Electronics Today

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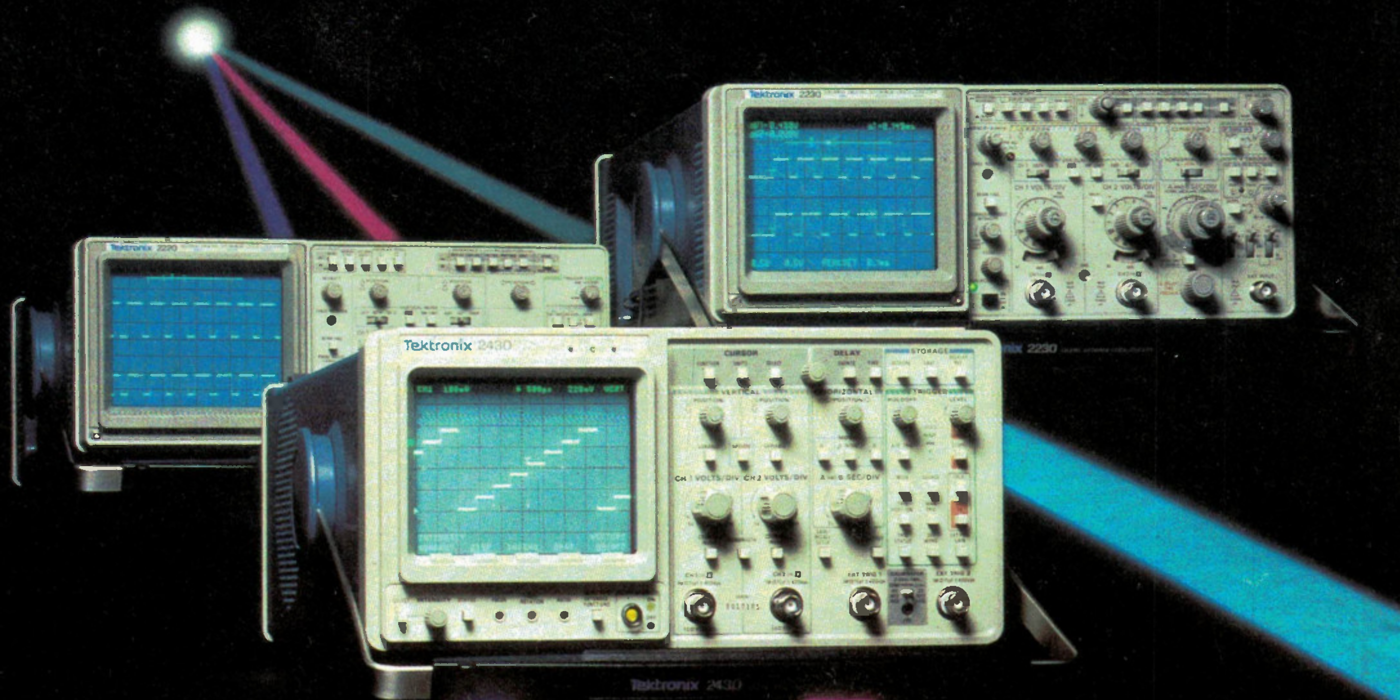
MM70924

July 1986

Canada's Magazine for Electronics & Computing Enthusiasts



Test Equipment Special!

What's new for the testbench

Stereo TV

How It Works

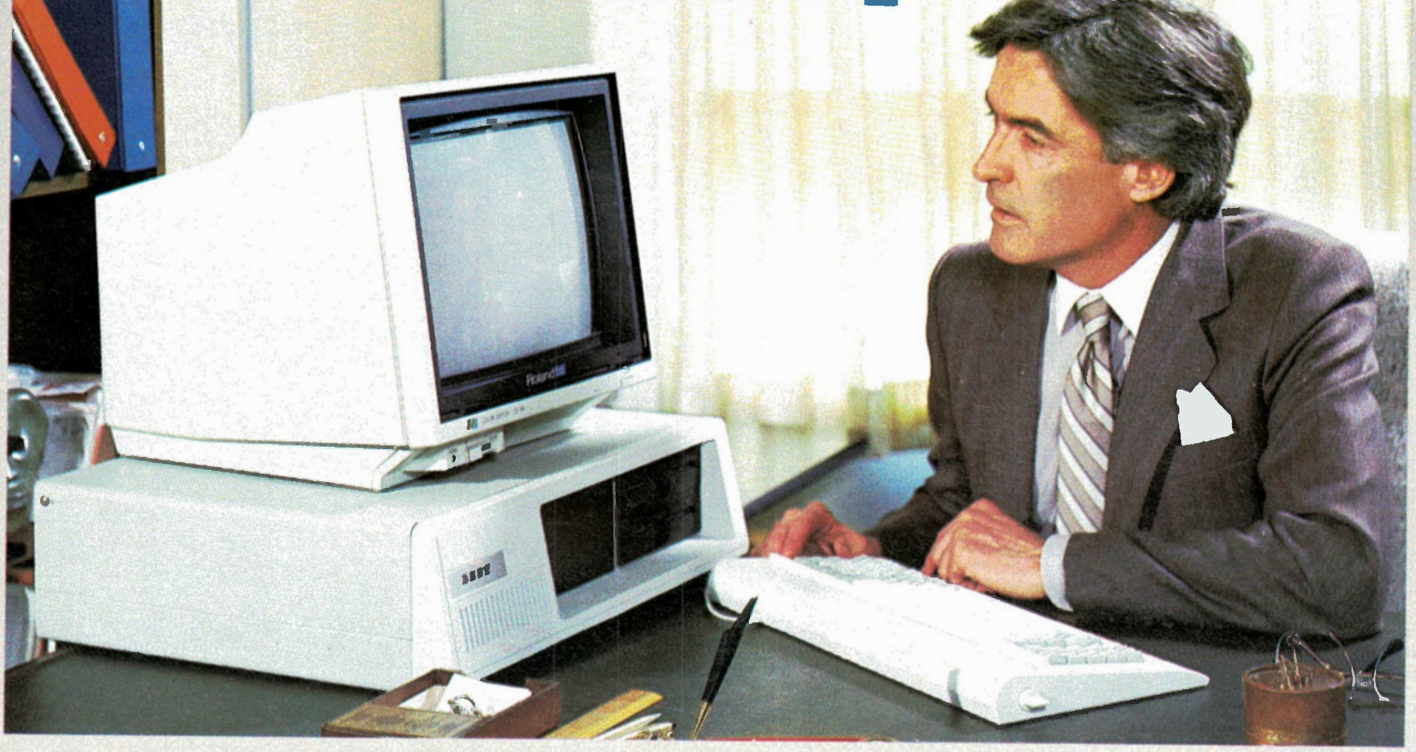
Bit Detector Project

Finding stray bytes

The EEMAC
ce Report

BEST Computers

Made in Canada, IBM PC, XT & AT Compatible



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- Flip top case
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Eugen Hutka
President

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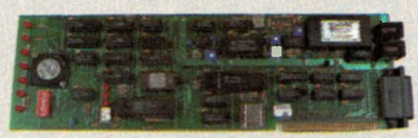

Board not exactly as illustrated.

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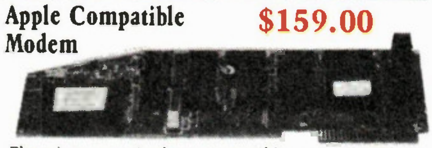

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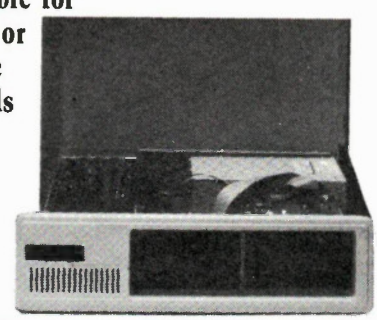

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Highlighting our Test Equipment Special, our cover photograph this month was provided courtesy of Tektronix Canada Ltd.

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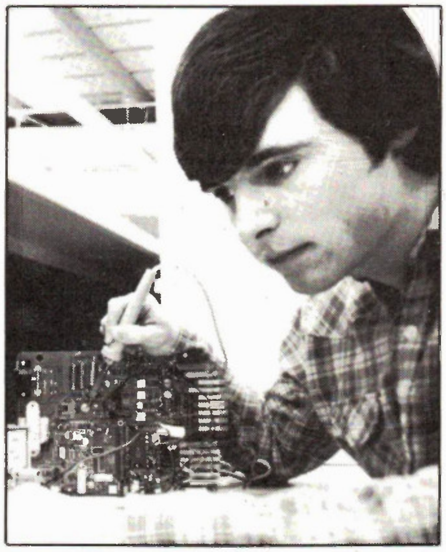

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Features

Projects

Series

Columns and Information

For Your Information

Advertisers' Index

Sales of home telephones will reach a stable annual growth of eight percent per year, creating a North American market of $4.2 billion by 1990, according to a release by a NY research firm called Packaged Facts. There was a huge growth in home phones over the last few years, largely due to the breakup of AT&T, the major supplier of telephone equipment. Most of the brands introduced soon after the breakup came and went quickly as consumers discovered the poor quality of the low-cost phones.

New Signal Conditioners

The new Daytronic 3000 series of stand-alone, single-channel signal-conditioners and digital indicators produce high-level analog output; accomodating virtually all types of transducers and signal sources encountered in electromechanical testing and control operations.

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Circle No. 52 on Reader Service Card.

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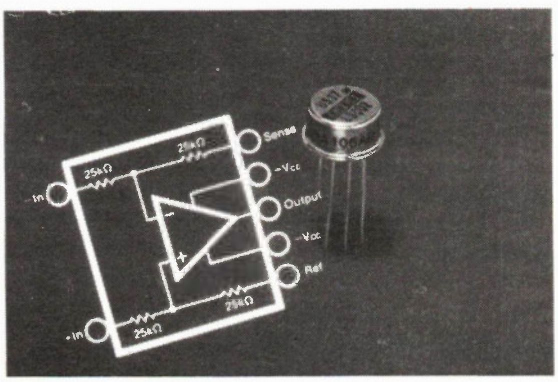

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Contact Mrs. Rose Monk, Allan Crawford Associates Ltd., System Products Division, 5835 Coopers Ave., Mississauga, Ont., L4Z 1Y2. (416) 890-2010.

Circle No. 51 on Reader Service Card.

Scientists at the Institute for Perception Research, a joint research organization in the Netherlands run by Philips Research and Eindhoven University of Technology, are working toward a more natural-sounding synthetic speech. The usual method of making computers speak is to put words together from phonemes, or basic units of speech sound. The resulting sound is somewhat artificial because of the difficulty in joining the phonemes smoothly; in natural speech, each phoneme is subtly influenced by its neighbours. One way out of this is to compose speech from diphones, or transitions between successive phonemes. These can be automatically extracted from natural speech and stored in computer memory. When retrieved and reconstructed, the diphones produce better quality and intelligibility.

TRANSFER 5 BILLION BITS/SECOND

The transfer of five billion bits per second on a data communication local area network has been achieved with the aid of fibre-optic methods by researchers at the Chalmers Institute of Technology in Gothenburg, Sweden. Within a few years, it is stated, there will be a great need for transfer speeds in this range in order to facilitate the exchange of information between "electronic" offices, automated industries, global data banks and satellites, for instance.

Five billion bits per second is thought to be one hundred times faster than the fastest transfer time hitherto obtained. This would make it possible to transfer the entire text of the Encyclopaedia Britannica between two word processors in different locations in less than one-third of a second, or connect 50,000 computers via a common cable without any loss of transfer speed.

High-speed data transfer on local area networks is a relatively new science, which makes possible communication between computers, word processors, automatic industrial units., via a common cable in small, limited geographicca areas such as an industrial plant or university.

- David Dempster

The recommended cures: Canadian companies must unite in the development of base computer technologies, a major commercial microchip foundry must be established in Canada, and computer technology must be seen as a strategic industry, all-important to our survival as an industrial power.

The recommendations aren't surprising, coming from a manufacturer of computers, but it's difficult to say that he isn't right.

The president of Control Data Canada, T.S. Dudley Allan, told a meeting of Canadian aerospace companies that Canada has a "pretend" electronics industry. Despite its achievements, he says, we're dabblers, doing a little here, a little there. Not many companies use computer-aided technologies but are waiting to see what will happen. Another problem is that Canada is dependent on the US and Japan for computer microchips.

Continued on page 8

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While every effort has been made to ensure that all constructional projects referred to in this magazine will operate as indicated efficiently and properly and that all necessary components are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in the design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in design of any such project as aforesaid.

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Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. Electronics Today 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.

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

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

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NEW SOLID STATE INSTRUMENTATION HELPS SCIENTISTS STUDY LIGHTNING

Scientists have undertaken an intensive research project this summer to learn more about how thunderstorms spawn lightning, a phenomenon that causes an estimated $260 million (U.S.) in property damage and kills or injures about 350 persons a year in the U.S. each year, according to a recent report from the National Science Foundation (NSF). The problem is considered so important that hundreds of meteorologists and atmospheric scientists from all parts of the world held a six-day conference in June to discuss various aspects of atmospheric electricity.

The research project, six weeks long, started July 14th in New Mexico and involved at least 19 research groups from nine institutions, including five universities. Funded by the NSF's Division of Atmospheric Sciences, the study used a jet airplane, two sailplanes, at least 20 balloon flights, six radars and several rockets. New Mexico Institute of Mining and Technology's Langmuir Laboratory for Atmospheric Research was the site for the project, a complex of buildings and instruments atop the 10,000-foot South Baldy Peak in the Magdalena Mountains near Socorro.

Dr. William P. Winn, a New Mexico Tech physicist and one of the organizers of the project, said the site was especially good for such experiments because the mountains heat the surrounding air at high altitudes, causing convection and the development of electrically active and isolated thunderstorms over the laboratory.

How clouds become electrified has remained a puzzle and the scientists want answers. They think the presence of ice and water particles play an important role, but details of necessary interactions remain unresolved. Efforts to learn about lightning have been going on for some time, according to Dr. Winn. However, the availability of light-weight solid-state integrated circuits open a lot of possibilities for better instrumentation which means better data, he said. Many new instruments have microcomputers built in, making some kinds of measurements of storms possible today that were not economically feasible five years ago.

The researchers hope to understand the role precipitation particles such as rain, hail and ice play in generating electric charges in thunderclouds. They also hope to learn more about winds and air movements which carry such charges from one place to another. Six radars were to be used to get information about the motions of water and ice particles. And the jet was slated to fly around storms to measure the flow of air into and out of the clouds as they develop. One sailplane had a special camera for photographing precipitation particles and both sailplanes were equipped with electric field meters.

Balloon-borne measurements of electric fields also were made. Small rockets trailing grounded wires were launched to trigger lightning when conditions appeared right. One of six radars used was designed and developed by New Mexico Tech scientists to scan an entire thunderstorm every 20 seconds, a rate about 10 times faster than ordinary radars. Its purpose-- to help sort out the relationships between electric charge, precipitation and lightning.

Also planned to be used was a unique instrument called a very high frequency interferometer to provide a three-dimensional "x-ray" view of the lightning channels within a thunderstorm cloud.

AVALANCHE SYSTEM DEVELOPED

An electronic avalanche rescue system for saving lives of mountaineers and downhill skiers buried in snow has been developed by researchers at the Royal Institute of Technology, Stockholm. Called Recco, and marketed by Recco Co., also of Stockholm, it consists of self-adhesive stickers which are attached to each ski boot. These stickers reflect microwave signals emitted from a search antenna used by the rescue team.

How effective is the system in deep snow? According to the developers, the signals penetrate through 10 meters of snow and are clearly reflected by the stickers and pin-pointed by the rescuers. The stickers, which require no energy source, feature a miniature antenna and a diode, harmless electronic components. An alternative version of the sticker can be sewn into trousers, this model being suitable for ski touring. The detection equipment includes a transmitter and receiver (carried on a packframe if the rescue team is land-based) weighing about 12 kg, headphones, and a hand-held scanning antenna. When the latter is pointed at the avalanche victim's reflector sticker the rescuer hears a high-pitched tone in his headphones.

Avalanche victims can be located without difficulty, it is claimed, with an accuracy of 0-30 cm. Depending on outside temperatures, the detection equipment operates for up to two hours with fully-charged batteries. Batteries can be replaced in less than a minute.

Persons located under an avalanche within 10 minutes have an 80 percent chance of survival, it is stated. After two hours, their chances of survival are only 20 percent; thus, rapid location is of the utmost importance. In this respect, the Recco system is best utilized by a helicopter team.

DATA HIGHWAY AT CHALK RIVER

At Chalk River Nuclear Laboratories, Chalk River, Ontario, a task force has been set up to overcome a communications problem created by the incompatibility of various disk formats. In that, they are not alone; but they are doing something about it. This incompatibility limits the efficient use of their word processors because text prepared on one machine can only be read by, edited or updated on another machine of the same make. This problem is further complicated by the fact that facilities to transfer text from one operator to another are virtually non-existent.

As a result, the Electronics branch of CRNL receives frequent requests from staff to reformat disks or transfer technical information. However, there is hope on the horizon. The task force, composed of Gerry Lynch, Electronics branch, and Jim O'Byrne, Office Services branch, has implemented a pilot text transfer system. For a six month period secretaries will gather data for the task force to get a better idea of CRNL's requirements for a permanent system in the future. The pilot system uses the newly-installed INTRAN CATV cables as a "data highway" to connect the Computing Centre, five AES and MICOM word processors and the typesetter in Printing Services section. Secretarial staff participating in the test are now able to transfer text to each other as well as off-site via the AES communication link. In addition, Bell Canada's DataPac System offers an alternate route outside through the INTRAN cable and the Computing Centre.

"We've recognized the problems caused by the lack of communication between different word processors for some time," says Gerry Lynch. The pilot system uses existing hardware and technology and overcomes the lack of standardization in internal storage of text by using international standards for data communication. Word processors involved have required only minimum modifications to be compatible with the network. To get a better idea of how the system operates in actual office situations, it is being used by secretarial staff rather than technical personnel. Gerry Lynch says that the main aim of the experiment is to discover appropriate specifications and practical guidelines for establishing a permanent text transfer system at CRNL in the future.

It was the responsibility of George Gilks and Ed Nicholson of the Electronics branch to get the system operational. Ed Nicholson supervised the installation of the cable connecting buildings and machines, while George Gilks made necessary modifications to enable the word processors to communicate with each other. Secretaries are being trained by George Gilks and he will also give them technical advice during the trial period. It is now possible for secretarial staff to share workloads, store and receive data from the Computing Centre and have easy access to specialized output equipment such as the typesetter. Report from various sources can be assembled by transferring partial texts to one source for final formatting.

Yvonne Rawlingson, Electronics branch secretary, who represents the secretaries involved in the test, has been using the existing system for the past year. According to her, it has been a major time-saver for both secretarial and professional staff.

In the past, monthly highlights for progress reports were typed on different word processors. Because of machine incompatibility, it meant a major retyping job for the branch secretaries and more proofreading for the branch heads. That problem is now history. Now, each secretary transfers her part of the report to Rawlingson's machine and within minutes it's assembled and ready to go. After the trial period the pilot text transfer system will be disassembled. The task force will then make long-term proposals to improve CRNL's interbranch and off-site data communications.

CONSISTENCY METER MEASURES SUSPENSIONS WITH DIODES

From Sweden comes news of a consistency meter which uses light-emitting diodes to transmit infrared pulses for measuring the concentration of particles in suspensions in process industries and water treatment and sewage plants. The developer of the device, Cerlic Controls AB, of Solna, Sweden, has named the instrument the ACM and they state that it can be easily calibrated to measure consistencies from 0.005 percent to 4 percent with extreme accuracy and sensitivity.

It is able to operate for long periods of time with zero due to the absence of mechanical parts and its self-cleaning design. It is claimed that it is unaffected by changes in temperature, velocity and viscosity and because of its versatility, paper mills will be able to build control systems around screens, cleaners and fourdriniers. Said to be highly efficient, yet simple and inexpensive, the ACM consists of a transmitter and a signal processing unit joined by a 10-metre cable. The transmitter, which weighs only 3.5 kilograms, detects particles by means of infrared light generated by diodes. The display on the signal processing unit presents a percentage value that corresponds to the measured consistency. The equipment can measure white water consistency as well as suspended solids in liquors and waste water.

The ACM is said to supercede virtually all other types of consistency meters, both mechanical and optical, within the 4 percent range. The self-cleaning design diminished clogging, even pitch-clogging, giving months of uninterrupted operation under severe working conditions, according to Cerlic.

– David Dempster

Continued on page 13

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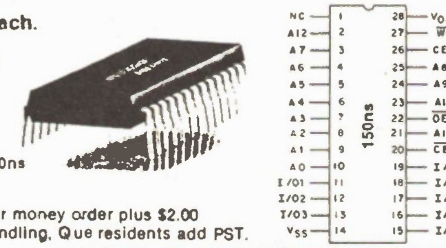

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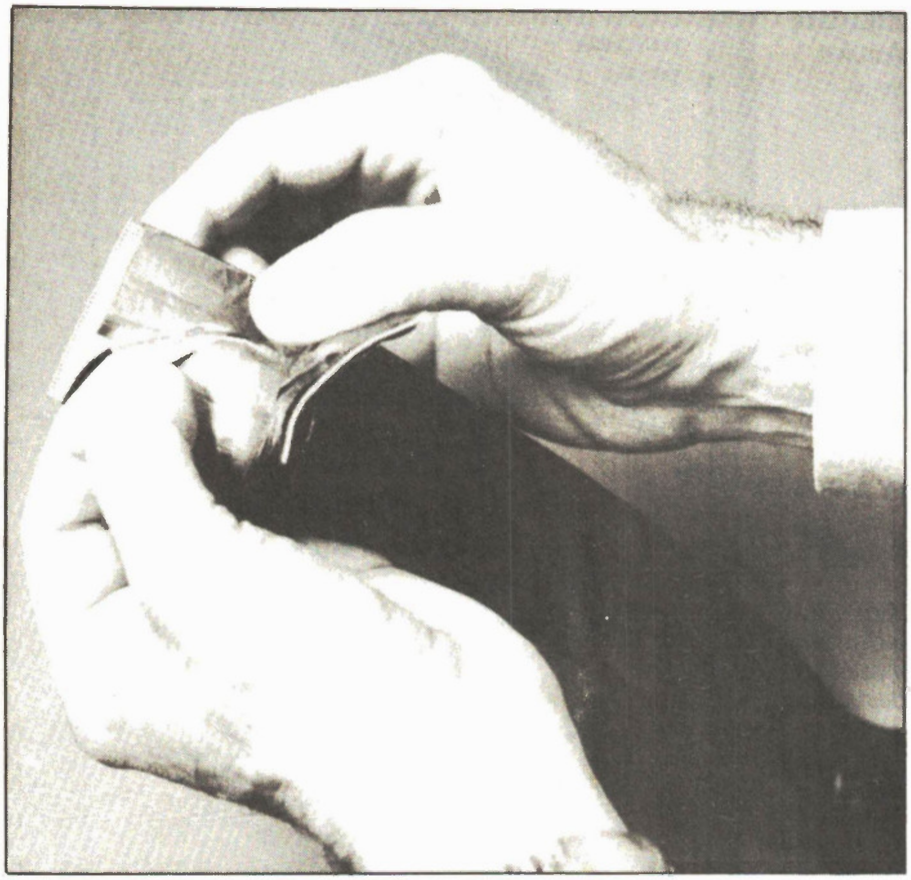
Laminated RF Shielding



By Wayne Morrow, Laminates Division
Keene Corporation, Providence, RI.

IT'S no secret that more and more OEM electronic products need more and better EMI/RFI shielding. And in more and more cases, the material of choice is composite EMI/RFI shielding. That's the foil-coated sheet-type material which is most often applied like wallpaper or contact paper to create the barrier.

The question then becomes: which composite shielding? The decision can get complicated, since there are literally hundreds of choices within the generic category of composite shielding. However, the right choice can make a big difference in the device you're designing. It affects electronic performance, weight and space, FCC compliance and overall serviceability. Also affected are material and manufacturing costs.

This article will discuss the options available, and offer some guidelines for narrowing down the selection. It also will discuss some of the myths that have arisen about EMI/RFI shielding.

Why Composite?

First, however, why shield in the first place, and why go with composite shielding rather than metal sprays or conductive plastics? The answer to the first part isn't as obvious as it sounds. There are always the very obvious FCC type 15 emission regulations to contend with. Less obvious, though, is the performance reliability of your product. Susceptibility of your device to incoming interference could be a bigger problem than emissions, so the design should be looked at from both the emission and suscepti-bility standpoints. In fact, there is some talk about regulations for susceptibility as well as emissions.

Why composites rather than metal sprays? They are cleaner to apply than metal sprays, so they pose no OSHA or EPA issues. And they don't impair structural integrity of the enclosure, as do some conductive plastics or additives. Moreover, there is greater assurance against voids in the barrier due to incomplete spray coverage or resin mixing. However, composites usually require an extra, essentially manual, production step.

A VCR Rescue

Recently, a major VCR manufacturer found that composite EMI can also serve a 'rescue' function. Some 8,000 of its ready-to-ship units were emitting out-of-compliance EMI levels.

The original zinc spray-on shielding inside the enclosure wasn't containing the emissions well enough, so the company was faced with finding a 'fix'. There wasn't enough internal clearance to accommodate overspraying the original coating with another 5 mil of zinc. Also, masking for an after-the-fact spray operation would have been prohibitively expensive. In addition, there was no certainty that more of the same would solve the problem. The VCR manufacturer came to Keene to explore whether some type of composite shielding might work.

At first, they considered a two-part system. First, apply a polyester film, coated on both sides with adhesive. Next, apply copper foil to the film surface.

A one-step, 2-mil foil/adhesive construction was tried, using much less expensive aluminum foil instead of copper. The VCR manufacturer die-cut the shielding to fit the cabinet walls, including all holes and wiring lead entries. This was done on the same dies that trim the original plastic enclosure, and allowed the manufacturer to retrofit the cabinets very inexpensively. Thus, about $1,600,000 worth of 'bad' product was salvaged.

Composite Shielding Choices

There are four basic types, or constructions, of composite EMI shielding. Each can usually be supplied with or without pressure-sensitive adhesive backings:

- adhesive coated foils, usually in copper or aluminum
- foil/film laminates, with or without adhesive
- foil/paper laminates, with or without adhesive
- specialty composites

The specialty composites include:

- foils with special adhesives that are fire retardant, or conductive to provide grounding paths.
- margin laminates, where the foil shield doesn't completely cover the backing

areas. Margin laminates are available with center laminate (two edges free of foil), butt laminate (one edge free of foil) and ship-lap laminate for shielding cylindrical shapes.

Silver, copper, aluminum, zinc, nickel and steel are used as the conductive material. Most requirements, however, are filled by either copper or aluminum.

Performance Characteristics

Since EMI shielding is largely a matter of surface reflection from the conductive foil, theoretically the foil can be as thin as desired; i.e., a consistent, uninterrupted layer one atom thick would fulfill the electronic function.

However, mechanical conditions relative to handling, forming, die-cutting, stress and abrasion resistance usually determine the backing material and total thickness. The backing, for example, electrical grade kraft paper, can be selected to add the necessary thickness, shape retention and other mechanical properties specified.

Environmental factors also influence the choice of backing. For example, polyethylene film backing has good chemical and humidity resistance while electrical grade kraft paper retains its shape after folding, and has some handling 'heft' to it. But where service temperatures exceed 90C, aramid fiber, which withstands temperatures up to 220C, might be the better backing choice.

Aluminum or Copper?

The widespread concern about EMI is relatively new, but EMI shielding already has its myths. The most pernicious one is that copper shielding is always preferable to aluminum. Not so! If you believe copper is 'the only way', you are likely to pass up some good savings in product cost and weight. The fact is, aluminum is perfectly adequate for the vast majority of applications, and costs about two-thirds less than copper. It's also much lighter.

Where the relative costs of the composites are ranked, 0.003-in. thick copper with pressure sensitive adhesive coating is the most expensive, the least expensive being 0.002-in. thick aluminum with pressure sensitive adhesive coating. The striking weight difference between the two materials becomes especially important in avionics.

For instance, 0.003-in. copper shielding (one ounce rolled, annealed copper foil with 0.001-in. adhesive) yields 1.56 sq. yd. per lb. By contrast, the aluminum composite (0.001-in. aluminum foil with 0.001-in. adhesive) yields 5.125 sq. yd. per lb., four times more. One of the lighter-weight aluminum composites (0.00035-in. aluminum foil with 0.0005-in. polyester film for a total thickness of only 0.001-in.) yields 9.637 sq. yd. per lb.

Despite the weight and cost advantages, aluminum-based composite shielding more than fulfills FCC regulation 15J, Class A and Class B.

Aluminum

As indicated in the curves, RF attenuating copper foil is superior to aluminum at lower frequencies, but the gap diminishes at higher frequencies. Moreover, both metals well exceed FCC code requirements (as well as NEMA 101 requirements). In fact, a product may well be over-engineered when copper shielding is specified.

Exception: one situation favoring copper over aluminum is the requirement to solder something to the conductive surface, such as a ground wire.

Copper

Sometimes, copper's superiority may also be important in near-field situations. To understand why, it's important to see how shielding works fundamentally.

Attenuation of radiated interference waves by conductive barrier has three components. The first is reflection by the outer surface of the shielding metal, by far the largest. Next is absorption within the metal layer and, lastly, is re-reflection by the inner surface of the metal. The closer and more powerful the source, the greater the influence of the absorption and re-reflected components.

By nature, copper has proportionately better absorption and re-reflection properties than aluminum. So, where the emitter is powerful and near-field, copper foil does have a slight edge.

Volume Production

With regard to costs, the greater the volume of shielding material required, the more it pays to find the least expensive shielding material that fills requirements. Approach the question with awareness that the entire area of shielding materials is in a state of change. The best solution a year ago may not be the best today.

If the final decision is to specify composite laminate, ascertain that the supplier you contact for advice offers all four basic types of composites. This should include the specialty margin laminates. That way, application engineers at the supplier can be totally objective.

