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Electronics & Technology Today

Canada's Magazine for High-tech Discovery
September 1987
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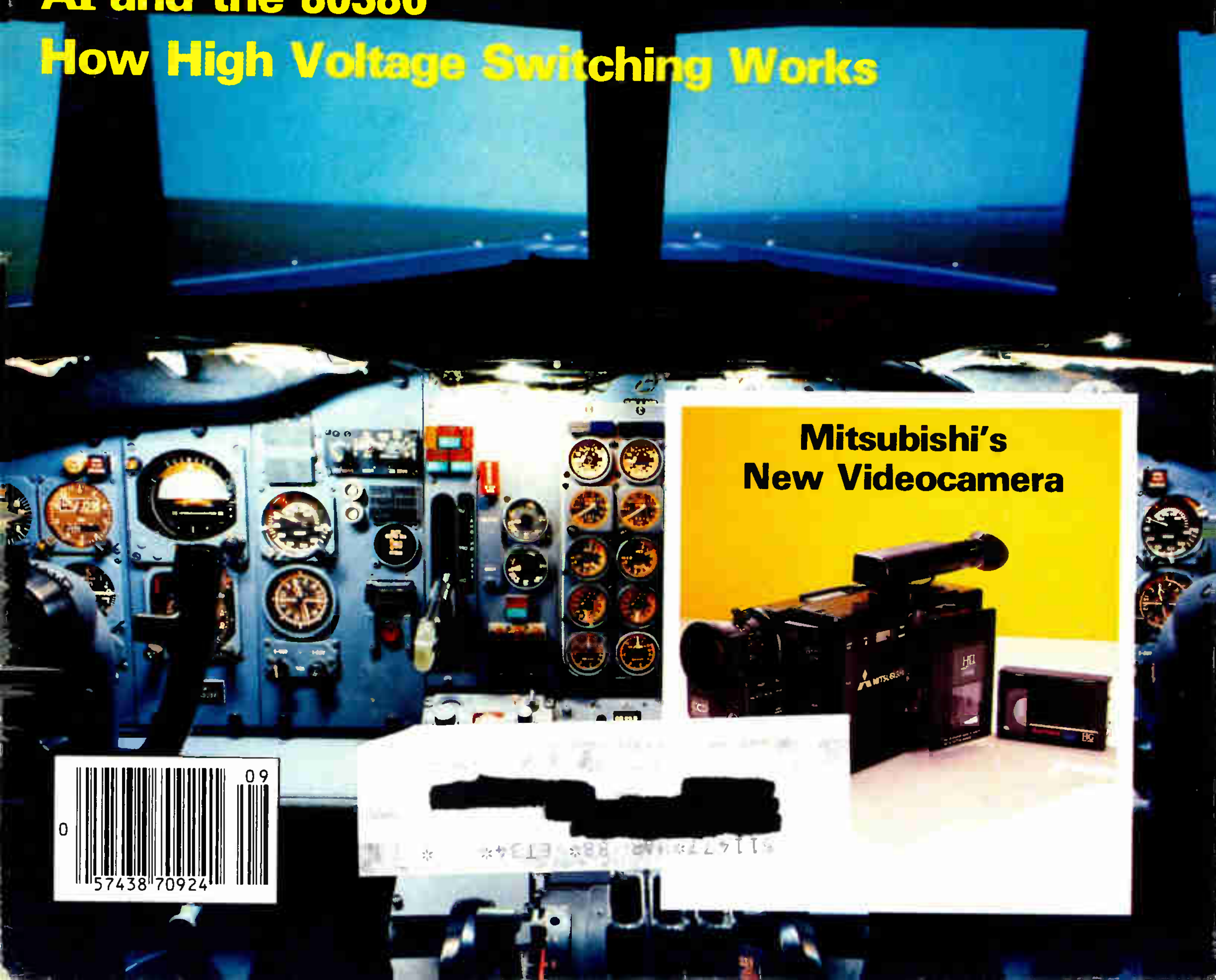
From desktop to mainframes

An Easy Frequency Meter

AI and the 80386

How High Voltage Switching Works



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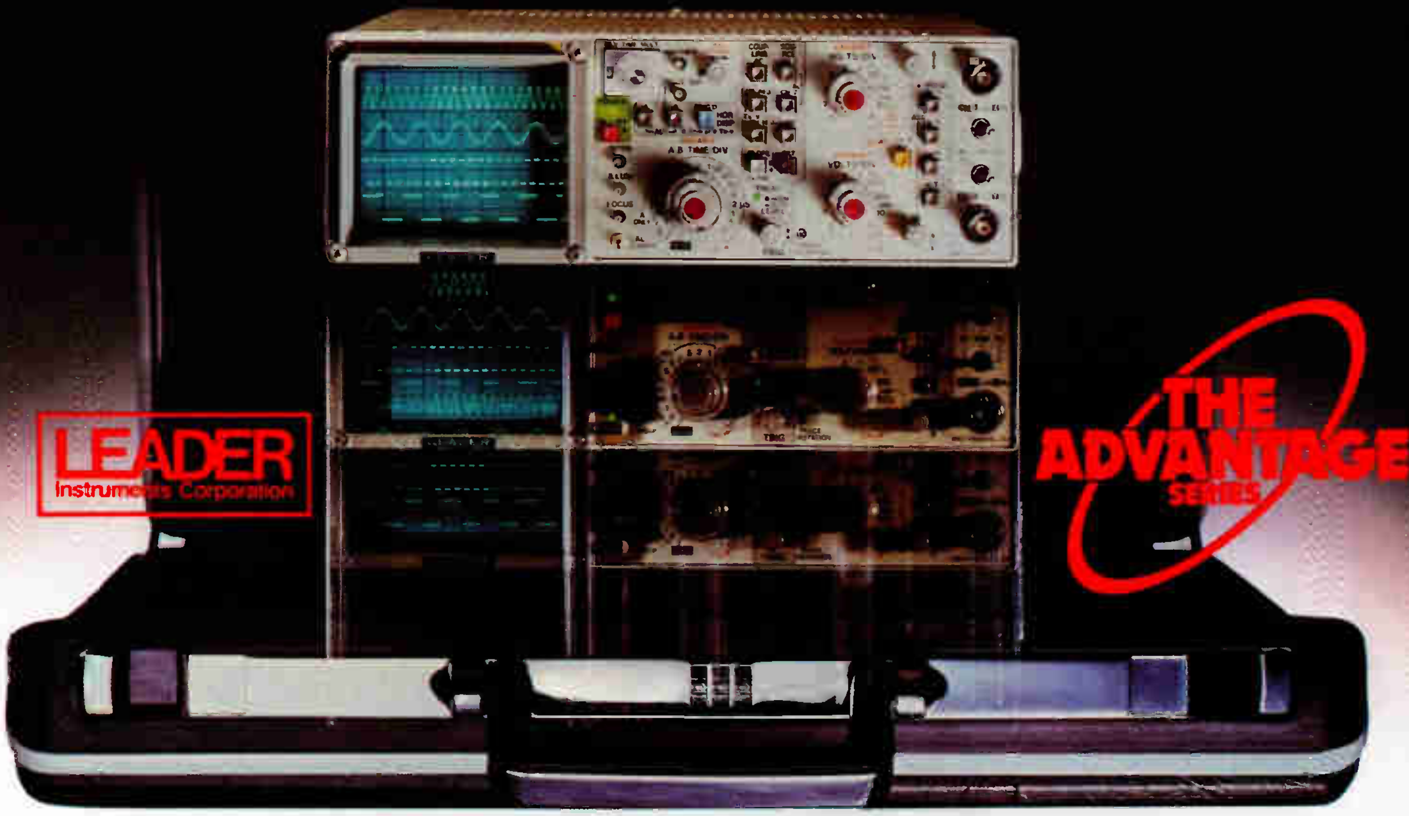

Omnitronix Announces An On-Site Diagnostics Breakthrough.

The new Leader *Advantage Series* gives you brief-case portability with lab-grade features. Finally there is a family of oscilloscopes that breaks the barrier between true portability and multi-feature functionality. Leader's new *Advantage Series* from Omnitronix. Their sturdy die-cast aluminum frames are just 230 x 290mm by 75mm high. And they weigh a mere 4kg!

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Canada's Magazine for High-tech Discovery

Volume 11, Number 9 *September, 1987*

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INFORMATION

For Your Information

Electronics & Technology Today

Electronics Today Adds Technology!

If you're a regular reader of Electronics Today, you can't help but have noticed the increasing amount of editorial material that involves high technology. You'll also have noticed a new look from cover to cover, and special supplements on subjects like satellite TV reception.

Since the common denominator is the technology that plays such a great part in our everyday lives, effective this month we are now Electronics and Technology Today.

What is important for you to note, however, as you browse through this issue, is that electronics, and projects, and the things that made Electronics Today the most successful magazine of its type in Canada, are still the major part of the magazine. We are not dropping one for the other, but rather expanding the perspective to give you, the reader, more of the material that we know interests you.

This is our job as publisher. It's a challenge for us to accomplish, and we want you to be the judge. We want you to let us know in the months ahead what kind of job you think we're doing. Even though Electronics Today is ten years old this year (an excellent record in Canadian publishing), we can't assume we've got it right and perfect. We'll continue to change and mature with the fascinating, unpredictable world of electronics and technology.

Although we're happy with the changes we've made, we're far from complacent. We're evaluating what we've done both editorially and graphically and are looking for ways to make our magazine even more attractive and valuable for you. We know we have to keep pace with a changing and complex world and hope you like what we've done.

HW Moorshead

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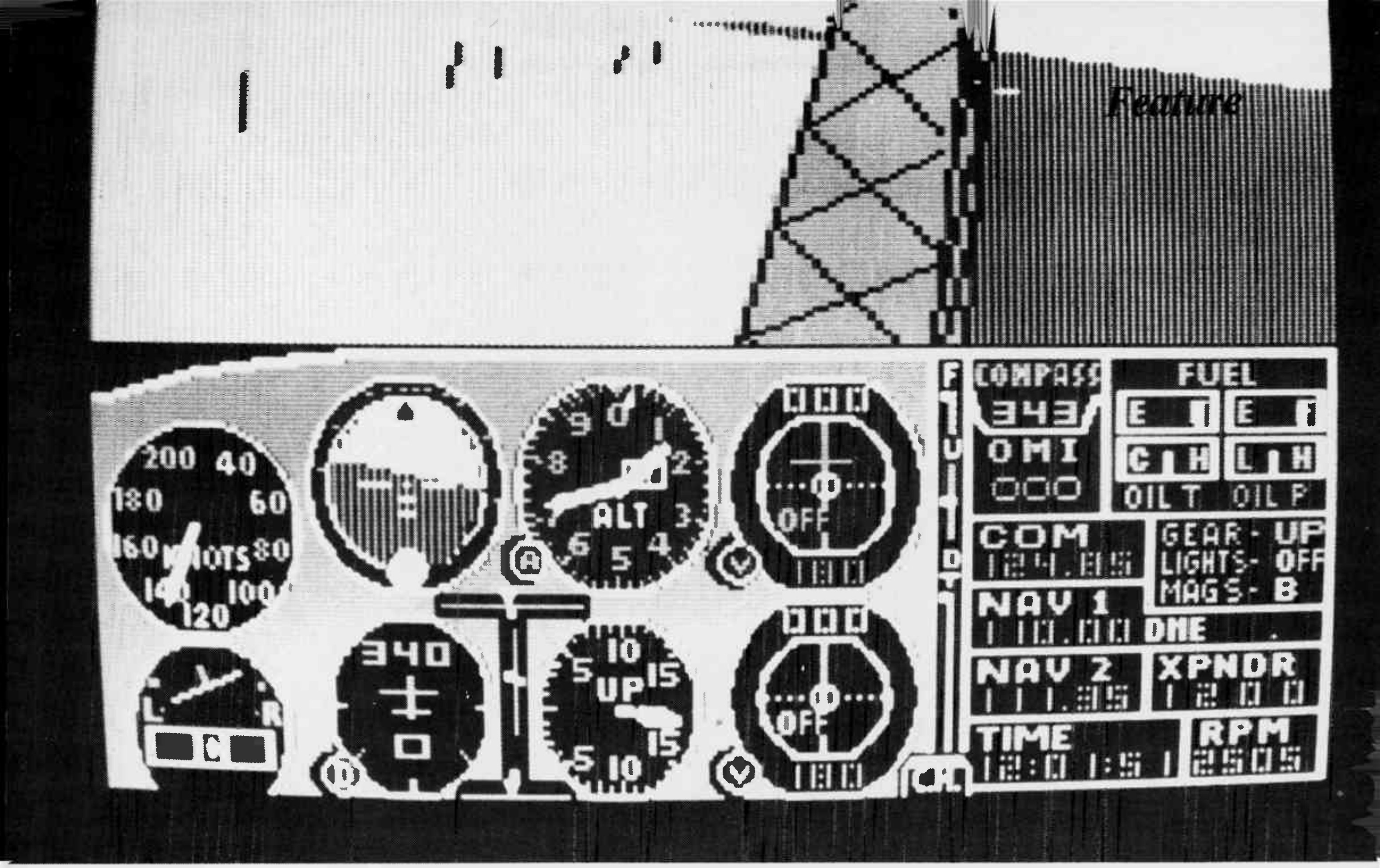


Flight Simulators for Micros

Head into the wild blue, shoot up targets, crash into the ground, all from your armchair.

By Bill Markwick

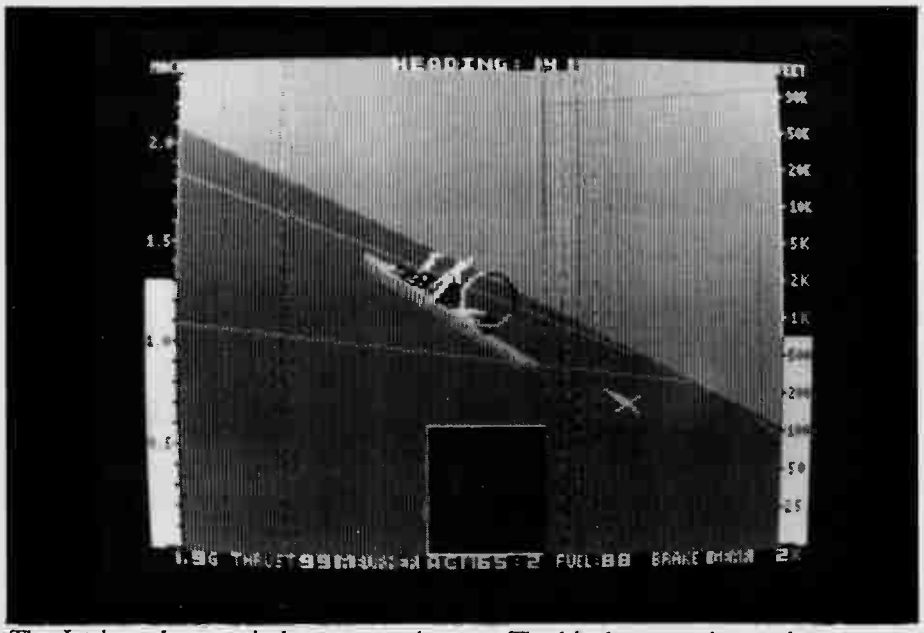
Perhaps you first tried flight simulators when Microsoft brought out their versionmulator for the Apple II, and perhaps you were put right off the whole idea. W of the Sublogic Flightper-second screen updating, the Apple simulator was described by a friend as looking "less like flight than being jerked around on a string". In addition, if you changed the controls, you had to wait a half-second to find out whether you were still stable or plunging into the ground. You probably took off from Chicago's Meigs Field and fell into Lake Michigan a whole lot.

That's all in the past, thanks to programs written for computers with more memory and speed (IBM PC, etc.) or those with hot 32- bit processors (Atari 520, Amiga, Mac). They update imperceptibly (almost), the scenery is much more detailed and realistic, and they're packed with extra features.

The IBM Series

For IBM PCs and compatibles with 128K or more, as well as the XTs and ATs, we have the Microsoft Flight Simulator, updated by the Sublogic corporation. There's only one aircraft, still a single-engined Cessna, and the plane still starts off from Meigs Field. The update rate is 5 times per second, producing a slight stepping effect, but one that's infinitely better than the Apple version. You can fly around the Chicago area with vastly improved detail in the graphics, and land at several different airports..

There are nine preset "modes". By selecting 1 to 9, you can have good weather flight, dusk, night, bad weather, and so on. The "realistic" flight mode makes you watch for all sorts of things: the engine can stall on fast throttle movements, the wheels stick if you go off the runway, and more. The "easy" flight mode is much



The Jet launches a missle at a naval target. The black square is a radar screen

You can enter the Editor from any of these modes by pressing Escape, change whatever parameter you want, and continue flying. It's possible to set the time, the seasons, the altitude, the location and more.

In addition, there's a WWI dogfight game. It takes place over a surrealistic checkerboard with two-dimensional mountains. You're flying a Cessna again, but this time it's armed with machine guns and bombs. There are lots of enemy biplanes with pilots of varying skill. Even pacifists like myself can get wrapped up in this one for hours until you have to limp back to the home airport, the engine missing and fuel pouring from bullet holes in the tanks. One drawback is that you can't change any of the parameters via the Editor, supposedly because it would give you an unfair advantage, but it also means that you can't turn off the sound of the engine drone, bad news for pilots who like a bit of the old goggles-and-white-scarf in the AM when it's too hot to sleep. Non-aviators do not appreciate our infatuation with flight simulation.

The Handbook that comes with the software is just first-rate. It explains everything lucidly, including subjects like instrument flying (which I've yet to master).

There are 20 other modes, all of them configurable by the pilot using the Editor. When you get it the way you like, your mode can be saved to the disk for future use.

The IBM version isn't the best as far as screen resolution, updating speed or graphics detail, and the 4-color option is pale and washed out. The monochrome display looks like a rainy afternoon in winter. However, if you don't have a 32-bit computer, you can spend hours and hours finding out all sorts of features that are buried in this software. It's a gas.

