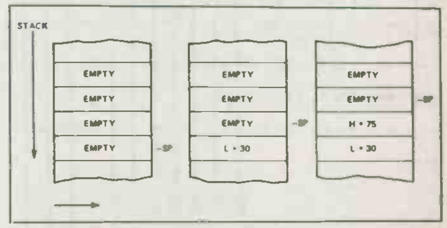
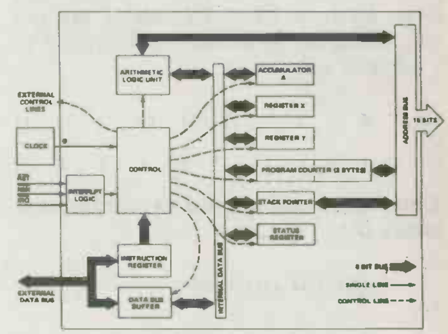


Fig. 10 Pushing the number 7530 hex in the HL pair.

The 6502 set allows the pushing and popping of only two single registers onto the stack. These are the accumulator and the status register; for example, 48 — **PHA** copies the contents of the accumulator onto the stack. Notice that I keep saying copies onto the stack: this is to emphasise the fact that pushing does not destroy the contents of registers.



The final couple of points will be of interest to Z80 users mainly. If you have pushed a sequence of register pairs onto the stack, before popping them off again remember that last in, first out rule. Having said that, what happens if you push HL then pop DE? With that question, we'll leave you next month.