Consider the Source

Before specifying EMI shielding, or even making an inquiry of a supplier, be sure you know these electronic parameters specifically:

• the nature of the interference: the strength, frequency, and relative proportions of electric fields and magnetic fields (impedance);

the proximity of the emitter to the shielding (near field vs far field).

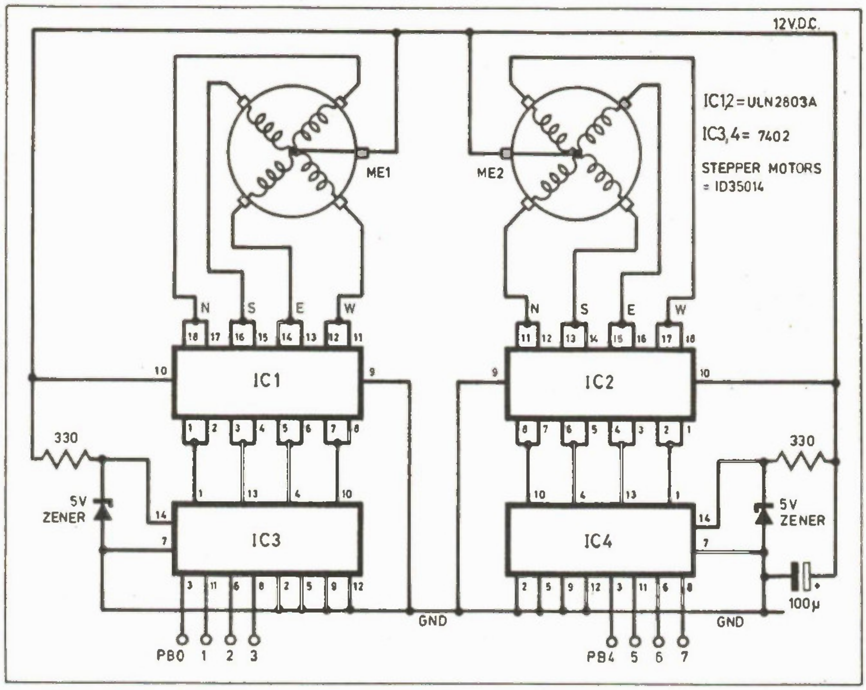
For instance, if the interference is a combination of electronic and magnetic emissions, both electrical conductivity and magnetic permeability of the shielding must be considered. Of the six commonly used shielding metals, only nickel and 1045 steel have appreciably poorer magnetic permeability.

Tailor the Need

Another factor to consider is the required mechanical strength and rigidity to withstand fabrication and end-use service. If the shielding is to be applied like wallpaper, characteristics of the adhesive rather than the strength or rigidity of the backing material may be the chief concern. However, often the shielding will be constructed into a self-supporting mini enclosure. In that case, formability and amenability to assembly or die-cutting may be paramount. If MIL specs are entailed, the application engineer will apply a different set of criteria. Fire resistance requirements also call for a custom approach to selecting adhesives and backing laminates or coatings. The supplier must, of course, be fully informed on all aspects of the shielding problem to help the design engineer find the best solution. ■

Stepper Motor Controller

By S.A. Baker



THIS CIRCUIT is designed for use with any computer with an eight line TTL compatible output port, e.g. VIC20, or Commodore 64. It is ideal for controlling a turtle as it operates two stepper motors.

Some recommended dimensions for this turtle are 61.1mm diameter wheels and 229mm between the wheels. These dimensions mean that with both motors running in the same direction, the turtle will move 2mm forwards/step. (The motor's step is 7.5 degrees). If the motors are stepped in opposite directions, the turtle will turn through 1 degree/step.

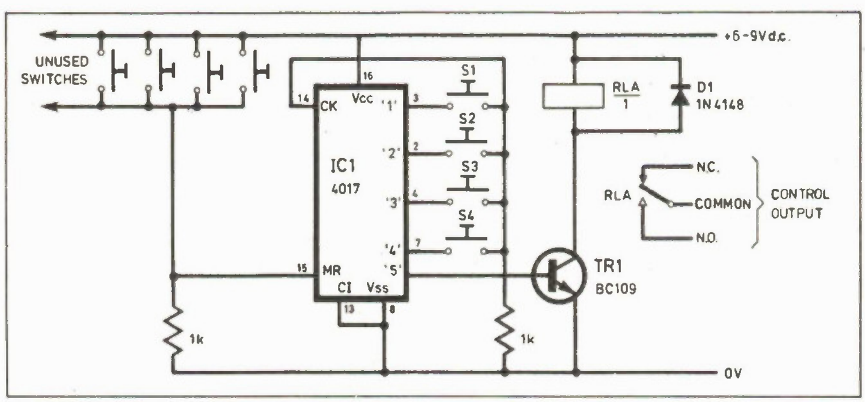
To make motor ME 1 step forwards, the output port should be poked with 255-(1,5,4,6,2,10,8,9). To make the other motor step forwards, the port should be poked with 255-16(1,5,4,6,2,10,8,9).

The 255- compensates for the inverters in the circuit. The inverters are NOR gates with one input grounded. They are present to ensure that the ULN 2803A, which is a Darlington amplifier, receives 5V whatever the inverter's input voltage.

The power supply must be 10-15V and capable of supplying 2A.

Simple Pushbutton Codelock

By David Cox



THE CIRCUIT below operates around just one chip, a 4017 counter. When power is first supplied, the first output of IC1 goes high.

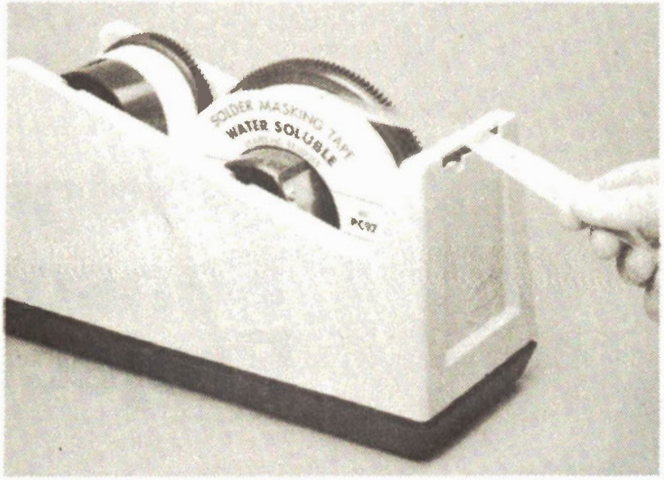
If the first coded switch S1 is pressed, the counter would be allowed to clock on one count. If any other switch is pressed, nothing would happen. Now that the IC's second output is high, the second button may be pressed, allowing the counter to clock one again.

Now if one of the unused switches is pressed, the counter will be reset. This goes on until the counter reaches the fifth output. At this point, the output is carried to the base of Q1, allowing the relay to operate. The resistance of the relay coil should be greater than 100 ohms in order to avoid damage to the transistor.

Up to nine switches may be used in the code, and if more than the four shown here are required, simply connect the extra switches between the next output and the clock input pin. The base of Q1 should be connected to the output after the last switch. Any extra 'unused' switches should be wired in parallel with those already shown. ■

Continued from page 8

Water-Soluble Solder Mask



For all you electronic environmentalists out there searching for a biodegradable, water-soluble solder mask, rest easy. Ersin Multicore Canada has introduced its PC97 tape.

Both the tape and its adhesive are completey removed using plain hot water or water containing saponifiers. It can also be removed simultaneously with flux residues in aqueous in-line or batch cleaning systems.

Available as a tape or preformed dots in various sizes, PC97 is static free, has a shelf life of over one year, and requires no set-up or drying time. The tape is furnished in 60 yard (54 meter) rolls, and comes in a variety of widths. The dots are available in blue and packaged in rolls of 10,000, with standard diameters of .7, 5/8, 1/2, 3/8, 5/16, and 1/4 inches.

For more information (and to find out the meaning of saponifiers) contact: Robert Gauthier, Ersin Multicore Canada Inc., 3525 Robert Chevalier, P.A.T., Montreal, Quebec H1A 3R7
(514) 642-4095 or (416) 278-7323.

Circle No. 54 on Reader Service Card.

If you're into robots, the Robotic Society of America is soliciting new members. For $15 (US) for individuals or $25 (US) for companies, you get a membership in a group that appeals to professionals and hobbyists alike, dealing with robots that work on their own or in conjunction with computers. As an incentive, new members will receive a copy of the Robotic Sourcebook, a description of commercially available robots and sources of books, kits, industrial robots, etc. They're at PO Box 54 H, Scarsdale NY 10583.

GMFCanada Limited has opened a new headquarters in Mississauga, Ontario, for the marketing of industrial robots. The 18,000 square-foot facility houses all of the marketing operations, training, demonstration areas and a systems assembly area. GMF is the largest robotics company in the world, manufacturing industrial equipment and machine-vision systems.

Control Data has installed $23 million worth of made-in-Canada Cyber 180 computers at California State University, bringing the total number of Control Data systems at CSU to 36, of which about 60 percent are Canadian-made or designed.

The press release then goes on to say that the computers "serve more than 325,000 students and thousands of faulty members and administrators." Fawlty Ivory Towers?

We regret that the Multi-Use Printed Circuit Board, Part II, scheduled for this month was delayed due to production difficulties. We'll have the second part for you as soon as possible.

Also, our regular feature, Designer's Notebook, will resume next month.

Rogers Cable TV has a new service for subscribers who own personal computers. Called XPress, it is a 24-hour-a-day information service featuring news, business, finance, weather, sports and entertainment data from more than 30 international sources, such as AP, CP, SportsTicker, etc. The service will initially be offered in Toronto, Brampton and Mississauga.

The one-way service originates in Boulder, Colorado and is sent by satellite to cable companies. The subscriber only needs an IBM-PC or compatible, an Apple IIc or IIe or a Commodore 64 or 128. No modem is required. The service costs $24.95 per month with a one-time hookup fee of $59.95 for IBMs and Apples, $69.95 for Commodores.

Zentronics is now carrying a new line of STD BUS power supplies from Power-One. The initial selection is three standard models designed to the popular STD specs. They're available in rackmount, stand-alone and surface-mount, all in three levels of power with single or triple outputs. For more information, contact Zentronics, 8 Tilbury Court, Brampton, Ontario L6T 3T4, (416) 451-9600.

Circle No. 56 on Reader Service Card.

A patented new technology for producing a colour cathode ray tube with a perfectly flat faceplate was announced by the Zenith Electronics Corporation in Illinois. The "flat tension mask" (FTM) offers reflection-free viewing, high resolution, and up to 70 percent increased contrast ratio compared to conventional displays. The first model will be a 14-inch monitor for computers, with deliveries beginning in 1987.

The Ontario Government plans to create a Premier's Council to "steer Ontario into the forefront of economic leadership and technological innovation". The 20-member council will establish broad priorities, encourage the most effective investment in basic research, and maximize the effectiveness of the government's investment in technology centres. The council will oversee a $1 billion, ten-year technology fund, half of which is new funding.

Sound Level Meter

The Bruel and Kjaer Type 2235 sound level meter is suitable for a wide range of applications including: building acoustics, audiometer calibration, and frequency analysis.

The hand-held portable device has a wide range and is capable of measuring sound level pressures from 24 dB to 130 dB; this can be further extended to 150 dB with the addition of a 20 dB attenuator (Type ZF 0020). It is also capable of measuring maximum or instantaneous sound pressure level with automatic or manual reset in accordance with IEC standards. Measurements are displayed with 0.1 dB resolution on a digital display indicating both overload (measurement is suppressed) and battery conditions. AC and DC outputs are provided for chart or tape recordings and audio monitoring of measurements. Optional filter sets can be added, providing 1/3 or 1/1-octave frequency analysis of sound pressure, and with an external optional microphone the unit becomes ideal for audiometer calibration.

Windeyer Associates, Andy McKee, 3460 Simpson Street, Suite 306, Montreal, Quebec H3G 2J4. (514) 695-8225.

Circle No. 55 on Reader Service Card.

Rotation Sensor Project

An electronic tachometer for checking the speed of rotating shafts.

By Mike Feather

TECHNIQUES for measuring the shaft speed of, for example, an electric motor have traditionally relied upon the use of some form of mechanical tachometer, in which the speed is displayed directly on an analog scale.

These devices provide a useful check on the speed of large motors, but the speed of smaller motors is likely to be considerably reduced if tachometers are coupled up to them.

Other methods employ a small DC generator coupled directly to the motor shaft. The output of the generator can be made to vary directly with the motor speed and a voltmeter may be used to provide an indication of this. Once again, the arrangement is really only suitable for use with large motors.

Electronic Methods

Most electronic methods employ some form of arrangement in which a sensor of one type or another picks up the shaft speed without the necessity for any mechanical coupling to it.

Such sensors include magnetic, slot optical and photo-reflective types and these are described later in this article.

Each of these sensors provides a pulsed output, the pulse frequency being proportional to the shaft speed, so that the task of speed measurement becomes one of determining the frequency of the sensor output pulses. Frequency meters, both analog and digital, are available, but they tend to be rather expensive instruments and this month's practical project describes the theory and construction of a frequency meter/tachometer unit based on the inexpensive 2917 tachometer IC.

The completed unit provides a calibrated analog output voltage which varies directly with the frequency of the input signal. For shaft speed measurement, any of the sensors described may be used.

The 2917 Tachometer Chip

The 8-pin tachometer DIP IC is a frequency-to-voltage (F/V) converter. It employs a charge pump technique in which the input frequency produces a directly proportional DC output voltage. The pinout and internal circuitry of the chip are shown in **Fig. 1** and Table 1.

The first stage consists of a differential amplifier, one input of which is grounded

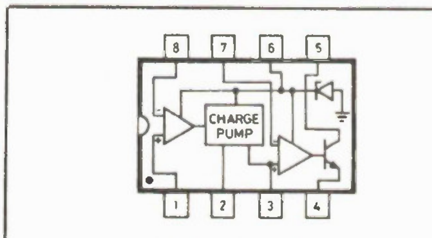


Fig. 1. Internal circuitry of the 2917 tachometer IC.

Pin	Function
1	Frequency input
2	Timing capacitor
3	Filter capacitor/resistor
4	Output transistor emitter
5	Output transistor collector
6	Vcc
7	Bias current
8	Ground

Table 1: Pinout details of the 2917 IC.

while the other serves as the signal input. The signal voltage required for correct operation is typically 250mV peak, but the input is protected for voltage swings of up to 28V.

If the frequency of higher voltages is to be determined, e.g., the contact breaker pulses of a car engine, then some form of potential divider network must be used.

The next stage comprises the charge pump circuitry. An external capacitor and resistor determine the DC output voltage for a given pulse input frequency. The output of the charge pump is applied to an operational amplifier which can be used in the op amp or comparator mode, so allowing either proportional or speed-switched outputs.

The final stage consists of a floating NPN transistor which can be used to drive a variety of loads, the maximum sinking current being approximately 50mA.

The chip includes an internal zener diode which, with the addition of an external dropping resistor, allows operation from unregulated power supplies.

As mentioned, three basic speed sensing arrangements are employed with the tachometer unit: magnetic, optical switch, and photo-reflective sensors.

Magnetic Sensors

The arrangement of the magnetic sensor type of pick-up is shown in **Fig. 2**. Rotating of the toothed ferrous wheel (e.g., a gear wheel) adjacent to the pole of the pick-up develops an alternating voltage at the output terminals of the device. The frequency of this AC output is proportional to the speed of rotation of the wheel. The clearance between wheel teeth and pick-up pole should not be greater than 2.5mm for correct operation of the sensor.

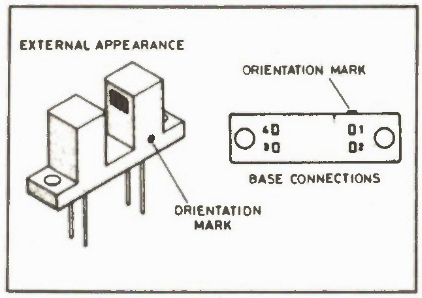


Fig. 3. Details of the slotted optical switch sensor.

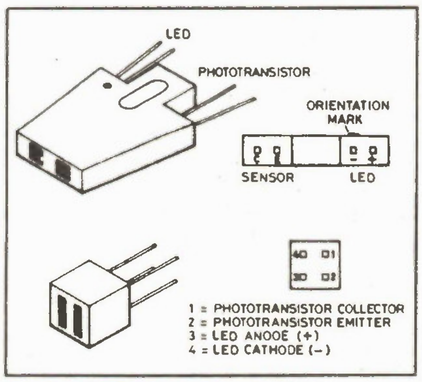


Fig. 4. The diffuse scan photo-reflective sensor: top, the large type is shown and, above, the miniature version.

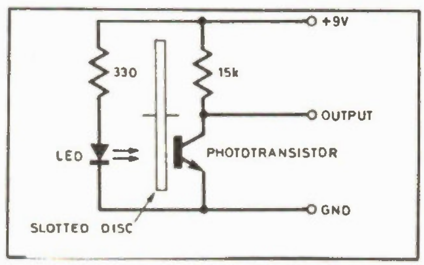


Fig. 5. Basic circuit for opto-switches.

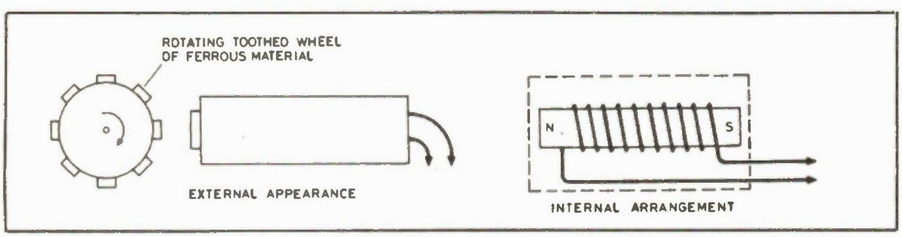


Fig. 2 Magnetic pick-up used for speed sensoring.

Slotted Optical Switch Sensor

A typical slotted opto-switch is shown in **Fig. 3**. The device consists of an infrared LED and a phototransistor sensor mounted in a slotted plastic housing.

A rotating opaque disc with holes or slots around its circumference may be situated in the slot and the phototransistor can be used to provide a pulsed output voltage, the frequency of which varies directly with the speed of the disk. **Fig. 5** shows the circuitry used with this type of sensor.

Infra-Red

Photo-reflective sensors also use an infra-red LED/phototransistor combination, but the phototransistor responds to reflected radiation from objects placed close to the device. Two types are commonly available and these are shown in **4**.

For shaft- or wheel-speed sensing applications, a small piece of bright aluminum foil makes a suitable reflecting surface. The optimum sensor/reflector distance is approximately 5mm for the larger device and 1.2mm for the miniature version.

The associated LED/phototransistor circuit arrangement is the same as that used for the slotted opto-switch sensor shown in Fig. 5.

The Frequency/Tachometer Transducer Unit

The circuit of the main unit is shown in **Fig. 6**. The design provides two ranges of speed and frequency measurement: 0-500Hz and 0-5000Hz. For direct measurement of the frequency of pulse trains or alternating voltages, no transducers are required and the unit may be used as it stands. A 5V DC voltmeter is used for indicating the frequency.

The signal from the sensor is applied to the input of the 2917 IC via C2. A 5-pin DIN socket is used for the input connector. The frequency range is selected by S1 which switches the appropriate capacitor into the charge pump circuitry. R1 determines the charge pump output voltage and a 100k resistor is used in this application.

The op amp/comparator is used in the linear mode and the output voltage from the device is taken between pin 4 (the transistor emitter) and ground. VR1 is a potential divider circuit which allows variation of the output voltage for calibration purposes. R2 is the dropping resistor for the Zener diode circuitry. The LED and its series resistor provide a visual "on" indication for the unit.

Note the connection from the +9V supply line to the input DIN plug. This is used for providing a supply for opto-probes. The current drain of the circuit is small and a 9V battery will allow long periods of continuous operation.

Construction

Construction of the circuit is very straightforward. The PCB design and component overlay diagrams are shown in **Fig. 7,** although the circuit could be constructed on a small piece of Veroboard.

Connection pins should be inserted and soldered into the PCB at the points shown. Other components can now be inserted and soldered on to the board.

The front panel of the case should now be drilled and its components mounted as indicated in the photograph. Connections between the front panel and the p.c.b. pins can now be made using 7/0.2mm insulated wire. Care should be taken to ensure that the connections to the panel LED are the right way around. The battery connector is soldered to the on/off switch, again noting carefully the polarity. Finally, the 2917 IC is inserted into its socket in the correct orientation.

If an optoelectronic sensor is to be used in combination with the unit, this should now be constructed. **Fig. 8** shows a pro-

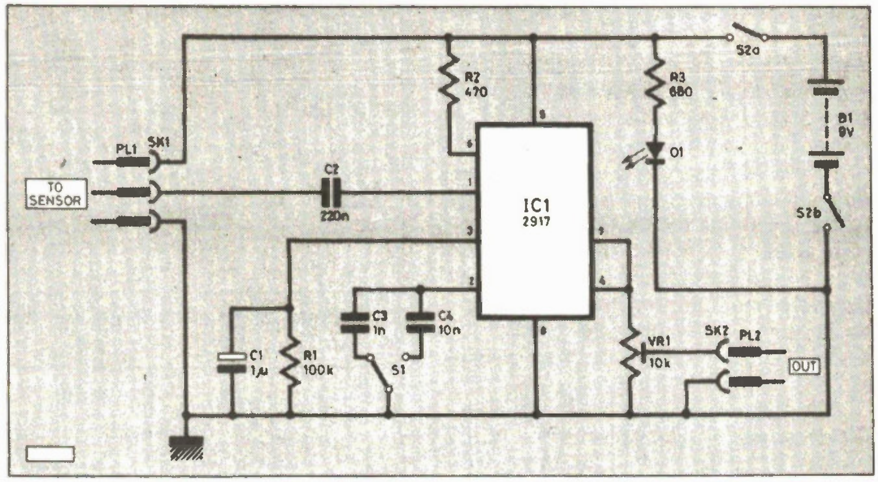


Fig. 6. Circuit diagram for the fequency measurement/tachometer unit.

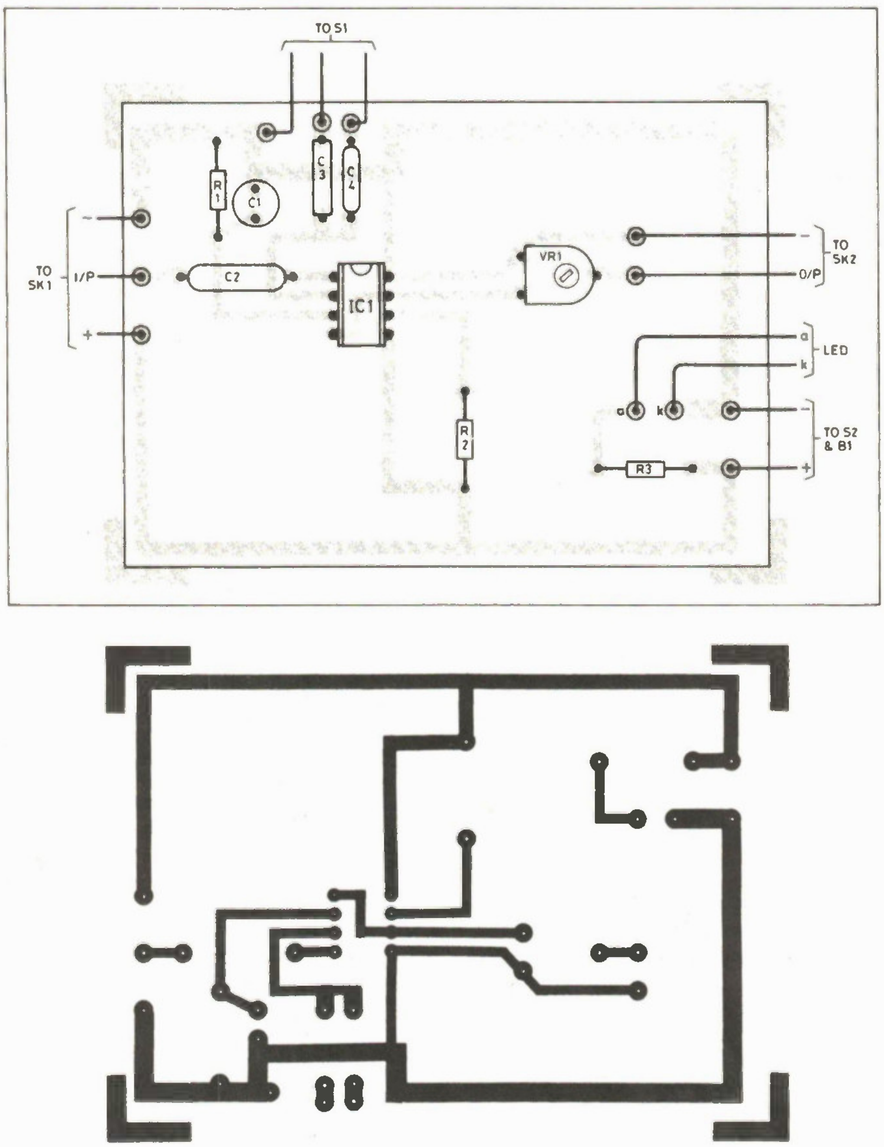


Fig. 7. the component overlay for the frequency measurement/tachometer unit and the PCB.

Continued on page 48

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Almost Free PC Software

Volume IX

The premise that good software ought to be cheap isn't one that the microcomputer industry as a whole seems to embrace, what with most programs costing several hundreds of dollars... and usually being copy protected, infested with bugs or poorly documented when you finally do get them. We think that cheap software is almost as fundamental as clean water and classic Coke.

This ninth volume of our popular almost free PC software represents another superb collection of programs for the IBM PC and compatible systems. Whether you're into games, business, hacking or just being in the same room as a microcomputer, this disk will enhance the usefulness of your PC at a cost that won't even dent your wallet, let alone blow it out of the sky as most applications packages can.

Small C If you've ever wanted to try writing programs in the C language, this compiler will fascinate you. It's a restricted implementation of C, producing code which is compatible with Microsoft's MASM and LINK programs... you'll need these to get it going.

Map is an interesting little utility which will check how DOS is situated in the memory of your computer and tell you a number of things about it. It's a useful programming tool, especially helpful if you're debugging software which interacts directly with DOS.

Note is the source file for the memory resident note pad that we ran in the March 1986 edition of Computing Now!. It requires MASM and LINK to use. It will create a resident memo page that you can call up from within any application.

Pango is one of the wildest games we've come across for the PC. While its premise is a bit improbable, it's fast and weird and more fun than a stoned house cat.

PC-Spell is a pretty decent spelling checker written in BASIC. Despite its pedestrian sounding origins, it's fast, accurate and easy to use. It can be listed if you want to see how it works, and comes with a large dictionary file and a utility to assist you in customizing it.

Peacock is a memory resident program which allows you to change the colours of your screen with alternate function keys. It's useful, for example, if you run software which insists on changing the screen to something loathsome.

Recover is a utility to assist you in getting data back from damaged files. It lets you look at your files one sector at a time and put the pieces back together.

SDB is a small relational database. It isn't dBASE III, but it also doesn't cost quite as much. It's still pretty powerful and is eminently suitable for many business applications. It features on line help.

Tally is a program which accurately counts the number of characters, words and lines in a file... all within your lifetime.

Xeno edits the tracks and sectors of your disks in a user friendly format... or, at least, one that doesn't lunge for your throat every time you boot it. You can use it to explore DOS, fix trashed disks, unerase files and do all the other low level magic that sector editors are renowned for.

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```
0000  43 50 43 20 20 20 20 20 - 45 58 45 20 00 00 00 00   CPC     EXE
0010  00 00 00 00 00 00 E5 79 - 00 00 02 00 00 99 00 00         ey
0020  44 49 43 54 49 4F 4E 41 - 20 20 20 20 00 00 00 00   DICTIONA
0030  00 00 00 00 00 00 E5 79 - 00 00 29 00 00 83 00 00         ey  )
0040  4D 41 50 20 20 20 20 20 - 43 4F 4D 20 00 00 00 00   MAP     COM
0050  00 00 00 00 00 00 E5 79 - 00 00 4A 00 00 27 00 00         ey  J
0060  4D 41 50 20 20 20 20 20 - 44 4F 43 20 00 00 00 00   MAP     DOC
0070  00 00 00 00 00 00 E5 79 - 00 00 54 00 80 05 00 00         ey  T
0080  50 41 4E 47 4F 20 20 20 - 45 58 45 20 00 00 00 00   PANGO   EXE
0090  00 00 00 00 00 00 79 03 - 21 00 56 00 80 74 00 00          y ! V t
00A0  50 43 2D 53 50 45 4C 4C - 42 41 53 20 00 00 00 00   PC-SPELLBAS
00B0  00 00 00 00 00 00 E5 79 - 00 00 74 00 00 05 00 00         ey  t
00C0  50 43 2D 53 50 45 4C 4C - 44 4F 43 20 00 00 00 00   PC-SPELLDOC
00D0  00 00 00 00 00 00 E5 79 - 00 00 76 00 00 0D 00 00         ey  v
00E0  50 43 2D 53 50 45 4C 4C - 53 4F 52 20 00 00 00 00   PC-SPELLSOR
00F0  00 00 00 00 00 00 E5 79 - 00 00 7A 00 80 02 00 00         ey  z
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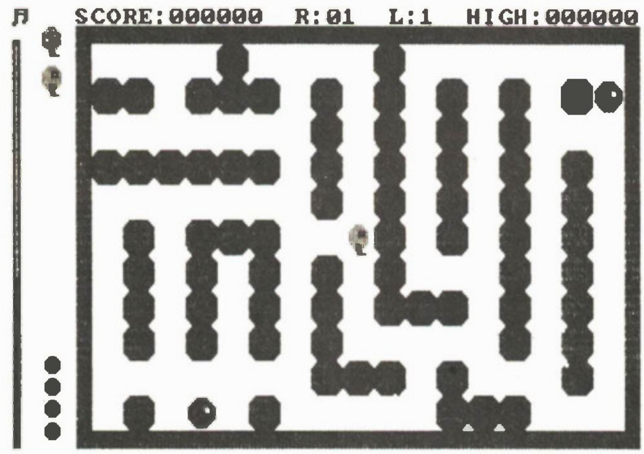
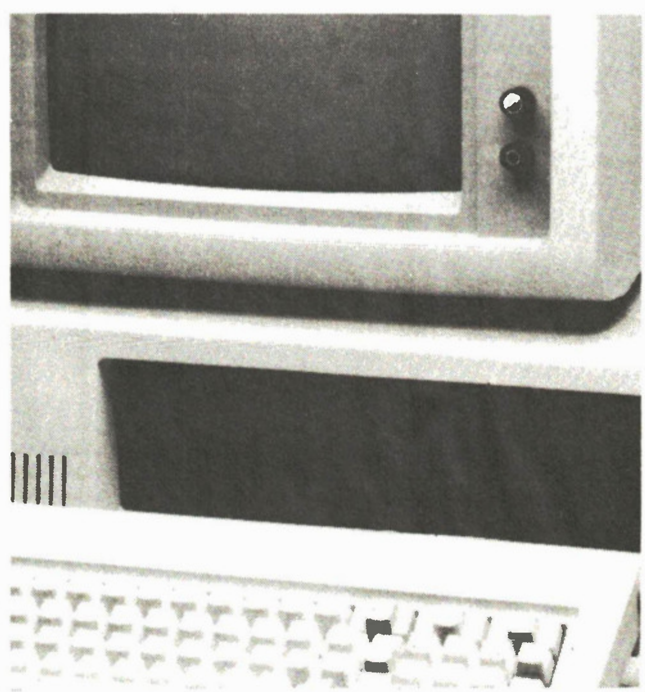




Almost Free PC Software

Volume X

In human terms, the number ten is rather magical. It's the number of digits we have, the number before which everything can be dealt with with one character and the legal drinking age on Baffin island. At least, this is what people say. In computer terms, ten is minor inconvenience, and nothing to get excited about. The real party starts at sixteen.