Jet

The Jet program is from the same people, and so far appears to be available only for IBMs. The reaction of most people to it has been the same: it's more of a video game than a flight simulator. You can fly either an F-18 or an F-16, from either a land base or a carrier. Your targets can be enemy bases or fuel depots, fighters, or naval cruisers. Your plane carries missiles, bombs and a cannon.

The feel of the jets is nothing like the floating-on-air feeling of the Cessna. These jets are, apparently, the most well-behaved airplanes in the world. Other than diving it straight into the ground, you're safe.

The difficulty in hitting targets can be selected on a scale of zero to nine. In the zero or practice mode, you can't even crash; the jet just waits on the ground until you take off again. Nine is fairly difficult because there are multiple targets and they're all shooting at you.

Despite complaints of the un-airplane-like handling, it's an enjoyable game. Some of the features are a hoot: you can bail out when hit and switch to the Tower view (with zoom). You can watch the plane tumble to the ground and a tiny stickman sway beneath his parachute.

Whatever the drawbacks, it's a

The World War I dogfight territory from the Microsoft Flight Simulator. The Cessna does well against biplanes.

Continued on page 26

Switching High Voltages

Switching very high voltages in power applications causes a continuous arcing in the switch. Here's one method of subduing the arc.

By Dr. H. Virani

An essential part of any interrupter is the switching arc. In high voltage applications the most modern techniques used for extinction of the arc use either sulphur hexafluoride gas (SF_6) or vacuum. Oil can also be used (oldest technique), as well as air (used now only for the highest performance applications), but, the two techniques under consideration for the future are SF_6 and the vacuum.

Sulphur Hexafluoride

SF_6 gas was first used in switch gear because of its superior insulating properties compared to air. Its excellent arc extinguishing ability was discovered later. SF_6 is an ordinary gas that is widely available; it is colourless, odorless and non-toxic. It is an inert gas which means it does not sustain combustion, and as a result, its use as an insulator in electrical switch gear provides safety and security to staff and to the installation.

Arc Quenching Principles

To interrupt the arc in an SF_6 circuit breaker the relative movement between the gas and the arc column must be provided for. This has been achieved in several ways:

Differential Pressure Principle derived from the air blast breaker, but now considered uneconomic.

The Puffer Piston Principle which has prevailed in high and extra high voltage applications.

The Rotating Arc technique provides an economic breaker in high voltage applications since only a low energy operating mechanism is sufficient.

The Self-extinguishing Principle is somewhat of a hybrid since it utilizes the heat of a rotating arc to build up a pressure difference enabling a gas flow.

In considering high voltage applications, the rotating arc principle is used for low to medium performance (up to 1250A continuous current rating and 520MVA (25 KA breaking capacity at 12KV), while the puffer breaker provides higher performances.

Current Zero

The unique properties of SF_6 gas that make it an excellent insulating and arc extinguishing medium have already been mentioned. It is however in the vicinity of current zero that the arc is cooled mainly by radial conduction. This is best explained by the curves of Fig. 1A which shows a pronounced thermal conductivity peak for SF_6 around 2000 deg K.

It is in the same region, because of the electro negative character, where the electron density is already low. This

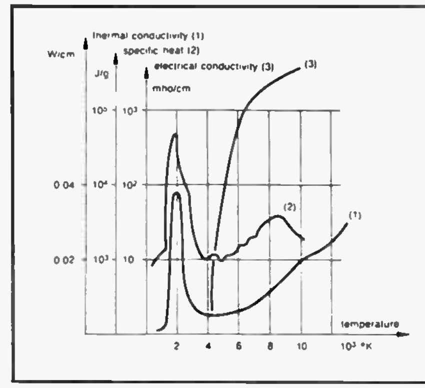


Fig. 1A. The thermal conductivity of the gas increases at 2000°.

is shown by the SF_6 curve in Fig. 1B where it is clear that from 3000 deg K to 2000 deg K this is the region in which its constituents rapidly recombine into molecules of the gas. In doing so, rapid cooling of the arc and rapid recovery of the dielectric strength is achieved.

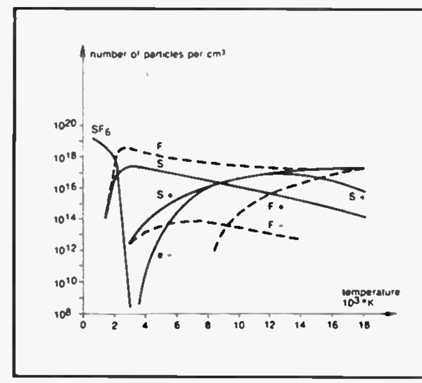


Fig. 1B. The gas rapidly recombines in the area of 2000 to 3000°.

Rotating Arc

In the rotating arc technique, the basic physical properties of SF_6 are used to quench the arc. In this technique the relative motion between the SF_6 and the arc is achieved by movement of the arc, following a circular path in the gas' en-

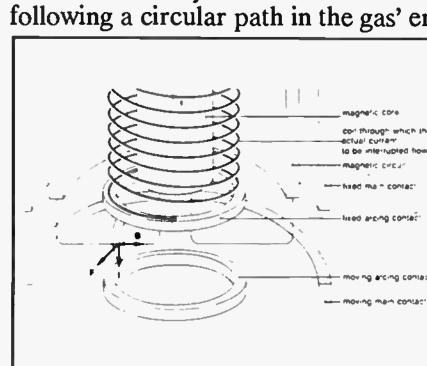


Fig. 2. The rotating arc mechanism.

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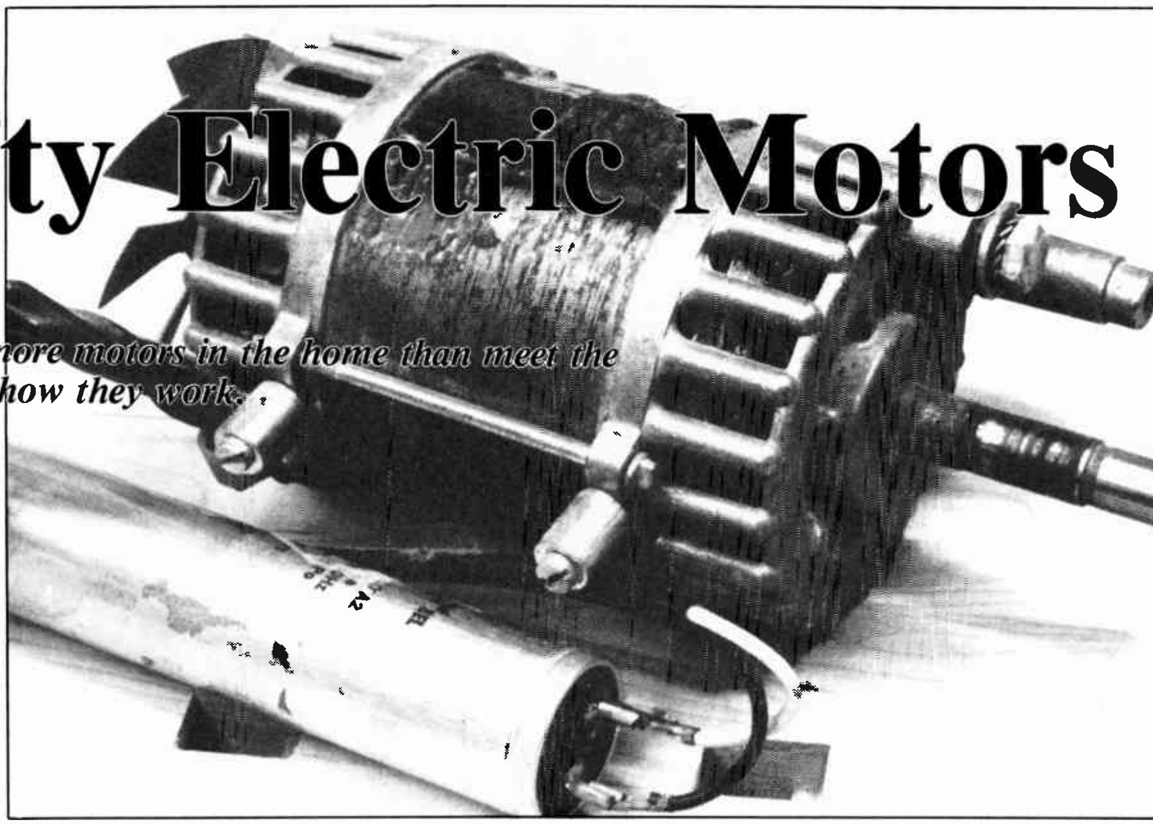
Fifty Electric Motors



There are more motors in the home than meet the eye; here's how they work.

By E. Penn

So they said to me, "The average home has fifty electric motors. Write that up for us in your inimitable style, will you?"

Sure, fifty motors. Some houses may have fifty, those upwardly mobile urbanite practitioners of conspicuous consumption, with their electrically-operated toilet seats and battery swizzle sticks, their houses bulging with ever more motorized gadgets to save them muscle power so that they have to go out and jog to keep from turning into Jell-o. Not me, the original Mr. Practical. However, I'll scout around the place and write up the few motors that I have and explain how they work.

The Living Room

Of course there are motors here. Just looking around, I can see two cassette decks and a VCR. Oh, yes, there's an electric clock, and I guess that's a motor, too. Hmmm, the setback thermostat on the wall has a timer motor. And the turntable. And the ceiling fan. Yikes. I'd better list these.

Electronics: The low-cost cassette deck I use for copying (my own practice tapes, not bootleg, thank yez) has two motors. Both of them are simple *synchronous* types, just a coil of wire around a round or horseshoe iron pole-piece. Inside this is the *rotor*, mounted on the main shaft (capstan). The 60Hz alternating current induces a circulating current in the rotor, and the motor turns at a speed fixed by the power line frequency, a necessity to keep down the audio wow and flutter (within limits).

To get the thing to start instead of just sitting there humming, there's usually a copper ring or a milled slot somewhere on the pole-piece. This unbalances the magnetic field and starts the rotation. These motors are usually called *shaded-pole* types.

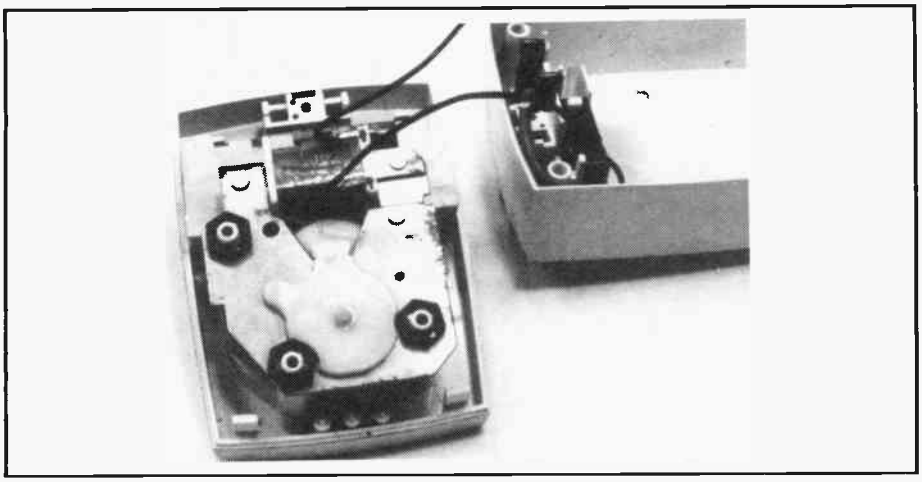
The other deck and the turntable have an electronically- controlled *servomotor*. Something on the capstan, usually a disk with slots that trigger a photocell or pickup coil, feeds a pulse train back to the control electronics. When the feedback signal equals a crystal-controlled reference signal, the motor is turning at the desired speed. If the motor varies, the feedback signal varies and the electronics send a corrective voltage to the capstan windings.

If you vary the reference signal, you can vary the turntable's speed by a semitone or so, very handy if you practise by playing along with a record. No record ever seems to keep concert pitch intact.

The cassette decks also have simpler shaded-pole motors for running the supply and take-up spools, the VCR has two motors, and there's a cooling fan in the back of the stereo cabinet.

Timers: The clock and the thermostat have simple motors as described above, just a coil, pole-piece and rotor. A train of small gears reduces the speed to whatever the mechanism requires, such as one rev per minute for the second hand. Since these motors lock to the line frequency, their long-term stability is very good. In fact, whenever I reset the electric clocks each spring and fall, I can't remember them ever being incorrect. They're probably accurate to better than a minute per year because the power-line frequency variations average out.

Fans: Fans don't need much starting torque, and usually not much power, but they have to run silently. The usual



A simple synchronous timer motor. The coil and horseshoe-shaped pole make a rotor drive a reduction gear train.

fan motor is a larger cousin to the simple motor described above, with the rotor turning the blades directly. In the case of ceiling fans, the hub is actually the rotor and the windings are inside. Mine is a very low-cost unit and it goes *bding, bding, bding* as it rotates cause you can't balance the cheapies to save your life.

Small appliance and power tool motors using the coil/rotor method are called *split-phase* types, and they work the same as the shaded-pole types described above, only they're larger.

Well, let's see, three motors in one cassette, two in the other, two in the VCR, timer, clock, fans. Wow, eleven motors and I just got started. But then, A/V equipment raises the total, doesn't it; I mean, that really isn't very many motors.

The Bedroom

In the bedroom we have another ceiling fan, another synchronous clock and an air conditioner. The air conditioner has two motors, one a small split-phase to drive the blower and another *induction motor that's a bit more heavy-duty and drives the compressor.*

Induction motors are the big brothers of the split-phase types. They basically consist of a rotor turning inside the pole-piece, which is wound with wire (the *stator*). Everything is scaled up: bigger wire, bigger rotor, more current. In addition, they use various designs to provide a quick start with lots of torque. In the case of the air conditioner, a capacitor is connected to one of the stator windings. This introduces phase shift, unbalances the stator, and starts the motor.

If the motor is not too large, say 1/2HP or so, the capacitor is permanently wired in (a *capacitor-run* motor). In larger motors where the capacitor would introduce losses, a centrifugal switch cuts out the capacitor when the motor is up to speed.

Some induction motors use a starting winding instead of a capacitor; this too is switched out at speed.

A computer lurks on a desk upstairs, the very computer on which these gems are being converted to bits and bytes. It has two electronically-controlled motors for the disk drives (300RPM) and one small shaded-pole for the fan.

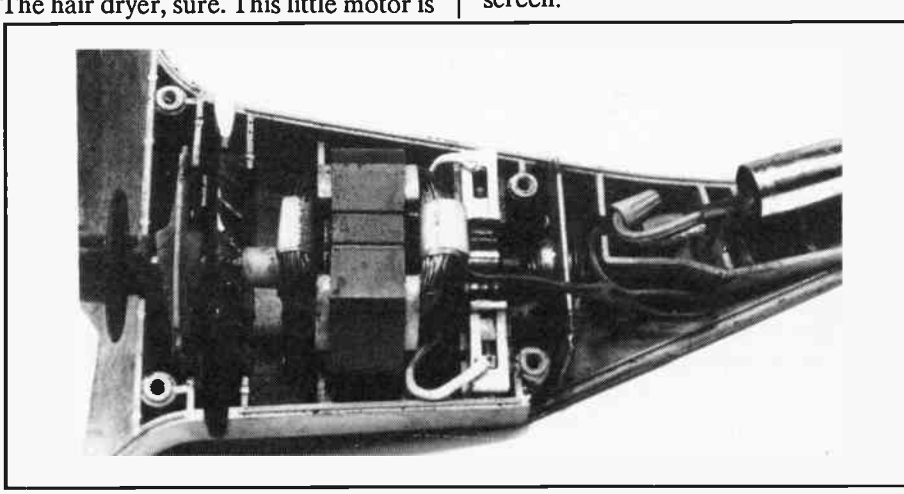
Oh yes, and the alarm clock. That's seven. Eighteen total. Eighteen? Well, of course, you tend to forget about things like three motors in a computer, don't you, so I suppose I'm not really a capitalistic materialist yet.

The Bathroom

The hair dryer, sure. This little motor is called a *universal* type, because it will run on either DC or AC thanks to brushes that conduct the current into the rotor; the rotor has windings called the *field* to generate the magnetic field, as opposed to the induction motor's solid mass rotor. Hair dryer motors have to be fairly small and quite powerful, so a low-voltage motor is used (lower voltage, higher current, thicker wire with less turns equals small size). To get the 12 to 24V from the 115V supply, the motor is wired in series with part of the heating element, or may be wired across a section of it.

Despite the noise generated by the brushes, the universal motor is a great favorite for appliances, especially since its speed can be controlled by either varying the main input voltage or by electronically controlling the field current, and its maximum speed is not limited by the line frequency. I have a blender (in the kitchen, not the bathroom) that has 14 speeds. Only two make a noticeable difference, slowest and fastest. All those others, like "mince", "chop", "glop" and "putrefy" are just sparkles from the marketing department.

Well, that's it. What? My razor? You can't count *that*. Well, I suppose if you're going to define a motor as a gadget that converts electrical energy into motion, I'll have to allow you one more. The razor is a special case, the *vibratory* motor. An armature fastened at one end just buzzes back and forth between pole-pieces following the AC cycles, eliminating gears and so on. It's noisy and has very low power, but it's ideal for an economic razor because the motion lends itself to zipping a blade back and forth under a perforated screen.



A typical universal motor using brushes and a wound rotor.

Another Bedroom

In this bedroom is a vacuum cleaner and a sewing machine, both with universal motors. Forgot about those. Gack. 22.

The Kitchen

Bet you think you've got me here. Kitchen gadgets. Well, there's the can opener. It was a gift, like, I can open cans without power, you know? There's the mixer, the blender and the food processor, all universal motors. Naturally, they're all really useful things, don't you know.