ETI

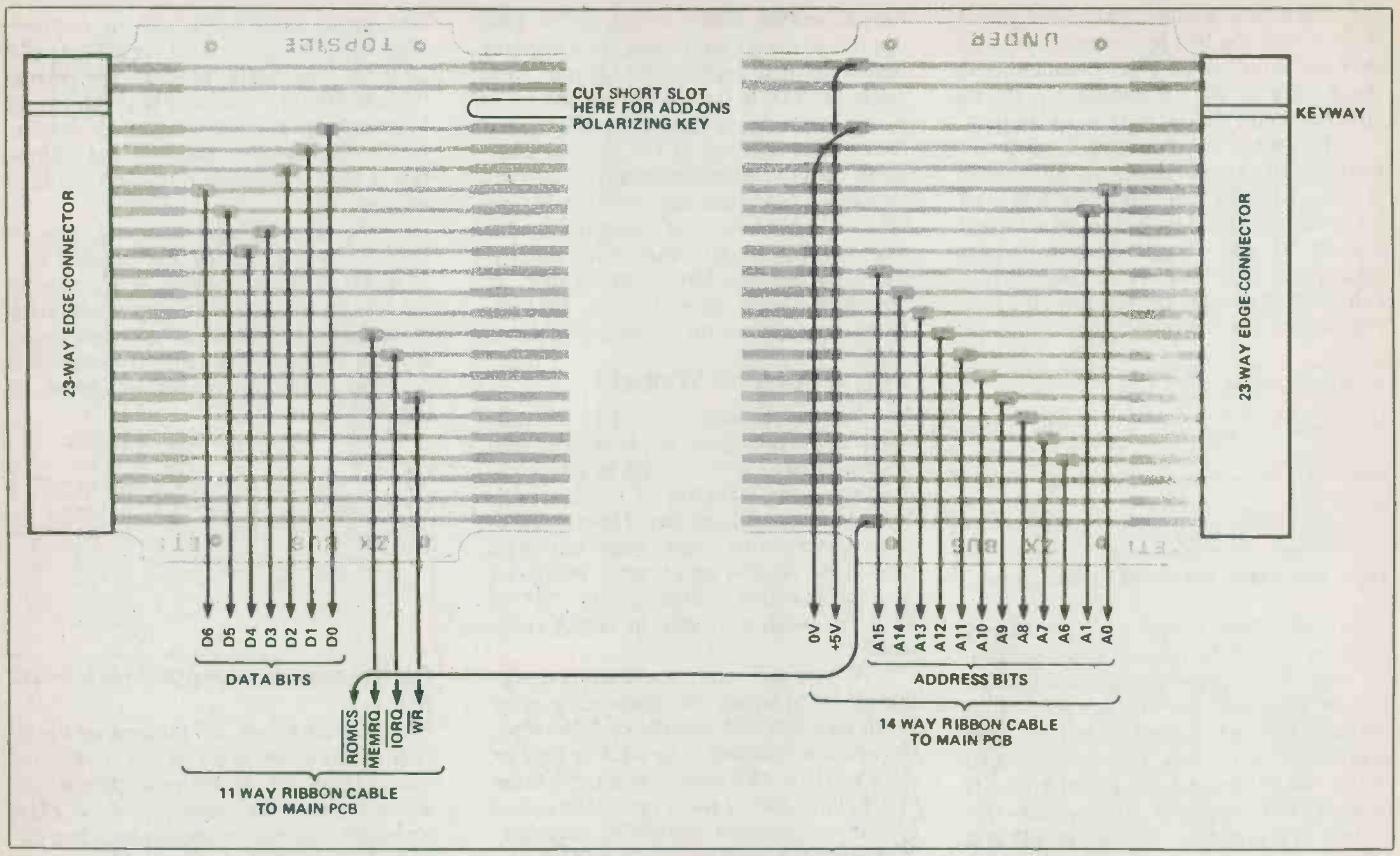


Fig. 2. Overlay for the edge connector PCB; this will allow the use of other peripherals. Rib-bon cable with 14 ways and 11 ways is used, although one of the wires from the 11-way piece is soldered to the other side of the PCB as shown.

As an example, the switches on the PCB could be set to the following logic levels (address bits 2,3,4, and 5 are uncommitted, so the decoder will respond to a range of addresses):

switch	6	7	8	9	10	11	12	13	14	15
logic level	1	1	1	1	1	1	1	1	0	0

Thus servo 1 will respond to an address in binary of:

0011 1111 1111 1100
or 3 F F C

in hexadecimal. In decimal this gives servo addresses of:

Servo 1 POKE 16380, X
Servo 2 POKE 16381, X
Servo 3 POKE 16382, X
Servo 4 POKE 16383, X

The servo 4 location is the highest byte of the second 8K block.

Testing

Once all the cables are wired up, the interface can be tested by plugging in to the Sinclair expansion port. Ensure that the jumper links and IC/address switch combinations are set up, and start with no ICs plugged in. If the computer resets correctly and still seems to work, then the first hurdle is over. Check that the 5 V power rail appears at all the IC sockets and then disconnect the interface to plug in all the ICs. With both presets at mid-travel, turn PR1 45° anti-clockwise and PR2 45° clockwise; this will give a suitable pulse width to start with.

Plug in the interface again, reset the computer, and write zeros (using either the POKE or OUT command) to your chosen servo locations. On checking the servo outputs with a scope the 20 to 25 mS repetition (frame) rate should be observed, and the positive-going pulses should be at their smallest width of about 1 mS. PR2 may be used to adjust the 'minimum' pulse width. To decrease the pulse width, turn PR2 clockwise. All the servo output channels should be producing identical pulse sizes, but with the appropriate phase lag according to the time slot where they occur.

Now, choosing a specific servo channel, observe the pulse output on a scope as the number 17 is written to this channel. The pulse width should shift to be about 2 mS, and this 'maximum' pulse width can be adjusted using PR1. If a servo is at hand it can be connected up as shown in the diagram of Fig. 4, whereupon it should immediately take up the position dictated by the pulse width. Different numbers can now be POKEd to the servo to test a number of pulse positions.

PARTS LIST

Resistors (all ¼W, 5%)

R1-8,25,26	10k
R9-23,27	3k3
R24	470R

Potentiometers

PR1	47k miniature horizontal preset
PR2	470k miniature horizontal preset

Capacitors

C1	470p ceramic
C2,3,6	10n ceramic
C4	47u 16 V tantalum
C5	100n ceramic

Semiconductors

IC1,2	74LS170
IC3	40103B
IC4	4555B
IC5	4093B
IC6	4520B
IC7-9	74LS85
Q1	2N5210
D1-3	1N4148

Miscellaneous

SW1-3	4-way single-pole DIL switches (wire links can be used)

PCBs; 0.1" 23-way double-sided edge connector; 5-way Molex connector socket; Veropins; case for interface, size 146x91x23 mm; case for plug — general purpose Vero potting box; 14 and 11-way ribbon cable.

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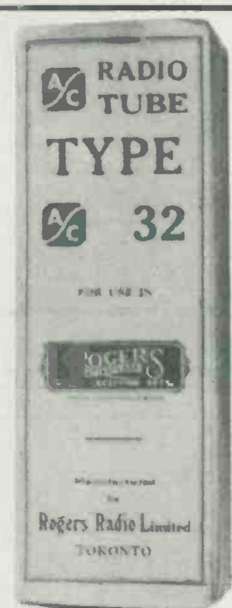