In a software sense, ten is rather special as it's the number we've assigned to a decidedly better than splendid collection of public domain programs for the IBM PC. This stuff is supremely special, as befits a number of such obvious significance. While the actual number of programs on this disk is rather smaller than in the past, the programs themselves are rather larger and more sophisticated. They'll blow the socks clear off your computer if you've left any on top of it, and make you forget about data base management, spreadsheets and all the other pedestrian nonsense that usually lives on disks.

It's software so good that anyone else would have copy protected it.

Monopoly is the first working implementation of the classic board game that we've come across... and we've had several that bombed pretty colourfully. This one is great, though, with fast and occasionally sarcastic play, a graphic board display and pretty good sound effects.

D20 is the latest version of Steve's sorted directory program. This one uses DOS two calls and handles subdirectories.

Edit is largely what it says, a public domain text editor. Once again, we've had to dig through quite a few efforts along these lines to find one that didn't crash and burn every time someone had the audacity to sneeze in the same room as it. This is a lightning fast full screen editor, ideal for editing program source files, dBASE stuff or other ASCII phenomena.

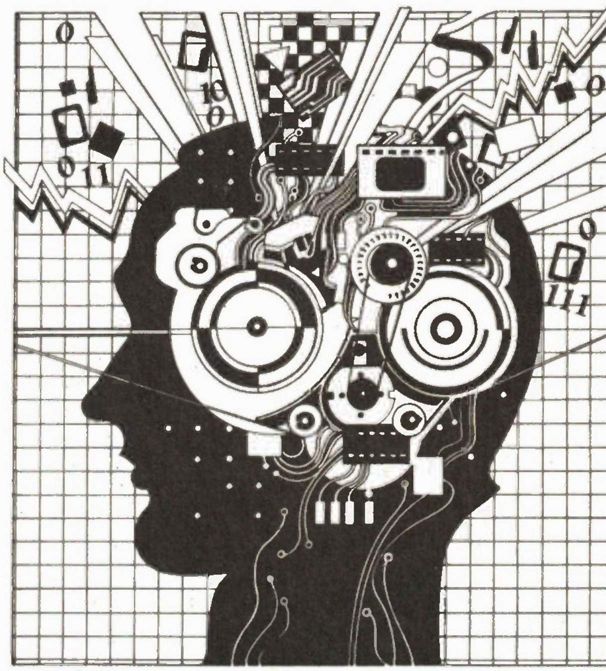
Banner takes mere text and prints it sideways on your printer... in gargantuan block letters that can be read from miles away if you have a good set of binoculars. It's not the sort of thing that you'd want to publish a book with, but it's a good trip for signs.

Mortgage is another utility to help you understand just what you've gotten yourself into. It's one of the nicest mortgage programs we've seen so far... lifelong debt and ruination has never been so well formatted.

Quick speeds up your PC quite a bit. It hooks into the video and makes it run a great deal faster, eliminating at least some of the glacial slowness that makes an IBM what it is.

Speech is a rather remarkable little germ of code. It talks through the PC's internal squeaker speaker. The voice quality isn't exactly human, but it's understandable on most machines. This is a really interesting bit of work, one that can be accessed from within other programs to create talking applications. It's great if the tube in your monitor burns out.

PC-AR is an accounts receiveable package for the PC. While not the equal of some of the commercial software that handles this function, it will take care of the records for a small or medium sized business quite well.



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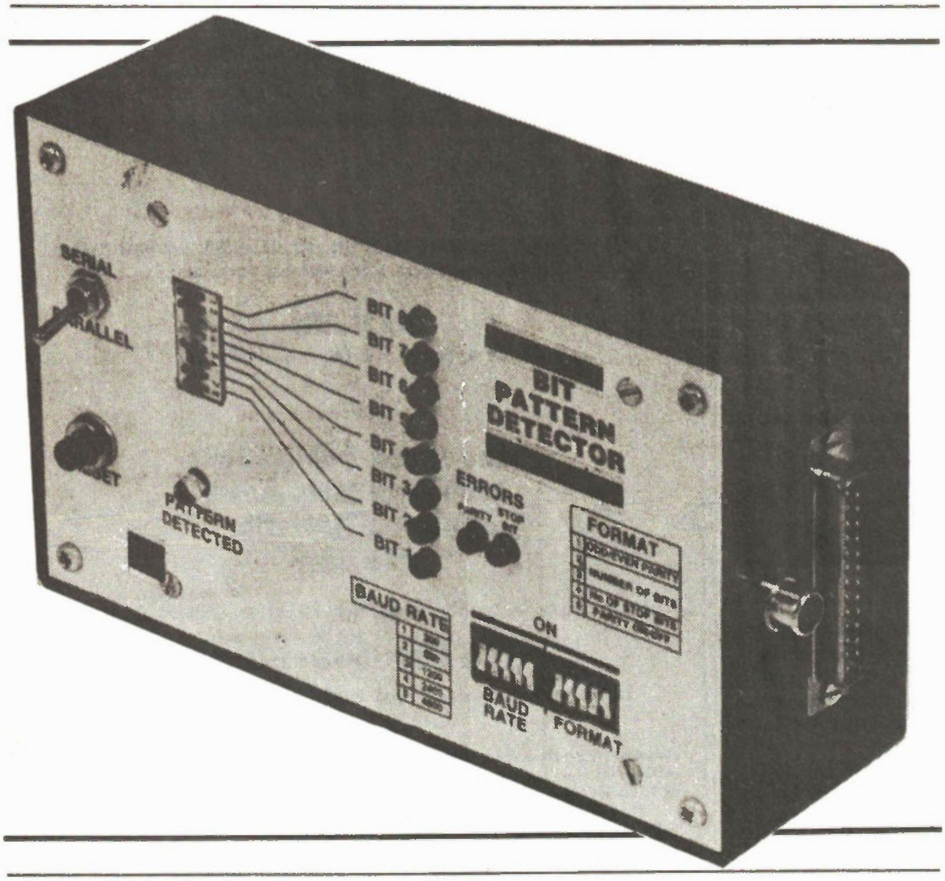
Bit Pattern Detector

Hunting for bytes? This project lights up when it detects specific serial or parallel data.

By Neale Hancock



THIS project gives you a simple and economical way to detect and display specific bytes of data. It may be used on both parallel and serial data paths, or just on parallel data paths if you want to save yourself the cost of a UART.

Two methods used to indicate the presence of a specific data byte are possible, Method 1 and Method 2.

Method 1 is used to search a stream of data for a specific byte, then simultaneously illuminate an LED and send out a trigger pulse when the byte is detected. When this method is being used, the byte to be searched for is set on a bank of switches. Every byte which travels down the data path is compared with this byte and when the two are the same an LED illuminates.

Method 2 requires a single byte to be sent down the data path from a terminal or a bit pattern generator. The bit pattern is set up on the switches and detected in the same way as in Method 1; it is also displayed on the eight LEDs on the front panel.

When the bit pattern detector is used on serial data paths, either Method 1 or 2 can be used to detect bytes of data. Method 1 is best used to determine whether a specific byte has reached the desired destination, and is convenient when troubleshooting RS232 links. In this case one can determine whether or not a peripheral is responding correctly to the data being sent to it.

Method 2 is best used to check whether or not the serial link is transmitting data without errors. If there is an error in the transmitted data you can identify which bits are incorrect.

Parallel data paths are a common way of routing data around a PC board. Therefore the bit pattern detector is ideally suited to checking inputs and outputs on data and address buses (providing that they are no greater than 8 bits wide). In parallel mode, Method 1 is used to trigger an event when the byte set by the programming switches occurs. This is ideal for microprocessor circuits when you need to trigger an interrupt line. Method 2 is best used for checking data flow through a circuit.

Circuit Synopsis

The basis operation of the circuit is as follows. The incoming serial data is converted to TTL levels to enable it to be received in a form acceptable to the General Instruments AY-3-1015D universal asynchronous receiver-transmitter (or UART for short).

The UART primarily converts serial data into parallel data, it also removes start, stop and parity bits from the serial signal. The speed at which the UART runs is set by the baud rate generator.

The buffer is used to select between data from the UART or the parallel input, to be sent to the comparator. The comparator is used to compare the incoming data with the settings on the programming switches. When the incoming data is the same as the settings on the switches the 'pattern detected' LED is illuminated.

The buffered display shows the byte present on the data path on a row of LEDs. These LEDs are driven by non-inverting buffers to reduce loading.

Construction

If you only require the bit pattern detector to operate in parallel mode you can omit a number of components. These components are IC1, IC2, IC8, Q1, D1, R1, R2, R3, R4, C1, C2, C3, C8, C9, C10, C11, LED1, LED2, SW1, SW2, SW3 and the 2.457 MHz crystal.

Before you commence construction examine the PC board for defects such as bridges and broken tracks. Also take note of the components which should be mounted on the copper side of the PC board. These components are marked in colour on the overlay. The reason for components being mounted there is because there is not enough clearance for them between the PC board and the front panel.

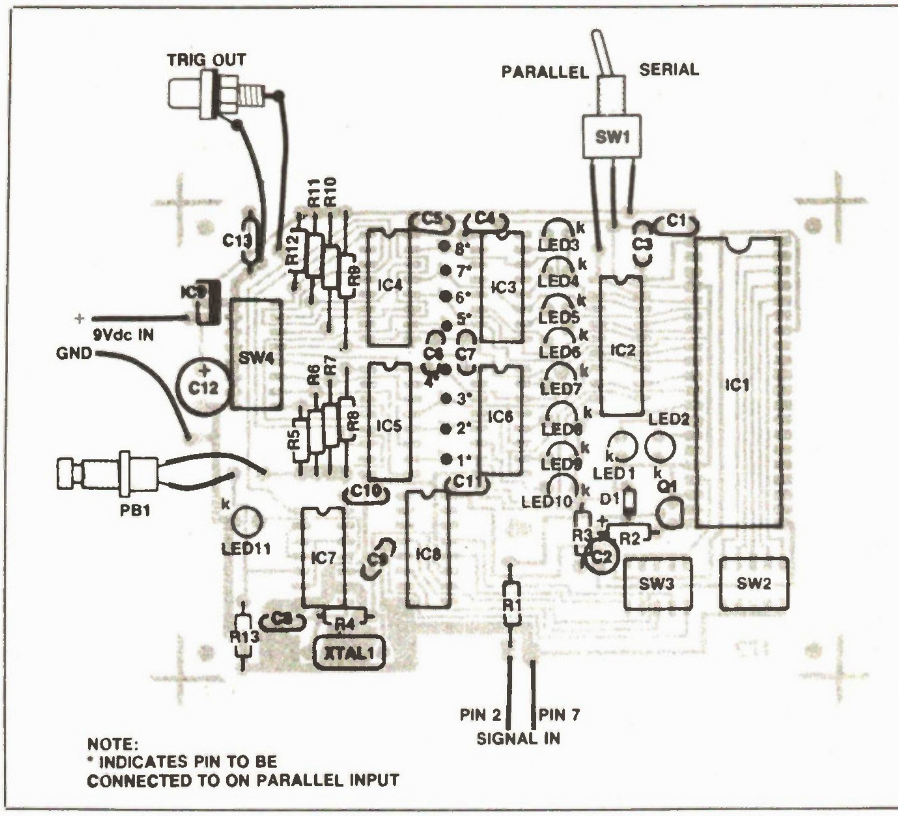
The resistors and capacitors should be mounted first. Take note of the orientation of the electrolytic capacitors C2 and C12, and remember that all the capacitors are mounted on the copper side of the PC board.

Next mount the diodes, but first check their orientation. Try to keep the spacing between LEDs 3 to 10 as consistent as possible, keeping in mind that they have to be aligned with the front panel. Also mount the three banks of DIP switches. The crystal, the regulator and the transistor can then be mounted on the copper side of the PC board.

Next mount the integrated circuits. All the ICs are CMOS except for IC1 which is NMOS so treat them all with respect. Remember NMOS and CMOS chips are static sensitive; they do not like having their legs touched, only pick them up by their ends.

When soldering in the integrated circuits, try not to overheat them by soldering rows of successive pins. This is especially important in the case of IC1 for which it is best to solder the pins from opposite ends, eg, pin 1 then pin 21, pin 2 then pin 22 etc. This prevents the chip from being excessively heated in one area and saves it from possible damage.

There are mercifully few flying leads to connect in this project, as the majority of the switches and all the LEDs are mounted on the PC board. Take note of the connections to the serial/parallel switch, the DB 25 socket and the 9 volt in-



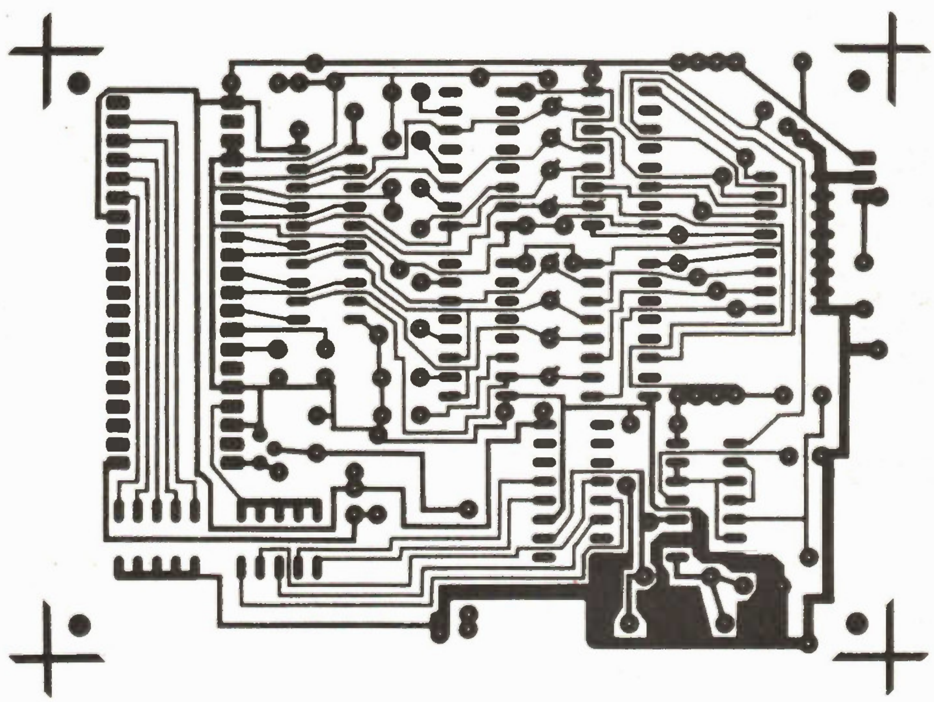


TABLE 1. DB 25 CONNECTIONS

Pin on DB 25 plug	14	15	16	17	18	19	21	22
Pad on pc board	1	2	3	4	5	6	7	8

put socket. The DB 25 socket is also used to access the parallel data input. Table 1 shows the recommended connections. However, as RS232 connectors can be configured in different ways on different computers, check that these lines are not used in your particular case. If they are, you may get false data entering ICs 4 and 5. If some of the recommended lines are used, connect the parallel data input lines to unused pins on the connector.

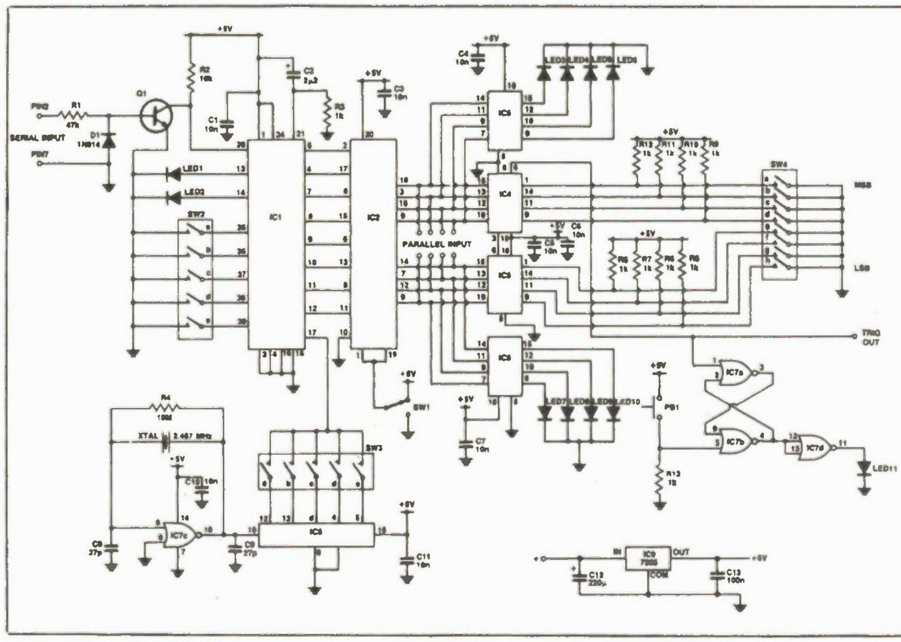
To allow all the LEDs and DIP switches to poke neatly through the front panel requires some careful drilling. To assist in this check the drilling diagram. By accurately aligning this diagram over your front panel, it can be used as a drilling template. When you have it in position, lightly punch the centres of all holes. To make the centres more accurate it may help to have a hard surface under the front panel when you are punching it. The outlines for the DIP switches can be marked by cutting through the diagram with a sharp blade or scalpel. This will transfer all the required markings on to the metal.

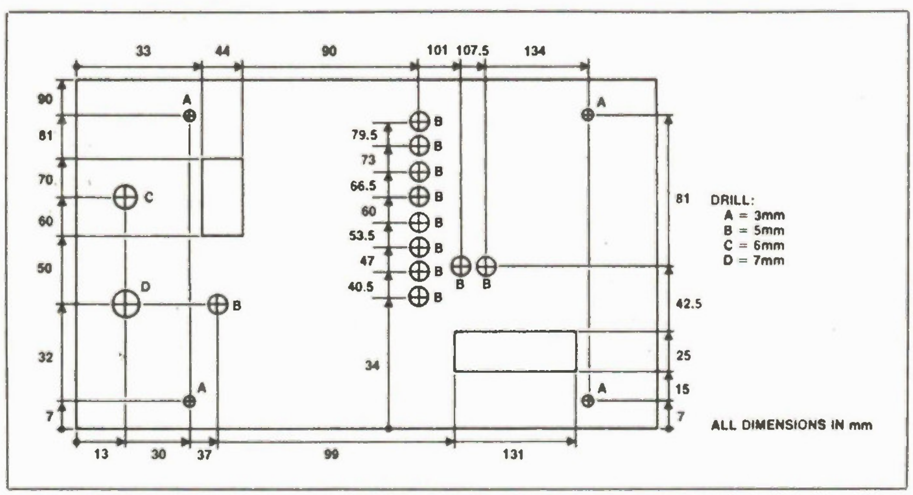
When you are drilling the 5mm diameter holes it is advisable to drill a pilot hole first, using a 3mm drill. Now use the 5mm drill where required. The edges of these holes can be cleaned using a large drill bit. The rectangular holes for the DIP switches can be cut using a nibbling tool or by drilling a series of holes and filing between them.

The circuit board can now be mounted behind the front panel using four nuts and bolts. Some 5mm spacers should provide adequate clearance between the front panel and the PC board. With a bit of wiggling the LEDs and the DIP switches should protrude through the front panel. If you have difficulty in getting the DIP switches through, file the holes gradually until they do. If the LEDs give you difficulty, twist them until they are evenly spaced so that they can be located in the holes.

Before you connect in the plugpack carefully examine the PC board for solder bridges; also check that all the components are located and oriented correctly on the board. Now connect the 9 volt plugpack, and check that the voltage rails are within 500mV of 5 volts. If not, disconnect the plugpack and check for short circuits on the PC board in the vicinity of the 5 volt supply rails.

To test the bit pattern detector set the 8-bit programming DIP switches to '0' and the pattern detected LED should light up. Switch any of the DIP switches to the '1' position and press the RESET button. The PATTERN DETECTED LED should go out. If this does not occur, recheck the board for shorts, broken tracks or dry joints.





PARTS LIST

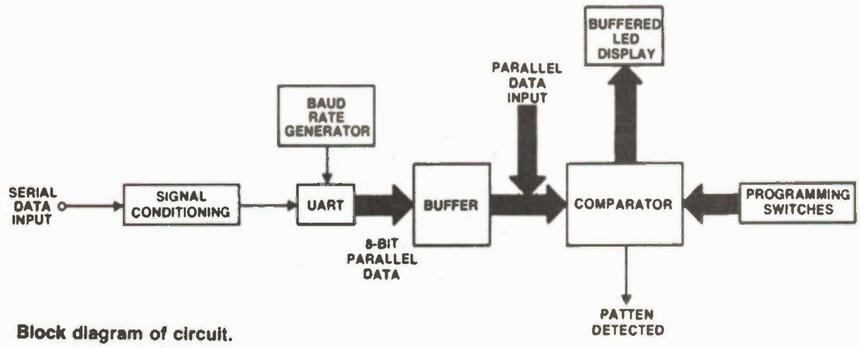
Resistors (All ¼ W, 5%)
R1 .... 47k
R2 .... 10k
R3, R5-R13 .... 1k
R4 .... 10M

Capacitors
C1, C3-C7, C10, C11 .... 10n
C2 .... 2u2 25 V electro
C8, C9 .... 27p
C12 .... 220u 25 V electro
C13 .... 100n greencap

Semiconductors
D1 .... 1N914
LED 1, 2, 11 .... red 5 mm
LED 3-10 .... green 5 mm
Q1 .... 2N5818
IC1 .... AY-1015D UART
IC2 .... 74HC244
IC3, 6 4050
IC4, 5 .... 74HC85
IC7 4001
IC8 4020
IC9 7805

Miscellaneous
SW1 .... SPDT
SW2, 3 .... 5-way DIP switch
SW4 .... 8-way DIP switch
PB1 .... pushbutton switch

DB 25 plug; 2.457 MHz crystal; case 160 mm x 95 mm x 50 mm; RCA socket; 3.5 mm phono socket;



Block diagram of circuit.

TABLE 2. FORMAT SWITCH SETTINGS

Switch No.			
1	on = odd parity		off = even parity
2,3	2	3	no of bits
	on	on	5
	off	on	6
	on	off	7
	off	off	8
4	on = 1 stop bit		off = 2 stop bits
5	on =		off =

Using It

When detecting bytes on a serial line firstly set up the BAUD RATE and FORMAT DIP switches to suit the serial port. Table 2 shows the settings for these switches. Next set the binary value of the byte to be detected on the eight DIP switches next to the SERIAL/PARALLEL switch. The top switch (bit 8) is the most significant bit and the bottom one (bit 1) is the least significant bit. Now send the data stream or the specific byte to be detected from this port. If either of the ERROR LEDs light up, check that the FORMAT or BAUD RATE DIP switches are set correctly.

To detect bit patterns or bytes on a parallel data bus, firstly flip the SERIAL/PARALLEL switch to the PARALLEL position and connect the relevant pins on the DB 25 connector (listed in Table 1) to the relevant lines on the parallel data bus. The eight LEDs should indicate the state of these lines. If a particular pattern is to be detected set its binary value on the DIP switches and the PATTERN DETECTED LED should light up when it appears on the data bus.

How It Works

Some serial signals are 'non return to zero' (NRZ) meaning that a high state is represented by a positive voltage and a low state is represented by a negative voltage. The diode D1 is used to convert any NRZ signals to 'return to zero' signals and the transistor Q1 is used to set the signal level at 5 volts. The resultant signal output from Q1 will comply to TTL standards, that is, 5 volts as a high level and 0 volts as a low level. This signal conditioning is performed because the UART (IC1) requires TTL input signals.

The oscillator circuit consisting of the crystal, the NOR gate (IC7c), R4, C8 and C9 oscillates at a frequency of 2.457MHz. This signal is divided down by the 7-bit ripple counter, IC8, to provide five different baud rates. These rates are switched to the UART by the bank of DIP switches, SW3.

The UART removes start and stop bits from the incoming serial bit stream and converts the serial data into parallel data. SW2 is used to set up the UART for the correct parity, and correct number of data and stop bits. LEDs 1 and 2 indicate errors with parity and stop bits respectively.

After the serial data has been converted into parallel data, it is compared with the settings on the DIP switches (SW4) via ICs 4 and 5. When the bit pattern is the same as the switch settings, pin 6 of IC4 goes low. However, this output goes high again when a bit pattern different from the switch setting occurs. To latch this output an R-S flip-flop is used. This consists of NOR gates IC7a nd IC7b. IC7d is used to invert the latched signal to a high level and thus switch on LED11 to indicate that the bit pattern has been detected.

IC2 is an octal tristate buffer which is used to select between serial and parallel incoming data by SW1. When SW1 is in the serial position, the data output from the UART is connected to the comparators. When this switch is in the parallel position the data output from the UART is disabled from the rest of the circuit, isolating the outputs of IC1 from incoming data. Otherwise this data would be fed into the outputs of the UART.

LEDs 3 to 10 display the incoming data in a binary form. They are driven by the non-inverting buffers IC3 and IC5. Thus the loading on IC2 is reduced when the circuit is examining serial data. The loading of the source of the parallel data is reduced when the circuit is examining parallel data.