There's an exhaust fan over the stove, a refrigerator with an induction motor for the compressor and a shaded-pole for the fan (which is supposed to keep frost out of the freezer section. It does that, all right, by letting the frost all freeze up inside the air ducts where you can't see it, and eventually the whole thing quits until you defrost it).

There's a popcorn popper which I haven't dissected but probably has a shaded pole. That's not materialistic, nohow; popcorn with late movies is nothing if not *civilized.* And there's the kitchen clock, a battery-operated *pulse* motor. An IC divides down the output of a quartz crystal oscillator to one pulse per second, which kicks over the mechanism. It keeps great time for a year on one "AA" cell.

That's 31. I can't believe it.

The Catacombs

Down in the basement, we find the expected washer and dryer, both with large induction motors. The dryer has a capacitor-run type; the washing machine is a special case because it has two speeds. The speed of an induction motor is determined by the line frequency and number of poles; they're generally 1725 and 3650RPM under load. The number of poles in the washer motor can be switched to either of these speeds. The slow speed is much gentler to my delicate undies, what.

I'm fooled again. There are synchronous timers in both machines. 35. Gadzooks.

The furnace has two induction motors, a simple split-phase to run the burner fan and a capacitor-start, induction run on the main blower. You can hear the click as it's shutting off and the centrifugal switch reconnects the capacitor.

There's a capacitor-run induction motor driving an extractor fan in the basement window. A solid-state control (like a lamp dimmer, really) controls the main voltage sent it to it and thus the speed.

Turning to my workbench, umm, yes, I know, here's where the motors pile up. But they're *useful*, or at least they soon will be, just as soon as I get around to making the stuff I was going to. There's a drill, a router, a jigsaw, a circular saw,a table saw, a small bandsaw and a sander. There's also a little battery-powered rechargeable vacuum cleaner (a gift to the handyman). It hangs in its charger on the wall, and when fully charged, is quite useful for vacuuming the coat of a small hamster. You can't get it near real dust or sawdust though, or it coughs and chokes.

46. I can't really believe this is me, Mr. Traditional Hand Tool, Mr. Back-to-Basics...

The Back yard

There couldn't be, not in the back yard. Look, I refuse to count my car, you didn't say automotive, did you. Oop, there's the lawn mower. And the lawn edger (well, if you're going to mow the lawn you can't leave grass sticking up the sidewalk edge, can you?). And there's the barbecue with a rotisserie, another gift, you see.

Ha! I've gone over the house with a fine tooth comb, and there are only 49! Well, I admit that 49 motors absolutely staggers me, but I came in under the wire, no Mr. Modern Consumer and Mr. Smart Shopper for me! (if only by a hair, I confess).

What? My *wristwatch?* Surely you can't expect me to count that...

Well, yes, it is the baby brother to the pulse motor in the kitchen clock, and that does, I guess, make it 50.

So. Now that my theories of spartan living have been shot up, I guess it doesn't matter if I indulge myself just a bit. I saw an ad for a battery-powered tooth polisher, and that really does seem like a sensible idea...

E. Penn is a Toronto writer who specializes (sometimes rather oddly) in matters of technology. ■

Centres of Excellence

How the Ontario government plans to spur technology.

By Frank Lenk

For most of history, governmental interest in technology, aside from the machineries of war, of course, has been nearly nonexistent. Recently, however, there has been a dawning realization that the next war is going to be an economic one, and that those nations with the strongest technological position are already well on the way to winning it.

Here in Canada, the main remedy will be to link up our established industries with the latest developments taking place in the university labs. To this end, the Ontario government last year instituted the "Premier's Council", with a mandate to "steer Ontario into the forefront of economic leadership and technological innovation." This typical bit of rhetoric has borne material fruit in surprisingly short order. This summer the Council designated a series of seven Ontario Centres of Excellence, intended to stimulate the ongoing relations between science and industry.

The Centres are not, as one might expect, specific buildings full of individuals devoted to a single purpose. Rather than simply congregating resources in one place, the idea behind these "centres" seems to be to link up people and equipment from within separate institutions, to achieve a meeting of minds rather than bodies. In fact, the various participants in each of the Centres are drawn from the creme de la creme of Canadian academia, business and even the labor unions.

Between them, the seven Centres cover a lot of ground, from underground to outer space. Here's a quick rundown of what will be happening, and where.

The Seven Centres

The Centre in Space and Terrestrial Science will be located mostly at York University, in Toronto, but will include participation from the University of Toronto, University of Waterloo, University of Western Ontario and the Canadian Atmospheric Environmental Service, plus about fifteen private companies. The Centre will be working in seven main areas, including atmospheric physics, earth-surface observation, solar/terrestrial physics, human performance in space, astrophysics, space geodynamics (a bird's eye view of the gravitational interaction between earth, sun and moon), and space technology. The latter endeavor will focus on development of robotics and artificial intelligence for use in space. Several service laboratories will also be established, working on microwave technologies, atmospheric observation, electro-optical technology, and image analysis and artificial intelligence.

The Groundwater Research project will delve a little deeper, as it were, to examine the processes that determine the quality of our groundwater supplies. This should lead to improved waste management technology, as well as improved monitoring techniques. The Centre is to be located at the University of Waterloo.

The Centre for Advanced Laser and Lightwave Research will be located at the University of Toronto. It will attempt to develop more broadly-tunable lasers, as well as ultraviolet discharge and extreme-ultraviolet plasma-driven lasers. It will also be carrying on research in laser spectroscopy and laser medicine. Optical techniques in communications, photolithography and similar applications will be studied. Finally, there will be studies of the possibilities inherent in ultra-fast -- that's picosecond and femtosecond -- pulse lasers. The Centre will also feature a "Users Facility", staffed by expert technicians, and available to qualified researchers from both universities and private business.

The Ontario Centre for Integrated Manufacturing (OCIM) will be spread across three universities: the University of Toronto, Waterloo University, and McMaster University, in Hamilton. A private company, Techno Scientific Inc, of Woodbridge, is also involved. The emphasis is going to be on "development of pre-competitive generic manufacturing technology... with potential applications in the five to ten year time frame". The idea is to provide a foundation for the next generation of CIM, or Computer Integrated Manufacturing, the ultimate fusion of CAD/CAM and automated production. Specific research will focus on robotics, sensing systems, machining processes, software modelling and optimization, as well as the management of eventual integrated manufacturing systems.

The Centre for Materials Research will be spread across five universities, including Waterloo, McMaster, Queen's, Western Ontario Toronto. It will be looking at the potential in five different areas. Biomaterials research will range from orthopedic and dental devices right out to "active" devices such as sensors and microcapsules. Microstructures research will deal with development of new crystalline materials such as high- temperature superconductors. Work in polymers will examine advanced fibre-reinforced plastic composites, water-soluble polymers, and polymers for electronics. The optoelectronics project will study new kinds of semiconductor devices based on high speed gallium arsenide technology. The interface science project will study the behavior of surfaces between different materials.

Information Technology

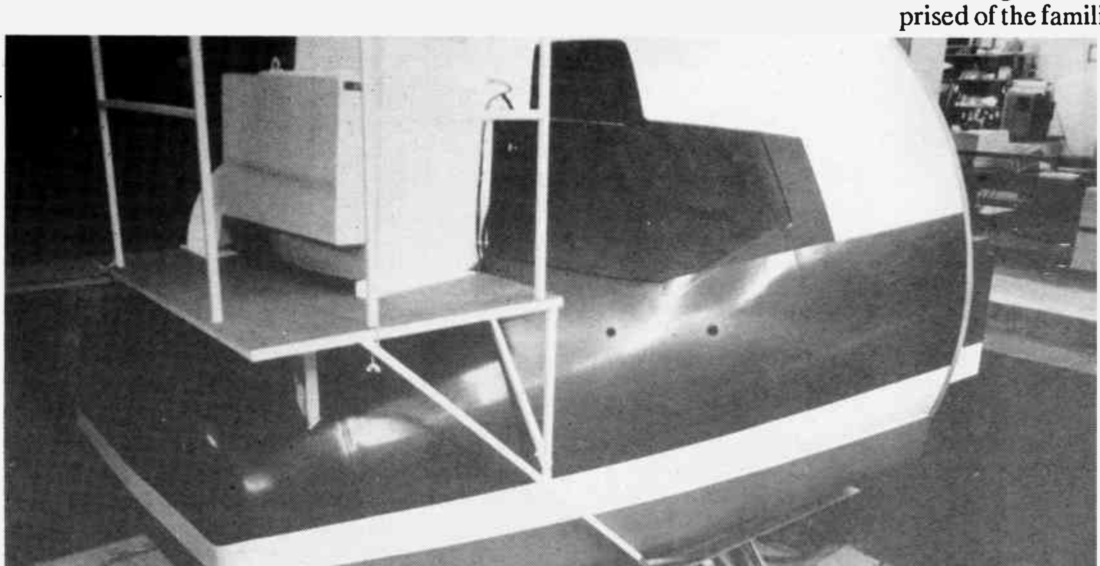
The Centre for Information Technology will be located at the University of Waterloo and the University of Toronto, but in partnership with the University of Western Ontario and Queen's University. Projects will encompass artificial intelligence, networking and communications, computational math, microelectronics, as well as applications software, including data management, programming languages and graphics.

Finally, the Telecommunications Research Institute of Ontario will be spread across four institutions: the University of Ottawa, Carleton University, Queen's University and McMaster University. It will conduct research on digital networking, radar systems, mobile and satellite systems, and optical systems.

There's no doubt that a lot of interesting work is going to happen under the auspices of these Centres of Excellence. Still, bearing in mind that all the players have been drawn from the existing mainstream of the Canadian establishment, it will remain to be seen whether the broader goals of the Centres concept can be realized. However, there's no doubt that the time has come for a more holistic, interdisciplinary approach to both science and technology. The Centres program is at least one more step along the way.

Frank Lenk is the Assistant Editor of Computing Now! magazine. ■

The True Feeling of Flight



A visit to the University of Toronto's cockpit simulator.

By Edward Zapletal

Without a doubt, some of the best flight simulators in existence are the cockpit types in use today by the airlines. These simulators offer astounding realism in all aspects of flight, allowing the airlines to train their pilots safely and economically. The equipment involved is complicated beyond your wildest dreams of video games, and it makes microcomputer flight simulation almost boring by comparison. To give us a better grasp of what's happening in flight simulator research, we visited the University of Toronto Aerospace Studies Institute in Downsview, Ontario. We were introduced to Dr. Lloyd Reid who briefed us on the flight simulator project, and were given a full tour of the flight simulator research lab by Project Engineer Peter Grant and his assistant, Paul Robinson.

The Hydraulic Wonder

At first glance, the most striking feature of the simulator is its lifesize DC8 nose-section, sitting in an enormous concrete pit that would hold a house. Donated by Air Canada, the mockup nose is mounted on a complex system of hydraulic actuator arms, more commonly referred to as the motion base. A program was running as we came in, and the entire nose- section was silently bouncing and gyrating on its cylinders.

This particular motion base is a six degree of freedom type manufactured by CAE Electronics of Montreal. CAE is world renowned for its expertise in large-scale, real-time complex simulation of aviation, power generation and transmission, air traffic control, marine, and space exploration systems.

The term "six degrees of freedom" refers to the three translational and three angular movements associated with aircraft flight. Broken down the three translational components are: surge (acceleration and deceleration), lateral, and vertical movements. The three angular components are comprised of the familiar pitch, roll and yaw motions.

The base itself consists of a number of hydraulic actuator arms, similar to very large shock absorbers, each having a full extension of three feet (commercial airline simulators employ actuator arms with extensions of five feet). The hydraulic pumps necessary to move the fluid through the system at 1500PSI are driven by three electric motors, each with a 50HP rating. You would think that this conglomeration of machinery would create quite a racket, and it does. However, all the noisy bits are tucked away in a room housed on a lower floor, and the result is perfectly quiet operation. In addition to the hydraulic systems, there is also a vacuum system for the onboard aircraft instruments, and a cabin ventilation system as well.

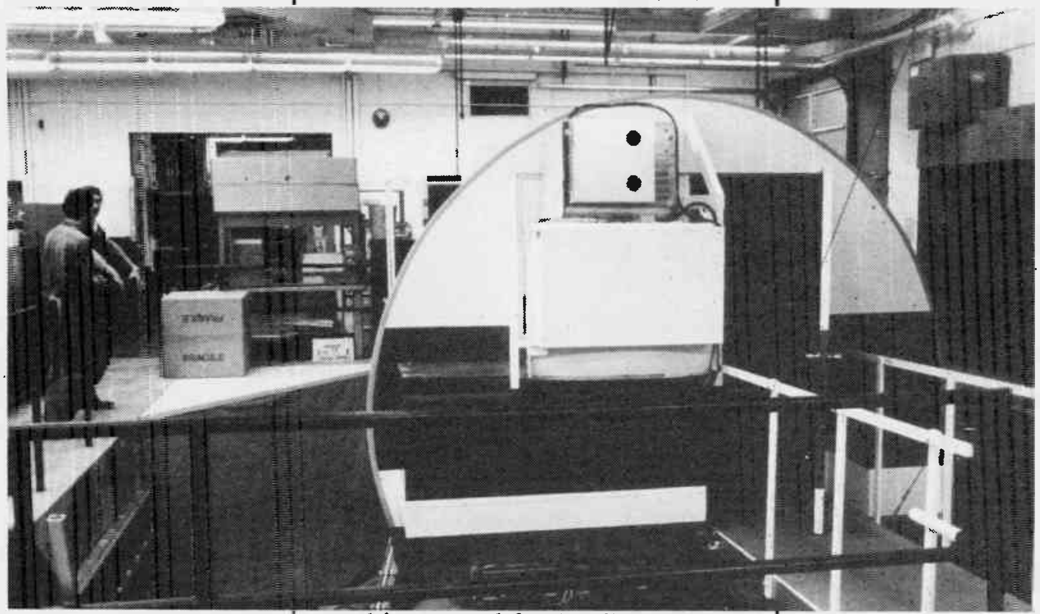
The Heart Of It All

On its own, the actual cockpit and motion base hardware make up a large part of what's visible in the flight simulator laboratory. There is, however, a fair bit of really indispensable hardware and software hidden off in the shadows.

As you might expect, the computer technology necessary to make this kind of simulator operational is highly complex. In order to be able to handle the

multitude of calculations and instructions necessary to make flight seem realistic in an earthbound machine, you need a true 32-bit computer. Enter the Perkin-Elmer 3250, not the sort of computer that you'd use for tinkering, let's say, with WordStar.

The PE 3250's computational speed makes it ideal for performing the number-crunching involved in reproducing the feel of a true aircraft flight. It's not directly linked to the motion base, however,



but interfaced to it by way of an 8085-based single board computer which feeds signals from the various hydraulic valves as well as from numerous controls within the cockpit.

The visuals are produced by a computer dedicated for that sole purpose. The Iris, by Silicon, is capable of displaying frighteningly realistic scenery with none of the jerkiness associated with off-the-shelf microcomputer flight simulators. Although it is not yet fully functional on the U of T flight simulator, it is being used in the development of an automobile simulator at the same location. When fully functional on the flight version, the Iris will control three visual displays within the cockpit, producing an incredible, almost 3-D field of view.

Software

Designing software for the flight simulator is an enormous, ongoing task, one which has taken almost three years. According to Peter Grant, thousands of lines of code already exist with more being developed all the time.

One of the more interesting aspects of the software, something referred to as "washout filters", was developed by Ph. D. student Paul Robinson. Washout filters are actually computer software routines that convert the pilot's perception of what an aircraft should be doing at any given time into simulator motion. A fair amount of information, therefore, about how a particular aircraft performs and how a particular pilot perceives that motion must be taken into consideration. For example, braking is simulated by tilting the simulator cabin slightly forward, just enough for the pilots on board to feel the physical sensation of deceleration rather than leaning forward; acceleration can also be simulated in the opposite manner. Over the past several months, the U of T people have invited numerous pilots to come and use the simulator and offer their opinions as to the "feel" of it. By compiling all the likes and dislikes from those who fly the real McCoy, the team has developed the washout filters for commercial use.

Although the simulator is not being used for actual flight training, it is being used for the study of flight simulator motion and motion in general. Also, there is much work going on in the area of wind turbulence and wind shear simulation because these weather phenomena are particularly hazardous to pilots.

A Flight

We entered the dim cockpit and strapped ourselves in with proper 5-point pilot's harnesses (the simulator's motion is remarkably powerful). All the instruments of a DC-8 are in place, most of them working under control of the computer systems. The magic is at work already: the whir of the air conditioning system, the cool air, the dim glow of electrical panels all around you; the angled mirror in place of the windshield is the only thing reminding you that you're in a mockup. We put on communication headsets so we can listen to Peter, at the controls back on the "ground".

The three of us stare at the blank windshield. Paul tells us that we're about to simulate a 747 approach and landing; the viewscreen comes to life and we're looking down on a black-and-white checkerboard landscape. Peter runs the prerecorded landing procedure and the motion base starts.

Suddenly we're at 2,000 feet! The illusion is perfect, with the tiny jiggling of the floor absolutely reproducing the feel of an aircraft moving through the sky. When you add realistic motion, even the stark graphics on the screen become a real world that we were plunging onto. Turbulence effects are added, the cabin tilting back and forth and bumping us around in our seats.

Then the runway rushes up and whizzes under us, but it's far more than just a display to watch — *we're falling through the air.* Then the plane levels out and the "wheels" hit with a bang.

What a ride. It was perfectly convincing.