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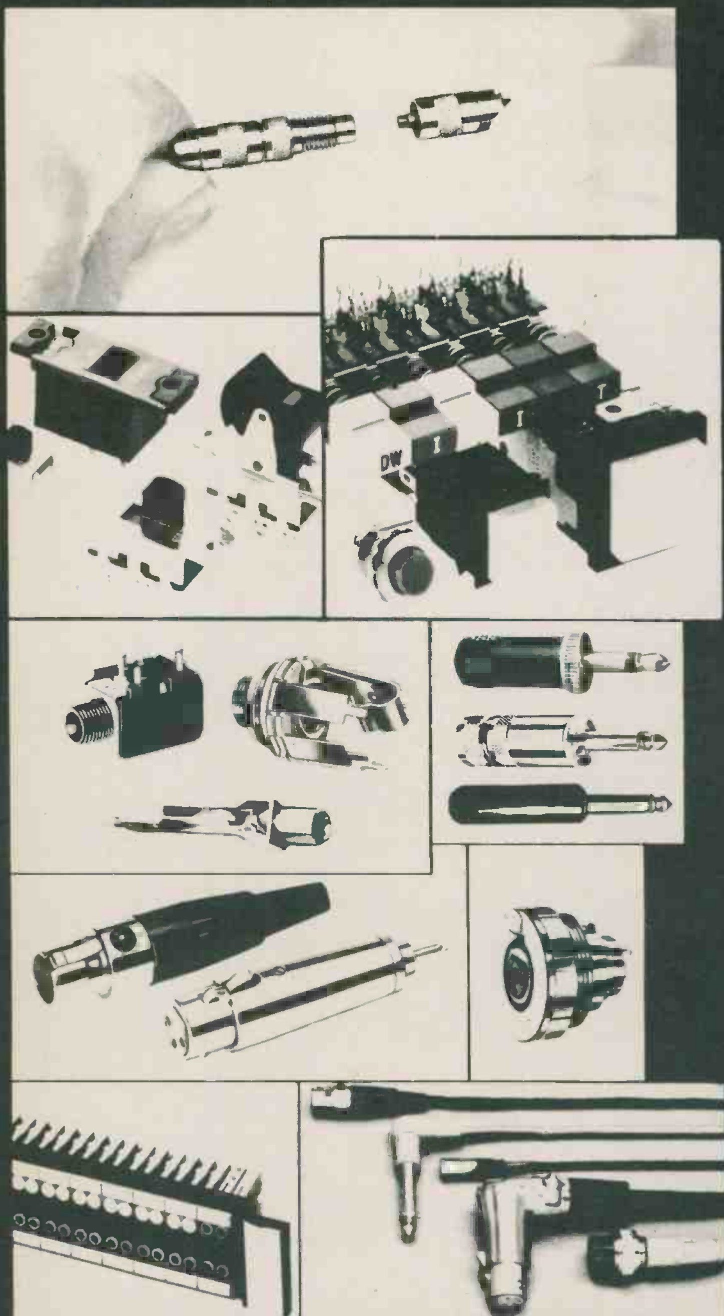

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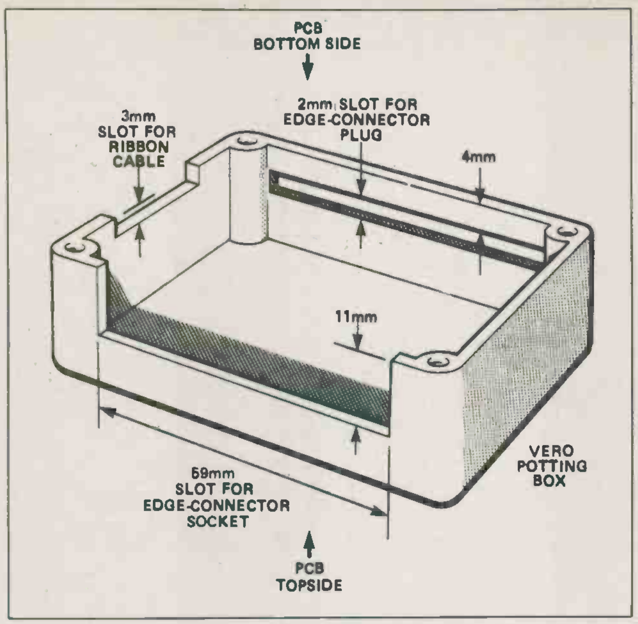


Fig. 3. Construction of the edge connector box.

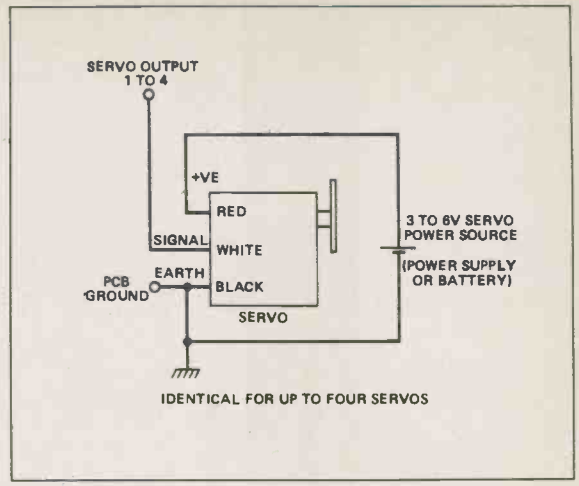


Fig. 4. Servo connections.