The 10nF capacitors connected between the Vcc pin of the integrated circuits and ground remove transients and any other undesirable ac signals which may be picked up by the Vcc rail. On the PC board, these components are located next to the Vcc pins of each integrated circuit. Capacitors C12 and C13 perform the above mentioned task for the incoming dc supply. ■

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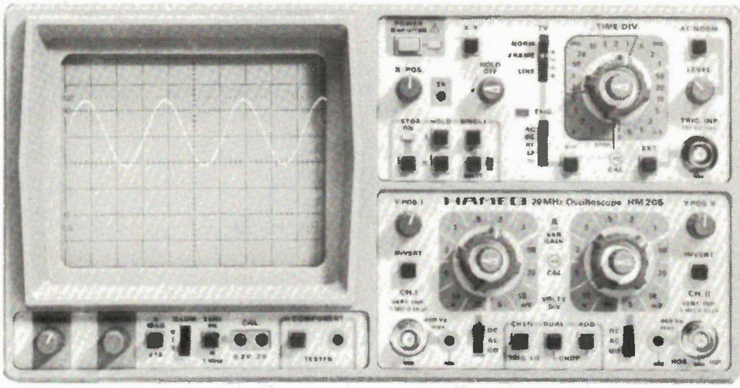

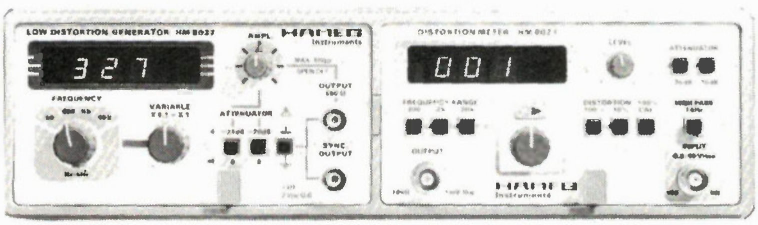

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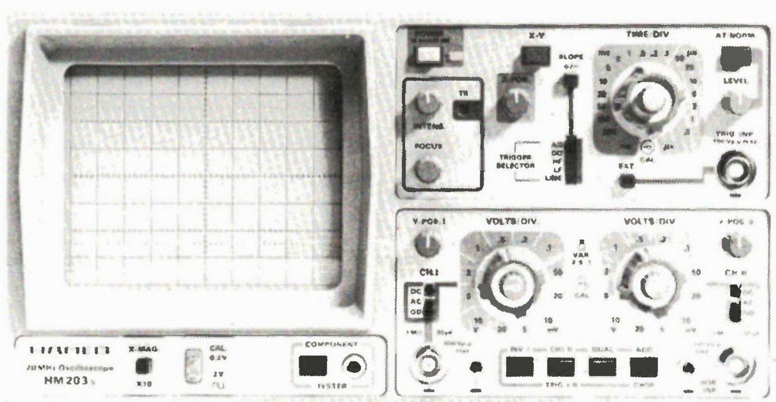

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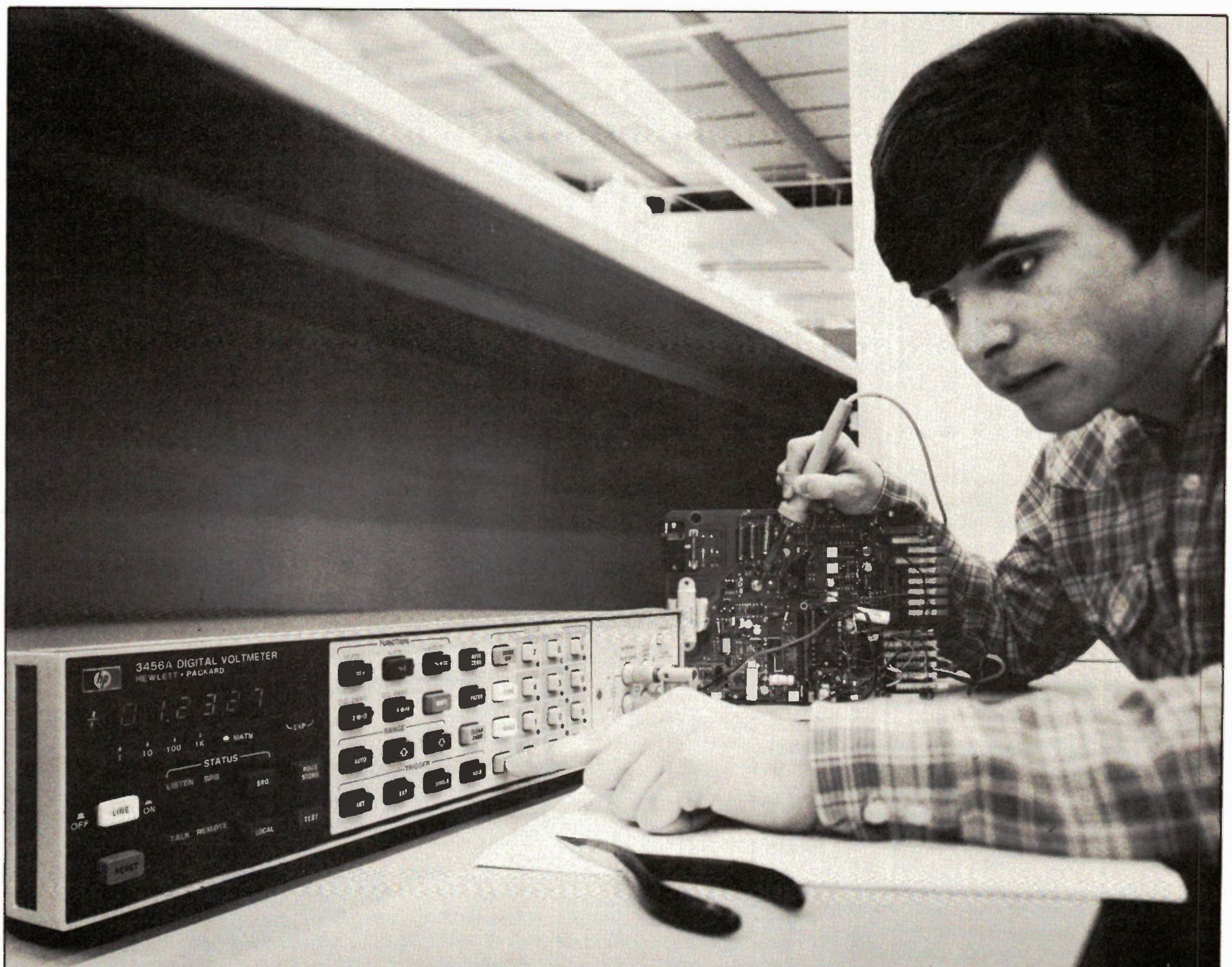
Electronics Today

Test Equipment

What's new in the test equipment lineup, plus ideas on applications and use.

By Bill Markwick



ONCE again it's time for a look through some of the test equipment available. Most of the items selected are aimed at the small to medium testbench, although of course they have universal applications. Occasionally we stray into the area of equipment with huge price tags, if only to see what can be done.

Not surprisingly, there are more and more microprocessors and special ICs being used in test gear. The result has usually been any or all of: a lower price, a smaller size, more features, better precision or extended test capabilities. The credit-card Digital Multimeter is now an inexpensive reality. Another advantage is that one unit can do the job of several, such as scopes with built-in voltmeter and frequency counter readouts.

The savings in price and size often mean that you can afford other, specialized units such as troubleshooting aids, power analyzers and so on.

Maybe its time to retire that great old tube scope that's given years of service, or replace that huge signal generator with one that's now a fifth the size. Here are just a tiny sampling of the many models available. If you don't see what you want, don't give up: every representative of every product in this article has a much wider range of models and types than we could possibly hope to show. And, of course, we apologize to anyone inadvertently omitted, or anyone whose product line couldn't be fully represented because of space restrictions.

Oscilloscopes

The scope is probably the first major piece of test gear that anyone considers buying. It's difficult to overemphasize its role as the heart of any testbench, or overstate the usefulness of a portable scope in field work.

When choosing a scope, there are three main possibilities: the analog, the analog storage, and the digital storage. If you use the scope primarily for looking at steady-state signals, particularly if you need maximum bandwidth (or maximum economy), then the analog scope is the winner. If you have a need to capture transient signals, those pesky voltages that only happen sometimes, then the choice is between an analog or a digital storage system.

It's a tad harder to make the decision about storage types. If you only need a capture facility once in a while, perhaps price would be the determining factor. However, if you require high performance, it boils down to this: the microprocessor, now turning up in most test equipment, allows the digital storage scope to have multiple memories for image storage and on-screen readouts of voltage and time parameters via movable cursors. The tradeoff is speed; digital scopes work by taking high-speed samples of the trace and assigning a digital value to each sample. This digital value is then stored in RAM. Obviously, there will be some loss of speed compared to the analog scope; the signal scanning is interrupted for a small but finite time period to allow sampling and conversion. To speed things up, digital scopes often let the signal build up for several repetitions to give the equivalent of extremely high-speed sampling; this works well for repetitive waveforms, but not for one-time transients. If high-speed transient signals are your thing, especially at 10MHz or above, the analog scope may have the edge. If you deal in low frequencies, say below 1MHz, the choice is yours.

Naturally, everyone would like to have everything all in one box, and at a good price. How close can we come to this? Surprisingly close, in fact. I'd pick one of the newer digital storage scopes in the under-$5000 range as being the all-around winners for versatility.

It's interesting to consider resolution and noise for a moment. The analog scope is not particularly concerned with either one; resolution is as good as the phosphor coating, and low-level noise, being random in nature, generally doesn't stick around long enough to make the phosphor glow. With digital scopes, however, the resolution is determined by the sampling method, usually an 8-bit system with a vertical resolution of 256 points vertically and 1024 horizontally (this varies with make and model). At low frequencies, the display looks fine. As the frequency increases, the display make look a bit coarse.

In addition, the low-level noise voltages are sampled along with the signal, and if displayed, give a jagged line and the impression of very low resolution indeed. Most scopes use signal averaging to eliminate this; a number of signal repetitions are sampled and the average value is computed by the microprocessor. The result can be superior to an analog scope: each time the number of samples is doubled, the apparent signal-to-noise is doubled. An averaged sample of 128 passes, for instance, suppresses noise on a repetitive signal by 21dB. Try holding the tip of an analog scope's probe between your fingers. The result will usually be a very blurry display of 60Hz noise. Try the same thing with the signal-averaging of a digital scope, and all the fur and fuzz drops away, revealing a much cleaner 60Hz noise voltage.

You might want to look into cursoring functions. Dots or lines on the CRT are set to bracket any desired amplitude or time period, and the value can be read directly from a digital display at the borders of the screen. They're sometimes available on analog scopes, though they're more naturally found on the digital storage types.

And one last point: before you dismiss digital storage models as too expensive, consider that the units with comprehensive cursoring facilities can also replace (or add) a voltmeter, frequency counter and elapsed-time counter. Besides, they're a delight to use!.

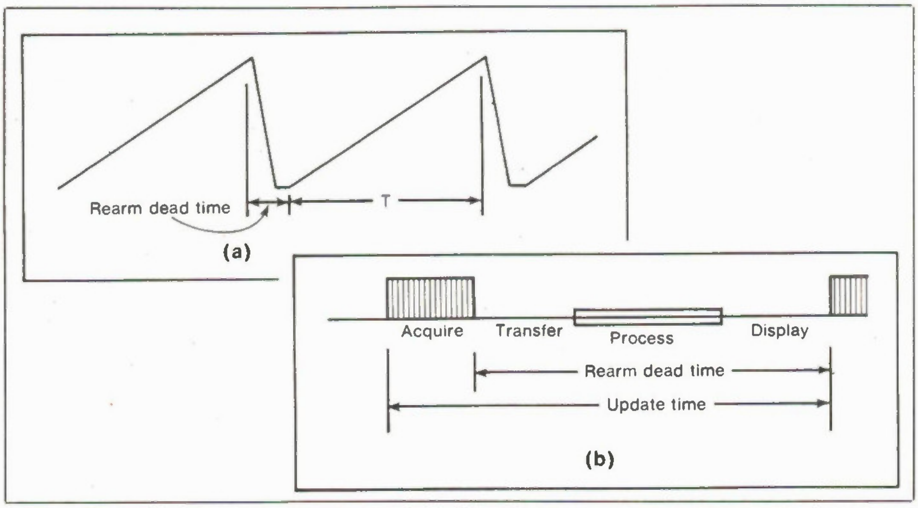
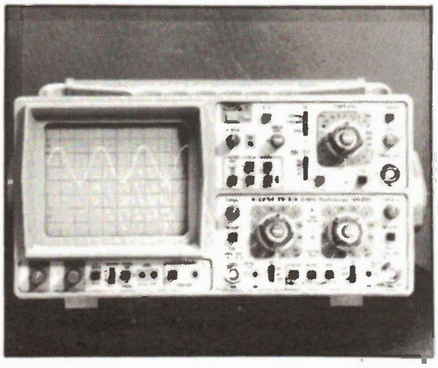
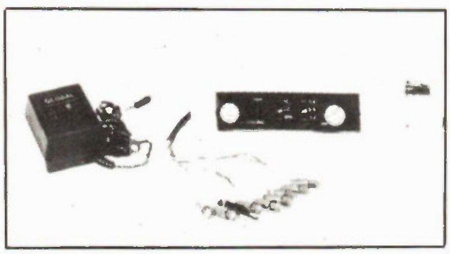


Fig. 1. An analog scope captures nearly all waveform changes because its trace is active most of the time (a). The inactive time, or rearm dead time, is only about 10 to 20 percent of T, the active display time. A digital storage scope, however, has a long-rearm dead time (b) because of sampling and conversion operations (Courtesy of Tektronix).



The **Hameg HM205** is a 20MHz dual-channel digital storage scope with 2mV/div sensitivity and triggering up to 40MHz. Our work with Hameg scopes has always pointed up their fine triggering amplifiers, and the 205 is no exception, with an active video trigger for viewing noisy or distorted TV signals. Other features include a built-in component tester and a 1kHz/1MHz calibrator. Signals stored in the single-shot mode are kept in memory, even if the real-time mode is used.

BCS Electronics Ltd., 980 Alness St., Unit 7, Downsview, Ontario M3J 2S2, (416) 661-5585. Circle No. 34



If you'd like to look at multiple signals, but aren't up to buying an expensive multi-input scope, the Global MX-8 Multiplexer is ideal for feeding up to eight analog or digital signals into any single or dual-channel scope. It features 40V peak-to-peak input range to accommodate CMOS, a frequency range to 5MHz and overvoltage protection to 100V. Probes and an AC adapter are included.

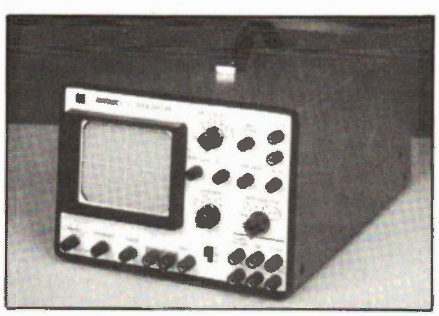
Distributor: Len Finkler and Co., 80 Alexdon Rd., Downsview, Ontario M3J 2B4, (416) 630-9103. Circle No. 35

As one of the world's leading manufacturers of test equipment, **Tektronix** has a comprehensive lineup of analog and digital oscilloscopes. The **2220** dual-channel has a bandwidth of 60MHz, a 4K memory, averaging, a plotter output and an optional RS232/GPIB output. The **2230** has the same, plus 100MHz bandwidth, 3 memories, battery backup option, and a cursor measurement system. Stored waveforms can be expanded, compressed or repositioned. Various modes such as trigger parameters and display settings can be tailored by the user with a menu system.

Tektronix Canada Inc., PO Box 6500, Barrie, Ontario L4M 4V3, (705) 737-2700.
Circle No. 36

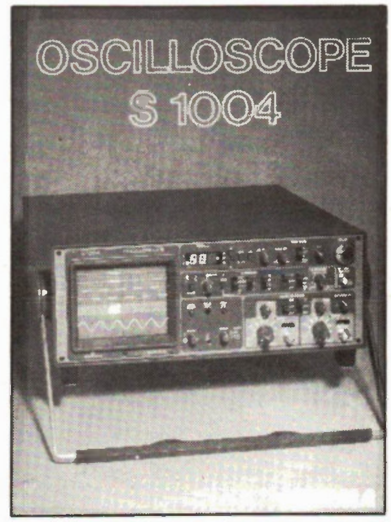
The **Heath ID-4850 Digital Memory Oscilloscope Kit** will turn any IBM PC or compatible computer into a 50MHz digital storage scope with a risetime of 7ns. It can also be used with any single-channel oscilloscope that has at least 5MHz bandwidth and an external trigger input. The supplied software allows full control of the oscilloscope functions from the keyboard of the computer. The computer displays the dual traces on an 8 by 10 graticule. Waveform displays can be stored on disk for later reference or waveform averaging. Also available assembled as the SD-4850.

Heathkit Centres, or the Heath Company, 1020 Islington Ave., Toronto M8Z 5Z3, (416) 232-2686. Circle No. 37



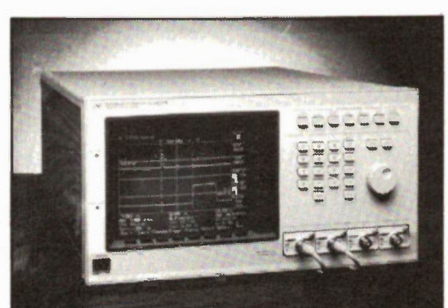
The **Samick-505** is a low-cost general purpose scope for the hobbyist or student. It features a bandwidth of DC to 4.5MHz, a vertical sensitivity of 20mV/div, a horizontal input from DC to 250kHz, phasing up to 140 degrees for frequency sweep and horizontal deflection circuits.

H.W. Cowan Canada Ltd., 99 Coons Rd., PO Box 268, Richmond Hill, Ontario L4C 4Y2, (416) 773-4331.
Circle No. 38



The **Hewlett-Packard 54110D Colour Digitizing Oscilloscope** is only one of many in HP's vast lineup of test equipment. It features a 1GHz repetitive bandwidth and adds full colour capabilities to the features of the 54100 scope introduced in 1984. 4,096 colours are available, of which any nine can be displayed at once. This simplifies viewing the rapidly changing environment of logic and data signals, differentiating between overlapping, superimposed or similar waveforms and helping to associate displayed information with corresponding data or waveforms. The 54110D measures frequency, period, pulse width, transition times, peak-to-peak amplitude, top and base voltage levels, preshoot and overshoot. A multiplexing input is available for multiple probes. At $31,749, they aren't for fixing the family TV, but what a way to work with logic.

Hewlett-Packard (Canada) Ltd., 6877 Goreway Drive, Mississauga, Ontario L4V 1M8, (416) 678-9430. Circle No. 39



An Austrian line of scopes is represented by the **Norma S 1004** dual-channel oscilloscope. One of its specialities is an auto-focussed beam with an internal

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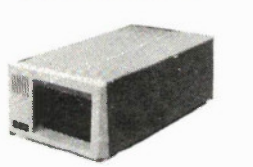
(D) OPEN FRAME Northern Telecom switcher as widely sold, +5v-4A, ± 12V-1Amp and -5 at 1 Amp, very good deal .... $ 18.95
Power cord for (D) above $ 3.50
(E) IBM OPEN FRAME, came from the defunct NCR compatible, +5v-7Amp, +12v-3Amp, -5, 12v-½Amp, runs the whole thing .... $ 59.95

V-20 CHIP

You may have heard of the NEC V-20 chip. It is an upgraded 8088 that can run programs up to 50% faster (depending on code). It also can run Z-80 code, allowing it to be used for Z-80 development. Especially good for Video when using code using it's features. A hot and hard to get CHIP at (5 Mhz) $24.95
Faster version runs at 8 Mhz .. $44.95

HARD DRIVE BOX



This nicely made box is ideal for externally mounted hard or floppy drives. It has space for one full height or two half height drives and power supply space at rear. This is a well made and rugged units for only $59.95.

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(A) Standard 8 slot hinged case XT® case. Fits side or back power supply (Specify) Has much heavier metal than competitors for stability, takes 1-4 ½ sized drives and fits very well $79.95
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As you know the IBM colour graphics card does not look very good on a monochrome monitor. This is because often two colors look the same on monochrome so you cannot read red print on a blue background or some such. This little gray scale proportinately scales each color into a different intesity allowing easy viewing on amber, green or white monitors. We sell it as a kit for only (with cable) $19.95
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Bare PCB and assembly data .... $ 29.95
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Bare PCB and assembly data .... $ 24.95
(F) 384K/MULTIFUNCTION card, exact copy of AST SIXPACK, Ser, Par, Clock, Cal, Game I/O with software and ports, W & T. OK. $169.95
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Bare PCB and assembly data .... $ 19.95
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Bare PCB and assembly data .... $ 12.95
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Bare PCB and assembly data .... $ 12.95
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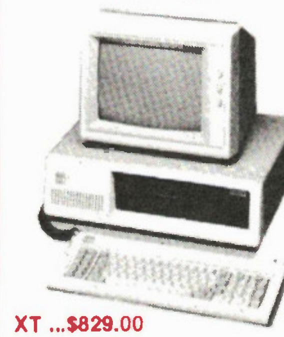
IBM COMPATIBLE SYSTEMS



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What a deal, the nicest systems of all at the lowest price for good merchandise. The basic system has the following. For $829.00

- 640K Motherboard
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- KRAM CARD, OK .... Add $139.00

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SME-XT, wired with OK 3 hr burn-in $199.00
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SME-XT, bare pcb, book parts list . $ 34.95

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SME-XT A Bare PCB, book, parts list .... $ 39.00

TURBO 8.00 MHZ VERSION
SME-XT B, wired, 3 hr burn in, OK . $249.00
SME-XT B, wired, no IC's at all ... $139.00

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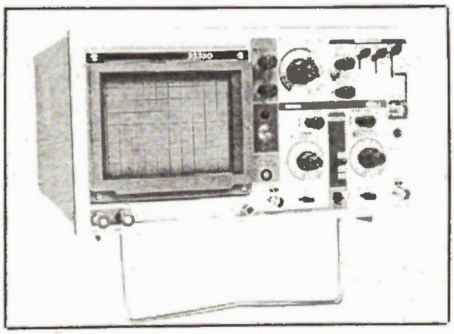
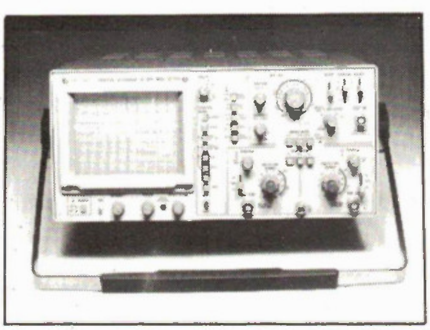
graticule for sharp, parallax-free viewing. The timebase is also automatic, setting itself to display 1.5 to 5 cycles of signal, plus manual control.
A second timebase employs an adjustable delay. Norma is represented by H.W. Cowan Canada Ltd. (mentioned above), and by:

Mesurina Ltd., 57 Hyde Park, Beaconsfield, Quebec H9W 5L7, (514) 697-6581. Circle No. 40



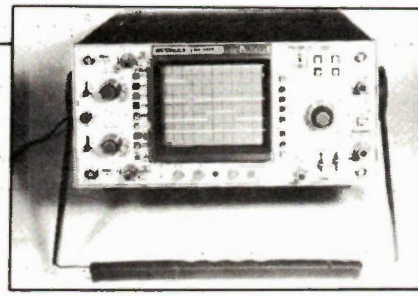
The **Model 33330** from KB is a 20MHz dual-trace scope with a 20MHz bandwidth aimed at general-purpose use. The vertical sensitivity is 5mV/div in 12 ranges, and the horizontal range is 0.2us to .5s per division. A component tester is included, providing up to 9V and 2mA to any components inserted into the front panel jacks. An intensity modulation (Z-axis) input is provided.

KB Electronics, 355 Iroquois Road, Oakville, Ontario L6H 1M3, (416) 842-6888. Circle No. 41



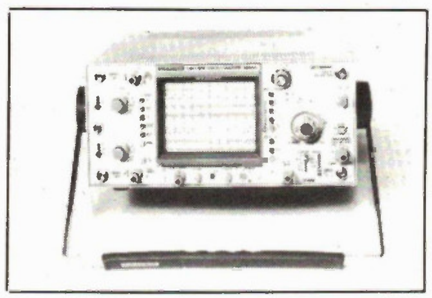
The **Meguro MSO-1270A** scope is a digital dual-channel with 20MHz bandwidth. It features a 2-kiloword 8-bit A/D converter for each channel, enabling high-density monitoring. The pre and post trigger functions, along with the split memory function, provide for easy comparison of two or four waveforms. The time axis is capable of 160 times magnification.

RCC Electronics, 310 Judson St., Unit 6, Toronto, Ontario M8Z 5T6, (416) 252-5094. Circle No. 42



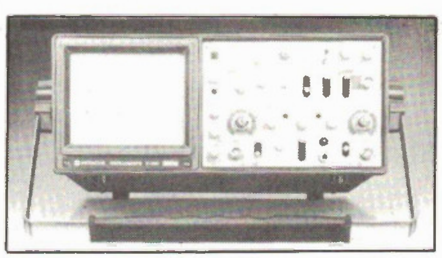
The **Leader LBO 5825** is a 35MHz real time oscilloscope, providing up to 500kHz of digital storage with dual channel capability. The memory for each channel permits four waveforms on two channels to be stored and displayed simultaneously, and if a waveform in the real time mode is included, six waveforms may be viewed. The waveforms can be stored for up to two weeks with the power off via a battery backup. An XY output for recorders is provided.

Omnitronix Ltd., 2410 Dunwin Drive, Unit 4, Mississauga, Ontario L5L 1J9, (416) 828-6221. Circle No. 43



The **Leader LBO 516** is a low-cost 100MHz two-channel scope. Like the Norma, it features a high-voltage tube and an internal graticule for parallax-free viewing. Alternate sweep on the main and delayed timebases, a 2ns/div sweep speed and trigger view make this scope ideal for servicing, R&D or teaching. A channel-1 output is provided for frequency measurements.

Omnitronix (see above)



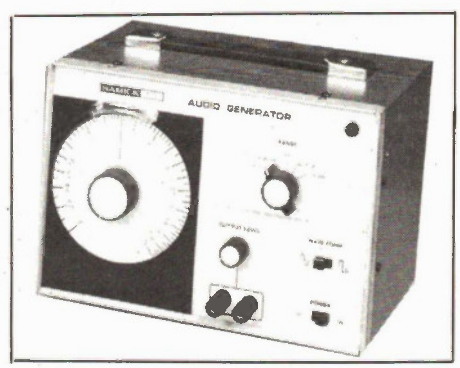
The **Hitachi V680** oscilloscope is a digital storage scope with full cursoring capability. It features 5mV/div vertical sensitivity, an adjustable delay line, a 60MHz bandwidth, and a third channel for viewing up to six traces. The cursors measure frequency, time and voltage as well as displaying the status of various controls. The V680 was reviewed in last month's *Electronics Today.*

Hitachi Denshi Ltd. (Canada), 65 Melford Drive, Scarborough, Ontario M1B 2G6, (416) 299-5900. Circle No. 44

Generators

The signal generator is as necessary as the oscilloscope, but rarely gets much attention. Although it's easy enough to make a circuit oscillate, as we all know when that pet circuit takes off and makes smoke, it's quite a challenge to make one that has both amplitude and frequency stability over a wide range. Plus, of course, low harmonic distortion. The lowly audio oscillator may not seem like much next to its regal cousin, the 100MHz synthesized RF generator, but it's an engineering challenge nonetheless.

If you're looking for a standard audio oscillator, any unit will do as a starter, but you'll find certain features very useful. A squarewave output is handy, as is a 50-ohm output; an stepped output attenuator switch is great in addition to the usual level knob. If you don't have the ability to attenuate signals down to the millivolt level, you'll have to build or buy an attenuator anyway. The function generator has some nice features, particularly for R&D: various waveforms, very wide range, and (usually) voltage control of the output frequency and amplitude.



The **Samick 705** is a low-cost general-purpose audio oscillator, suitable for small testbenches, servicing, instructional purposes, etc. Its range is 20Hz to 2MHz in 5 ranges; the output is 600 ohms, with sine and squarewaves switch-selectable. The distortion is less than 0.5 percent from 200Hz to 20kHz. The output sine voltage is 7V RMS open circuit and the squarewave output is 7V p-p.

H.W. Cowan Canada Ltd. (see under Oscilloscopes) Circle No. 45

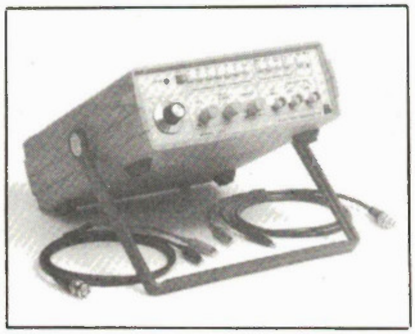
The **Samick 605** is a low-cost RF generator with a range of 100kHz to 70MHz in 6 ranges. The frequency accuracy is plus-or-minus 2.5 percent, and the output voltage is more than 30mV RMS into 50 ohms. A 3-step attenuator provides 40dB of attenuation, and a 400Hz audio signal is generated internally.

The **Beckman Circuitmate FG2** is a function generator with sine, square, triangle and TTL pulse outputs. Frequency range is 0.2Hz to 2MHz. The duty cycle of the signal can be set to any desired value and a DC offset voltage can be added to the output for applications requiring bias. A 20dB attenuator switch is standard. $279.

Lenbrook Electronics, Unit 1, 111 Esna Park Drive, Markham, Ontario L3R 1H2, (416) 477-7722. Circle No. 46

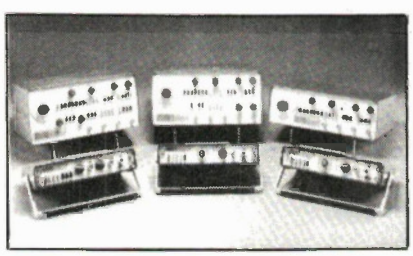
The **Fluke 6060A** is a synthesized signal generator for testing a wide variety of RF receivers, filters, amplifiers and mixers. It covers a frequency range of 0.1 to 1050MHz with 10Hz resolution and has a switching speed typically less than 100ms. Non-harmonic spurious products are -60dBc and harmonics are less than -30 across the entire range. Amplitude levels are selectablefrom -137dBm to + 13dBm with 0.1dB resolution.

Allan Crawford Associates Ltd., Test and Measurement Division, 6503 Northam Drive, Mississauga, Ontario L4V 1J2, (416) 678-1500. Circle No. 47



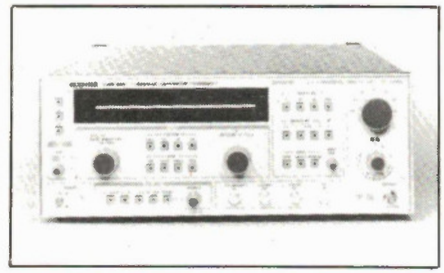
From Brunelle Instruments' wide range of test equipment comes the **Model 3020 Frequency Generator**. The output waveforms are sine, square, triangle, pulse and ramp, from .2Hz to 2MHz in seven ranges. Three decades of range can be controlled with a 0-10V control signal. DC offset of 10 volts can be added to the output. It's also available with an internal frequency counter as the Model 3030.

Brunelle Instruments, 73-6th Range South, St. Elie d'Orford, Quebec J0B 2S0, (819) 563-9096. Circle No. 48



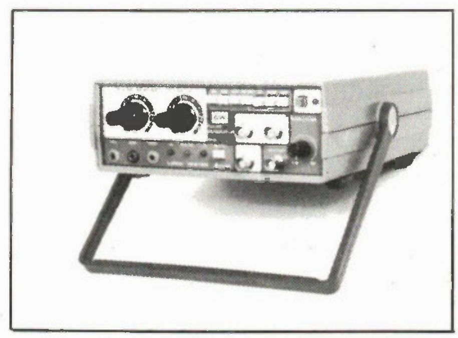
A new series of generators is available from **OK Industries**. The Model 205 is a 5MHz function generator, the Model 206 is a 5MHz sweep/function generator, and the Model 207 is a 5MHz pulse/function generator. All models offer sine, triangle, square and haversine waveforms, a TTL output, a 20V 50-ohm output, variable symmetry, switchable attenuation, and external sweep and trigger/gate modes. The 206 has both linear and log sweep, with a 10,000:1 range on the log sweep, plus a full marker function.

Len Finkler and Co. (see under Oscilloscopes).



The **Leader LSW 359** is a wideband sweep marker generator suitable for R&D, lab inspection, alignment of communications equipment, etc. It covers the frequency range from 1-1500 MHz in 3 bands. Each band has sweep speeds varying from 10ms-100s in four ranges, plus a manual sweep function. 1, 10, 50, and 100MHz markers are standard, as well as a variable marker.