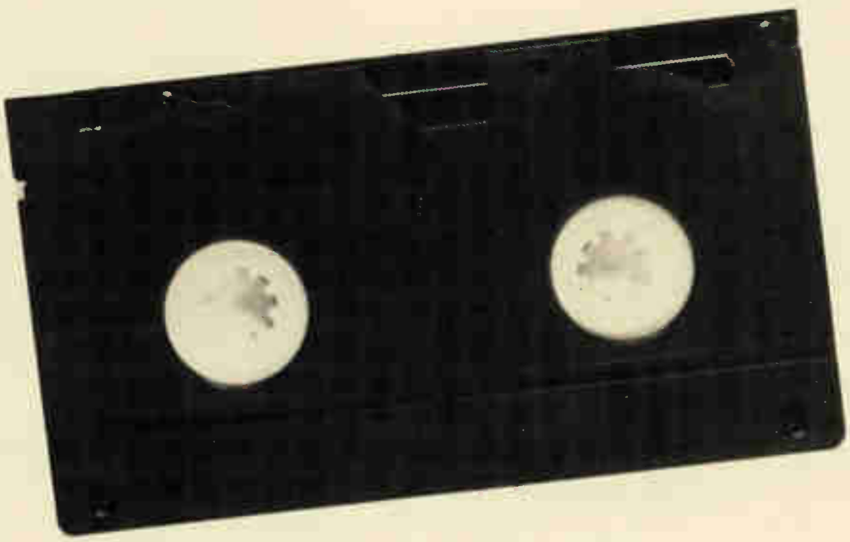
Motion and Simulation

You have to keep in mind that the enthusiasm and wonder of two *Electronics & Technology Today* editors comes from simulator experience based on desktop micros. People experienced in flying and simulators have pointed out that motion bases have another side; if the reproduced motion is incorrect, the pilot may learn incorrect responses.

This was brought home to an extent by their driving simulator, a Toyota dashboard and wheel mounted under a large full-color graphics screen. The driver can follow or pass a large truck on a twisting road. As we drove around curves in the road, both of us tended to slide over onto the "grass". Since we don't normally drive like that, there may have been something out of adjustment in the

Continued on page 62

Digital Audio Tape



Playing the waiting game.

By Edward Zapletal

For some time now, consumers have been flocking to the corner hi-fi shop to snap up the latest in ear-tickling technology: the compact disc player. At last, no more clicks, no more pops, no more dust-encrusted styluses to foul the music. Finally, the perfect playback medium, for a while anyway.

It wasn't long, however, before we began to hear about Japanese efforts to improve digital audio tape technology for use in the consumer market. With CDs selling at a brisk pace in North America, even outselling the venerable LP, record companies (producers of the prerecorded discs and soon the digital tape) are just a little concerned about this DAT business.

What Is DAT?

Simply put, audio signals are fed through a complex path of analog-to-digital converter circuitry, microprocessors handle all the nasty number crunching, and in its final form the music resides on the tape in the form of 12 or 16 bit words. During playback, the stored code is read from the tape and processed through digital-to-analog circuitry, and passed on through the audio output stage and so on. But if this doesn't sound new to you, it's probably because it isn't.

Digitally encoded audio tape has been in use for over a decade now in the professional recording and microcomputer industry. And just plain digital computer tape has been used in data processing for mass storage purposes for a lot longer than that. But as is the case with many technologies, it's usually far too expensive for the consumer market at the outset. What the Japanese have done is to take a well established

Continued on page 29

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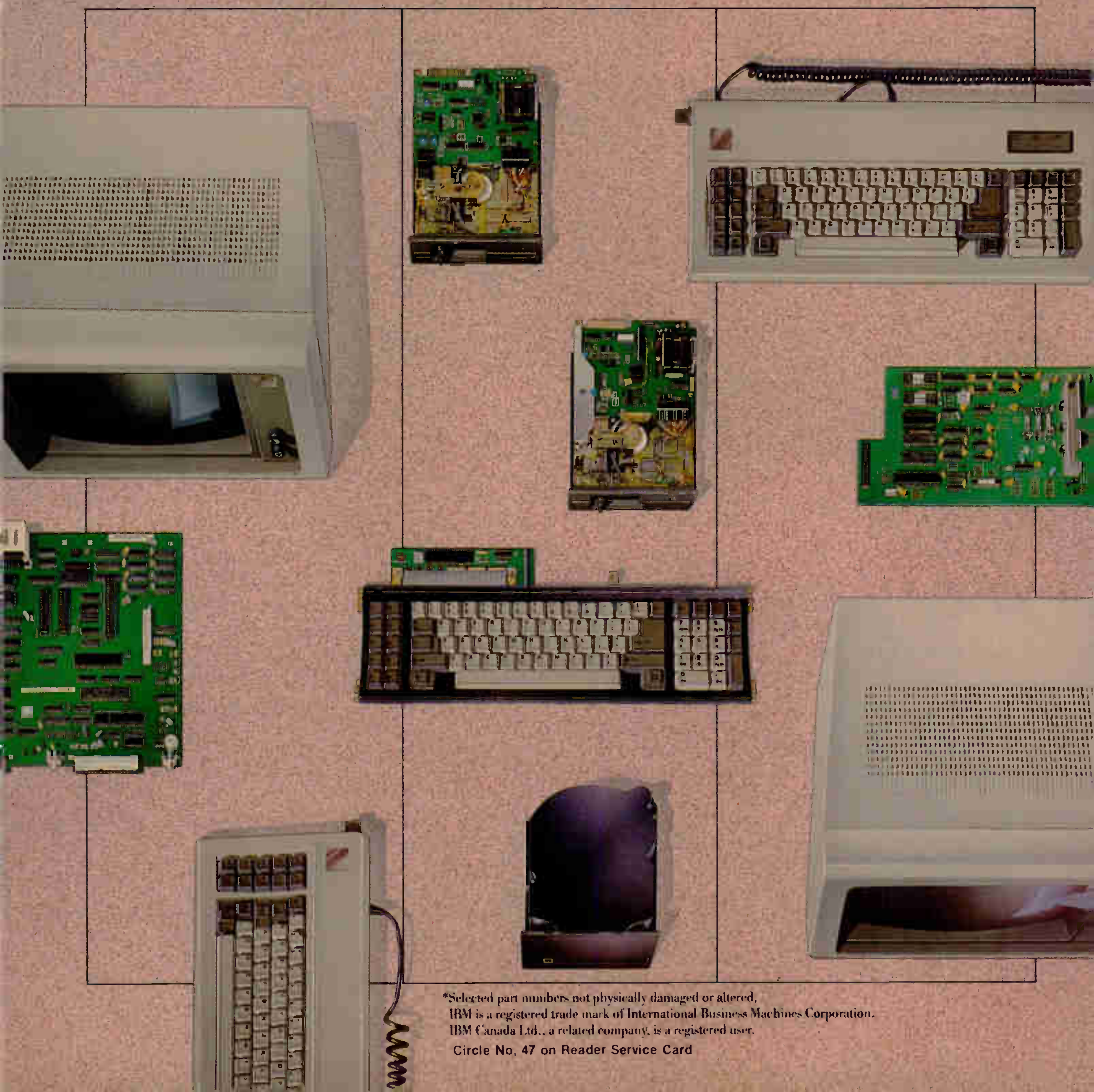

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Circle No. 47 on Reader Service Card

Continued from page 10

velope. This motion is caused by a magnetic field produced by the arc-current itself. This process is shown in **Figure 2.**

The main contacts separate first, ensuring that the current to be broken is diverted through the coil to the arcing contacts. When the arcing contacts separate, the arc current I appearing between the contacts is perpendicular to its own magnetic field B which is produced by the coil. The effect of this combination is a Laplace force F exerted upon the arc, which is consequently accelerated into a circular motion along the arcing rings (contacts). The coil is designed in such a way that the resulting speed of the arc is extremely high during the arcing period. This process has several advantages:

The arc is effectively cooled by the surrounding SF6.

Hot spots, which create metallic vapours and cause excessive contact wear, are avoided because of the motion of the arc roots.

The rotation of the arc will last no longer than half a period, until the next current zero. Since the magnetic field strength decreases with the instantaneous value of current, it is important that the arc sustain sufficient speed towards current zero in order to extinguish the arc and withstand the recovery voltage. The speed of the arc is maintained by a slight unphasing of the magnetic field with respect to the current, as shown in **Figure 3.**

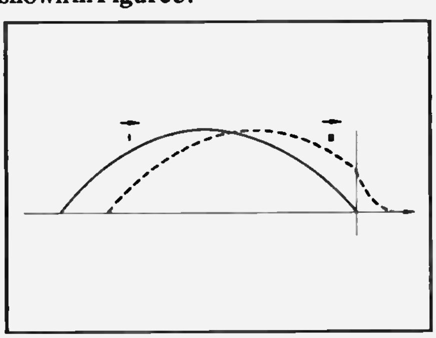


Fig. 3. The magnetic field and the current are out of phase.

The energy required to extinguish the arc is basically provided by the arcing current itself, thus a low energy operating mechanism is sufficient.

The higher the current, the faster the speed of the rotating arc, hence the cooling effect is proportional to the current, as shown in **Figure 4.**

Magnetic breaking in SF6 offers a perfect solution to the problem of breaking small currents, since the "soft" break-

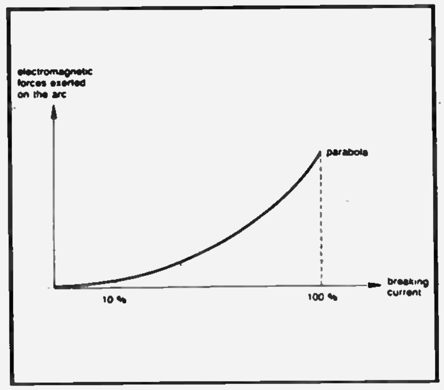


Fig. 4. The cooling effect is proportional to the current.

ing at low current values ensures an interruption without harmful over voltages. The rotating arc technique is therefore particularly useful for switching inductive load applications such as motors and transformers.

Sealing of SF_6 Enclosures

A high level of sealing is one of the important factors in the design of a device intended for long service. In high voltage applications, the devices are physically small. Each pole is a complete unit and is closed off by one or two covers which are bolted and bound to the enclosure using adhesive bonding techniques employed in aeronautic engineering.

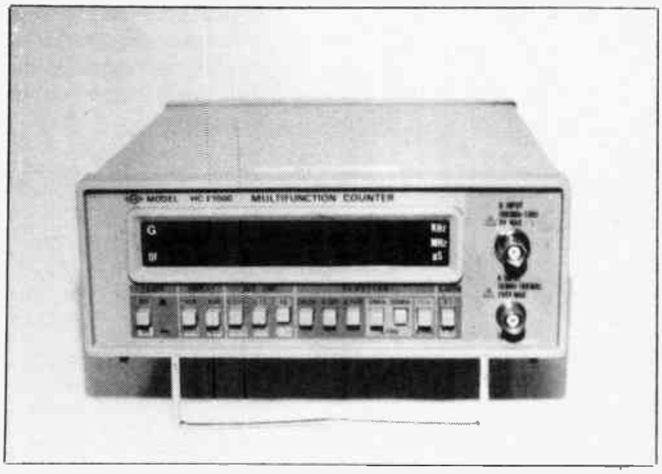
Conclusion

The concept of a sealed for life, maintenance-free switching device makes a significant advance over traditional breaking techniques.

The physical phenomena which occur during breaking may be well controlled and forecasted with SF_6 breakers.

These phenomena are repeatable, with no scatter from one unit to another, which leads inevitably to more rapid development with such equipment compared to others which are more closely tied to experimentation. ■

Dr. H. Virani is a freelance writer from Mississauga, Ontario.



Precision Frequency Counter

If you like our multifunction counter project in this issue, but would like a professional unit ready to run, KB Electronics has the HC-F1000 Multifunction Counter, with high accuracy and a stabilized crystal oven oscillator. IN the frequency mode, channel A measures from 10Hz to 10MHz directly, and 10MHz to 100MHz with a divide-by-ten prescaler; the accuracy is plus-or-minus one count. Channel B measures from 100MHz to 1GHz, also with one-count accuracy. The unit also measures the period of a signal, counts, and totalizes. The input sensitivity is 25mV, and a x20 attenuator can be switched in. For further information, contact KB Electronics, 355 Iroquois Shore Rd., Oakville, Ontario L6H 1M3, (416)842-6888.

Circle No. 3 on Reader Service Card

Note on PCBs

Wentworth Electronics of Burlington have supplied printed circuit boards to our readers for eight years. Due to a reorganization of their company, they will no longer be supplying PCBs for our projects. We'd like to thank them for eight years of participation in our construction articles.

Circle No. 45 on Reader Service Card

New KB Function Generator

The KZ 1405 Function Generator from KB Electronics is a new addition to their line of electronic test bench equipment. This generator produces sine, triangle or square wave outputs from 0.01Hz to 10MHz in eight selectable ranges. The output wave forms, with variable symmetry and DC offset can be gated with provision for phase control. These features along with an easy- to-use instrument panel make it an ideal general purpose signal source for both analog and digital circuit development and testing.

For more detailed information contact Jim Peffers, KB Electronics, 355 Iroquois Shore Road, Oakville, Ontario, L6H 1M3.

Circle No. 4 on Reader Service Card

Canadian Space Station

MacDonald Dettwiler Ltd. of Richmond, BC, is the "Pacific Coast Partner" in the Canadian Space Station Program together with Spar Aerospace of Toronto. The signing of a memorandum of agreement last July means that MacDonald Dettwiler will work with Spar on the space station and identify other contractors in BC to share in an estimated $30 to $50 million in advanced technology over the next decade. The two companies will also cooperate on RADARSAT, a Canadian remote sensing satellite.

Promoting AI

The National Research Council has created an Associate Committee on Artificial Intelligence to act as a focal point and forum in Canada for issues of national concern to the scientific and engineering communities.

Continued from page 20

technology, specifically the VHS video rotating head system, and rework it to suit DAT. In doing so, they have come up with a recording medium which rivals the CD in sound, and surpasses its 72 minute playback-only capability with 120 minutes of reusable tape.

Why All The Fuss?

Somewhat expectedly, a conflict between the record companies and the DAT player manufacturers has arisen out of all this.

The record companies, naturally, would like to protect their interests, and, have taken some drastic measures to better their cause. They have banded together and lobbied the U.S. House of Representatives to enact CD copy protection legislation. If successful, the law would require a form of copy protection encoding on CDs and copy-guard circuitry in any DAT players imported into the United States. There have also been rumors of stiff taxes imposed on any imported DAT hardware. Note: A Canadian equivalent of the law would soon follow because the entire North American market would have to be protected. This is where the battle is raging.

The DAT player manufacturers, however, see the legislation, specifically the copy-guard circuitry, as having a negative effect on potential sales to those who have already invested serious money into CDs. If and when automotive DAT players become a reality, individuals with large collections of CDs would be forced to tape their collections onto conventional audio tape, thereby losing the advantages of DAT quality. As it stands now, the DAT player manufacturers are reluctantly holding back releasing their product to the voracious North American market.

A Familiar Story

This is not the first time that record companies and tape player manufacturers have gone at it over the copying issue. In the late sixties and early seventies, when the first cassette players were arriving on our shores, the record companies could see that the taping of albums would become a popular pastime. The outcry was long and loud, but, the two systems eventually enjoyed a quiet coexistence. Because of that, DAT player manufacturers strongly believe that a marriage of the two systems is possible without messy copy protection systems in place.

Pros and Cons

Both the CD and DAT systems have drawbacks which make one the suitable alternative for the other in particular applications.

Finding fault with the compact disc system is difficult if one only listens to the sound, but, remember it is playback only. When the CD was introduced onto the market in the early eighties, it was seen as a revolutionary type of LP. It still had a playback only capability, but the laser stylus provided astounding, hassle-free sound reproduction. And, because the manufacturers couldn't foresee a erasable CD in the near future, they naturally marketed the device right away.

In its favor, the CD offered 72 minutes of playing time, exceeding its predecessor's capacity by over 25 minutes. Tracks were randomly accessible and there was no flipping sides. The clincher, however, was the absence of clicks and pops normally encountered from surface scratches and grunge found on the conventional LP. The life expectancy of a disc, with proper storage techniques employed, is said to be forever since there is no mechanical wear on its surface.

On the down side, the CD is an extremely expensive medium to produce; dust-free clean rooms are necessary during the manufacturing process to ensure error free discs. The result of this being average disc prices around the 20 to 25 dollar (Cdn) mark.

Although CD players are becoming more commonplace in the automotive sound market, there have been some problems. Because the CD player tracks the disc with a laser, the amount of vibration which a player can tolerate is very low. Some manufacturers, however, claim that they have overcome this with fancy floating suspension systems and three beam pickups, etc. (Just remember how much abuse your old stereo cassette player takes in the harsh automotive environment, especially where there are great seasonal fluctuations.)

Depending on the outcome of the bill before the U.S. House of Representatives, DAT's big selling point will be it's reusability. With true sixteen bit sampling, the tapes will provide up to two hours of CD quality music. If a rugged tape drive system is introduced for the automotive market, those people who have invested copious sums into compact discs will be able to transfer their collections onto DAT for use in the car.

It is rumored that the cost of prerecorded tapes would be somewhat less than that of CDs since clean-room techniques would not be necessary; look for prices in the fifteen dollar neighborhood.

In taking a look at the negative aspects of DAT, we find that because the tape is a magnetic medium it still must be read with a head system. There will, without a doubt, be tape wear and possible errors as a result.

True random access is not possible due to the sequential layout of information on the tape, meaning, worst case search times in the neighborhood of one minute. Because the drive system is similar to that of VHS recorders, there are several motors, heads and other gizmos to consider for the automotive environment. However, if they can work out the tracking problems for CDs in cars, they'll undoubtedly work something out for the DAT drive systems.