HOW IT WORKS

Timing Generator

Each servo requires a pulse width variable from between 1 to 2mS and repeated every 20mS. The servo's position corresponds to the width of this pulse. Our system uses a seven bit binary number to represent this position which in turn controls the pulse generation. One position value is stored in an eight bit register for each servo channel. The data in these four registers is taken sequentially and used to generate a pulse of proportional width using a presettable down counter. The particular data for each channel is addressed by a two bit counter, which also routes the resultant pulse, via a demultiplexer, to the appropriate servo. An asymmetric clock, which triggers the two bit channel counter, also initiates the pulse generation. It has a full period of 5mS; thus all four servo channels are dealt with in 20mS to give the required frame rate. The timing diagram is shown in Fig. 8.

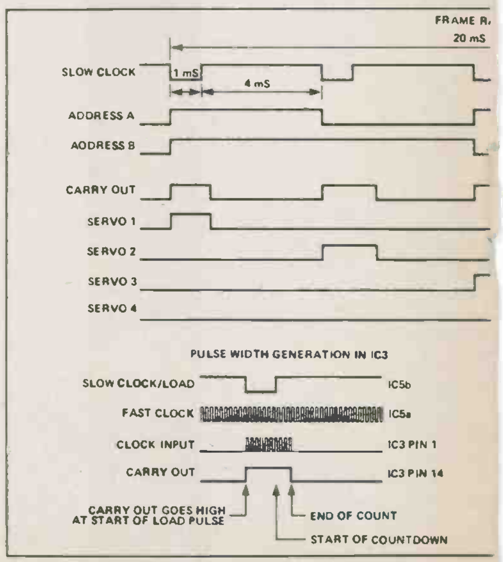
The detailed circuit diagram is shown in Fig. 7. The heart of this circuit is the eight bit binary down counter IC3, and its associated loading clock built around IC5b,c. Counter IC3 has eight preset inputs for determining the count start position. Input J0 is taken high for reasons of stability; we shall assume the other seven are set up to some binary value (this may be between 0 and 127). The clock input on pin 1 of IC3 is fed from a fast clock via an unusual form of AND gate (one half of decoder IC4 provides an AND function). The fast clock uses IC5a as a standard Schmitt trigger oscillator, its exact frequency being adjustable by PR1. The CARRY OUT signal on pin 14 of IC3 provides the servo pulse signals and is normally high during counting, but goes low when the count reaches zero. Since it's tied to one input of the AND gate, it disables the clock as zero is reached to prevent further counting. The CARRY OUT Line is also sent to the decoder IC4 where the pulses are distributed to their corresponding servo channels.

CARRY OUT goes high again for another pulse when the ASYNC LOAD input on pin 9 is taken low. This also loads the binary value on the preset inputs into the counter, though counting will not commence until the LOAD input returns high. The LOAD pulses from the slow clock have an asymmetric duty cycle which remains low for a period of 1mS, thus determining the minimum servo pulse width. When the ASYNC LOAD returns high IC3 is released to count towards zero. CARRY OUT switches low after a time determined by the fast clock and the preset binary value, thus terminating the pulse.

The allowable variation in servo pulse width for a given clock frequency, say 250 kHz, will thus be determined by the binary value. At a value of zero, it will be the minimum 1mS dictated by the LOAD pulse. When the binary input is 127 (taking into account the J0 preset input, it's actually 255), the pulse width will be the maximum of 1mS + (255x4uS). The inset timing diagram of Fig. 8 illustrates the pulse generation. NAND gates IC5b and c (forming the slow clock), are configured as a standard CMOS astable with variable duty cycle. The overall frequency is set by C2 and the total value of the preset PR2; while D1 and D2 separate the charge and discharge paths through each arm of the preset to alter the duty cycle independently of frequency (1mS high and 4mS low). The minimum pulse size for binary zero can thus be altered from 1mS by adjusting the duty cycle with PR2. The maximum pulse at binary 127 depends on the fast clock frequency and may be adjusted with PR1.

The two-bit binary counter formed from IC6, addresses the servo whose particular pulse is being generated at any given moment. IC6 is a dual four-bit counter (the 4520). The first two bits of one counter, pins 3 and 4, are used as the A and B addresses for the pulse selection. Counting is clocked on the negative-going edge of the load pulse by using the clock enable input on pin 2 and tying the clock input to ground. These repeating address states perform two functions: they select one of four registers containing the servo position data word and, they also select one path of the demultiplexer IC4 to route the pulse to its associated servo. Thus four servo timing slots occur in the 20mS frame period.