Omnitronix Ltd. (see under Oscilloscopes)



The **Goodwill Instruments GPG8018** is a pulse generator with a logic tester function for use with CMOS or TTL. The frequency range is 0.5Hz to 5MHz, and the pulse period range is 100ns to 0.1s. It can be used with an oscilloscope for adjustable sweep delay, or for testing counter circuits and shift registers, or for logic testing of TTL, CMOS and related logic families.

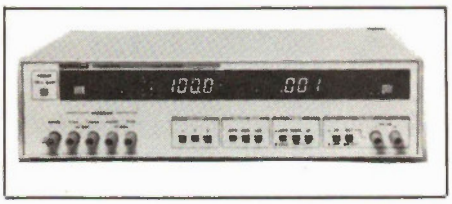
Duncan Instruments Ltd., 121 Milvan Drive, Toronto, Ontario M9L 1Z8, (416) 742-4448. Circle No. 49

The **King Instruments FG-2512F** is a 0.2 to 2MHz function generator with sine, square, pulse, triangle and ramp waveforms. With variable width and repetition rates, it becomes a pulse generator as well. It also has external voltage control and a DC offset voltage can be added to the output.

RCC Electronics (see under Oscilloscopes)

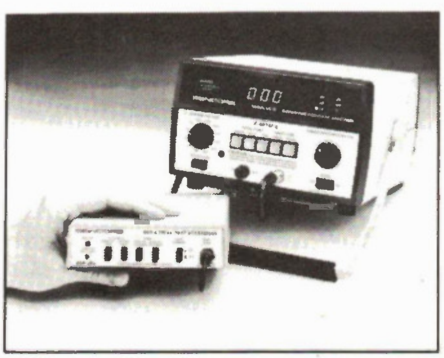
LCR Meters

Not something that the average tech spends his time daydreaming about, the LCR meter is indispensable to quality control, production testing and R&D departments. The ability to read the value of components quickly and accurately is no small thing, particularly when it comes to capacitors and inductors. In general, they work by placing the unknown component in one leg of a bridge and then applying a calibrated test tone. Balancing the bridge then produces a readout of the component value. Naturally a microprocessor takes care of the details, eliminating much knob-twiddling and nulling of meters. The older manual models always seemed quite willing to null, even at three or fourdifferent values that didn't make sense.



The **Leader LCR 745** is a digital LCR meter featuring automatic and manual ranging. This CPU-controlled meter is designed to measure capacitance, inductance, resistance, dissipation factor and quality factor. The accuracy is plus or minus 0.35 percent of the reading. Test frequencies of 1kHz and 120Hz are switch selectable.

Omnitronix Ltd. (see under Oscilloscopes)

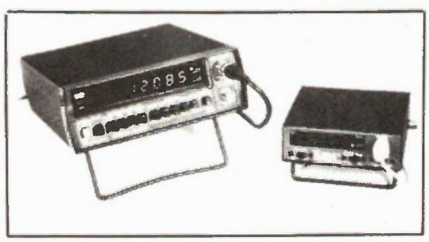


The **Sencore Model LC75**, also known as the Z Meter, is said to have high speed when checking capacitors and inductors due a larger charge current than previous models. It also tests for ESR (Equivalent Series Resistance), an important parameter for capacitors in switching PSUs, etc. Included in the capacitor test are leakage and dielectric absorption. An optional accessory, the SCR 250, allows the unit to test SCRs and triacs. Full autoranging.

Duncan Instruments (see under Generators).

The **Wayne Kerr LCR Meter 4220** is designed for the production line, and features not only auto-ranging, but detection of the type of component inserted. Capacitors, inductors and resistors can be tested over 8 decades of range. The component fixture is a 4-wire type which effective cancels errors caused by contact resistance and contact lead impedance.

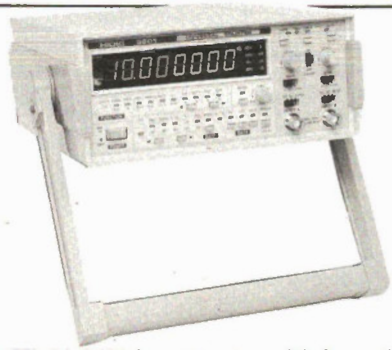
Wayne Kerr Inc., 600 West Cummings Park, Woburn, MA 01801, (617) 938-8390. Circle No. 50



The **Triplett 7000 Series** frequency counters cover a wide range of frequencies. The Model 7200, a compact version, counts from 5Hz to 160MHz with a variable gate time. The 7500 (10Hz to 150MHz) and the 7700 (dual channel, 10Hz-100MHz and 50MHz-550MHz) feature period and RPM measurement.

Len Finkler and Co. (see under Oscilloscopes)

Not as exotic as it might seem, the **Novasina Dewpoint Transmitter** indicates the dewpoint temperature and ambient temperature of air or other gas. That's the temperature at which condensation forms, for those who haven't struggled with pink fiberglass insulation during renovations. Typical applications are DP measurements in cold storage rooms, dry-

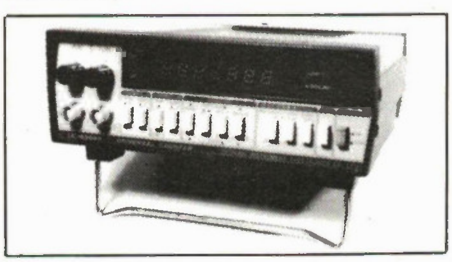


The **Hioki 3601** is a counter with lots of features all in one box, including period, frequency ratio, time interval, pulse width, duty cycle, totalize and RPM. Three ranges cover 10Hz to 160MHz, and the reciprocal counting method can be used to improve resolution. Averaging and difference measuring minimize the effect of noise. The unit can be connected to a GPIB (General Purpose Instrument Bus), enabling computer control and data acquisition.

RCC Electronics (see under Oscilloscopes).

The **Goodwill GFC8010F** is a 120MHz counter using two ranges, eight digits and LSI technology to shrink the size. The 1 megohm input impedance likes to see about 10 to 30mV depending on the frequency. Gate times of 0.1s, 1s, and 10s are switch selectable.

Duncan Instruments Ltd. (see under Generators).



If you need a two-channel counter, the **King Instrument KI6304A Universal Counter** has, indeed, two. It can measure frequency, period, time interval and ratio. It can totalize measurements. It has a range of 10Hz to 10MHz and 1MHz to 100MHz prescaled on A. It has a range of 2.5MHz direct on B. It has seven digits. It comes from:

RCC Electronics (see under Oscilloscopes).

Digital Multimeters

The DMM is now so inexpensive and so full of features that they're replacing the standard moving-coil multimeter as the basic bench meter. Maybe they'll even get to the point where they'll replace that $20 needle meter that you have in your toolbox.

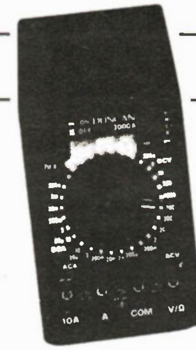
Once manufacturers get a custom chip to make their meters go, it's not abig step to design in extra features, such as diode testers or HFE measurement.

The **Brunelle 4060 DMM** has 3 1/2 digits, full-scale DC and AC volts from 200mV to over 750V, DC and AC current from 200uA to 10A, resistance from 200 ohms to 20M, a diode tester and HFE from 0 to 1999. DC accuracy is 0.25 percent and AC accuracy is 0.5 percent. The Brunelle line includes many other types of meters.

Brunelle Instruments (see under Generators)

If you prefer rotary switches to the side-buttons, the **Norma D1216** has what you want. It features DC and AC volts and amps, and a diode tester similar to the Brunelle 4060. DC accuracy is 0.2 percent and AC accuracy is 0.75 percent to 400Hz, 2.5 percent to 5kHz. A range of accesories is available for HF and HV measurements. Other styles of bench and handheld meters are available from the Norma line.

H.W. Cowan Ltd. (see under Oscilloscopes).



More good old rotary switches in the **Duncan Model 3000A.** Besides the usual, the 3000A reads DC and AC current to a remarkable 20uA FSD and HFE to 1000. A continuity beeper and diode tester are included.

Duncan Instruments (see under Generators).

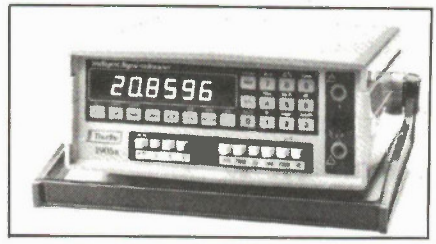
The **Triplett Model 4750** has some unusual features. Besides the usual DMM scales, it has dBm, autoranging, temperature, data hold, peak hold, and true RMS measuring for AC. A reading can be stored as a zero reference point for making relative measurements. Basic DC accuracy is 0.04 percent. A wide range of adapters and accessories is available.

Len Finkler and Co. (see under Oscilloscopes).

The **Fluke Model 37** is a benchtop multimeter that incorporates some of the features found in Fluke's very successful 70-series DMMs. The digital display has the analog bargraph for ease in reading changing signals, a storage compartment

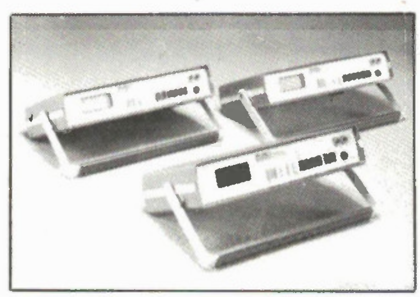
in the rear holds test leads and accessories, the unique Touch Hold feature captures readings for hands-free operation, and autoranging with manual selection is standard. Both min/max and relative measurements can be made. Under $360.

Allan Crawford Associates (see under Generators)



If you need more digits and computing power with your DMM, the **Thurlby 1905A** has that indeed. The display has 5 1/2 digits, and the micro inside can handle functions such as linear scaling with offset, percentage deviation, limits comparison, offset zero, decibels and so forth. Basic accuracy is 0.015 percent. Input impedance is selectable as 10M or an unusually high 10,000M. A data logging facility can record up to 100 readings in memory.

EDG Electronics, 3950 Chesswood Dr., Downsview, Ontario M3J 2W6, (416) 636-9404. Circle No. 57



A new series of portable and benchtop DMMs is the **OK 600 Series**. The three models feature 29 ranges, 0.1 percent basic accuracy, 3 1/2 digits, and AC/battery power. They also have a diode checker, overrange indication and high common mode rejection.

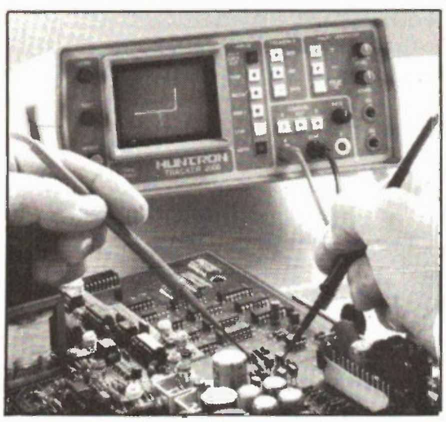
Len Finkler and Co. (see under Oscilloscopes).

The new **Hioki 3217** is the smallest DMM available so far: a bit larger than a credit card, it fits nicely in a shirt or coat pocket. It features 3 1/2 digits, AC and DC volts to 450, resistance to 2M, an instantaneous continuity checker with a beeper and over-voltage protection, and a diode checker. Autoranging is standard. Complete with leads, battery and case.

RCC Electronics (see under Oscilloscopes).

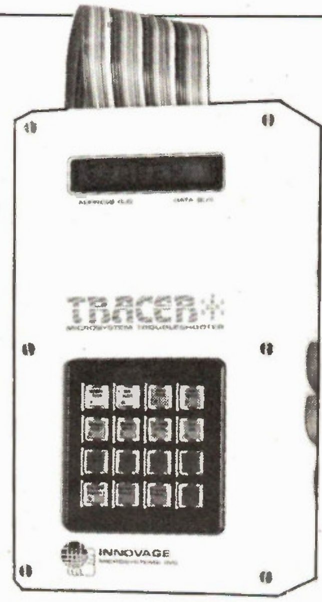
Troubleshooting Aids

There are so many troubleshooting aids that we've started collecting them for a future issue. In the meantime, here are a few items that will ease the problem of trying to find an escaped byte or a dead volt.



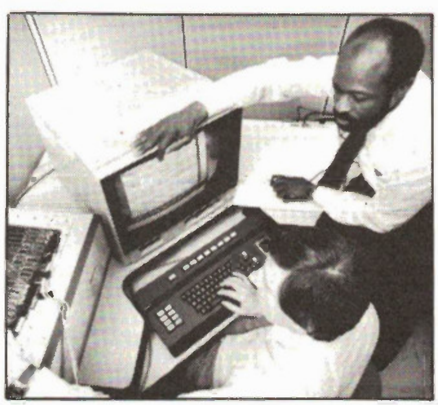
The **Huntron Tracker 2000A** and the **I Interface** from Cyprus Products can do in-circuit or out-of-circuit testing of ICs, analog circuits, digital circuits, etc. A wide range transistors and other reactive devices can be checked. The interface has two channels for test instruments, such as the Tracker on one channel and a meter on the other. A known good circuit can connect to one output and the device under test to the other, allowing comparison checking. The 2000A has automatic sequential switching and three test frequencies; a variable pulse generator allows testing of devices such as triacs and SCRs. Circle No. 58

Cyprus Products, 7648 Heather St., Vancouver, BC V6P 3R1, (604) 327-8814.



The **Tracer 100XT** from Innovage is designed for troubleshooting computers and logic systems. It connects to the CPU and allows you to operate it during testing. You can set breakpoints, test memory cells, examine or change memory contents, trigger a scope and more. Built-in diagnostics give you lots of information about the circuit under test. A Tracer is slated for a product review in an upcoming issue. The basic unit is $1750.

Innovage Microsystems Inc., 5-6125 12 Street SE, Calgary, Alberta T2H 2K1, (403) 255-9590. Circle No. 59

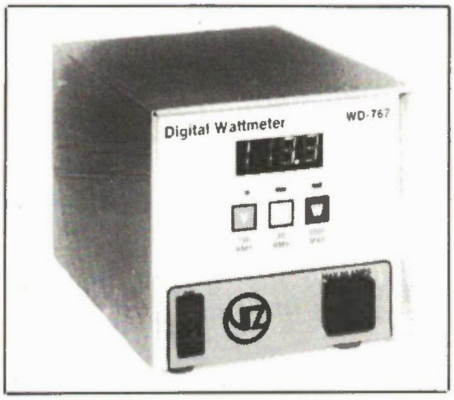


If your production models are plagued with stray electromagnetic emissions, the **Emscan** from Bell Northern Research reads EMI and displays the results on a colour monitor. All you do is place your gadget on the scanner, and its EMI emission is converted to an electronic fingerprint and displayed over the layout of the components, which is stored in the BNR computer-aided design system. Not the kind of thing you'll find at the corner milk store; there's no word yet about production quantities.

Bell Northern Research, PO Box 3511, Station C, Ottawa, Ontario K1Y 4H7, (613) 727-2958. Circle No. 60

Miscellaneous Equipment

A grab-bag of goodies that do specialized jobs. Not everyone would like a wattmeter, for instance, but when you need one, you really *need* it.

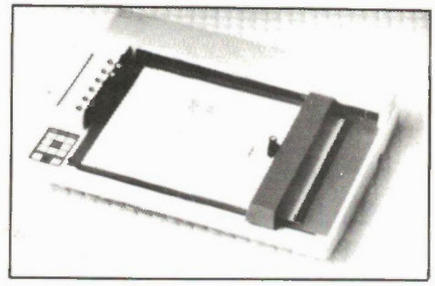


The **Viz WD767 Wattmeter** will display true RMS volts, true RMS current up to 20 amperes, and the true power level up to 2kW. The power factor can be determined by noting the difference between the displayed true power and the product of the displayed volts and amps. A unit is on the way for a product review, wherein we'll attempt to unravel the mystery of true versus apparent power in reactive circuits. In the meantime, should you want to measure true power within one percent, contact:

H. W. Cowan Canada Ltd. (see under Oscilloscopes).

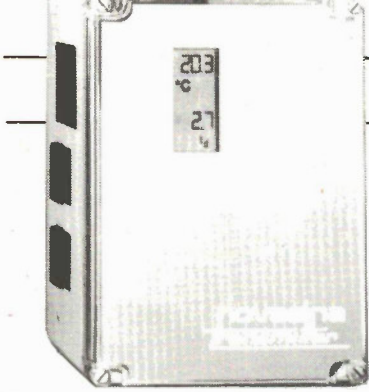
The **Daetron MC300** is a capacitor checker *par excellence.* It can test everything you've ever wanted to know about capacitors, plus some things you never thought of. A review of the unit appeared in the February, 1986 issue of *Electronics Today* . Test capacitance, dielectric absorption, leakage, insulation, cable length, sort capacitors in different modes, test transistors and zener diodes and more. All for $149.95 and it's made in Canada.

Daetron, 935 The Queensway, Box 641, Toronto, Ontario M8Z 5Y9, (416) 255-9701. Circle No. 61



If you're hatching a plot, the **Sekonic A3 Plotter** is six pen digital unit; with appropriate software it is capable of high-quality engineering and business graphics. It's compatible with most computers and features Centronics or RS232 inputs. Plotting speed is up to 300mm/sec with a maximum resolution of .025mm and an accuracy of 0.2mm.

Omnitronix Ltd. (see under Oscilloscopes).



ing processes, or other industrial processing.

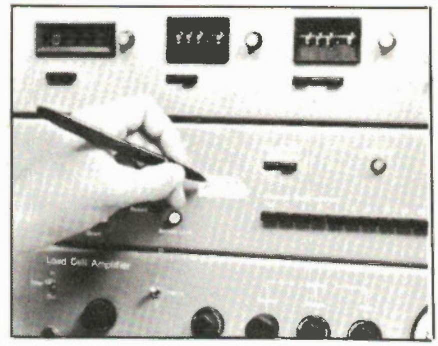
Alexander D. Smart Ltd., 351 Steelcase Road W., Unit 3, Markham, Ontario L3R 4H9, (416) 474-0550. Circle No. 63

When it comes to testing wire insulation, the old ohmmeter doesn't make it. You need a device with a high-voltage generator inside, and the **Kyoritsu 3111** is an insulation tester that fills the bill, converting its battery voltage to 500 and 1000V. Current is limited to 500uA. There's also a continuity function with a 2 ohm mid scale. The word *earth* at the top of the dial means that you can plant flowers in it.

Omnitronix Ltd. (see under Oscilloscopes).

The convenience of the handheld digital thermometer means that they're replacing the glass bulb type. The **Fluke Models 51 and 52** feature 0.1 degree C resolution, K or J thermocouples, internal compensation for ambient temperature, and a Hold button so you can run indoors and warm up before reading the liquid-crystal display. The Model 52 has two inputs, and will read either one or the difference between them.

Allan Crawford Associates (see under Generators).

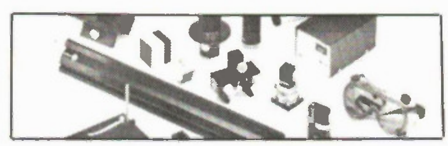


After you've bought every single piece of test equipment in this article, you'll want to get some labels so you'll know which is which. The **Brady Write-On** labels are available pretitled; just write, peel off and apply. They're furnished on dispenser cards that flex easily for typewriter use. Custom labels available on request.

W.H. Brady Inc., 10 Marmac Drive, Rexdale, Ontario M9W 1E6, (416) 675-2112. Circle No. 64

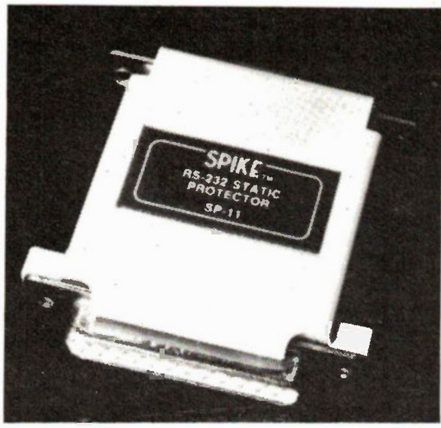
Yet another thermometer is the **Thermostar 21DS**. It's advantage is that it's a non-contact type that uses infrared optics and electronic processing. Single lens reflex optics allows simultaneous viewing and measuring of the target, and a filtering system lets the operator look safely at very high temperature objects. Analog and digital outputs are available for recorders or loggers.

Alexander D. Smart Limited (see above).



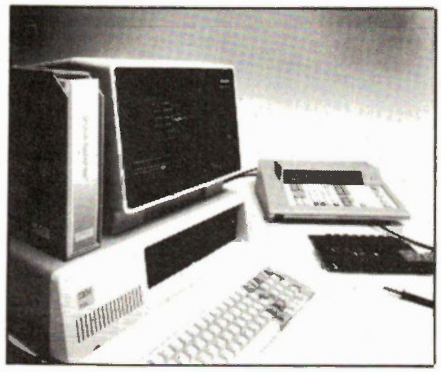
If you're interested in optical measuring and related test equipment the **Optikon** company has sent us the most amazing collection of catalogs and product sheets. Included are precision lens elements, prisms, mirrors, filters, fibre optics, lasers, every conceivable type of fibre optic generator and test set, spectral analyzers, photometers, radiometers, and more. They're also the representatives for Micro-Controle, a firm specializing in computer- or manually-controlled mounting devices and servomotors for optoelectronics, microscopy, microelectronics, etc.

Optikon Corporation Ltd., 410 Conestogo Road, Waterloo, Ontario N2L 4E2, (519) 885-2551. Circle No. 65



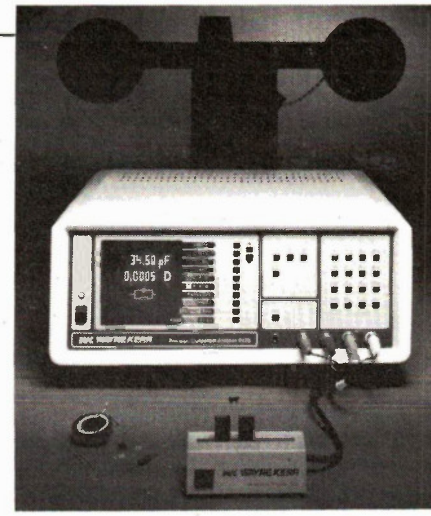
Now that more and more test units are becoming fairly intelligent, they communicate amongst themselves using one of several methods. If you're using the common RS232 serial communications links, you might be interested in the **E RS232 Static Protector**. It comes complete with in and out connectors and installs between a piece of equipment and its cable. Metal oxide varistors snip off overvoltage spikes, and where's a better place to find overvoltage spikes than a testbench?

Home Base Inc., 60 Nably Court, Scarborough, Ontario M1B 2K9, (416) 293-4488. Circle No. 66



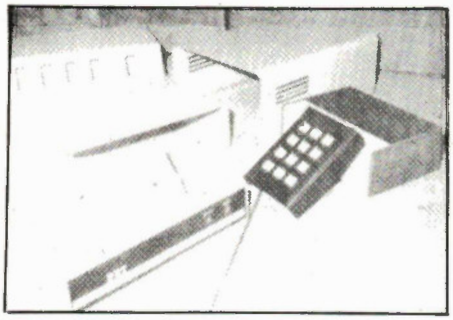
The **TestWriter** is a software product designed to reduce the time and money involved in developing guided fault isolation (GFI) programs for digital circuit testing. It's used with an IBM or IBM compatible computer in conjunction with the Fluke 9020A microsystem troubleshooter. Fault trees are automatically generated and displayed from information supplied by the user, such as component type and interconnections. The operator makes selections from menus, guided by prompts and graphics.

Allan Crawford Associates (see under Generators)



A colour brochure is available describing the **6425 Component Analyzer** from Wayne Kerr. It measures the usual LCR values, plus phase angle, dissipation factor, impedance, Q, and more. The display is a 7-inch CRT which shows values plus the schematic representation of the component or components being tested. The main menu (index) lets the user enter various limits for batch testing.

Wayne Kerr Instruments (see under LCR meters).



If you're thinking of making test equipment or other electronic products for yourself or for resale, you might want to contact **Canadian Computer Designers Mfg.** of Mississauga, Ont. They specialize in custom prototyping and new product design and development. Available are custom cabinets, computer cabinets, rack enclosures, custom heatsinks, bezels, brackets, etc.

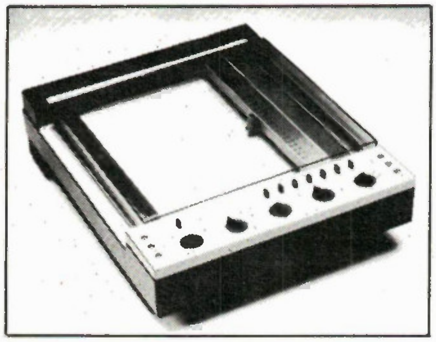
Canadian Computer Designers Mfg., 7150 Torbram Rd., Unit 10, Mississauga, Ontario L4T 4B5, (416) 673-7773.

Circle No. 67

The Alnor **8525 Thermoanemometer** has a digital readout, a hold button and an automatic averaging feature. Temperature can be measured from 0-70 degrees C (32-158 F), and air velocity can be measured from 20 to 2000 feet per minute. Some applications include air measurement in fume hoods, spray booths, air handling ducts, clean rooms, etc.

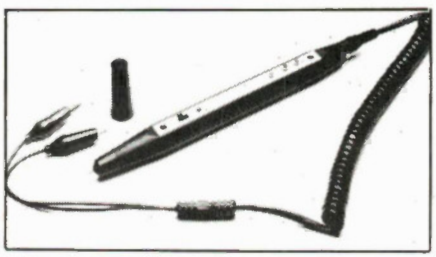
Alnor Instrument Company, 7555 N. Linder Ave., Skokie, Illinois 60077, (312) 647-7866.

Circle No. 68



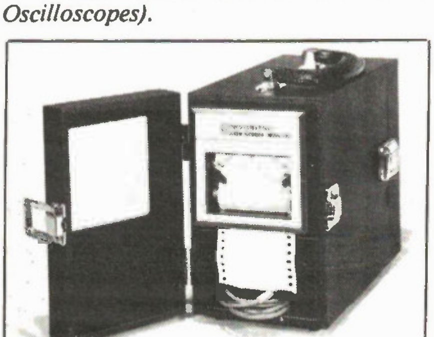
The **J.J. Lloyd PL 4** is an XY/t flat bed recorder that's easily transportable. Both input amplifiers have high-Z inputs and 18-step attenuators with maximum sensitivity of 25uV/mm. The electronically controlled chart drive has 9 speeds from 2mm/min to 20mm/sec. Calibration accuracy is greater than 0.2 percent.

Omnitronix (see under Oscilloscopes).



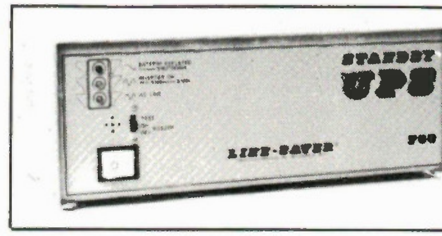
A digital logic pulser that helps performs in-circuit diagnosis is the **OK PLS-500**. The handheld pulser injects a signal into the circuit node so the response can be observed using a logic probe. This eliminates the need to desolder the device from the circuit board. The pulser is also capable of triggering or being triggered by another instrument. Pulse duration is 2us, long enough for accuracy and short enough to prevent damage to the device under test.

Len Finkler and Co. (see under Oscilloscopes).



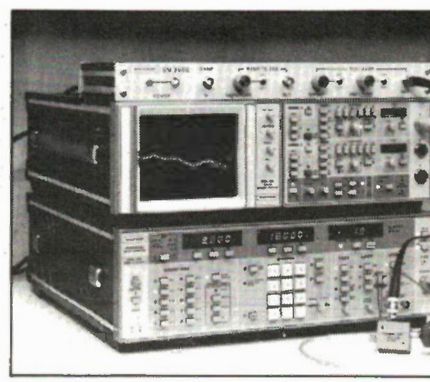
Another recorder is the **Kyoritsu 5350**. It's portable, loads by cassette, and its major feature is its ease of operation. There are three speeds, plus the capability of recording continuously for 33 days, measuring temperature, voltage, current, etc. It can also panel-mount.

Omnitronix (see under Oscilloscopes).



If you have a whole testbench full of computerized equipment, you know how annoying a power outage can be, particularly if you lose a lot of preselected settings. One cure is an uninterruptible power system, and one example of those is the **LS750 Line-Saver** by Kalglo. The 36V sealed rechargeable battery inside is converted to 750W worth of output, available in 120/240V, 50/60Hz. The output voltage is regulated by pulse-width modulation for best efficiency. Backup time is 5-10 minutes at full load, 35-40 minutes at one-third load.

Duncan Instruments (see under Generators).

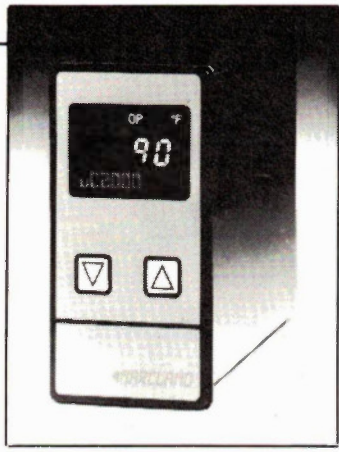


The **Wiltron SM3500** ramp generator is designed specifically for testing voltage controlled devices. Used in conjunction with the Wiltron 5600 analyzer, it simplifies the testing and analysis of devices whose characteristics vary due to an applied voltage. Loss or gain can be displayed over a 71dB range with 0.01dB resolution. The test ramp output can be adjusted for peak to peak voltages over a plus or minus 13V range.

Wiltron Instruments Ltd., Unit 102, 215 Stafford Road, Nepean, Ontario K2H 9C1, (613) 726-8800.