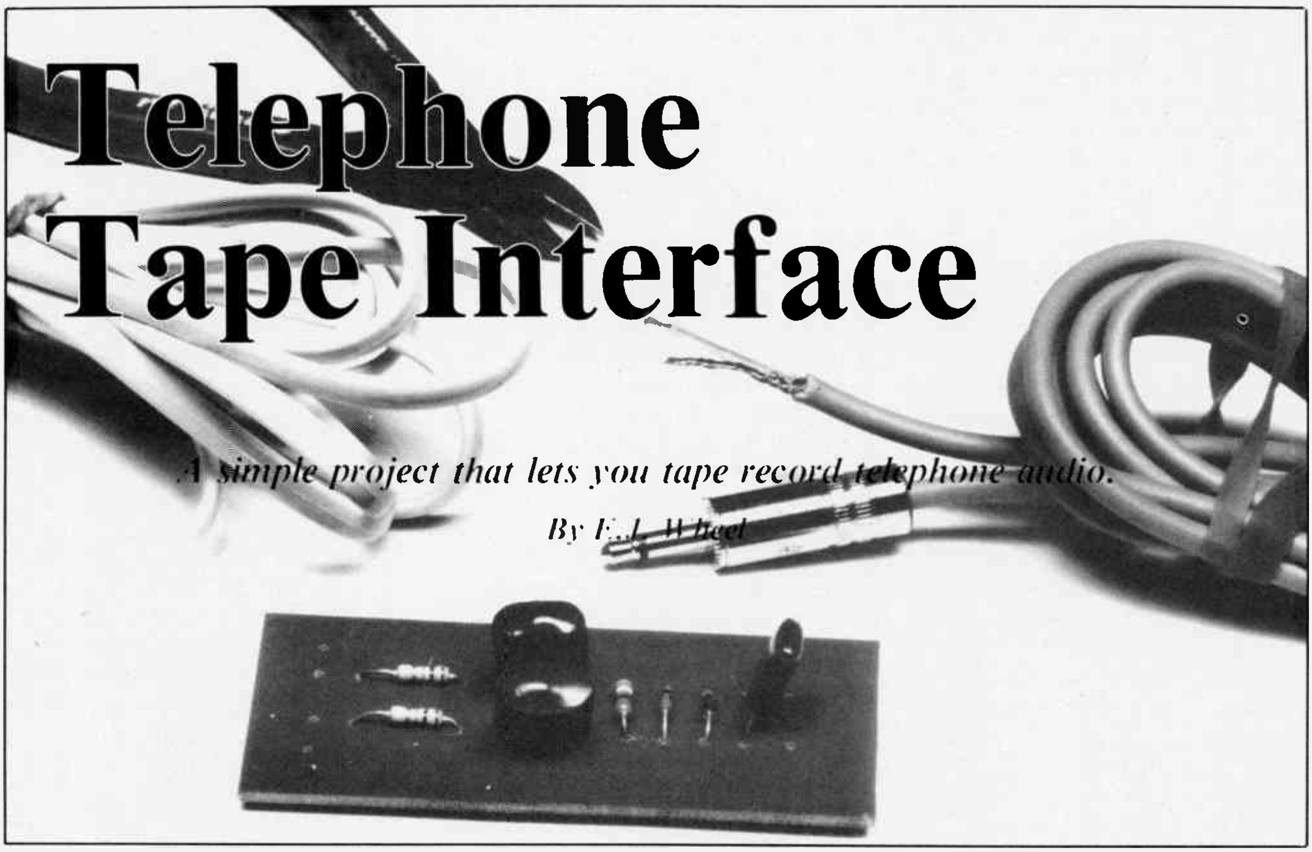
And last but not least: the cost. Home versions of the units are expected to cost, initially, in the \$2000 - \$2500 range. You can bet that sales won't be brisk at those prices but industry experts are calling for a more stable market price in the neighborhood of \$1000 - \$1500. Just as we saw the introductory prices for hi-fi VCRs at fairly high levels, after a time they too settled down to a more reasonable plateau.

In The End

The one big cloud hanging over DAT is the proposed legislation south of the border in regards to the copy-guard circuitry. If it becomes law, the manufacturers will surely be hesitant to market the devices with any speed in North America. And, just as there are ways to crack copy-protected computer software, there will no doubt be similar techniques developed to overcome DAT copy-guard circuitry. But will these techniques degrade the sound quality?

Even with all this battling going on, there is still research being carried out on erasable CDs. What would be the impact of this technology on the first generation CDs and DATs? Are new audio technologies doomed to the same rate of obsolescence as home computers once were? I guess we have to wait and see.

Edward Zapletal is the Assistant Editor of Electronics & Technology Today. ■



Telephone Tape Interface

A simple project that lets you tape record telephone audio.

By E.J. Wheel

Sometimes it's necessary to tape a telephone conversation, such as an interview. There are gadgets available for this, usually a coil of wire that sticks onto the receiver with a suction cup. The performance of these varies with regular telephones, and they won't work at all with electronic phones that use a piezoelectric instead of a magnetic earpiece.

This project is easy to make with parts you can get from any electronic supply store. It connects directly to the line and converts the phone line audio to a microphone-level signal suitable for tape recorders with a MIC input. It has no effect on the operation of the telephone whatsoever.

Telephone Operation

The telephone system feeds 48VDC to the set via a twisted pair cable, whose conductors are labelled *Ring*, *Tip* and *Ground* (after their connections to a standard 3-conductor phone jack). This DC is modulated (varied in voltage) to an AC audio signal by the carbon granules in a regular telephone microphone, or by an electronic circuit and piezo microphone in the electronic sets. The incoming audio AC is impressed on this 48VDC. The DC is filtered out by the internal network and the audio drives the earpiece.

To ring the phone, a 20Hz AC signal of about 100V is applied to the line, operating the ringer coil in regular phones or the electronic beeper circuit in electronic circuits.

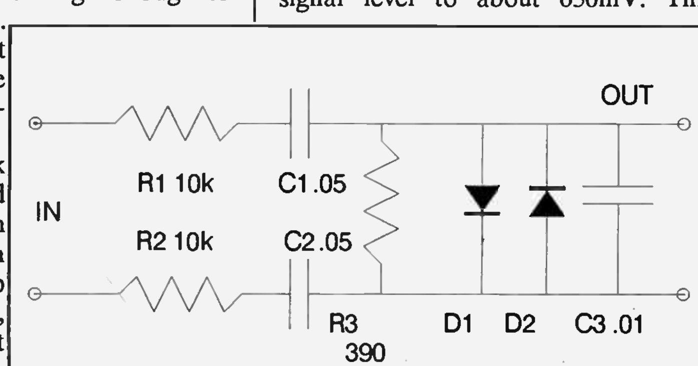
Circuit Operation

To extract the audio we want, we need to (a) block the DC operating voltage, (b) lower the incoming audio to microphone level, and (c) make sure the ringing voltage (or other high-voltage glitches) will not be high enough to cause any damage. We also don't want any effect on the telephone operation.

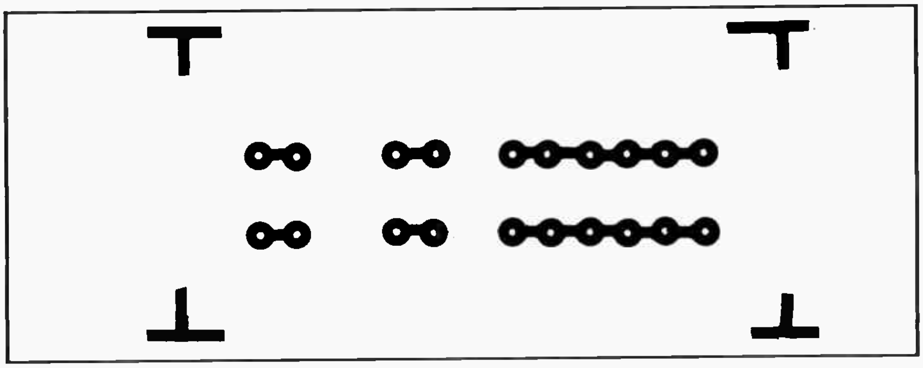
First, two 10k resistors, R1 and R2, present a high resistance to both the Ring and Tip sides of the line, isolating our unit from the telephone circuitry. Next, C1 and C2 block the DC operating voltage and pass the AC audio signal that we want.

R3 is used to load down our two isolating resistors and reduce the signal level. The reduction here is about 34dB, which is the same as multiplying the incoming signal by 0.019. If the audio level is 500mV, or microphone level signal is about 10mV, adequate for most tape recorder MIC inputs.

D1 and D2 are connected in inverse parallel across the output. Diodes don't conduct until the signal level across them reaches about 500mV, and then they conduct heavily, clamping the peak signal level to about 650mV. This



The schematic of the telephone/recorder interface.



If you use a printed circuit instead of a perfboard, this is the copper side.

prevents any high voltage on the line from interfering with your tape recorder inputs.

C3 is added to prevent any high frequency from getting into your tape input and causing trouble (such as "beating" with the tape biasing signal). It rolls off the treble response at about 5kHz (since a telephone rarely reproduces anything above 3kHz, it won't have any audible effect).

Construction

You can use any sort of plastic or metal handy box, widely available in electronic stores. Perforated board with the component leads soldered together underneath is the easiest way to do it, but if you like, you can drill, paint and etch a printed circuit using our PC drawing.

The resistors and capacitors don't care about orientation, but the diodes must be back-to-back; most diodes have a ring painted on one end of the body, or a tapered end. Make sure that one points up and one points down.

Use

The easiest way to hook into the system is to buy a dual adapter (if you have jacks). Your phone plugs into one and your interface into the other. The output should be a shielded single-conductor microphone cable with a connector to suit your recorder. The input cable is a telephone cord terminated in a standard telephone jack-plug. Radio Shack has a good selection of telephone cords and adapters (as well as all the other parts).

If your telephone uses connector blocks, use a two-conductor wire for the input lead. Connect it to the same terminals in the connector as the red and green wires from your telephone. You'll probably find the green and yellow leads from your phone together on one terminal.

The most convenient tape recorder for this use is the low-cost "shoebox" type. They're usually battery-powered, and have an automatic recording level to eliminate fiddling with volume controls. If your recorder just doesn't have enough gain for acceptable volume, increasing the value of R3 will raise the output voltage. Try a 1k or so; feel free to experiment.

Caution: although this circuit will perform without problems on standard Bell-type lines, it may cause problems on electronic PBX office exchanges. Some electronic switchboards do not have short-circuit protection, and you may damage the switchboard electronics if you err during installation. Check that your lines are standard Bell-type feeds before installing.

E.J. Wheel is a Toronto freelance writer.

Parts List

Resistors (.25 or .5W, 5%)

R1,2 .... 10k
R3 390

Capacitors (any film type)

C1,C2 .... 05u
C3 .... 01u

Semiconductors

D1,2 .... 1N914 or equiv.

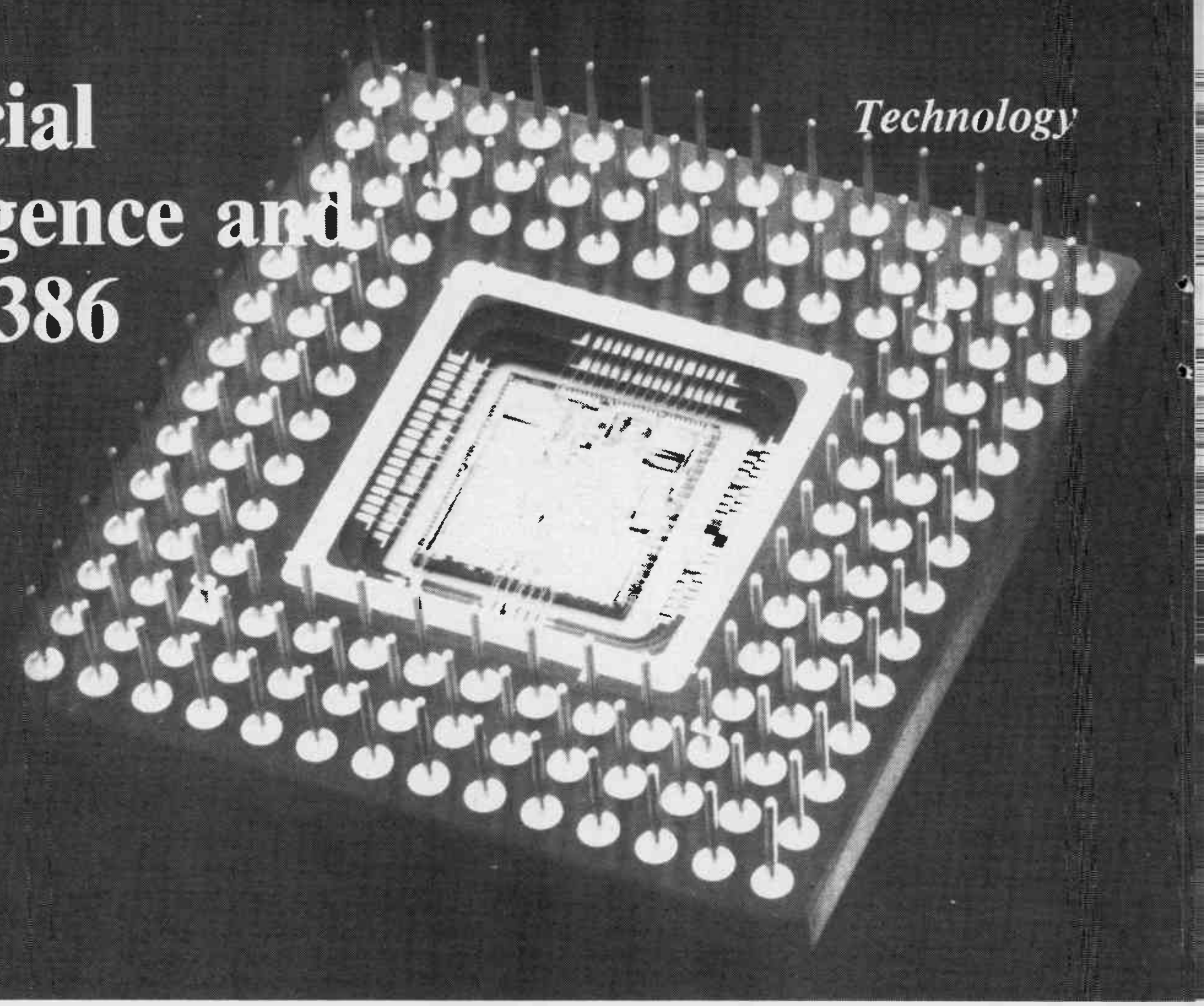
Miscellaneous

Utility box, telephone cord to suit telephone system, microphone cable and plug to suit recorder, perfboard or PC board.

■

Artificial Intelligence and the 80386

Technology



Artificial intelligence comes to the desktop micro thanks to the power of the 80386 CPU.

By Intel Corporation

Artificial intelligence (AI) has begun to leave the laboratory and enter the commercial marketplace. Sales of AI-based products are already significant, totaling more than $700 million in 1985, but this figure represents a small fraction of the potential revenues. So far, the great majority of products have been AI development tools; rapid market growth will take place with the emergence of plentiful end-use products.

The maturation of the AI market depends in a large part on the availability of low-cost, general-purpose computing systems capable of supporting AI processing requirements. AI applications have in the past been tied primarily to special- purpose devices, carrying a high price tag and providing a limited range of functions. General purpose microcomputers and workstations have lacked the computing power to support the rigorous demands of AI programs. With the introduction of high- performance 32 bit microprocessors such as the Intel 80386, that picture is changing. The merging of AI and mainstream computing environments is at hand.

AI Basics

As a labor-saving device, the computer has served primarily to speed up the execution of tasks that are essentially simple. Given a set of well-defined, repetitive procedures, such as a long string of additions and multiplications or a data base search, a computer will perform them millions of times faster than a human. A number of human faculties have proved harder for computers to emulate. The more complex abilities reasoning, planning, learning, sensing and using language are the concern of artificial intelligence.

Symbolic Versus Conventional Computing

AI methods differ fundamentally from conventional computing. While conventional computing consists primarily of numeric processing and arithmetic operations, AI programs manipulate symbols using logical operations. The essential unit of computation is the symbol (called an object in some programming models) which might represent a thing in the world, a group of things, a procedure or a piece of interim data. The computer itself creates, defines, groups and destroys symbols in the process of deducing relationships and reaching conclusions about problems.

For example, an AI program might infer that the symbol "dog" should be grouped in the symbolic category "mammals" because it possesses certain attributes such as fur and warmbloodedness. This conclusion is possible through a process of logical inference and is not amenable to the numerical approach of conventional computing.

The meaning of a particular symbol in an AI system, whether the symbol represents a thing or a procedure, for instance, is assigned by the AI system itself and can be modified as the problem-solving process unfolds. In conventional computing, a set of bits may represent something, such as a number or alphabetic character, but the interpretation is not under the control of the system. That a particular byte signifies a number to be added and not a letter to be deleted is rigidly predetermined by the procedural context; the programmer knows that at a given point in a program the computer is processing numbers, not words, and he instructs the computer to act accordingly.