IC1 and 2 are the servo position data registers (74LS170s). Each IC contains four 4-bit words of memory, and they are simply connected in parallel to give four 7-bit words. These registers are special in that



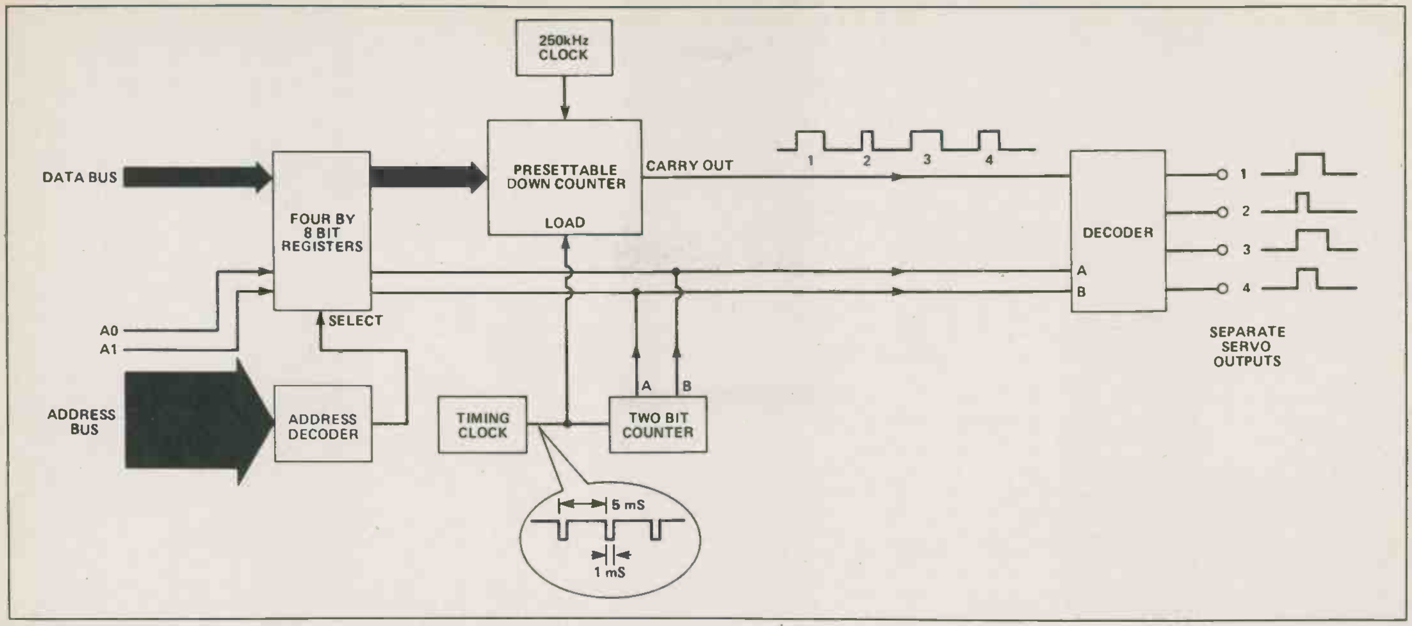
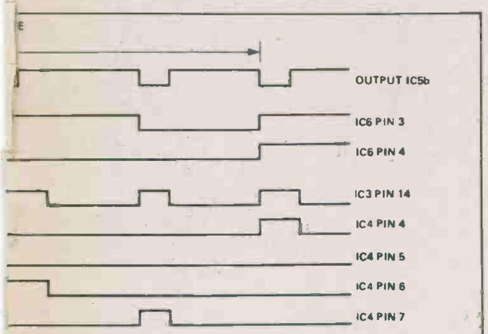


Fig. 5. **Block diagram of the ETI Servo Interface.**

they contain separate read and write address decoding for each word, allowing simultaneous reading and writing. The data inputs (on pins 15,1,2 and 3 and connected to the computer's data bus) are also separate from the data outputs (on pins 10,9,7, and 6) that are sent to the timing generator. Thus the timing generator can read the four registers in turn, by scanning through the read addresses on pins 4 and 5, while at the same time the computer can address any register via the write addresses on pins 13 and 14, and write new data into this location with a 'memory write' instruction. The write addresses are wired to the computer's least significant address bus bits, so the registers will simply appear as consecutive memory locations ('write only' memory). Direct memory mapping is thus achieved between the computer and the servo positioning.



Timing diagram for the servo interface.

The READ ENABLE input on pin 11 (active low) is grounded to allow permanent read access for the timing generator. The WRITE ENABLE input on pin 12 is driven from the address decoder output. Thus, the registers will only 'see' the computer's data bus when the interface is specifically addressed by the microprocessor for a memory write operation.