Circle No. 69

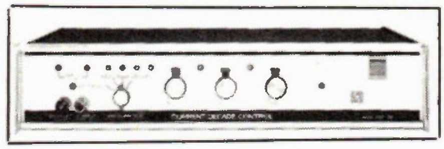
The **Marcland uC 2000** is a low-cost microcomputer-based temperature controller. The overall accuracy is 0.25 percent, and it can accept both J and K type thermocouples. Setpoint limits are set with the front panel membrane switches. The unit's tiny size make it ideal where space is at a premium.



Marcland Instrument Services Inc., 156 St. Denis, St. Lambert, Quebec J4P 2G2, (514) 866-4607. Circle No. 70

If you have to calibrate equipment or components to specific AC voltages, the **CDC-32** is an AC calibrator for meters, A/D converters, amplifiers, RMS converters, AC gain control circuits, etc. The output range is 10VAC RMS, with an accuracy of 0.06 percent of the setting. Output frequencies are 50, 60 and 400Hz. $995US.

Electronic Development Corporation,



11 Hamlin St., Boston, MA 02127, (617) 268-9696.

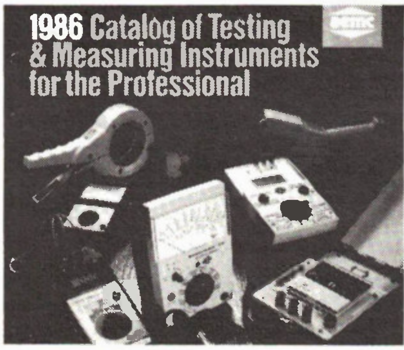
Inadvertently omitted from the section on oscilloscopes was the **Philips PM3055**. A 50Mhz scope, it features microprocessor control of just about everything. All parameters can be set instantly at the touch of one button, and an LCD panel reads out the settings. Automatic up/down buttons replace the usual stepped switches, and multifunction softkeys simplify the front panel layout. Other scopes in the 3050 series include a 100MHz model, IEEE computer hookup, etc. $1825.

Philips Electronics Ltd., S&I Division -Test and Measurement, 601 Milner Ave., Scarborough, Ontario M1B 1MB, (416) 292-5161. Circle No. 71

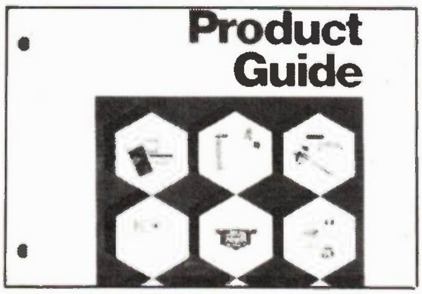
Catalogs

Here are just a few of the many catalogs we receive from distributors, and as usual, our apologies to those who had to be omitted due to space restrictions.

B&K Dynascan is represented by Atlas Electronics, 50 Wingold Ave., Toronto M6B 1P7, (416) 789-7761. The immense B&K line includes scopes, meters, generators, analyzers, and you name it.

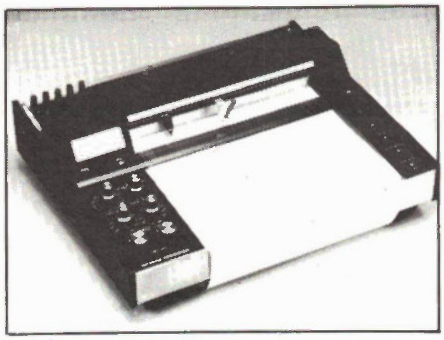


The **AEMC** line from Boston is represented by Duncan Instruments, 121 Milvan Drive, Toronto M9L 1Z8, (416) 742-4448. They make bridges, cable equipment, multimeters, add-on modules for varied functions, current testers, power meters, light meters, etc.



Cardinal Industrial Electronics supply western Canada with components, test equipment, cabinetry, audio equipment, chemicals and more. They have outlets in Calgary and Saskatoon, with the head office at Box 12000, Edmonton, Alberta T5J 2P4, (403) 483-6266. Circle No. 72

EICO the well-known manufacturer of test equipment in both kit and assembled form, is represented by H.W. Cowan Canada Ltd., 99 Coons Rd., P.O. Box 268, Richmond Hill, Ontario L4C 4Y2, (416) 773-4331. Circle No. 73



In the market for a chart recorder? The CR600 from J.J. Lloyds has a chart width of 250mm and two fully overlapping pens offering versatility as well as precision and linearity. The unit has an accuracy of better than 0.25%, linearity of 0.25%. Chart drive speeds range from 0.01mm/sec to 10mm/sec with a writing speed of 600mm/sec. The instrument also has switched calibrated ranges from 5uV/mm to 500uV/mm with a variable span control providing a complete overlap precision voltage source for calibration. Useful chart widths of up to 2 meters are possible using standard roll chart or Z-fold paper. Other features include: reverse direction, external speed, pen lift, and optional rack mounting hardware for operation in a vertical plane.

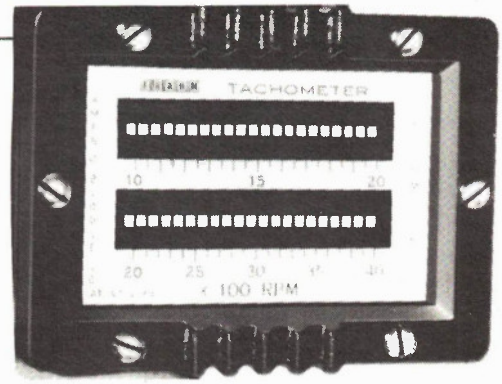
Omnitronix Ltd., 2410 Dunwin Dr. Unit 4, Mississauga, Ont., L5L 1J9. (416) 828-6221 Circle No. 74

If it's a weight indicator you're looking for, the **Bofors E1-TAD Digital Weight Indicator** is state of the art, designed to meet current and future user needs. In addition to normal weighing functions, its three microprocessors allow future communication to larger integrated systems. The unit may be operated from the front panel keyboard or via the Full Duplex 20mA serial loop. RS232c, RS422 and RS423 interfaces are optional.

Standard features of the E1-TAD are: zero-track, motion detection, 5 selectable tare modes, error messages from continuous diagnostics, a watchdog timer, remote control, and adjustable display brightness.

Options include analog outputs, BCD @ 5V or 24V levels, Setpoint Relays, and a real time clock. Various software options are available for batching, flow measurement, peak value display, manual tare, and accumulation.

Alexander D. Smart Ltd., 351 Steelcase Rd. W., Unit 3, Markham, Ontario L3R 4H9. (416) 474-0550 Circle No. 75



Checking the speed of your shaft is easy with **Frahm Vibration Reed Tachometers**. Handheld or permanently mounted, these tachs do not require direct contact with the rotating shaft or moving parts. No maintenance is required since there are no moving parts to wear or lubricate, and no power is required since tuned steel reeds are natural resonant indicators responding to machine vibration frequencies.

The instruments are not affected by ordinary temperature changes, stray negative fields or operating position and they will operate indefinitely under normal conditions with no discernible drift in natural frequency. Accuracy retention is within 0.3% of the rated vibration frequency. Standard and miniature types are available and all popular ranges are also available. Circle No. 76

Biddle Instruments, 510 Township Line Rd., Blue Bell, PA 19422. (215) 646-9200.

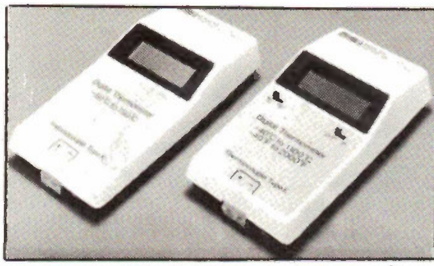
Get a grip on the situation with the **Brunelle Model 6000** digital clamp-on volt-ammeter and insulation tester module. The unit features 7 functions: AC/DC volts, AC amps, resistance, diode check, continuity test and insulation tester with the optional Module Model 6001.

Capabilities include DC voltage measurement up to 1000 V, AC current up to 1000 A from 50 to 500Hz, and resistance from 0 to 2MOhms.

The Module Model 6001 insulation tester is a direct plug-in unit featuring two ranges, 0 to 20MOhms and 0 to 200MOhms, and it delivers an output voltage of 500 VDC. Both units are covered by a complete two year warranty.

Brunelle Instruments Inc., 69, 6th Range S., St-Elie D'Orford, Quebec, J0B 2S0. (819) 569-1408 Telex: 05-836266

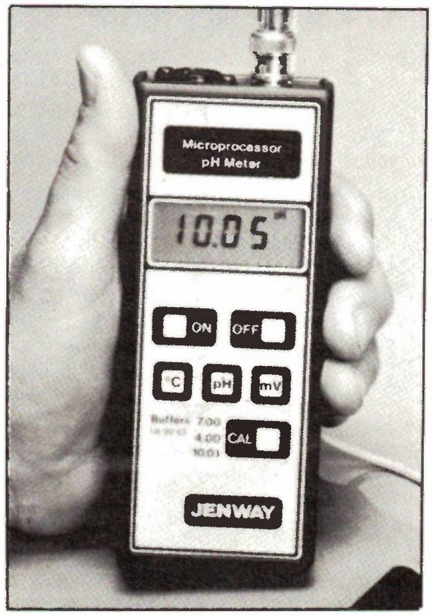
Circle No. 77



The **Series 400** digital thermometers from O.K. Industries Inc. feature large, readable LCD displays and compact 'calculator' style enclosures suitable for a wide range of applications.

These low-cost devices are capable of measuring -50 to 750 degrees Celsius with a one degree resolution (Model 401) and -40 to 1100 degrees Celsius with a 0.1 degree resolution. Both units feature switchable C/F displays, operate on a single 9V battery, and accept any K-type thermocouple. Naked bead thermocouples and batteries are also supplied.

Len Finkler & Co. (see under Oscilloscopes).



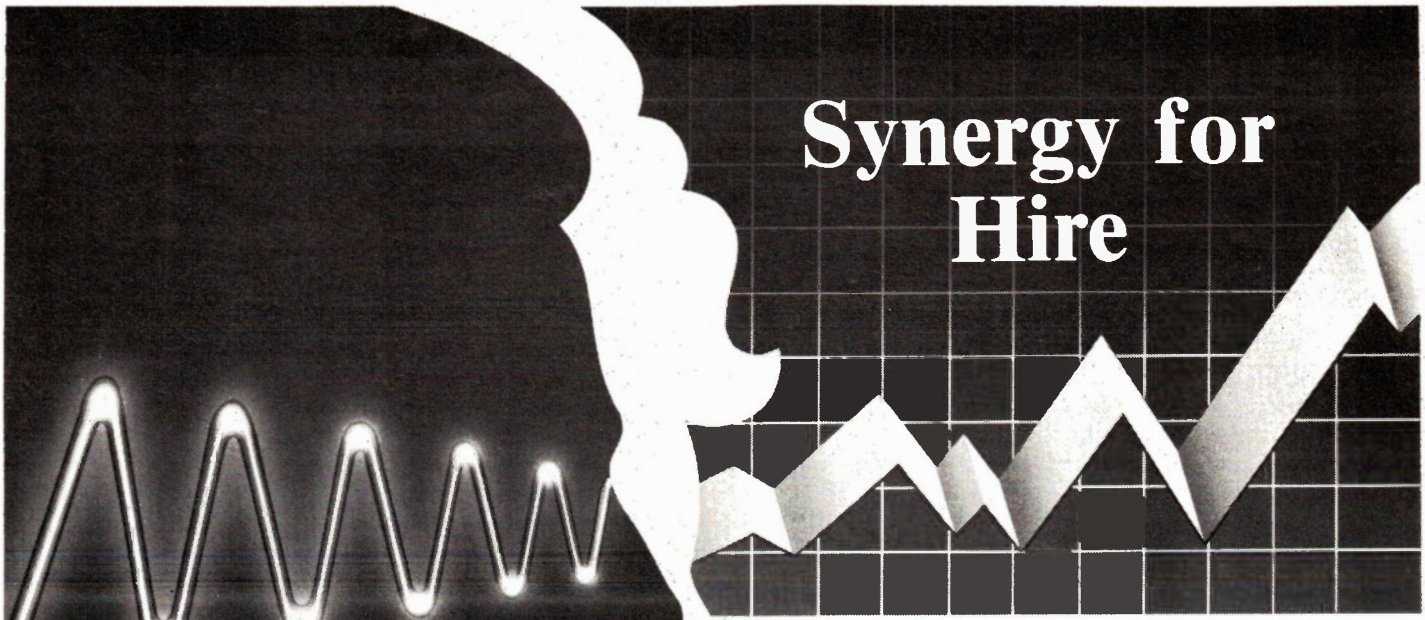
Claimed to be the world's smallest pH meter, the **Model 3100** from Jenway, in Britain, is a handheld unit capable of measuring pH in the range of 0 to 14, as well as temperature and mV measurement from -30 to 150 degrees Celsius and from 0 to plus or minus 1999 mV.

Contained within the 150 x 60 x 26 mm, 140g case, is a bevy of microprocessor-based circuitry including: integral buffer-comparison memories, back-up memories which retain all data after powering down, and a microprocessor which controls all measurement functions and performs automatic calibration.

Included with the unit is a gel-filled combination electrode, automatic temperature compensator/measurement probe, a pack of 4 and 7 pH buffer powders, and a 9V battery.

Duncan Instruments Ltd. (see under Generators).

Synergy for Hire



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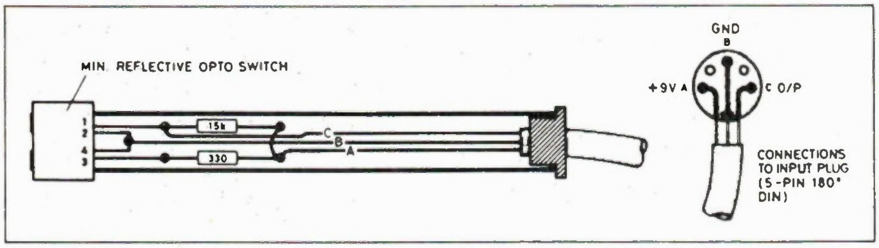

Fig. 8. The photo-reflective probe assembly and suggested method of construction.

totype probe arrangement which uses the miniature photo-reflective switch device.

Testing and Calibration

The PCB and all external connections should be checked for dry joints, solder bridges and other wiring faults.

An audio signal generator (20Hz-20kHz) and a 5V DC voltmeter are required for calibrating the unit. The frequency range switch is set to select the 0-500Hz range (the 1n capacitor is in circuit). Connect up the signal generator to the input and set it to 500Hz, 1V p/p output. VR1 can now be adjusted to give a 5V indication on the meter.

Adjust the signal-generator to other frequencies within the 0-500Hz range and check the linearity of the unit. The frequency range should now be switched to 0-5kHz and this range checked against the signal generator. ■

Stereo TV

An industry-wide standard and our hunger for quality TV sound has made stereo TV a reality.

By Edward Zapletal

IF YOU'VE been shopping around lately for a new television set, you've probably heard the words Multichannel Television Sound being thrown about quite a bit. What it all means is that stereo television is now a reality. More importantly it means that broadcasters will be able to offer separate audio channels for things such as second language broadcasts as well as a professional channel for transmitting programming and non-programming materials to other stations.

Until recently, television has remained pretty much the same as it was from the outset with respect to sound quality - mediocre. Oh they added extra speakers here and there, and maybe some bass and treble controls, but these were only bandaid solutions to the problem.

Enter, the Federal Communications Commission, the Electronic Industries Association, and the Broadcast Television Systems Committee (EIA's TV industry watchdog), three very important players on the stereo TV stage.

The MTS Success

With the spectre of AM stereo lurking off in the shadows, the TV broadcasters and equipment manufacturers were eager to avoid a similar fiasco by offering to the FCC, a stereo transmission system that would be accepted as the industry-wide standard.

In case you're not familiar with AM stereo, it never really got off the ground because the FCC threw the marketplace open, hence, manufacturers of the transmission systems couldn't agree on a single standard. This left the consumer electronics manufacturers and broadcasters in a confused state as to which of the systems to endorse. As a result of this, AM stereo, and AM radio in general, remain in critical condition to this very day.

After having reviewed the various submissions and suggestions from the manufacturers and broadcasters, the BTSC held a vote to select the best overall system. The system selected and given to the FCC for recommendation was developed by the Zenith Corporation, and in addition to this, a noise reduction system developed by dbx Corporation was also selected as the standard for NR. Other systems were submitted by Telesonics and EIA (Japan), as well as noise reduction systems from CBS and Dolby.

In the late Spring of 1984, the FCC handed down a favorable decision on MTS along with new very general technical rules which allow the television aural baseband to be used for more than just monophonic broadcasting. The frequency range of 0 to 120 KHz, which was restricted to audio-only in the range of 50 Hz to 15 KHz for the main channel, was opened up for use in television

stereophonic sound, second language programming and any other broadcast or non-broadcast use.

It should be noted here that our own Department of Communications and the CRTC have gone along, in principle, with the U.S. rules and regulations regarding MTS. Various draft versions of broadcast

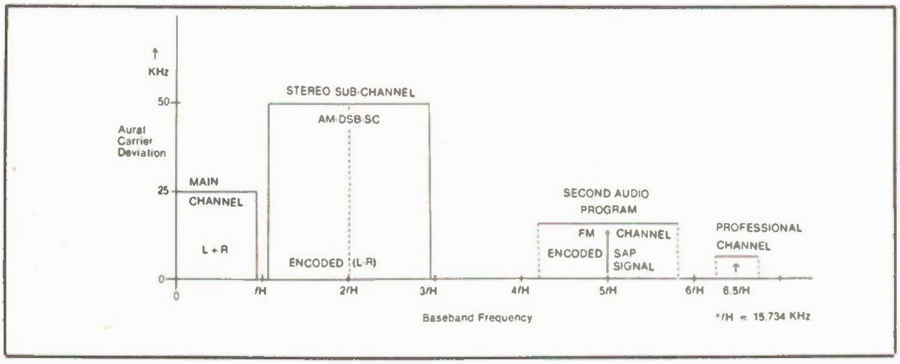

Fig. 1 A graph showing the layout of the baseband frequency vs. aural carrier deviation.

Signal Specifications							
Service or Signal	Modulating Signal	Max. Mod. Freq. KHz	Audio Proc. or Pre-emph.	Sub-carrier Frequency	Sub-carrier Mod. type	Sub-carrier Dev. KHz	Aural Carrier Peak Dev. KHz
Monophonic	L + R	15	75us				25*
Pilot				fH			5
Stereo	L-R	15	dbx encoding	2fH	AM-DSB-SC		50*
SAP		10	dbx encoding	5fH	FM	10	15
Prof. Ch.	Voice Data	3.4 1.5	150us	6 1/2fH	FM FSK	3	3
						Total	73

* Total does not exceed 50 KHz

Table 1 Transmission standards for the BTSC system.

specifications, procedures, and information circulars are available, and no licensing of any kind is being done at this time. Any of the handful of television stations currently broadcasting in stereo, in Canada, are doing it purely on an experimental basis after filing their intent to do so with the D.O.C.

BTSC Stereo

The heart of the BTSC system lies in its pilot tone, located at 15734 Hz. The pilot tone allows receivers to recognize that transmissions are in stereo and to switch to that mode. To ensure compatibility and to prevent BTSC type receivers from falsely detecting other MTS formats, the FCC protected that frequency for use only in the BTSC system. **Fig. 1** shows a chart of the complete audio baseband as it is now allowed to exist with provisions for the Second Audio Program and Professional channels. Table 1 is a summary of the signal specifications.

The concept of television stereo sound is not a completely new one; some of the basic features such as L + R main channel, L-R sub-channel and the pilot tone were derived from its FM stereo cousin.

In the BTSC television main channel, the aural carrier modulation consists of a L + R audio signal with a pre-emphasis of 75 microseconds. The frequency range of this channel remains unchanged (50 Hz to 15 KHz) allowing older, non-stereo, television sets to receive the monophonic signal as they normally would.

The new TV L-R sub-channel, however, is subjected to level encoding (**Fig. 2**) which is part of the dbx Companding System. This level encoding in turn causes double-sideband, suppressed carrier amplitude modulation of a subcarrier at twice the horizontal picture scanning frequency (15734 Hz). The audio bandlimits of both the pre-emphasized L + R and encoded L-R channels are 50 Hz and 15 KHz.

Second Audio Program

One of the more innovative aspects of the BTSC system is the provision for simultaneous broadcasting of a second audio program or SAP. Put more simply, it means that a program broadcast in English, could also be received in another language such as French by merely switching the MTS decoder on your TV to the SAP position.

The subcarrier for the SAP channel has a frequency of 5fH (78.670 KHz) and is frequency locked to 5fH in the absence of modulation. The SAP audio signal is subjected to level encoding which is identical to that of the L-R sub-channel. The resulting SAP modulating signal is bandlimited to 10 KHz and frequency modulates the SAP subcarrier to a peak deviation of 10 KHz.

Although it is not in wide use as of yet, some experimentation is being done in areas close to the American-Mexican border, as well as in the Los Angeles area. At present, no licenses for SAP have been issued in Canada as the CRTC has not yet made an exact decision on just how to implement it.

Pro Channels

Imbedded amongst all this talk about MTS is its third and least apparent feature, the professional channel. It lives way up in the 6 1/2fH area of the baseband and is used primarily by the broadcasters for relaying voice or data information to crews in the field, or to other stations.

The maximum modulation frequency for voice signal is 3.4 KHz and for data is 1.5 KHz. While there is 150 microseconds of pre-emphasis applied to the voice signal there is none applied to the data signal. The total aural carrier peak deviation for this channel is 3 KHz.

Noise Reduction

Audio signal processing is not new to the broadcasting industry and whether it is used or not is up to the particular broadcaster. However, should noise reduction be implemented, the mandatory system to be used is the dbx Companding System, which is based on complementary audio processing at both the transmitter and receiver ends. The block diagram in **Fig. 2** outlines the basic operation of the dbx encoder system used on the L-R and SAP sub-channels.

In order to maintain monophonic (L + R) compatibility, companding is not used on the main channel, however, it is provided on the stereo sub-channel. This is necessary because most of the noise is introduced in the sub-channel.

The system includes separate stereo difference and SAP compressors on the transmitting end, and a single expander for both stereo and SAP in the receiver. Stereo separation will be strongly influenced by the degree to which compressor and expander processing are complementary.

MTS Decoding - How It Works

The following description of the Zenith MTS Decoder is based on the unit used by Zenith during the EIA field tests. The block diagram is shown in **Fig. 4**.

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In fact, we're almost on the edge of apologizing for coming up with nonsense like this.

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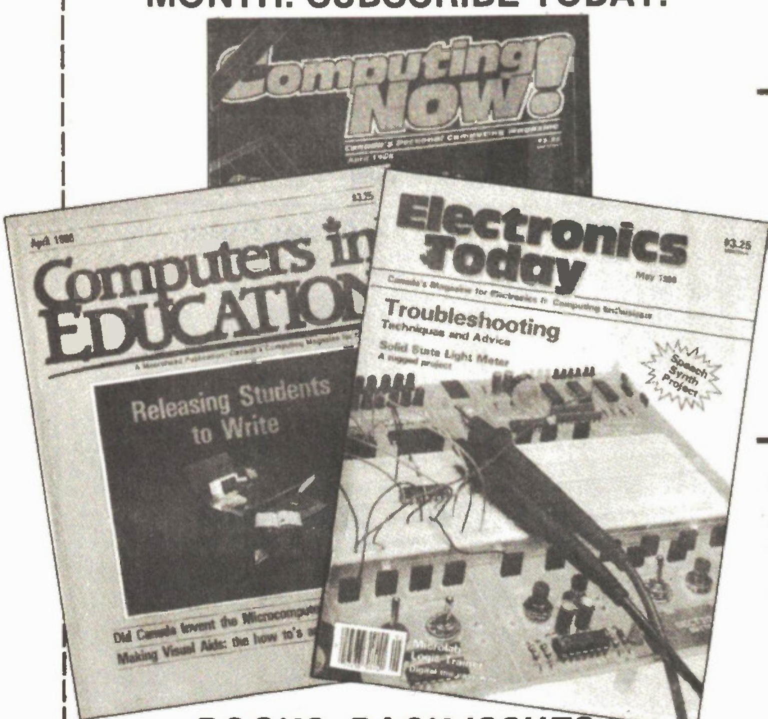

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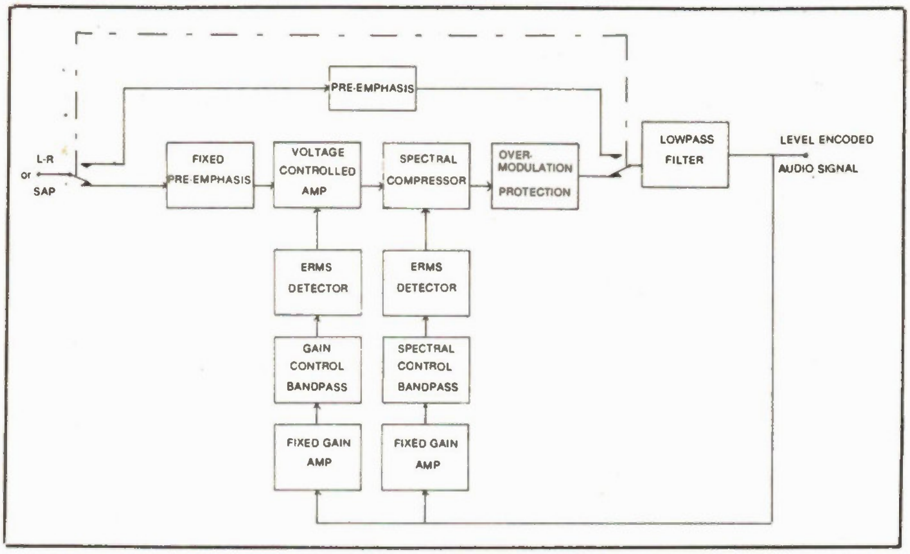

Fig. 2 Block diagram of the dbx Encoder system.

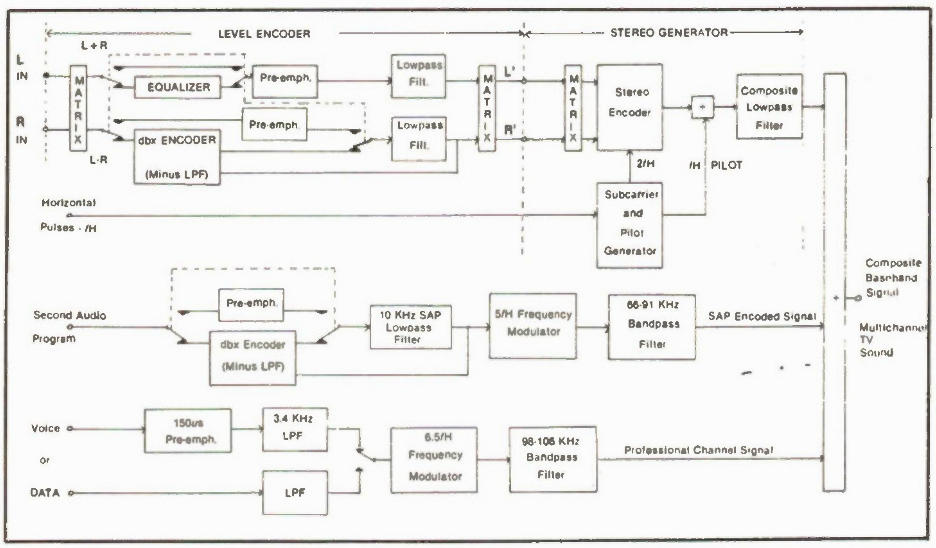

Fig. 3 MTS composite baseband signal generation system.

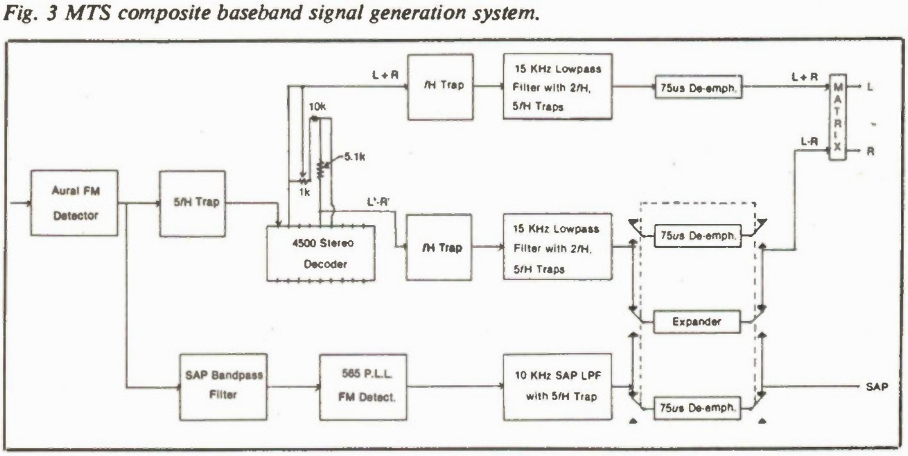

Fig. 4 Block diagram of the Zenith MTS decoder system with associated filters and traps.

The output of the aural FM Detector consists of the entire composite baseband (0 - 120 KHz). The 4500-type Stereo Decoder has inherent 5fH rejection neither in the pilot path nor in the stereo sub-channel path. For this reason, a 5fH trap circuit precedes the Stereo Decoder. The unit is designed for L and R outputs but L + R and L-R are needed for the companding process. In addition, no de-emphasis is required at the outputs of the 4500.

The dbx encoded L-R signal has to be bandlimited in order not to mislead the Expander Control circuits. The decoder has unwanted inherent outputs at fH, 2fH, 3fH, 4fH, and 7fH (SAP) and at all sidebands of those, except at fH. For this reason the lowpass filter has traps at some of these frequencies. If high precision, high stereo separation expansion is desired, a compensating circuit may be included in the L + R path to duplicate that part of the Expander amplitude and phase response that is due to parasitics and to deliberate bandlimiting. This is similar to the process used in the Level Encoder of Fig. 3.