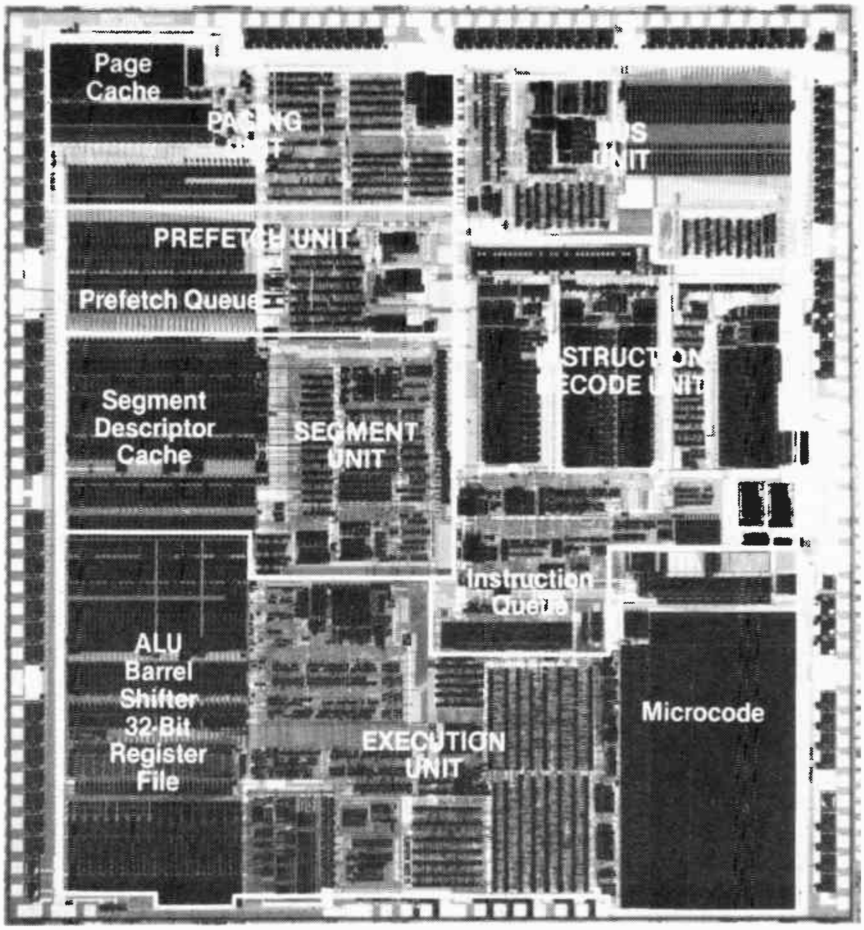
One way symbolic processing is implemented is through the use of a "tag", a set of bits associated with each data word that specifies how the data are to be interpreted and treated at any given time. Tags distinguish numbers from letters and other types of data. New tags can be assigned by the system as needed. Normally used in developing AI systems, tags may be deleted upon completion of the application (explained later).

Conventional computation tends to proceed in a linear, predictable fashion. Programs dictate an orderly series of steps to be performed. AI is much more fluid, with the system finding its own path through a problem and tracing associative webs in unforeseen ways.

Similarly, traditional computation often takes a "brute force" approach to a problem, exhaustively weighing each alternative before arriving at a result or deciding a course of action. A data-base program, for example, might search all 1,000 records in a file to locate a particular name. In complex, real-world situations, the number of possible choices is too great for even the fastest computer to consider. AI systems, like human beings, attempt to find shortcuts to a solution by looking for patterns and by following heuristic rules (rules of thumb).

Software Requirements

Because of the inherent differences of conventional and symbolic computing, symbolic computing requires the use of specialized high-level programming languages quite unlike standard number- crunching languages such as C and Fortran. Lisp (an acronym for list processing) is the predominant AI language in the United States. A variety of Lisp dialects are used, with the industry beginning to converge on Common Lisp. Prolog (short for "programming in logic"), similar in many ways to Lisp, is also a popular AI language, especially in Europe and Japan. A third language, Smalltalk, has some adherents in the research community, but has yet to achieve significant commercial success.



Hardware Requirements

AI programs place a number of demands on the hardware that runs them. The programs and their data structures are typically enormous, requiring tens or hundreds of megabytes of storage. AI processors must therefore have the ability to address large amounts of both physical and virtual memory.

While conventional programs tend to step through large blocks of instructions sequentially, frequently looping within a block (a property called "locality of reference"), AI programs exhibit frequent branching, jumping through widely spaced parts of the program unpredictably as new associations and connections are generated. The computing engine must therefore provide the ability to quickly skip from one memory location to another across the entire address range. This function is supported by "linear" memory models, in which the address space is a continuous, "flat" array, with no internal divisions to impede long jumps. Since AI programs require frequent reference to main memory, performance is determined largely by the speed of fetching new instruction sequences and data from memory. The current crop of 8- and 16-bit computers do not have the necessary speed and memory capabilities.

Applications and Ramifications

The breadth of current and potential AI applications is extensive. Advanced robotics and process control systems are placing increasing emphasis on AI technology. AI is an essential part of machine vision, speech recognition and speech generation systems. Natural language processing, still experimental, should eventually produce computers able to understand language as used by human beings (as opposed to the fixed commands commonly used in current man-machine communication).

All of these applications require the ability to make sophisticated inferences based on a complex mix of inputs and a variety of stored information. Such systems draw from a body of facts, heuristic rules and observations (the knowledge base) to reason about problems in specific areas and generate solutions and explanations. Some such systems encode the expertise of one or a few human specialists to address a narrowly defined set of problems. Some notable examples are the Prospector system, used in mineral exploration; Internist-1, a medical program that has proved successful in diagnosing certain illnesses; and Delta/Cats-1, used by General Electric to guide diesel locomotive maintenance.

Expert systems are among the first AI technologies to reach the market. Their early success has led to a secondary market for expert system shells, tools that allow software developers to build knowledge bases and create expert systems for specific end- user applications.

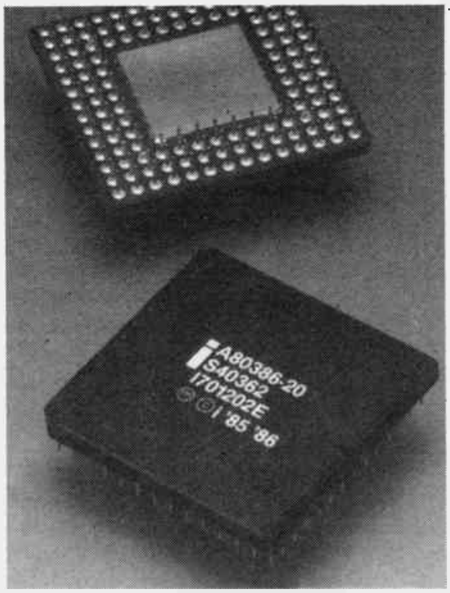
In a broad sense, AI can be applied to nearly all problem-solving endeavors. Just as important, the innovations pioneered by AI will eventually be absorbed by conventional computing.

The Need for General-Purpose Hardware

Despite its tremendous potential, the AI market is currently constrained by the high cost and inflexibility of dedicated hardware platforms for AI applications. Dedicated symbolic processors are expensive (often $100,000 or more); too costly for widespread use. In addition, dedicated machines fail to support standard non-AI programming languages, operating systems and applications. Users are forced to acquire several pieces of equipment, one for AI and a second for conventional tasks such as office automation. Still another may be required for technical non-AI applications such as computer-aided engineering (CAE). AI application software is often not transferable even among different symbolic processors.

Vendors of symbolic processors are moving to mitigate some of these problems by developing add-on hardware support for standard languages such as Fortran and C, as well as operating systems such as Unix. Such interfaces add cost, however, making the hardware even less affordable for the majority of potential users.

The result is that hardware adequate for AI computation is not affordable, and what is affordable is not adequate. These conditions have combined to severely restrict the sale of AI hardware. The absence of a substantial hardware base has in turn inhibited independent software vendors (ISVs)



who hesitate to invest resources on programs confined to a narrow range of hardware systems. And the lack of a sufficient breadth of available software applications stifles the overall AI market. Maturation of the market will come about only with the availability of low-cost, industry-standard AI computers.

The 80386: Bringing AI into the Mainstream

The increase of AI technology into the market requires the seamless integration of commercial computing and symbolic computing. Symbolic computing, in other words, must migrate to general-purpose hardware. Combining the high performance and memory access requirements of symbolic computing with industry- standard processor architectures and widespread software support has been the chief obstacle to achieving this goal. The introduction of Intel's 80386 32-bit microprocessor clears that hurdle.

The 80386 provides performance and a memory addressing range unmatched among microprocessors. At the same time, the 80386 offers access to the industry's largest software base, more than $6 billion worth of programs developed for Intel's 8086 family, which includes the 8086 and 80286 processors.

General purpose 80386-based systems will offer users a "single footprint" for both AI and conventional computing functions. Such systems can cut the price of AI development and end-use considerably, from more than $100,000 in some cases to $10,000 or less, and will stimulate software development by supporting standards.

The 80386 provides all of the fundamental features required by AI systems. Complete sets of software development aids for 80386- based AI applications are forthcoming from a number of leading ISVs. Overall, the 80386 substantially reduces the cost and increases the versatility of both AI development systems and delivery vehicles.

Performance and Addressability

With sustained performances of 5000 to 9000 dhrystones per second (a standard computing benchmark), four to six times the performance of a VAX 11/790 superminicomputer, the 80386 is among the fastest commercial microprocessors ever developed. This performance level greatly surpasses dedicated symbolic systems, especially when executing compiled programs. (Fully developed and debugged AI applications often can be compiled).

The high throughput of the 80286 results from an innovative architecture and advanced chip fabrication technology. A parallel-processing technique known as pipelining allows the processor to execute as many as four different instruction steps simultaneously. The chip is available with high clock speeds of 16 and 20 megahertz. The 80386 bus has a throughput of 32 megabytes per second (at 26MHz), the highest for any microprocessor.

AI is among the most memory-intensive of all computer technologies, demanding rapid access to vast amounts of storage. The 80386 sets new standards for memory addressability, supporting a total of 4 gigabytes main memory, 4 gigabytes of linear address space and 64 terabytes (2^{46} bytes) virtual memory, enabling the chip to host even the largest programs and data structures.

Speeding Memory Access

Fast access to memory is provided by the processor's high-speed bus and an on-chip memory management unit (MMU). The MMU incorporates address translation caches (high-speed on-chip memory). Because the MMU is on chip, address translation can be performed in parallel with other processor activities. The high- speed bus and integrated address translation mechanism combine to permit an unprecedented two clock-cycle access to off-chip high- speed memory. An additional advantage of an on-chip MMU is software portability because all 80386 programs are necessarily written for the same MMU. Other processors supporting a variety of incompatible off-chip MMUs offer no such guarantee.

The slower buses and off-chip MMUs of competing general-purpose processors limit off-chip memory access to four clocks or more, and this exacts a heavy performance penalty in AI applications. In an effort to improve memory access, several of these processors feature on-chip code and data caches. The assumption is that the processor is likely to address a given block of data or instructions a number of times in succession before referring to another block. By loading it into the cache, the block is placed on the chip within easy reach of the processor; only when a new block is referenced does the processor need to go off-chip for code or data.

These assumptions are not borne out in practice. First of all, current on-chip caches are very small (typically 256 bytes). Most code blocks do not fit in such small caches; nor are suitably small data blocks liable to be referenced many times in succession. this is especially true in AI programs, which exhibit very poor locality of reference (explained in the Hardware Requirements section). As a result, the processors are forced to go off-chip for nearly every memory access, rendering the cache useless, and are impeded by their low bus throughput. Performance in AI applications suffers measurably.

Instead of opting for ineffectively small on-chip code and data caches, Intel's approach with the 80386 maximizes bus speed for fast access to off-chip caches. Such caches can be arbitrarily large (up to 4 gigabytes) enabling true performance benefits.

The 80386 also provides on-chip MMU support for a virtual memory scheme called paging. Virtual memory allows the processor to quickly swap information between main memory and secondary storage devices such as hard disks, thus permitting the efficient use of large programs and data structures that exceed the size of the physical memory itself. With its on-chip MMU and integrated address translation cache, paging on the 80386 can be performed rapidly; a must for AI applications.

While the two-clock, non-pipelined bus cycle of the 80386 is ideal for high-speed cache memory, a three-clock, pipelined bus cycle can be used with slower dynamic RAM (DRAM) memories; without adding wait-states that slow microprocessor throughput. The combination of pipelined and non-pipelined bus cycles is a unique feature that enables system designers to take maximum advantage of both caches and less expensive DRAMs.

Linear Memory Model

The 80386 supports the linear memory architecture required by AI programs, permitting system memory to be treated as a flat unstructured array up to 4 gigabytes long. With a single "jump on condition" instruction, the processor can immediately reference any memory location through a 32-bit offset. (An offset is a number that, added to the current memory address, specifies a new location to be referenced. A 32-bit offset means a single jump can cover the entire 4-gigabyte address range).

The 80386 provides a flexible set of general purpose registers. Registers can be used to 8-, 16- or 32-bit data words, and support a range of addressing modes needed to efficiently refer to varied data structures.

Software Compatibility

Full compatibility is provided with 16-bit applications created for the 8086 and 80286 microprocessors, as well as new 32-bit applications developed specifically for the 80386. This means that 80386-based systems can take advantage of a huge software library, including programming languages, compilers and popular application programs.

Most significant, any such programs can run concurrently in the 80386 multitasking framework. A multiple-execution capability, found on no other processor, enables the 80386 to simultaneously execute applications written for different operating systems. A 80386-based system could, for example, support office automation applications written for MS-DOS, engineering programs using Unix, and AI software also using Unix, all running side-by-side, visible to the user in multiple screen windows. ■

Digital Counter/Frequency Meter

A simple, versatile portable unit for events counting, frequency or period measurements and more.

By Mike Tooley

The Digital Counter/Frequency Meter is a versatile unit that's completely self-contained and can perform a variety of time and frequency related measurements on digital as well as analog signals. It's a fairly ambitious project that may not be suitable for the newcomer to electronic construction.

Circuit Description

The Digital Counter/Frequency Meter is based on the popular 7216 Universal Counter chip. This device comprises a high frequency oscillator, decade timebase counter, eight decade data counter and latches, a seven segment decoder, digit multiplexers and eight digit drivers which directly drive large LED displays. The counter inputs are rated for operation at a maximum frequency of 10MHz in frequency and unit counter modes and 2.5MHz in other modes. The chip is expensive, at about $30, but contains almost everything needed for a versatile test unit. The 7216 can function as a frequency meter, period counter, frequency ratio meter, time interval counter or as a totalizing counter. Minimal external circuitry is necessary in order to implement a full-function instrument as witnessed by the complete circuit of the meter as shown in **Fig. 1.**

Since both of the 7216 (IC1) signal inputs (input A at pin 28 and input B at pin 2) are digital with a typical switching threshold of 2V with a 5V supply, external input signal conditioning is essential. This is provided by means of two wideband amplifiers formed by transistors TR1, TR2 and associated components for input A, and TR3, TR4 and associated components for Input B.

The input circuits are identical and aim to privide a reasonable squarewave output of 5Vp-p (peak-to-peak) for sinusoidal input levels as low as 100mV RMS when the Input Selectors (switches S1 and S2) are switched to the AC position. The input selector also caters for DC coupled signals (important for low frequency applications and event counting) while a TTL position ensures optimum response for large amplitude input signals.

Display Hold and Reset facilities are provided by switches S3 and S4 respectively while Range and Function switching are provided by S5 and S6 respectively.

Display

In order to economize on wiring, the unit uses two four-digit common-anode multiplexed seven-segment displays (IC2 and IC3), the pin connections for which are shown in **Fig. 2.** Supply decoupling is provided by means of capacitors C6 to C9 while diode D3 is used to reduce the supply voltage when working from dry rather than rechargeable batteries. When rechargeable cells are used, D3 is simply bypassed by means of a link on the stripboard.

When the unit is operated from rechargeable (Nickel Cadmium) cells, the batteries may be recharged when the unit is off by connecting sockets SK3 and Sk4 to a 12VDC supply (a bench power unit or car battery). Diode D2 protects against inadvertent reverse connection of the charging supply, which would

Specifications

Functions: Frequency, period, frequency ratio, time interval, unit counter, internal oscillator frequency.

Ranges: 0.01s/1Hz, 0.1s/10Hz, 1s/100Hz, 10s/1kHz.

Display: 8-digit LED

Inputs: AC/DC/TTL

Sensitivity: 100mV RMS sinewave, 30mVp-p squarewave

Supply: Four C-type drycells or NiCads fitted to the rear of the front panel. The filter can be glued in place using epoxy around the extreme edges.

Once wiring of the front panel has been completed, the board should be mounted in place using four long bolts. The wiring between the front panel and the stripboard can then be completed as

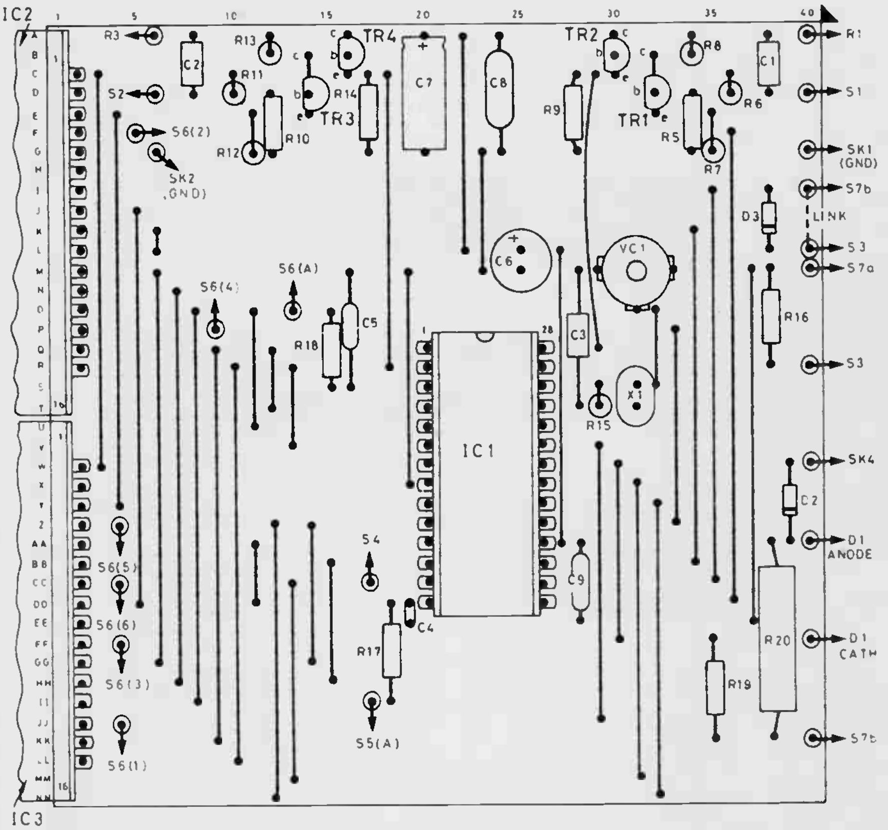
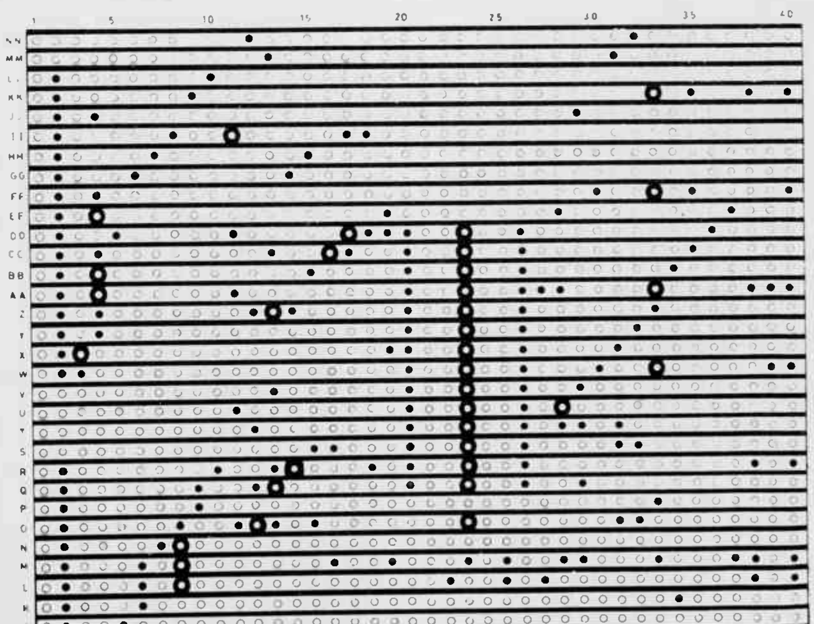


Fig. 3. The circuit board component layout and details of breaks to be made in the underside of the board.