Capacitors C3,C4 and C5 are included across the supply lines providing the requisite TTL supply decoupling.

Address Decoder

The block diagram of Fig. 5 gives an overall view of the servo interface system. The address decoder block can be considered as essentially separate from the main timing generator; its circuit is shown separately in Fig. 6. The address decoder merely allows the computer to send information to the timing generator. It detects when the computer outputs an address that corresponds to its own address, and then enables the servo position registers, so allowing them to be written to from the data bus. Certain control lines from the microprocessor are also gated into the address decoding so that the registers will not be enabled unless the computer is specifically writing to memory.

The decoder is built from a cascaded arrangement of identical four-bit TTL comparators, IC7,8 and 9. Each comparator compares a binary word on the A inputs to that set up on the B inputs. If the two words are the same, then the A = B output on pin 6 goes high, so long as the A = B input is also high. The A = B inputs are connected to the A = B outputs of the preceding stages, to give a total of 12 bits of comparison. The A inputs go directly to the most significant address bus bits and two control lines, while the B inputs are set by links or switches that tie the TTL inputs to ground when closed. Pull-up resistors R12-23 ensure a logic high input when these switches are open. One, two or all three of the comparator stages may be used on the PCB depending on the application. Resistors R10 and R11 ensure that the A = B inputs are kept high if the preceding stages are not used. With the control line arrangement shown on the circuit diagram, (SW3c,d must be closed to suit Z80 control signals), we are left with 10 lines for the address bits. Ten bits will decode a 16 bit address space into 64-byte blocks as the memory map diagram in Fig. 4 illustrates. This will usually be quite adequate since the switches can set this block anywhere in memory.

To summarize, when the address bits and control lines all correspond to the logic levels set on the switches, then the A = B output goes high. This output is buffered and inverted by transistor Q1 to provide the WR ENABLE output for the timing generator. For Sinclair users, it is also taken via D3 and a jumper link to the ROM chip select line (ROMCS). If this line is logic high, the Sinclair 8K ROM is switched off; when IC9's output is logic low, the diode allows the ROM to be selected by the ZX81 as necessary. The 8K ROM is not fully decoded on the ZX81, and 'echoes' of it appear across the 64K address space. It is often useful to place the interface at an address within one of these echoes and the jumper link achieves this by de-selecting the Sinclair ROM when the interface is addressed.

Jumper link Jb selects the MREQ control line for memory-mapped I/O on the ZX81. Since all the address and control line inputs are equivalent, they could be arranged in an arbitrary order with any mix of address bits and control signals monitored for any logic pattern.

continued on page 68

continued from page 10

New manufacturing technologies for improved productivity and product quality will highlight TORONTO '84, the third SME Tool & Manufacturing Engineering Conference and Exposition. Slated for October 2-4 at the Toronto International Centre, the event is sponsored by the Society of Manufacturing Engineers (SME) and produced and managed by Hugh F. Macgregor and Associates, 360 Consumers Road, Willowdale, Ontario M2J 1P8.

Four workshops and three technical sessions focusing on new manufacturing techniques in dimensioning and tolerancing, EDM, material handling analysis, jigs and fixtures, robot systems, and deburring make up the conference announced today by SME. Running concurrently with the conference, the exposition will feature demonstrations of advanced machine tools, automated production systems, and a wide range of metalworking equipment, tooling and accessories. More than 175 equipment builders and distributors are expected to participate, SME said. Show hours are noon to 9 p.m. Tuesday and Wednesday, October 2 and 3 and noon to 6 p.m. Thrusday, October 4.

In our June issue we published A Computer Output Driver circuit in the Circuit Supplement feature, but for some strange and mysterious reason, unknown to the likes of humans, the parts list was omitted. Our deepest apologies to those of you who lost countless hours of precious sleep, not to mention great quantities of hair. Here is the new and improved parts list:

IC1	74LS02
IC2	74LS00
IC3, IC4	74LS374
IC5	74LS86
Q1-16	2N5551
Q17-32	2N4923, 2N6123 etc.
D1-16	1N4002, 1N4004 etc.

LOOSE ENDS

The regulator IC for the Modem Auto-Answer Project in the June issue is incorrectly listed in the parts list as a 7405. It should read 7805. Il should read 2 x 4N35.

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Phone Checker
by David Dempster

In the United States, they are making life a little easier for consumers — at least for those who are having problems with their telephones. They are doing it by making it possible for the consumer to test his or her own portable equipment.