The L + R path includes a lowpass filter identical to the one in the L-R path assuring identical response in both, and thus good separation.

The SAP path includes, first, a bandpass filter arrangement. This is followed by a 565-type integrated circuit phase-locked loop FM detector. Next in the sequence is a 10 KHz lowpass filter intended to eliminate spurious signals above 10 KHz that might influence expansion control in a non-complementary manner. The fixed de-emphasis constituting the last stage in the Expander keeps the spurious signals out of the audio.

The block diagram also illustrates the use of a single switchable Expander for L-R and SAP. Whichever signal is not expanded has a 75 microsecond de-emphasis network instead. Two expanders are desirable for station monitoring - one for stereo and one for SAP.

What's Available

There probably isn't a major manufacturer of television sets out there who isn't producing something in the way of stereo products. Component TV has become extremely popular in recent years and although the initial outlay of cash may be slightly higher, upgrading your set is less difficult if you only want to change the tuner or the monitor separately.

VCRs have progressed steadily as well: first with stereo, then true Hi-Fi, and now they're available with built-in MTS decoders as well. With this kind of set-up, all you need to do is hook up to your component stereo and speakers and you're away.

Now that the manufacturing industry has the sound problem worked out for the most part, it looks as though they are concentrating on redesigning the picture tube to make it more space efficient. All that's left to do now is pressure the programming folks into giving us some real quality TV to watch on these high-tech sets. ■

BABANI BOOKS

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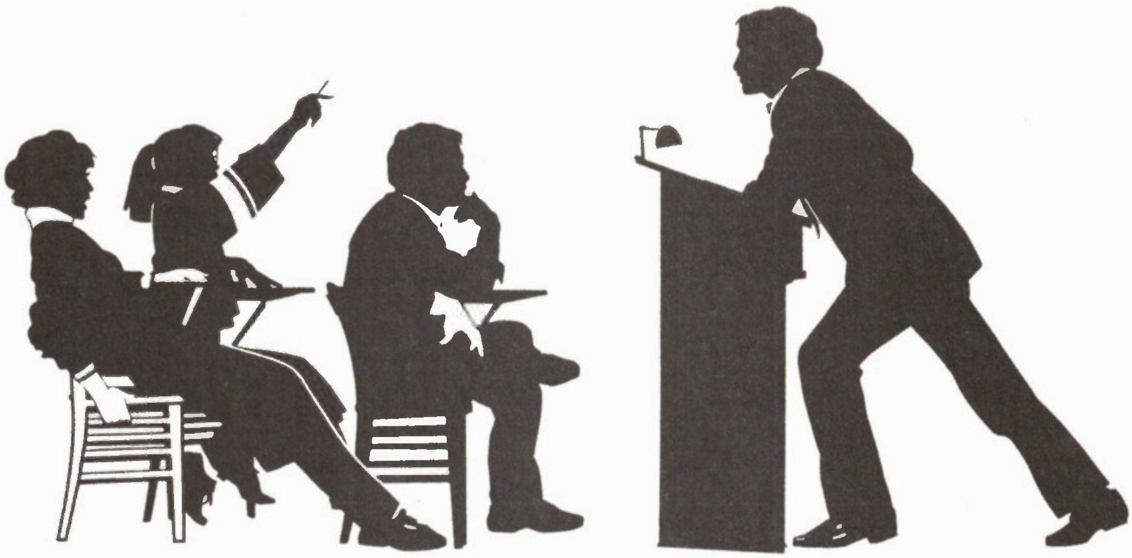

A review of the basic action of diodes and transistors.

By Michael Tooley and David Whitfield

IN electronics, we often categorize materials as either conductors (e.g., copper or aluminum) or insulators (e.g., mica or polystyrene). There is, however, a third category of material upon which the whole of our modern solid-state technology depends: the semiconductor.

The controlled diffusion of impurities into the crystal lattice structure of materials such as silicon or germanium (which would both be normally classified as insulators in the pure form) allows us to produce materials which are neither conductors nor insulators. These materials are semiconductors and their electrical conductivity is a function of the amount of impurity present. (For the curious, the level of impurity is usually less than one part per billion).

Due to superior characteristics at high temperatures, the majority of modern semiconductors are fabricated from silicon (Si) rather than germanium (Ge). There are still, however, a few applications in which germanium devices may be preferred (as we shall see later) but, for the purpose of our explanation of semiconductor action, we will confine our discussion to silicon, and its atomic structure.

The nucleus of a silicon atom is surrounded by three distinct electron shells. The inner shell contains two electrons, the middle shell contains eight electrons, as shown in **Fig. 1**. Since these four outer (valence) electrons are available for bonding with adjacent atoms, silicon is said to exhibit a valency of four (i.e., it is tetravalent).

Bearing in mind that the number of protons (+) in the nucleus is exactly equal to the number of orbiting electrons (-), we can simplify the atom as shown in **Fig. 2**. Only the four protons which balance the valence electrons are shown.

In pure silicon each one of the four valence electrons is shared between adjacent atoms, as shown in **Fig. 3**. The result is a crystal lattice in which electrons from covalent bonds and, since there are no "free" electrons available to carry charge, the material behaves like a near-perfect insulator.

If we now introduce a number if impurity atoms, each having a valency of five (pentavalent), into the regular crystal lattice of silicon atoms it will then contain a number of "free" electrons which are not involved in the bonding process and which are therefore available to take an active role as charge carriers (see **Fig. 4**). It should, however, be noted that the material will still be electrically neutral (i.e., the total number of positive charges will exactly balance the total number of negative charges).

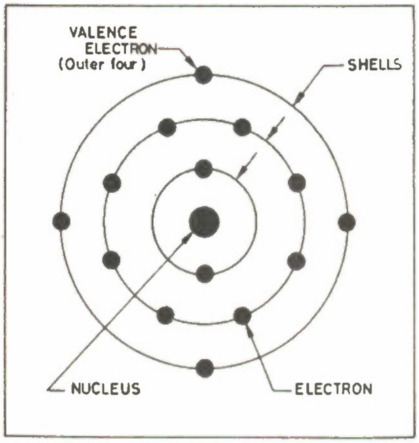

Fig. 1 Model of a silicon atom.

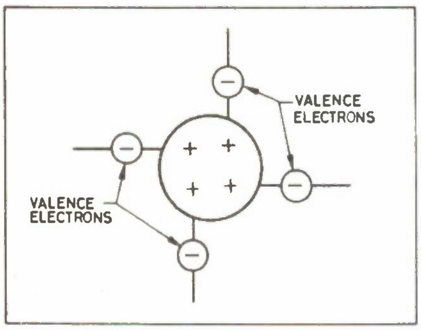

Fig. 2. Simplified silicon atom.

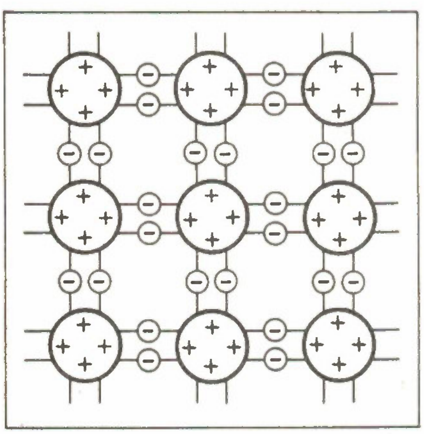

Fig. 3. Lattice structure of pure silicon showing covalent bonds.

Since the pentavalent element produces a surfeit of electrons, we call it a "donor" impurity. The semiconductor material produced is said to be n-type as the majority charge carriers present are negatively charged electrons.

If, on the other hand, we now introduce an impurity element which has a valency of three (trivalent) into the regular crystal lattice, we will produce a material which again is electrically neutral but which now has a number of incomplete bonds known as holes (see **Fig. 5**). These holes are simply gaps into which electrons can be fitted; as electrons travel within the lattice other holes will be created so we

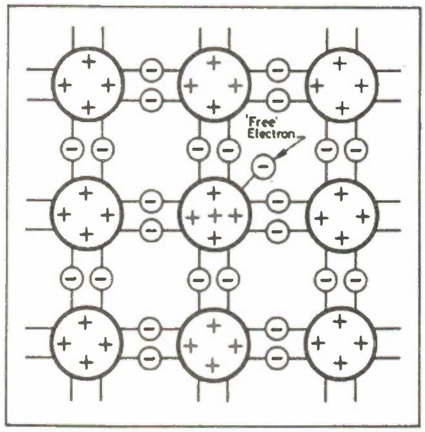

Fig. 4. Effect of introducing a pentavalent impurity.

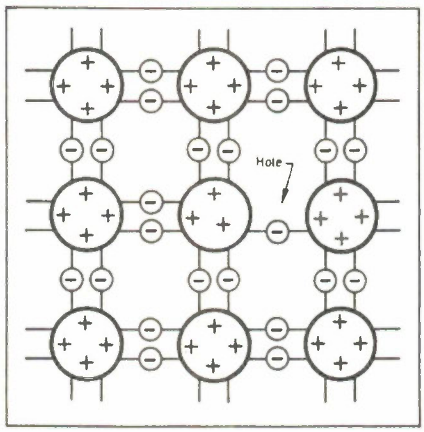

Fig. 5 Effect of introducing a trivalent impurity.

can think of the holes as being mobile positive charge carriers.

Since the trivalent element produces a shortage of electrons we call it an "acceptor" impurity. The semiconductor material is said to be p-type as the majority charge carriers are holes.

The process of introducing impurity elements into pure semiconductor material is known as "doping". Suitable impurities are phosphorus, P, or arsenic, As (both pentavalent) and boron, B, or aluminium, Al (both trivalent).

By means of a sophisticated manufacturing process in which both types of impurity are employed, regions of n-type and p-type material can be produced within the same slice of silicon. The result is called a p-n junction.

The P-N Junction

When a p-n junction is formed, some of the free electrons within the n-type material diffuse across the junction into the p-type region and recombine with some of the vacant holes. Conversely, some of the holes within the p-type region diffuse across the junction and recombine with free electrons in the n-type region.

This process (illustrated in **Fig. 6**) results in the creation of a region either

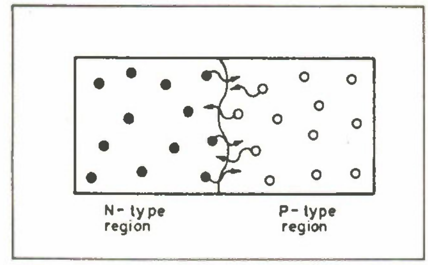

Fig. 6. Diffusion of electrons and holes within a p-n junction.

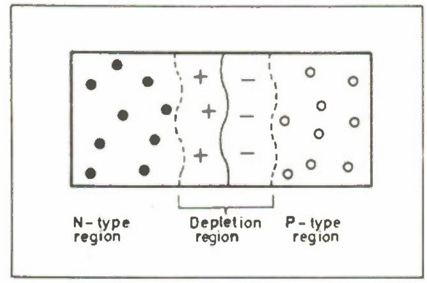

Fig. 7. The depletion region.

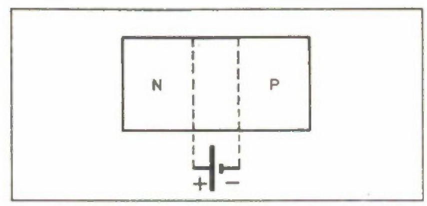

Fig. 8. Equivalent potential associated with the depletion region.

side of the junction boundary in which no free charge carriers exist (i.e., it contains no free electrons or vacant holes). For this reason it is known as the depletion region or depletion layer.

The process of diffusion across the junction boundary continues until equilibrium is eventually reached. At this point the p-type material has acquired a small negative charge and the n-type material has acquired an equally small positive charge, as shown in **Fig. 7**. This difference of charge can be considered as equivalent to a small internal voltage source, as shown in **Fig. 8**.

In order to remove the depletion region it is necessary to apply an external potential to the junction which is exactly equal but of opposite polarity to that which results from the junction's own internal charge, as shown in **Fig. 9**. This potential effectively negates the internal charge imbalance and reduces the width of the depletion region to zero. Thereafter, and with increasing applied potential, charge carriers are able to move across the junction boundary; electrons freely moving from the n-type region into the p-type region. This is known as the forward biased condition and an appreciable value of conventional current will flow from the p-type region (anode) to the n-type region (cathode).

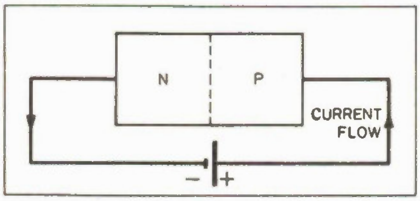

Fig. 9. Forward biased p-n junction.

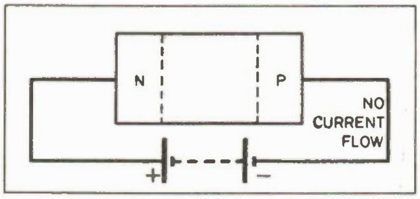

Fig. 10. Reverse biased p-n junction.

If the external potential is applied with the same polarity as that which results from the junction's own internal charge, the depletion region widens and movement of charge carriers across the junction is further inhibited (see **Fig. 10**). The symbol for a diode is shown in **Fig. 11**. Readers should note that the arrow of the symbol shows the direction of conventional current flow.

Diode Characteristics

The properties of any particular diode are best described by means of characteristic graphs showing current plotted against applied voltage. Typical characteristics for low power silicon and germanium diodes are shown in **Fig. 12 and Fig. 13** respectively. The following general points should be noted:

1. For clarity, different scales have been used for the forward and reverse voltage and current axes of both graphs. In particular it should be noted that the forward current has been shown in milliamps whereas the reverse current scale has been shown in microamps.

2. Since the voltage axis is horizontal and the current axis is vertical, the steepness (or slope) of the graph provides an indication of the equivalent resistance of the device. Readers should note that, steepness of the graphs vary according to the applied voltage. The steeper the characteristic the lower the equivalent resistance will be.

Readers should now devote some time to comparing the characteristics of the two types of diode and should note the following specific points:

1. Silicon diodes do not start to conduct until the forward voltage reaches approximately 0.6V. Beyond this point the current rises rapidly.

2. Germanium diodes do not start to conduct until the forward voltage reaches approximately 0.2 V. The increase of current beyond this point is somewhat less rapid than for the silicon type.

3. Silicon diodes consume very much less reverse current and can generally withstand very much higher reverse voltages than their germanium counterparts.

4. Silicon diodes have steeper forward characteristics and can generally withstand higher forward currents than their germanium counterparts. Although the significance of the forward voltage drop (0.6V approx. for silicon and 0.2V approx. for germanium) may not at this stage be apparent, readers should bear these values in mind for future reference. As an example of their significance we shall now briefly consider the functioning of a simple diode checker.

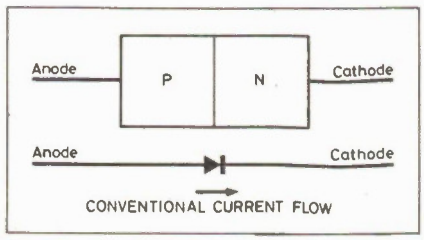

Fig. 11. Diode symbol.

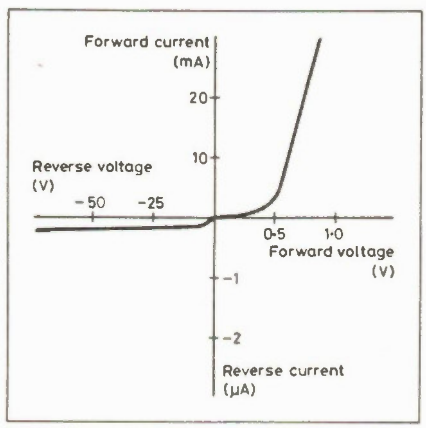

Fig. 12. Typical silicon diode characteristic.

Simple Diode Checker

The type and functional state of a diode may be easily checked if we simply measure the voltage drop that appears across it in the forward and reverse biased conditions. A forward voltage drop of between 0.1V and 0.3V would indicate that the device was a functional germanium type whereas an indication of between 0.5V and 0.7V would indicate a functional silicon type.

Since a functional diode should consume negligible current in the reverse biased condition, the reversed voltage drop should be virtually the same as the supply voltage. Any other indication, or deviation from the expected forward biased voltage, would be suspect.

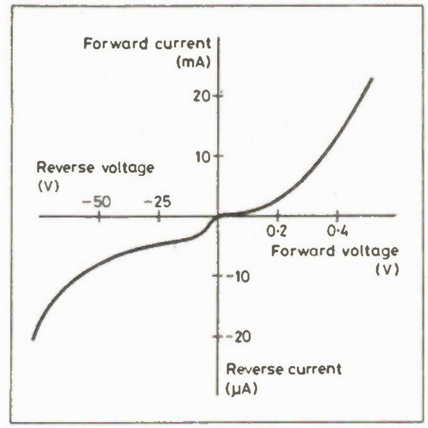

Fig. 13 Typical germanium diode characteristic.

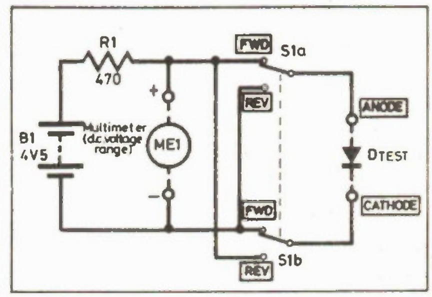

Fig. 14. A simple diode checker.

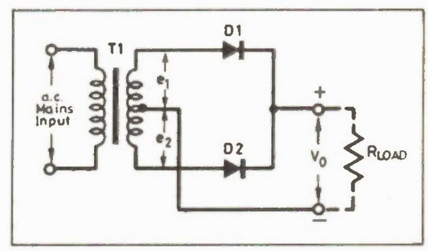

Fig. 15. Bi-phase rectifier arrangement.

A simple diode checker based on these principles is shown in **Fig. 14**. A forward current of less than 10mA is applied to the diode and the forward and reverse voltage drops are then measured using a multimeter. Some typical indications for the diode checker are given in Table 1.

Unfortunately, "in circuit" diode testing is not quite so simple unless one can be certain the conditions within the circuit remain static and the diode remains in a continuously forward biased state. It is, therefore, usually safer to remove a diode from the circuit before testing it.

Peak Reverse Voltage

Readers have already seen in Figs. 12 and 13 how an appreciable reverse voltage may be applied with only negligible reverse current flow. However, if the reverse voltage is increased beyond a certain point, the reverse current rapidly increases and the diode breaks down due to excessive power dissipation. (The power dissipated by the diode being equal to the product of the reverse voltage and the reverse current).

The maximum reverse voltage which can safely be applied to a diode is known as the peak reverse voltage, or simply PRV. (Note that some books refer to this as the "peak inverse voltage", or PIV). Germanium diodes have typical PRV ratings in the region 30V to 100V whilst their silicon counterparts have typical PRV ratings of between 40V and 800V.

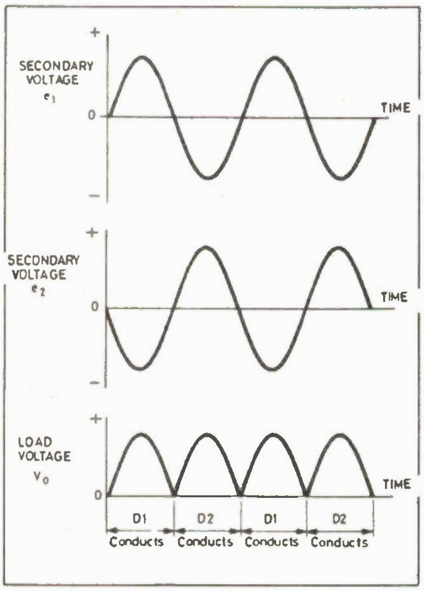

Fig. 16. Waveforms for the bi-phase rectifier.

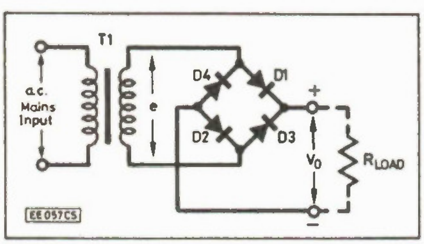

Fig. 17. Bridge rectifier arrangement.

The Bi-Phase Rectifier

The efficiency of our simple power supply can be greatly improved by positive, half cycles of the incoming AC supply. This can be achieved using the "bi-phase" rectifier arrangement shown in **Fig. 15**. Here a split (or "centre-tapped") secondary winding is used.

The alternating voltages at either end of the secondary winding are said to be in "anti-phase"; i.e., when the voltage at one end goes positive with respect to the centre-tap the voltage at the other end goes negative. The two diodes thus conduct alternately, as shown in **Fig. 16**. The net result of all this is that the charge lost by a reservoir capacitor can be replenished at twice the rate (i.e., about every 8ms

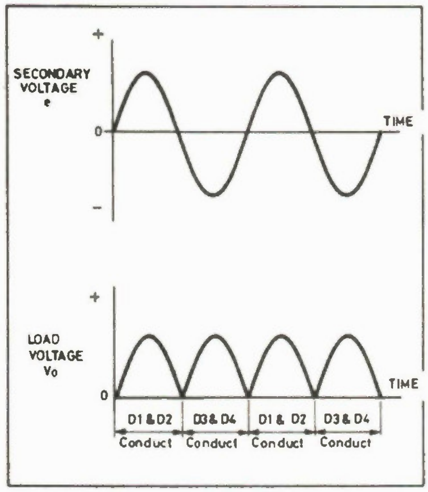

Fig. 18. Waveforms for the bridge rectifier.

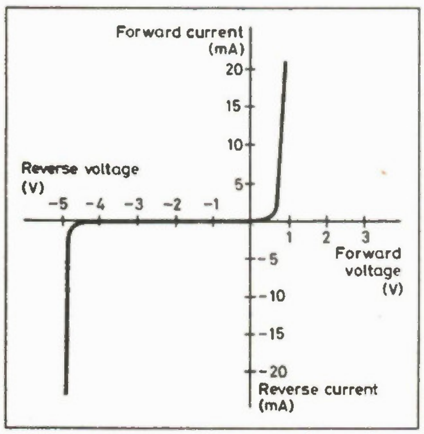

Fig. 19. Typical characteristic for a 4.7V [zener] diode.

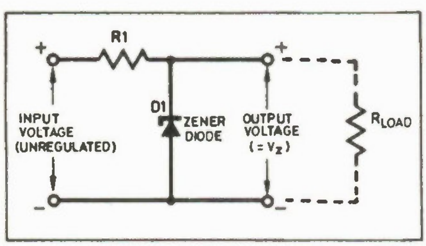

Fig. 20. Simple zener diode voltage regulator.

rather than every 16ms when the supply is at 60Hz). This, in turn, leads to more effective smoothing and so the output contains less ripple.

The Bridge Rectifier

An alternative to the bi-phase rectifier arrangement is the use of a bridge rectifier, as shown in **Fig. 17**. Here four diodes are used with opposite pairs of diodes conducting on alternate half cycles of the AC input, as shown in **Fig. 18**.

The bridge rectifier arrangement obviates the need for a split secondary winding and often makes use of a specially encapsulated rectifier (in which all four diodes are contained within an epoxy resin block).

The Zener Diode

Whereas reverse breakdown is an unpleasant fact of life when designing rectifier circuits it can be quite useful in other areas. Silicon diodes can be manufactured so that they exhibit a controlled reverse breakdown and, provided the current is limited to a safe working value, the diode will not suffer permanent damage. Devices of this type are called zener diodes and can be purchased with accurate breakdown voltages from 2V7 to over 100V.

A typical characteristic for a 4V7 zener is shown in **Fig. 19**. Once the reverse zener voltage has been exceeded, the voltage drop across the diode remains substantially constant. The zener can thus be used to provide and accurate voltage source; all we need to do is to supply an appropriate value of current using a series resistor connected from a higher potential supply.

Fig. 20 shows a simple zener diode regulator. Provided the load current does not exceed a critical value, the output voltage remains close to the nominal zener voltage regardless of moderate load current and input voltage variations. Finally, **Fig. 21** shows how our enhanced power supply can be modified to incorporate a regulated output.

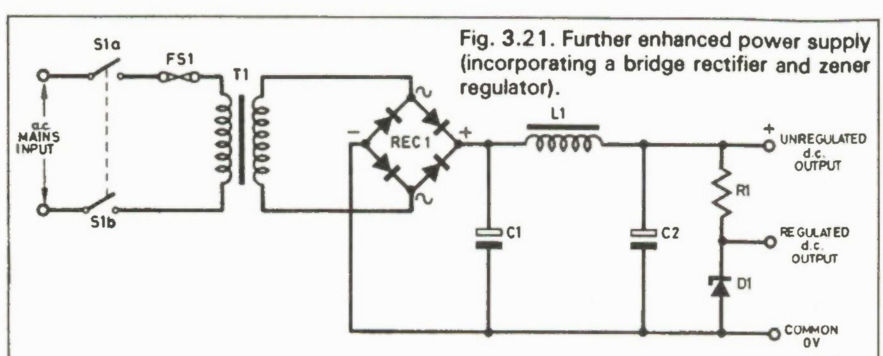

Fig. 21. Further enhanced power supply (incor- porating a bridge rectifier and zener regulator).

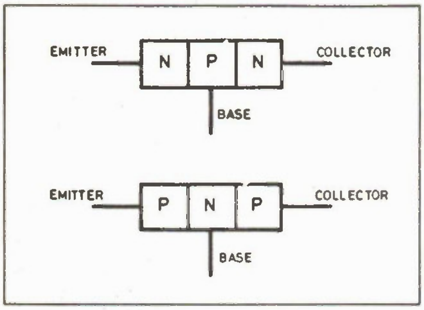

Fig. 22. Basic construction of NPN and PNP transistors.

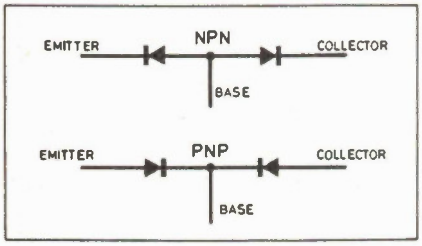

Fig. 23. Diode equivalent models for NPN and PNP transistors.

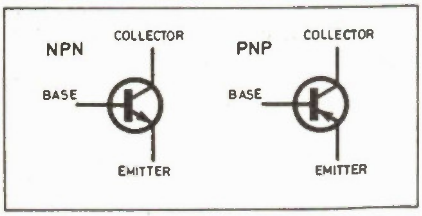

Fig. 24. Symbols used for NPN and PNP junction transistors.

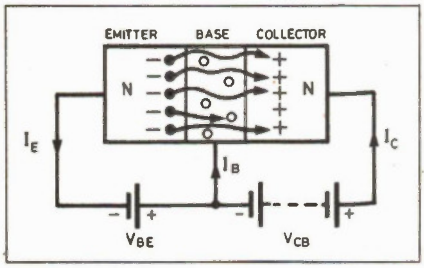

Fig. 25. Bias voltages and currents within an NPN transistor.

The Transistor

Whereas diodes have only one junction, transistors comprise two semiconductor junctions fabricated on a single slice of germanium or silicon. Two varieties are possible; NPN and PNP as shown in **Fig. 22**. In either case, the junctions are formed between the emitter-base and collector-base. This allows us to develop the simple diode models of NPN and PNP transistors shown in **Fig. 23**.

The symbols used for NPN and PNP transistors are shown in **Fig. 24**. Readers should take particular note of the direction of the arrow at the emitter which indicates the direction of conventional current flow.

In normal use, the base-emitter junction is forward biased whilst the collector-base junction is reverse biased. **Fig. 25** shows the biasing arrangement for an NPN transistor. Electrons present at the emitter will move into the base region where they become "minority carriers". Some electrons will recombine with holes in the base region but, since the base is made very narrow and the collector is positively charged, the greater proportion of electrons leaving the emitter are swept across into the collector region.

The emitter and collector currents are thus almost equal, the difference between them being equal to the base current (i.e., that which results from recombination of electrons and holes within the base region). We can, therefore, establish the following relationship between the currents in a transistor:

Ie = Ib + Ic

Typical currents for a small silicon transistor would be:

Ie = 2mA, Ic = 1.98mA
and
Ib = 20uA (i.e., 0.02mA)

Transistor Characteristics

Since transistors have three terminals, their characteristics are somewhat more difficult to show graphically than was the case with diodes. In most cases we can adequately specify a transistor's characteristics using just three graphs:

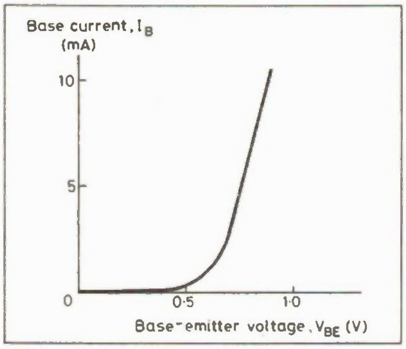

Fig. 26. Typical input characteristic for a silicon transistor (VCE constant).

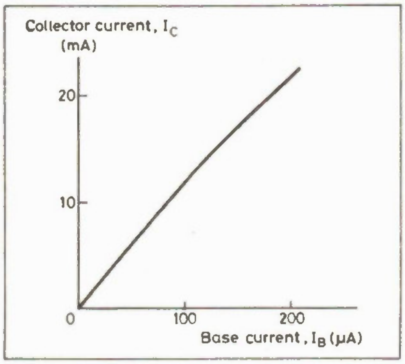

Fig. 27. Typical transfer characteristic for a silicon transistor (VCE constant).

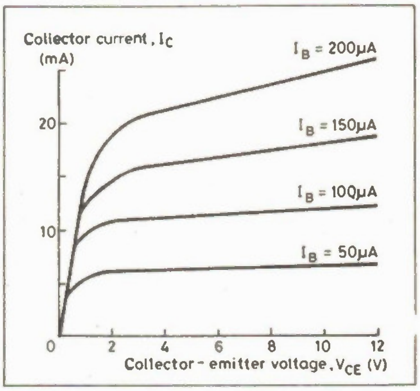

Fig. 28. Typical output characteristic for a silicon transistor (IB constant).

a) the input characteristic; Ib plotted against Vbe with Vce held constant.

b) the transfer characteristic; Ic plotted against Ib with Vbe held constant.

c) the output characteristic; Ic plotted against Vce with Ib held constant.