Parts List

Resistors (1/4W, 5% unless noted)

R1,3,9,14 .... 1k
R2,4,17,18 .... 10k
R5,8,10,13 .... 47k
R6,11 100
R7,12 220
R16 .... 22k
R15 10M 5W
R19 270
R20 27 .... 2.5W

Capacitors

C1,2 .... 470n
C3 .... 27p
C4,5 .... 68p
C6 .... 100u
C7 .... 10u
C8,9 .... 100n
VC1 .... 5.5-65P trim

Semiconductors

D1 .... red LED with bezel
D2,3 .... 1N4001 or similar
TR1-4 BC548, 2N3906 or similar
IC1 7216 counter
IC2,3 4-digit common anode multiplexed display

Miscellaneous

X1 .... 10MHz crystal
S1,2 Miniature SPDT toggle, centre-off
S3,4 min. normally-open momentary PB
S5 1-pole 4-way rotary switch
S6 1-pole 6-way rotary switch
S7 min. DPDT toggle switch

28-pin IC socket, box approx. 205 x 140 x 75mm, terminal pins (23 required), stripboard, BNC chassis-mounted sockets (2), red and black chassis mount sockets for external power, battery holder for 4 C cells, red filter.

The Intersil ICM7216DIPI is available from Electrosonic, 1100 Gordon Baker Rd., Willowdale, Ontario M2H 3B3, (416) 494-1555.

shown in Figures 3 and 4. This can be achieved by means of ribbon cable. Note, however, that it is important to keep the wiring as short and direct as possible. Failure t observe this precaution may result in glitches which result in spurious readings at low battery voltages.

Finally, the battery holder and charging sockets should be fitted using small bolts.

Testing

If using dry batteries, ensure that the dotted wire link (see Figures 1 and 3) is *not* in place before inserting four 1.5V C cells. If using rechargeable cells, check that the link has been soldered in place, and then insert four charged C-type NiCad cells.

Switch S5 to the "on" position and measure the DC supply voltage appearing across capacitor C7. This should be in the range of 4.5V to 5.5V. If this is not the case, check the wiring of switch S7.

The Function switch S6 should then be set to the "check" position and the Range switch set to "0.01s/1Hz". If all is well, the display should read "10000.0", indicating a clock frequency of 10,000Hz.

If this reading is not obtained, check the wiring to IC1, IC2, IC3, S5 and S6. If the display is blank, check first that the supply is present IC1 pin 18 and then check crystal X1, R15, VC1, C3 and associated wiring.

Having obtained a display of 10000.0 with the Function and Range switches as before, press Reset switch S4. The display should change to ".0" for as long as the button is held down. Note that the leading zeroes (those before the decimal point) are not displayed.

Release S4 and depress the Hold switch S3. The display shopuld not change (it should remain at 10000.0) for as long as the button is held down. Release S3 and select each range in turn and check that the following indications result:

Range	Indication
0.01s/1Hz	10000.0
0.1s/10Hz	10000.00
1s/100Hz	10000.000
10s/1kHz	0.000.0000

Note that in the latter case, the leading "1" overflows at the left side of the display and that 10s elapses before the count is completed and the display is up-

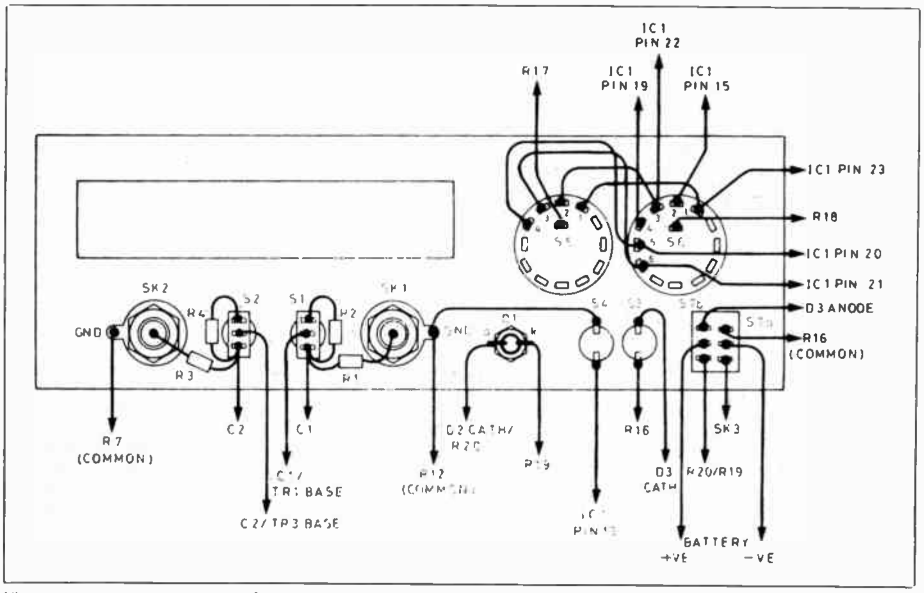


Fig. 4. Interwiring to the front panel mounted components.

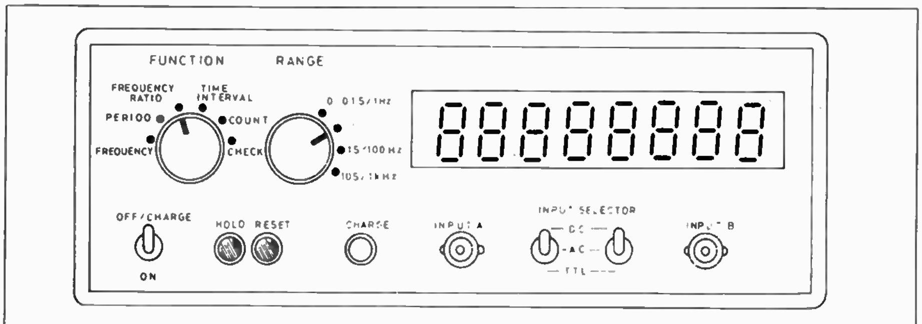
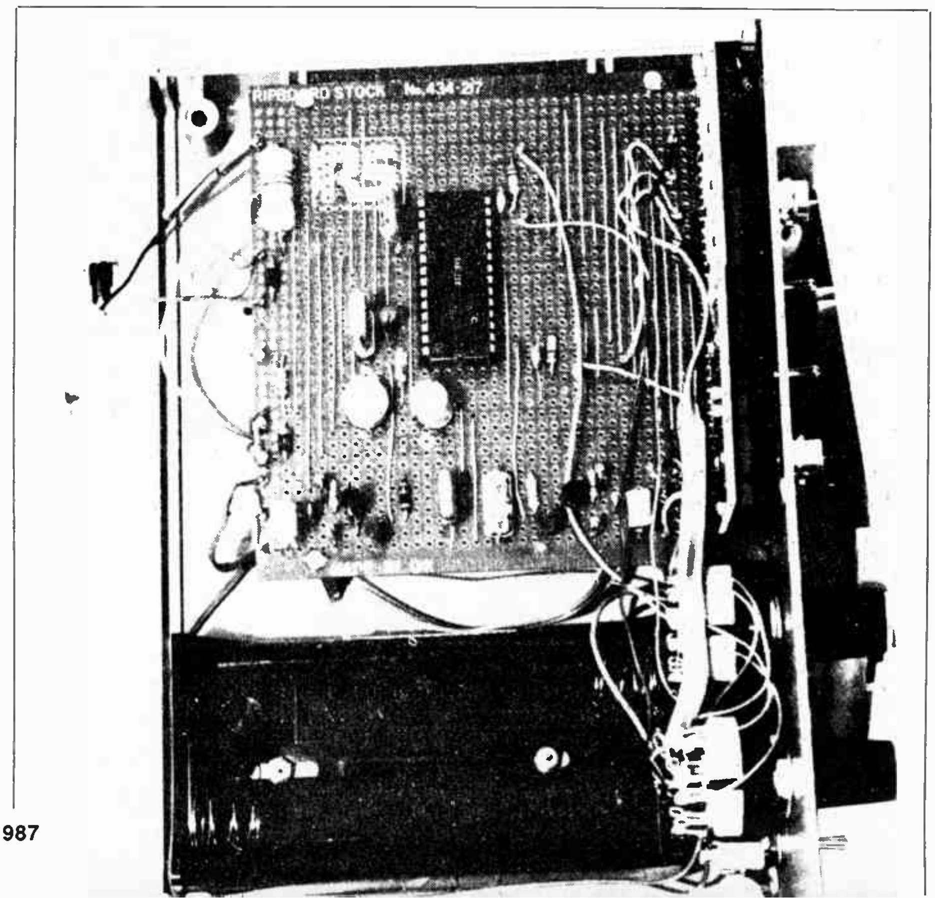


Fig. 5. Layout of controls and labelling on the front panel.



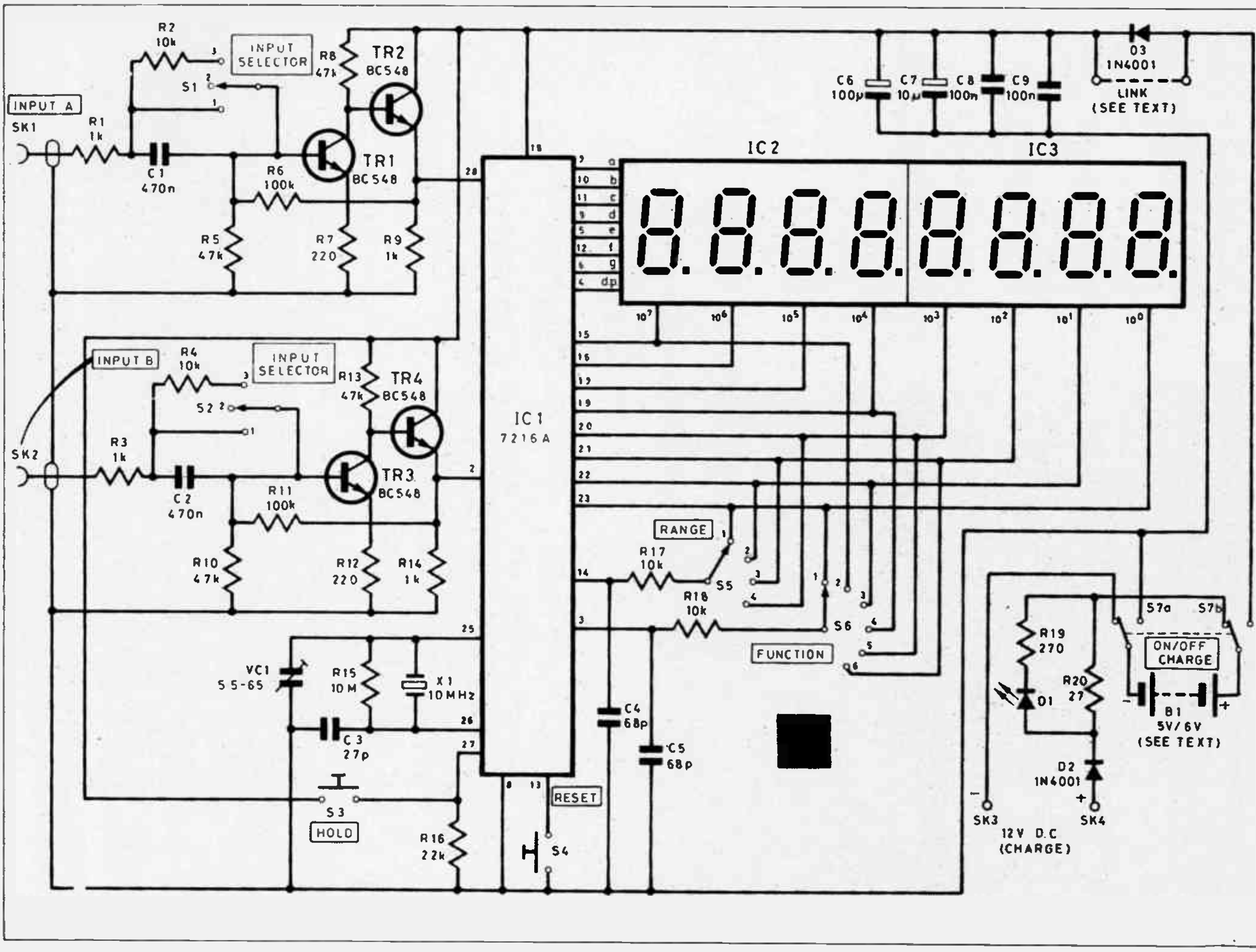


Fig. 1. Complete circuit diagram for the Digital Counter/Frequency Meter.

otherwise damage the battery. D1 indicates that the battery is being charged.

The charging current is limited to approximately 230mA by resistor R20 (which must be rated at 2.5W or more). The time taken to obtain full charge from complete discharge is about 12 hours.

Construction

With the exception of the front panel mounted components and the battery holder, all of the Digital Counter/Frequency Meter components are mounted on a 0.1 inch matrix stripboard measuring approximately 110mm by 110mm and having 40 tracks, each with 40 holes. This may be cut from a standard size stripboard.

The stripboard component layout of the unit is shown in **Fig. 3.** Readers should note that a total of 45 track breaks are required and these should be made using a spot face cutter. If such a tool is unavailable, a sharp drill bit of the appropriate size may be substituted.

The following sequence of component assembly is recommended: IC sockets, terminal pins, displays, links, resistors, diodes and capacitors. Before inserting the integrated circuit into its holder and mounting the board in its final position, constructors should very carefully check the components, links and track breaks. Furthermore, it is also worth checking that all of the polarized components (electrolytic capacitors, LEDs and diodes) have been correctly oriented.

Careful examination of the underside of the board for dry joints, solder splashes and bridges between adjacent tracks should also be undertaken at this stage. When the board has been thoroughly checked, the IC should be inserted into its holder.

The interwiring of the front panel mounted components is shown in **Fig. 4.**

The display aperture (100mm by 20mm) should be carefully marked out and then cut. The aperture can then be filed and sanded smooth.

The red display filter should then be

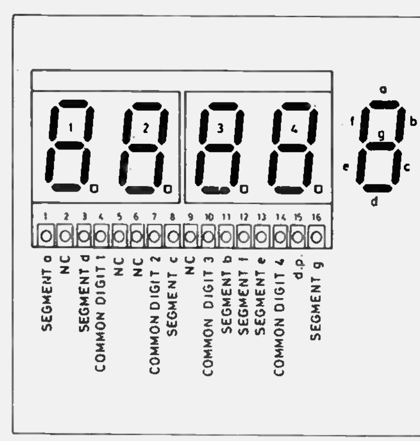


Fig. 2. The pinout details for the display module.

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Following the success of the MD-3 high resolution monitor, TVM has developed a complete family of high resolution, high performance video display monitors designed to satisfy any requirements and any budget.

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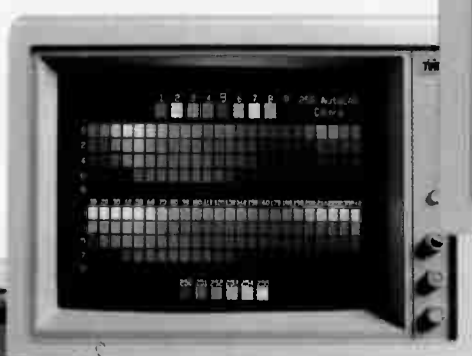

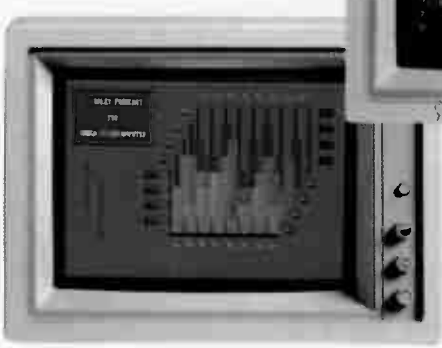

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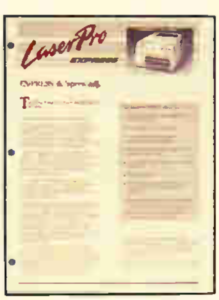

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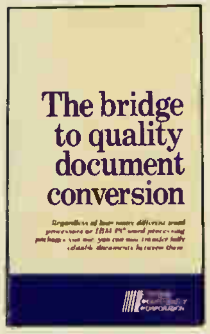

Document conversion systems from Systems Compatibility Corporation allow you to transfer editable documents between word processors. Software Bridge converts documents between 11 PC word processing packages; Doc-Exchange converts between IBM PCs and Wang OIS and VS Systems; DEX Document Exchange system converts between DEC VAX and AT&T 3B2 computers; and SoftScan, for IBM PCs and compatibles, translates ASCII into word processing documents.