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continued on page 66

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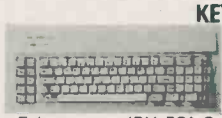

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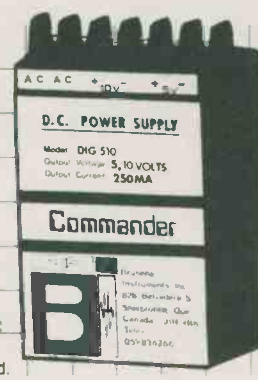

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Circle No. 6 on Reader Service Card

continued from page 64

for your information

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NEC Electronics has announced the development of a CMOS gate array containing 11,000 gates; the previous industry record was 8,000 gates. It's a semi-custom chip; logic paths can be tailored to suit the application. The power consumption is 20mW, and the speed is 2 nS per gate.

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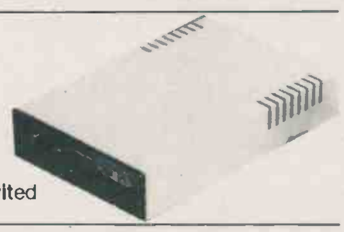

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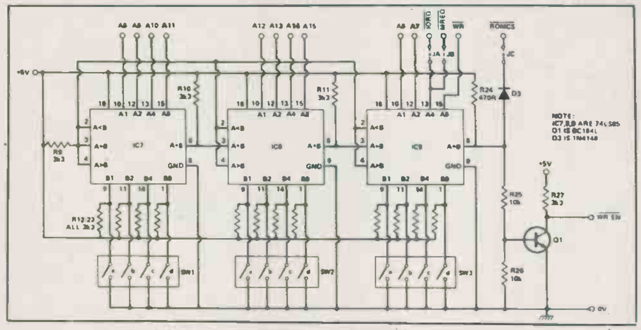
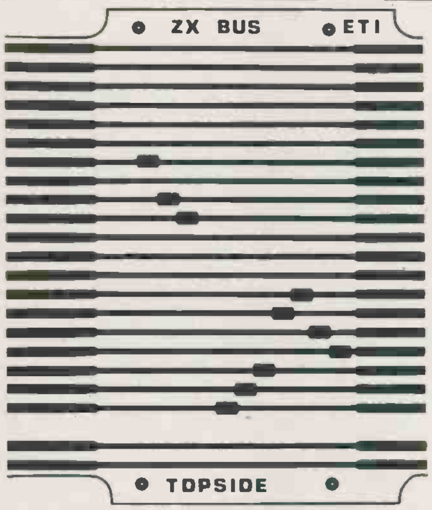
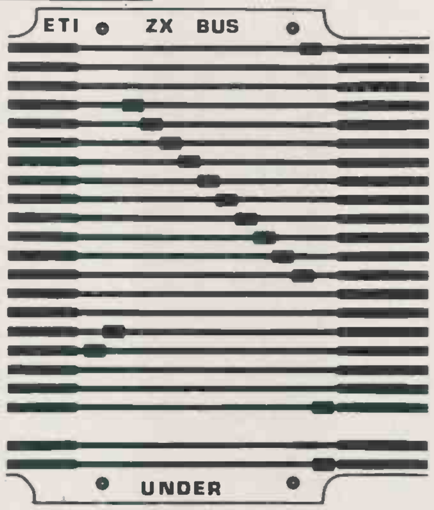
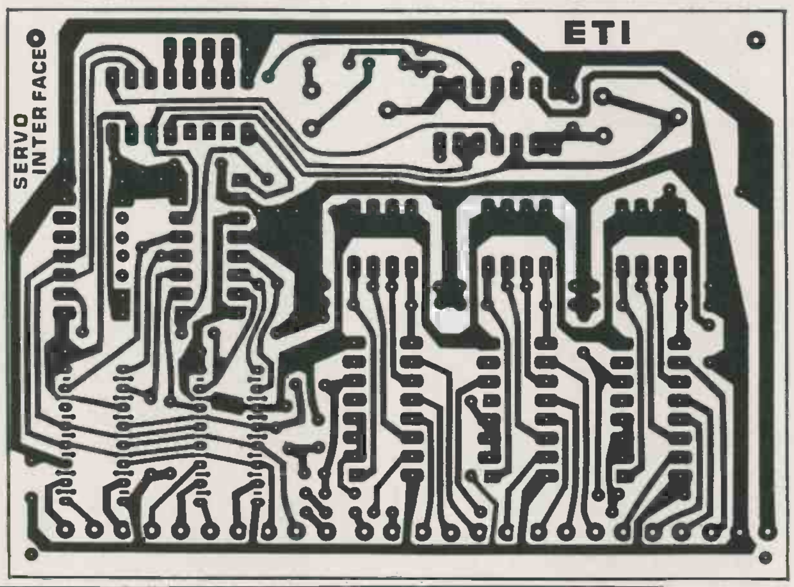


Fig. 6. Circuit diagram of the address decoder block.