We have shown a typical set of characteristics for an NPN silicon transistor in **Fig. 26 to 28**. Readers should note that the input characteristic is simply that of a forward biased junction diode and that the transfer characteristic is substantially linear (i.e., doubling the value of base current results in a doubling of the value of collector current, and so on). This latter effect is important since it leads to the concept of "current gain"; a small change in input current at the base of a transistor results in a corresponding, but very much larger. current change at the collector.

Thus, assuming that we input current to the base of a transistor and take our output current from the collector of the transistor, current gain can be defined as:

Current gain = Collector Current/Base Current

= Ic/Ib

Typical values for the current gain of small silicon transistors range from around 100 to over 300.

Next month: Some practical transistor circuits that demonstrate the previous theories. ■

Computing Now! Microcomputer Directory

Finding the hardware or software one wants for one's microcomputer applications is very often an exercise in finding out what exists. Following this, one must locate what one has chosen, often through a labyrinth of dealers and suppliers. Conventional magazine directories and surveys can help with all of this... somewhat... but to date a comprehensive useable directory of what's available in Canada has yet to be published.

Most directories are constructed so as to be easy to compile. This one has been designed to be easy to use. Rather than selecting arbitrary categories, the items in the directory will be classified by system and within each system, in a tree structure dividing them into subclassifications.

This will result in a large directory with a lot of duplication in it. However, it will be a reference highly valued by its readers because of its resulting ease of use. It will be the essential reference work for anyone involved in microcomputers, from single system end users to small and mid-sized businesses. For advertising information contact Denis Kelly at (416) 445-5600 immediately.

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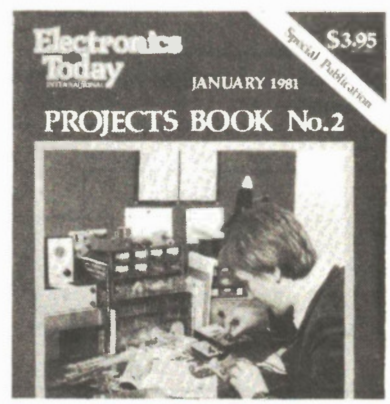
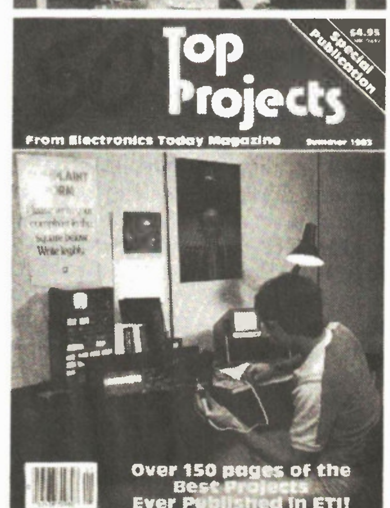
ANNOUNCING PROJECTS BOOK NO. 3





Hobby Projects was first published in the summer of 1980 and contained 25 Electronics Projects reprinted from Electronics Today magazine. It was a sell out and was followed in January 1981 by Projects Book No.2 and in the summer of 1983 by 50 Top Projects, both of which were also virtually sell outs.

We have been asked when the next edition will be published and planning has thus started on Projects Book No. 3 which will go to press in August with a Fall 1986 cover date.

The contents of Projects Book No. 3 will be approximately 25 of the most popular projects which have appeared in Electronics Today since 1983. In addition, there will be new projects not yet seen by our readers. This edition will be in demand by previous purchasers of earlier editions and by other Electronics Today readers for the new projects.

It will be of especially great interest to: a) recent readers, b) casual readers, and c) non readers of Electronics Today which will mean that your advertising message will be seen by a slightly different readership.

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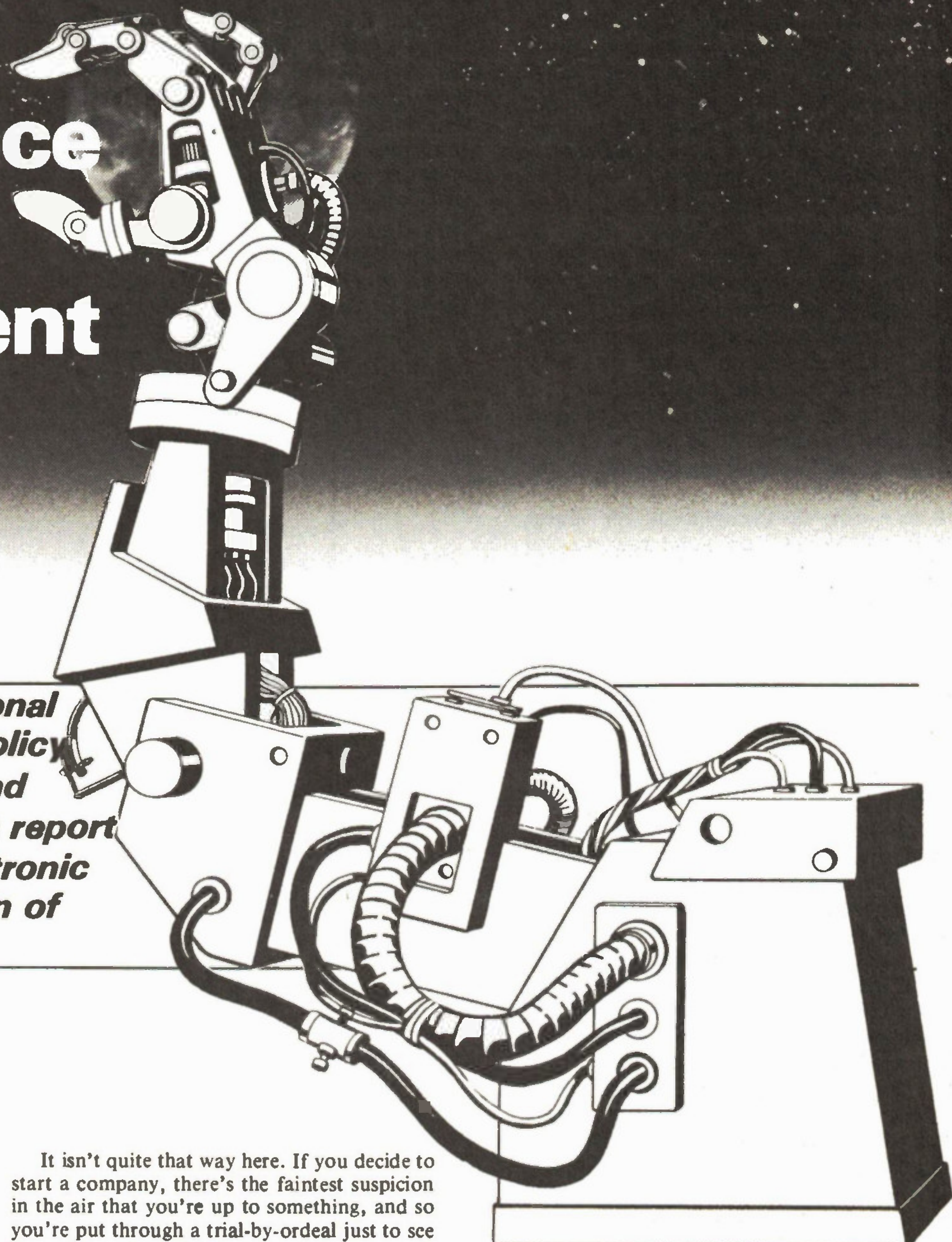
Creating The Science Environment



Canada needs a new national science and technology policy to stimulate innovation and research, according to this report by the Electrical and Electronic Manufacturers Association of Canada.

Editor's Preface: In general, the technical journalist tends to perceive the Canadian electronics industry as a warehousing venture. There are a few outstanding and successful innovations, but for the most part Canada does not have the environment to stimulate, encourage and support original design and manufacture.

Mention to anyone in the industry that you've invented the better mousetrap and plan to produce it, and you'll get a lengthy list of reasons why it isn't likely to succeed. Components cost too much, assembly is cumbersome, funding is difficult, taxes are crippling, you can't compete with imports, etc.

It isn't surprising that our outlook on designing new products is so negative, varying from doubt to outright defeatism. Without a support structure, an individual company is left on its own to do the best it can with piecemeal assistance. It would be interesting to see a study investigating the differences between Canadian entrepreneurial attitudes and those of say, Taiwan, Japan, or the USA.

Perhaps we'd find that other countries have an environment as stimulating to industry as Europe was to musicians and composers in the 17th and 18th centuries. For example, an encouraging atmosphere, a vast market, and a large established peer group produced the flood of world-class composers for which Germany is famous.

It isn't quite that way here. If you decide to start a company, there's the faintest suspicion in the air that you're up to something, and so you're put through a trial-by-ordeal just to see if you're serious. Little or no information is easily available to the small entrepreneur concerning legalities, taxes, accounting, and so on. The difficulty in getting venture capital is a story in itself, and government financial assistance comes and goes with each new budget.

Of course, the required information, support and finances for new companies or new products can be found somewhere, waiting to be unearthed by some brave undaunted soul who is dedicated to making a go of it. And, of course, we shouldn't say that hard work isn't called for, or that some rigorous filtering isn't required, or that the system should back any scheme no matter how flimsy. It's just that we're cutting off far too many ideas and talents through the lack of a proper strategy.

The Electrical and Electronic Manufacturers Association of Canada (EEMAC) recognizes that the job of coordinating all this falls to the government. On May 7, 1986, they presented a brief to the federal government, entitled *Creating The Science Environment*. The majority of the text of the report is reproduced with their kind permission.

— Bill Markwick

Introduction

In 1944 Dr. C.J. Mackenzie, President of the National Research Council, said that "the inherent material strength of any modern country is directly correlated with the strength of its resources and activities in science, technology and research". In 1983 Dr. P. McGeer, then BC's Minister of Science and Technology, wrote in reference to Canada, that "one of the most severe penalties a country can impose on itself in today's world is to have inferior policies towards engineering and science".

Sad to report, in the forty years between those similar observations, little has been done in Canada in recognition of this principle which so many other industrialized nations have taken to heart. We are therefore highly supportive of any steps taken to create and implement a Science Policy for Canada.

Today, the competition for world trade relies heavily on industrial skills in engineering and science. As a major trading nation, we neglect these at our peril. EEMAC's objectives are:

1. To see an improved climate for science and engineering both at the legislative level and in the population at large,
2. to see education reform that gives all students an appreciation of the importance of science and engineering in the modern world,
3. to restore the capability of the educational system to provide a larger portion of our gifted people the opportunity to study engineering and science,
4. to increase the interaction between universities and industry,
5. to increase the amount of publicly-funded research and development performed by industry.

The federal government's Science Policy, and its commitment to a policy, is a crucial concern of industry. Strong support and representation at the highest level is needed to create the emergence of Canadian engineering and science as a driving force in the economy.

A Science Policy should not address itself solely to pure research. The directions taken in industrial research and development will be crucial to Canada's international trade performance.

Increasingly, Canada's economic well-being and the standard of living of our people will depend not only on our declining natural resources, but our ability to compete both at home and abroad in technology and knowledge-based industries.

Since this is the area that EEMAC knows well, the following pages detail our concerns and recommendations. They form an integrated proposal designed to create an environment which will encourage successful R&D in Canada.

Industrial R&D

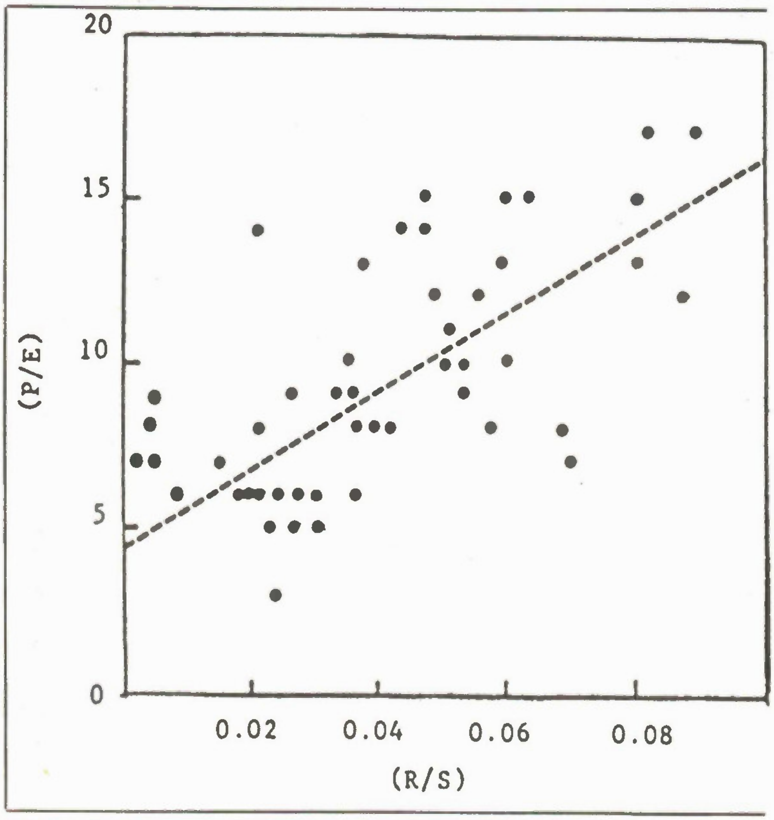
Research and development is not an end in itself, but a process and activity by which advanced nations compete for industrial economic advantage. Research and development (R&D) triggers a risky, expensive process which allows industry to create new jobs, new products, expand imports and replace imports, generating new wealth.

The lack of growth in Canada's manufacturing industry, and in the Electrical and Electronic sector in particular, indicates that industrial development has been inadequate. The failure of the electronics manufacturing industry to benefit from world-wide innovation is particularly disturbing because it is a key industry which affects many others.

The Electrical and Electronic Sector is a heavy R&D spender relative to most industries, but obviously its expenditure is still not enough to ensure its own future health. In 1984 many companies in the sector spent over 4 percent of gross revenue on R&D, more than triple the national average. Other companies in this sector experiencing strong growth are spending in excess of 5 percent and up to 20 percent of gross revenue. To bring R&D spending even up to the 5 percent level across the sector is not realistically possible without substantial public support, particularly in enabling technology contracts (where the only deliverable product is a demonstration of technological capability). The enabling technology contract is an attractive solution, since it could be coupled with a redistribution of government R&D expenditures.

Under the best conditions, R&D is an expensive, high-risk proposition. R&D started today will not begin to yield results for some years, and most successful innovations require large amounts of capital before the product can be brought to market. Successful R&D requires additional cash flow for a host of start-up activities, including market development, tooling, plant expansion, inventory, additional staff, and extensive retraining.

An effective R & D strategy must be comprehensive and must complement the entire manufacturing and marketing process. Industrial R & D must be market-driven, constantly evolving to satisfy ever-changing international and domestic requirements.



1978 Price/earning ratio for 50 American companies as a function of R&D to sales.

Canada's R & D strategy must endeavour to:

- Create entire new industries and jobs which do not exist in Canada today;
- Nurture, strengthen and expand the nucleus of dynamic companies in their struggle for success in the international high-technology marketplace;
- Expand investment in Canada by multinational companies with particular emphasis on world product mandates;
- Help retool existing industry, utilizing computer-aided manufacturing, computer-aided design and other innovations which foster competitive product development intervals, boost productivity, and improve product quality;
- Retrain the work force to understand and master the pervasive force of new technologies and tools.

Training and retraining of manpower is

a two to six year endeavour, not including the time required to expand facilities and staff. The time requirement to implement tax reform, new investment procedures and technological interaction is also in the order of five years. The evolutionary cycle of a product is also measured in years. These realities dictate that long-term commitment is required from industry, education, labour, and government for change to be effected.

Enabling Technology

One of the main reasons that government support to industrial development is lower in Canada than in some other industrialized countries is because major products are not developed under government contract where the development of industrial capability is seen as a major and necessary component of the investment. In other industrial countries with which we compete, non-tax support represents as much as 33 percent of industrial R & D. In Canada, it is about 12 percent.

This is clearly an opportunity that we are missing in Canada. Government contracts are often placed on a very competitive basis where no allowance can be made for the substantial development costs that may be required to create that particular manufacturing capability in Canadian industry. The funding of these kinds of development costs under such major contracts is widely practiced in other countries, does not attract the attention that grants or tax incentives do, and is not considered unfair competition.

For whatever reason, the government has tended to favour "buy" in the make/buy decision, seeming to overlook the industrial benefits of manufacturing advanced products.

The relationship of funding by governments, industry, and university is not particularly out of line in Canada. What is out of line is the division of R & D performed by those three sectors. It is clear that governments in Canada are not directing sufficient funds to R & D in industry particularly by the procurement mechanism. To become comparable to the U.S.A., an additional $1 billion should have been spent in industry in 1982. At the same time, $680 million less should have been spent in intramural government laboratories and $340 million less in university laboratories. This simply underlines the size of the distribution distortion that exists in Canada.

(1) Recommendation: Defence and other government purchases should be used to build greater technical capability in industry, particularly in design.

(2) Recommendation: Move development work out of government labs and procure from industry where there is more likelihood of commercial development. Award technology contracts to industry, not government labs.

Incentives, Procurement, and Grants

About 16 cents of every industrial sales dollar is deposited in government coffers in the form of Federal sales tax, income tax, and corporate tax, whereas secondary manufacturing industry, on average, retains earnings of about 4 cents. With such an uneven partnership, industry depends heavily on government to take a significant part in its ongoing development, particularly in respect to research activities and the application of scientific development, particularly in respect to research activities and the application of scientific developments. Such government participation is widely practiced in the OECD countries but has yet to achieve these levels in Canada.

As part of government's cooperative role with industry, we believe that this assistance can be provided in four ways:

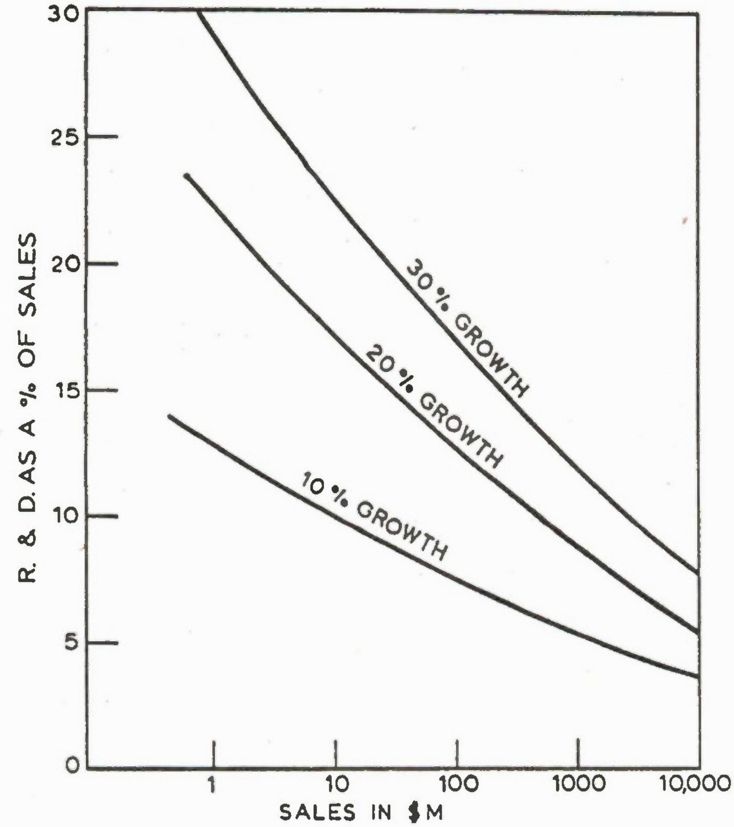
A. Through contracts for the provision of technological capability. This is an area where Canada is one of the few industrialized nations in the world that does nothing. This is commented on in Government procurement below.

B. By direct grants. We believe that the level of granting in Canada is adequate on the surface at present although the process is too bureaucratic.

Since the taxation of grants was introduced in the 1985 federal budget, this financing method is less attractive. It is also hampered by its use as a regional development tool. Imposing regional economic imperatives on R & D funding is a destructive philosophy. Industrial research is more likely to succeed in proximity to universities and other industrial research.

For small-sized companies, government grants are a necessity but, in general, selective tax incentives are the most efficient method of increasing industrial cash flow. This then stimulates indigenous R & D and the cash flow needed to turn R & D into jobs and exports. Any revenue foregone by government will be recovered in the long term through increased employment and expanded industrial activity.

C. By providing tax incentives for



Average performance of 15 American technology companies 1977-1982.

research and development. Here again, we believe that the level of tax incentive is adequate and that recent steps to remove the limits on the application of such incentives are positive. However, these incentives will be of no help unless they are in fact delivered to industry at the level intended. Nor indeed will they be helpful if they introduce any degree of uncertainty in the administration of R & D costs by the performer.

Unfortunately, incentives are not as beneficial as they seem. While R & D expenditures attract a 20 percent credit (except where companies with revenues below $200,000 are eligible for a 35 percent rate) the actual value may only be in the region of 7 percent. This occurs because the credit is considered income and taxed. This reduces the effective credit typically to 13 percent; further, the provinces do not recognize the federal credit and their taxation creates an additional reduction to about 10 percent. The credit is only applied to costs "all or substantially all" of which are attributable to R & D.

Only stand-alone R & D facilities avoid the problem of attribution. Such facilities are rare in industry in Canada, and the difficulties of technology transfer dictate the integration of R & D and manufacturing.

These two factors, the taxation of credits and attribution, reduce the original tax credit of 20 percent to about 7 percent. This tax incentive is not the significant positive factor that public utterances would lead us to believe.

(3) Recommendation: That changes be made in the Income Tax Act so that the R & D performer realizes the full value of the tax incentive. Specifically, allow "attributable" current expenditures (based on generally accepted cost accounting methods) rather than the debatable "all or substantially all" present requirement of the Act.

(4) Recommendation: Federal grant programs be maintained at the same relative levels which exist today (about 17 percent), not to exceed 20 percent of all R & D conducted in industry in Canada so as not to provoke countervailing action. For maximum efficiency, granting programs be simplified and streamlined. Tax reform must make the value of these programs fully realizable, and their value must be independent of geographic location.

(5) Recommendation: Provincial governments to relinquish their taxing of federal R & D incentives or alternately provide some offsetting benefits to R & D performers in their province.

The new federal measure which introduces a 100 percent tax credit for some companies on the first $2 million of R & D tax expenditure is an important development. It will be a real stimulus to smaller private companies. While encouraged by this move, EEMAC cannot accept ownership criteria in this legislation. Such discriminatory requirements are contrary to the Government's well established position on foreign investment and inhibiting to the creation of world product mandates.

(6) Recommendation: That ownership criteria be excluded from any legislation intended to promote and encourage research and development in Canada.

D. Government Procurement. Government procurement should be a tool for technology development. Government departments should look for opportunities to be the first buyer of new products. Money for this purpose should flow through departmental budgets to ensure that each procurement satisfies a real need in the right time frame. The risks of such activities must be accepted and failure in a product development does not mean failure in the associated technology development.

(7) Recommendation: In every practical case, government should be an early purchaser of new Canadian products. Early sales provide needed cash flow, encourage the solution of production start-up problems, bring down unit costs and accelerate the development of market skills.

E. Mechanisms directed to companies which are not sufficiently profitable to realize tax credits.

This is particularly important for small start-up operations and for other companies that may be temporarily unprofitable. The new measure offering 100 percent tax credit, though only applicable to some companies, is a positive move.

Investment Capital

To achieve substantial industrial growth in the next decade, industry requires large amounts of investment capital from corporations and individuals.

It is often said that there is an attractive pool of capital in Canada but coupling to it for technology development has not had noticeable success. We believe that some steps must be taken to make such investments practical and popular.

The recent granting of a lifetime exemption of $500,000 of capital gains from taxation is a positive step to improving the availability of capital. However, since this measure is not directed at industry, we are not convinced that it will benefit the high risk, R & D based enterprises that are seeking funds.

A mechanism is needed to encourage small-investor participation in technology-related activity.

The need for this capital generating device is that Canadian companies raise less than a third of their capital by equity, mostly using debt instruments. This compares with U.S. figures of over a half by equity.

To be attractive for buyers to take on high-risk investments, a substantial tax write-off is needed, adjusted for the degree of risk as indicated by the level of assets in a company.

(8) Recommendation: Adopt a national stock savings plan with a siding scale of tax write-off for investors ranging from 150 percent for small developing companies to 50 percent for large companies.

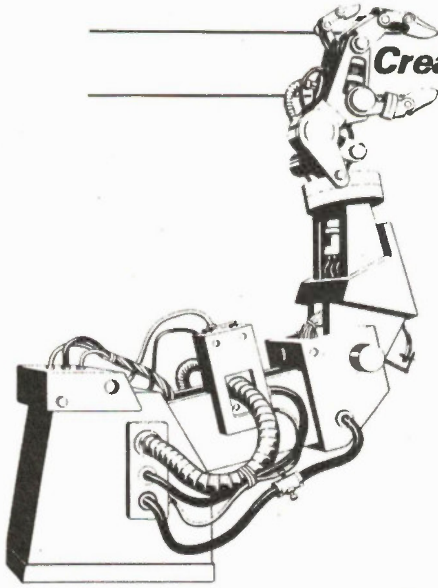
Manpower Development

The federal government directly funds postgraduate development through the Natural Sciences and Engineering Research Council (NSERC). It also substantially supports education through credits and transfer payments to the provinces.

In the recent past, Canadian industry could look to the universities for leadership on many technical issues. The universities often had access to the best equipment and staff who were working at the forefront of science applicable to industry. This is no longer true and, given the relatively static buying power of the new NSERC budget, is unlikely to change.

The high rate of technical change has accelerated obsolescence and has, in many instances, radically increased the cost of state-of-art equipment. University staff, perforce spending less than full time on research, cannot remain at the forefront of specific industrial problems given the current rate of change. Thus, a new covenant must be struck between the university and business. The basis for the new covenant should be the provision of industrial experience for university staff, university exposure for industrial staff, and a reemphasis of the fundamentals in university education.

(9) Recommendation: In cooperation with the provincial Ministers of Education a strategy for education and skilled manpower development be determined that is consistent with the National Science Policy.



The post-secondary component of education must not be considered in isolation; primary and secondary education, and all the factors which come into play at those levels, must also be considered.

(10) Recommendation: To implement a strategic planning approach to education reform.

Provincial governments should play a leading role in focussing ongoing discussion of post-secondary education matters between government departments, industry and the educational institutions.

(11) Recommendation: Create an accelerated turnover of 2 percent per year of existing faculty and hire 1 percent per year new faculty in strategic areas and increase capital expenditure in key areas. Faculty salaries to be brought closer to industry levels.

(12) Recommendation: Allocate new resources in staff, equipment, and space to engineering and computer science faculties and introduce industrial experience into university courses.

In our opinion, the distribution of resources within the universities is a very serious problem. Clearly the governing boards of these institutions must revise their distribution criteria to produce some correspondence to the needs of society in the context of its future intellectual and economic well-being.

(13) Recommendation: Institute a five-year plan of renewal for universities to provide adaptability and move to a market-influenced system with funding by individuals, business and industries.

We believe that there is a level of technological illiteracy, with its roots in the high schools, being propagated through the university system.

In an age of rapidly increasing technological complexity, where no one is unaffected, society on the whole has been reactionary. So too have our institutions of learning. While science programs usually call for competence in Arts and Humanities, the reverse is sadly not true.

(14) Recommendation: Establish uniform high school graduation standards and reduce technological illiteracy with required Science content in schools and universities.

Government/Industry/University Interaction

The human technical resources of Canada must be fully marshalled to effect rapid growth in secondary industry. To this end, interaction and transfer must take place linking government bodies, universities and industry.

For the electrical and electronic industries, which perform close to one quarter of Canada's industrial research and development, the transfer of technology is recognized to be of such difficulty that research and development must be done as intimately as possible with the manufacturing function.

(15) Recommendation: The staffs of government research laboratories should be encouraged to spend periods of time working in industry through a system of mutually rewarding incentives.

(16) Recommendation: To encourage university researchers to work with industry they must get full credit for this during performance evaluation at their university.

There should also be a great deal of encouragement for policies and programs that encourage the interchange of personnel between university/industry/government laboratories. A new program for industry with specific financial incentives for becoming involved with universities at the working level would be an appropriate incentive.

For any further information on this report, contact EEMAC, One Yonge St., Suite 1608, Toronto M5E 1R1, (416) 862-7152. ■

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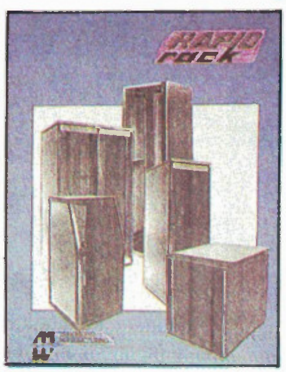

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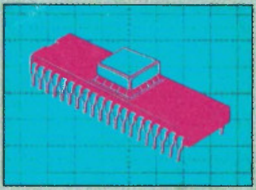

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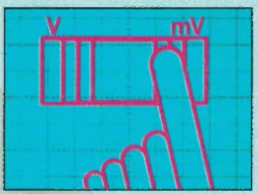

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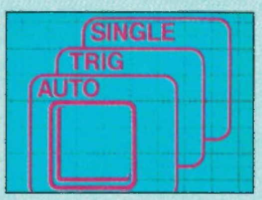

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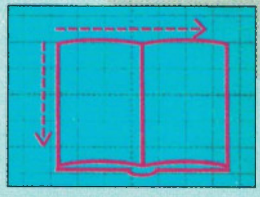

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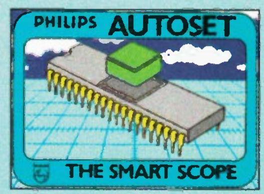

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