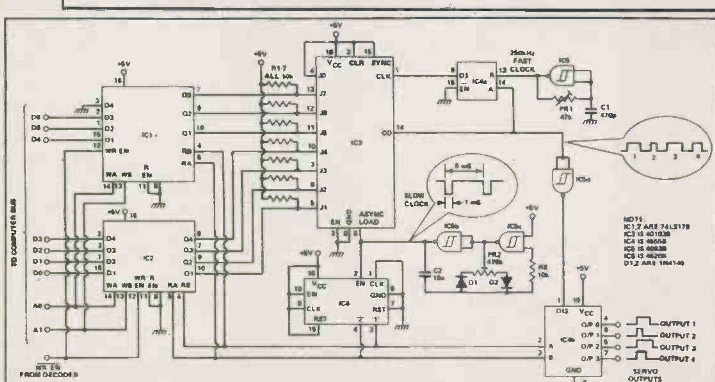


Fig. 7. Circuit diagram of the timing generator.

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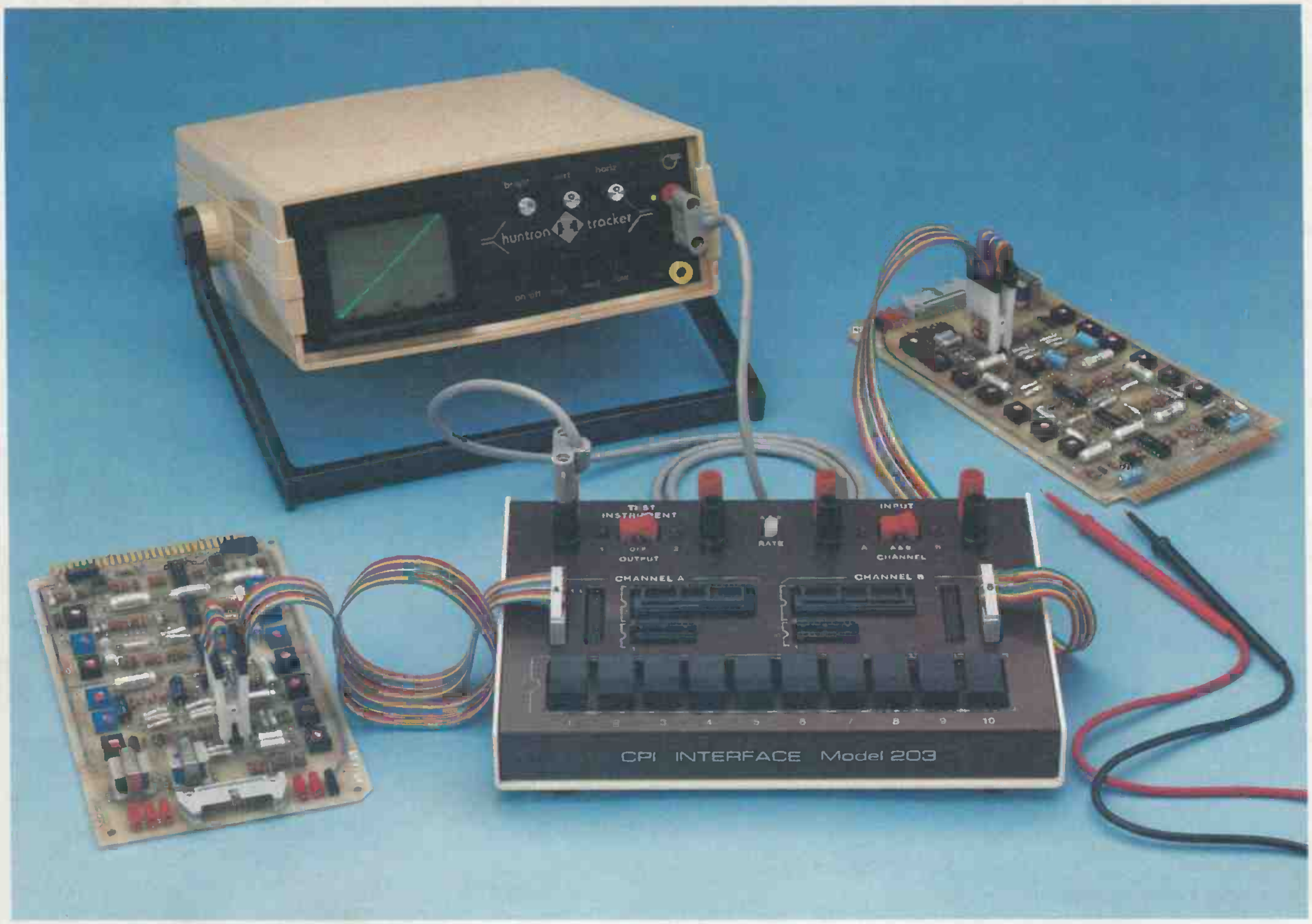

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