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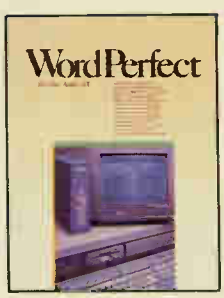

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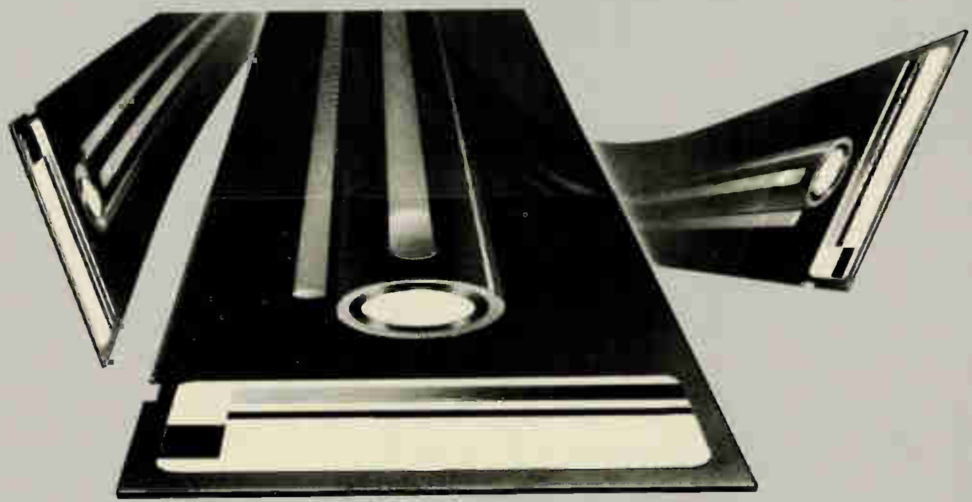

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Erasable Optical Discs

The next generation of optical storage devices is quietly in the works

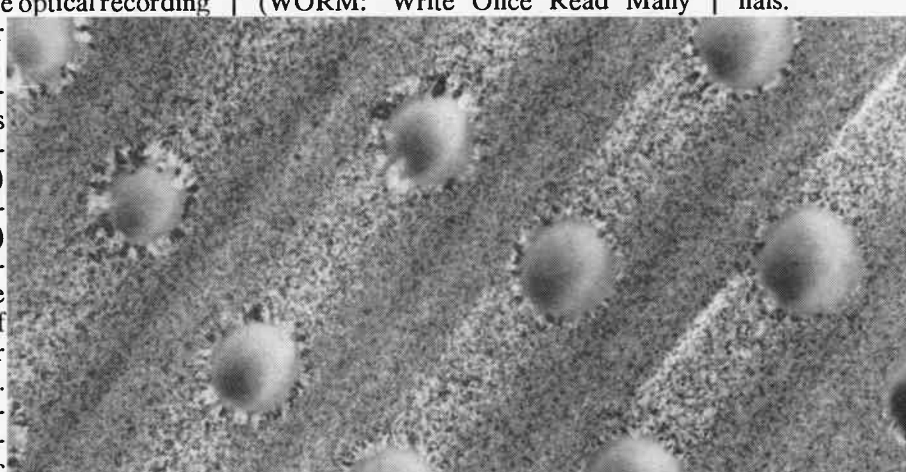
By Philips Research, Holland

Researchers at the Philips Labs in Eindhoven, the Netherlands, have found a highly promising new group of materials for erasable optical recording of either analog or digital signals.

These are semiconductor materials such as gallium antimonide (GaSb) and indium antimonide (InSb) doped with other elements, as in the manufacture of semiconductor material for IC chips. These new compounds have a number of specific properties that make them suitable for the repeated recording and erasure of information with a laser beam. Information is read out by the familiar laser-optical technique used in Videodisc and Compact Disc systems.

Optical Recording Methods

The essential differences between the various laser-optical systems are in the material in which the information is recorded and the way in which the information is "written" to the disc. Videodiscs and Compact Discs are pressed, with the information contained in the press pattern. In the DOR system (Digital Optical Recording) the user can record information once only; this is done with a laser beam which melts a pattern of holes into the material (WORM: 'Write Once Read Many times').



Other methods and materials have long been sought that could be used indefinitely for recording, readout and erasure of information. The difference in reflection between the crystalline form and the non-crystalline (amorphous) form of the same material was a good starting point.

The information is recorded by rapidly heating small areas in a thin layer of crystalline material to slightly above its melting point with a fairly powerful laser beam. These small areas then solidify in a process known as the super cooled phase. This produces amorphous areas in a crystalline material and these can be detected optically by the variation in reflectance. The differences in reflection are quite sufficient for digital readout and sufficiently well-defined for the reproduction of analog video signals.

Because the crystalline form of materials is the most stable, all materials naturally tend to change into this phase. This effect can be used to erase the information on the disc. Heating to just below melting point with a laser beam will return the material to is fully crystalline state.

Magneto-Optical Recording

Research into materials and techniques for erasable optical data storage has been underway for many years. A method that is known, but technically rather complicated, is magneto-optical recording. This is now being developed (by Philips and others) and research into amorphous-crystalline materials has continued more or less in parallel with this, with the result that gallium-antimonide and indium antimonide were discovered as suitable materials during the course of 1986.

These materials have a long shelf life, which is of course very important as they are insensitive to ordinary ambient temperatures and to humidity. Information can be erased and rerecorded about a thousand times, which is quite satisfactory for consumer applications, but not enough for professional use.

Compatibility

Existing non-erasable discs can be played on equipment developed for erasable recording, both magneto-optical and crystalline- amorphous. However, magneto-optical discs cannot be played on existing recorders because these do not have the magnetic field required for that system. It will however be possible to play crystaline-amorphous discs on existing players, after a minor adjustment to the hardware.

Research into these possibilities for erasable optical recording continues with improvements in the signal-to-noise ratio expected as a result. The number of times information can be erased and rerecorded must also be increased. Every attempt will be made to find other materials from the same family, with even better properties, that are easier to make, etc. Here tellurium-selenium alloys come to mind, of course. These materials should also be suitable for erasable optical recording based on the crystalline-amorphous phase transition in the material. But research has shown that this material cannot recrystallize quickly enough for practical use.

Greater things are expected of magneto-optical recording. This is technically much more manageable, but is more complicated in hardware terms. The energy of a laser beam in combination with a magnetic field is used to heat and reverse the polarity of small areas in a thin layer of magnetic material. The two directions of magnetization can be distinguished by polarized laser light. The information is erased by heating with a laser beam while a magnetic field is applied; new information can be recorded immediately by modulating the magnetic field. This simultaneous erasure and recording can be repeated indefinitely.

This research is important because vast quantities of information can be stored on optical discs. A disc of 30 cm diameter can accommodate several hundred million bytes. The potential for applications is unbounded; sound, vision, text and graphics for work, leisure, travel, education, documentation, etc. The advantages of an erasable disc are obvious, even though the non-erasable disc is ideally suitable for the requirements of public records offices and other institutions where information permanency is a must. ■

"TEACHER SEZ THERE ARE [illegible] ON THE [illegible] —BOY, THE PAPER MUST BE AWFULLY THIN" dated. If the indications given are not obtained, check carefully the wiring of switches S5 and S6.

Now return to the 0.01s/1Hz range and select each of the functions in turn. Check that the following indications are produced:

Function	Indication
Frequency	.0
Period	.0
Freq. Ratio	.
Time Interval	.0
Count	.
Check	10000.0

If the indications shown above are not obtained, carefully check the wiring associated with switches S5 and S6.

Finally, the unit should be tested using a TTL signal source. Apply a 500Hz squarewave (or pulse waveform having a 50% duty cycle) to the input.

Select Frequency on the Function switch S6 and 1s/100Hz on Range switch S5. Check that the display reads approximately ".500" on each setting of the Input Selector S1, then return S1 to the TTL position. Check that the following indications are produced as the function switch is rotated:

Function	Indication
Frequency	.500
Period	2000.000
Freq. Ratio	n/a
Time Interval	n/a
Count	(see note)
Check	10000.000

Note: In this position, the display will count, starting from zero on the least significant digit. Check the operation of the Hold and Reset switches (S3 and S4) with the function switch in this position.

This completes the testing of the instrument, which is now ready for use. The typical life of a battery is between 8 and 12 hours operation and thus the additional expense of NiCad cells will soon be recovered. The meter will operate with supply voltages as low as 4.5V. Below this, the display will become noticeably dim and the instrument may produce spurious readings. ■

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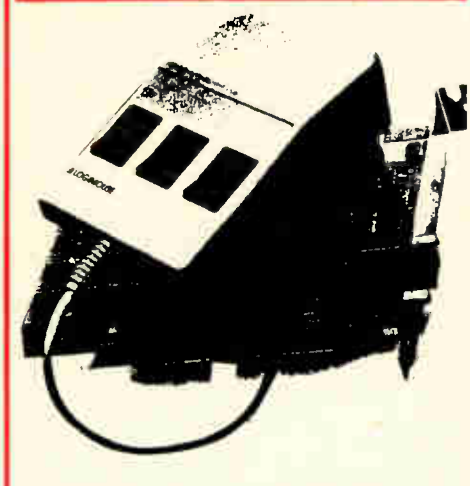

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Product Review

Mitsubishi HS-C20U Video Camera

By Timothy B. Palmer-Benson

There is no getting away from it, and and Mitsubishi readily admits it, the HS-C20U VHS-C is the spittin' image of the JVC GR-C7, the VHS-C camcorder that's giving plenty of competition to the 8mm camp ever since it was introduced about this time last year. There are some minor differences between the two, but they are more in what you get with one package and what you get with another. The HS-C20U weighs only 2.2 lbs and its size is only 7 by 5 by 9 (HxWxD) inches.

In case you're unfamiliar with the VHS-C format, it's a system that offers regular VHS SP (Standard Play) and (EP Extended Play) in a small cassette tape a little bigger than an American style cigarette pack. The tape has the regular 1/2 inch width and will play back in a regular VHS VCR when placed in a special cassette housing. Maximum playing time is 20 minutes at SP and 60 minutes at EP. The special cassette housing along with a whole host of other bits and pieces comes as a package with the Mitsubishi. For instance, you get the VHS C cassette adapter so you can play tapes made by this camcorder in a regular VHS machine, and you get a whole set of video and audio patch cords and straps, a charger and one rechargeable battery. You also get a Samsonite-style carrying case to put everything in and it's all available for the suggested retail price of $2499.95.

CCD

The camcorder uses a half-inch CCD (charged coupled device) instead of a picture tube and high density chip-mounting technology in multi-layered circuit boards. The CCD image sensor not only contributes to reduction in camcorder size and weight, but also eliminates colour smearing during pans and the burn-in that can occur with conventional tubes. The system is more durable with a greater resistance to shock and vibration. An average amount of light is required for the CCD element. Mitsubishi's specifications list minimum light level as being 15 lux, which is slightly more than the light given off by a candle. Still, even under bright room lighting you may get a warning of insufficient light.

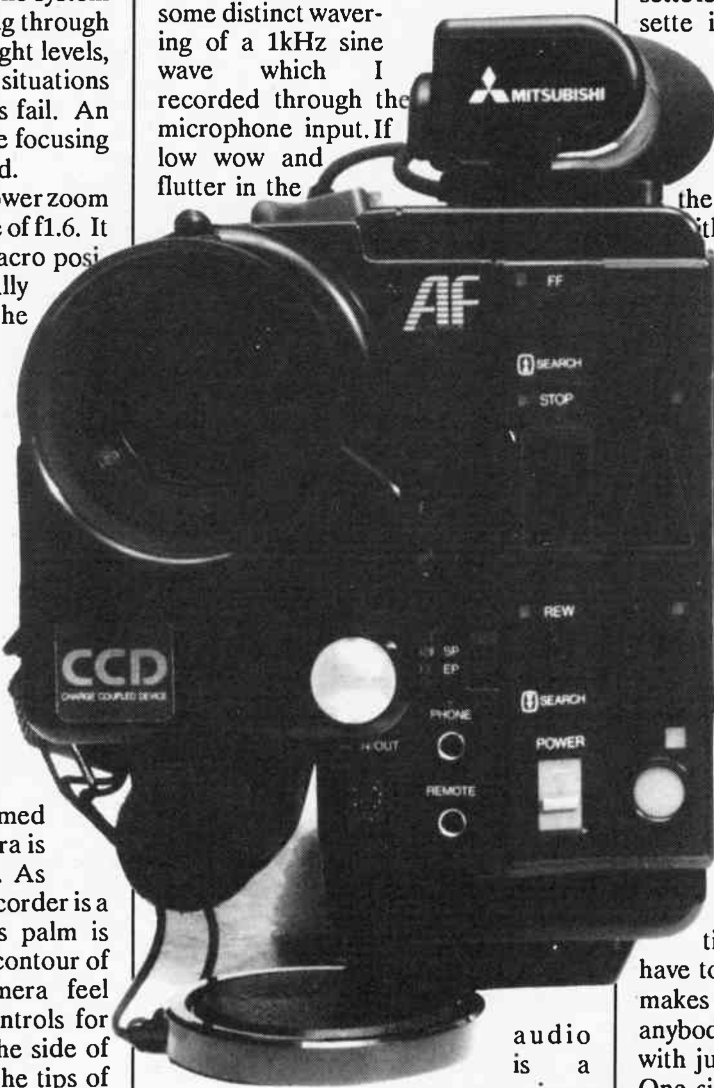
The camcorder has a tiny, high resolution electronic viewfinder about the size of a rifle bolt that can be rotated 360 degrees and tilted 90 degrees. Its 500 line resolution CRT inside gives a readout on various functions while the camera is operation. For example, a small bar in the upper right corner of the screen shows when the unit is in the pause or standby mode. The word "light" blinks on and off when the amount of light is insufficient and there's a blinking square to warn about low contrast.

Other features of the HS-C20U include Quick Review, Passage Image Sensing, Automatic Fading and of course, HQ circuitry. Quick Review lets you review the last couple of seconds of a recording and then puts the camera into record/pause ready for the next shot. Phase Image Sensing is a departure from the normal infrared and ultrasonic auto focusing methods used by other manufacturers; a focus sensor made up of 24 micro-lenses and 48 CCDs converts light entering the sensor window next to the lens into a voltage which is analyzed by a microcomputer. The computer then determines the best setting for the sharpest focus. This system is designed to get around the problem that most other automatic focusing methods run into when they are pointed at a reflective surface. There are only a couple of instances in which the system can be fooled, such as shooting through a wire mesh fence or in low light levels, but it does work in a lot of situations where competing camcorders fail. An example of this is the accurate focusing on tree leaves or on a flower bed.

The unit has a 9-54 mm power zoom lens with a maximum aperture of f1.6. It has auto iris control and a macro position allowing one to get up really close to a subject. Naturally, the lens can be controlled with the zoom ring or with the telephoto and wide angle controls. The iris control adjusts automatically to the proper opening after one has pushed a button for either incandescent light or daylight. When there is excessive light behind the subject, a Backlight Compensation Control (BLC) automatically adjusts the iris for correct exposure of a subject in the foreground.

A Tryout

In use the Mitsubishi performed much as expected. The camera is well balanced and easy to use. As far as ergonomics go, the camcorder is a winner. The grip for one's palm is curved so that it matches the contour of the hand, making the camera feel natural and secure. The controls for zooming are positioned on the side of the lens assembly body - at the tips of one's fingers - and the start/stop trigger is set beside the thumb rest for ease of control. Because of the CCD, there is virtually no picture smearing, but under bright sunlight, the camera provided a somewhat grainy picture with slight ghosting around the edges of objects (Could this be a sign of inadequate bandwidth?) Colour was a little less vibrant than what I like and was quite noticeable with something like a red rose but then, red is just about the most difficult colour for any television system to reproduce. Back on the plus side, the unit's zoom and focusing motors are virtually inaudible and the microphone is somewhat less susceptible to wind noise. By the way, the microphone is detachable - it pulls out as a complete unit with two mini plugs at its end so that you can use a better quality microphone if you wish. The camcorder's audio performance was adequate with amplitude response being within plus or minus 5 dB from 100Hz to 10kHz. There was some distinct wavering of a 1kHz sine wave which I recorded through the microphone input. If low wow and flutter in the audio is a primary consideration in your camcorder purchase you may wish to consider the frequency modulation system used by the 8mm format.



Indoors, the camera provided reasonable contrast and reasonable colour under average home lighting conditions. Perhaps not surprisingly, the unit provided its best performance when I played a recorded tape back through the camera and into my video system rather than playing the recorded tape back with a VCR. Except for a faint whirring, the VTR operates so quietly that one wonders if it is really in record mode. Not wishing to trust the record indicator in the viewfinder, I found myself twisting my head around to look through the window of the VTR just to satisfy myself that the tape was actually moving! I did experience a little bit of difficulty later on with the VHS C cassette adapter. It is supposed to stretch the VHS tape out to a normal VHS cassette length once you put the VHS C cassette into the larger cassette, but it would not do it automatically. I had to do it manually instead of relying on a 1.5 volt battery that is contained within the adapter. It took me a while to notice that the battery's terminals were covered with a thin and almost invisible layer of cellophane. No wonder the automatic loading mechanism wouldn't work!

Battery Power

I got about 45 minutes use out of the Mitsubishi before it needed its battery recharging and this was with all its automatic features going full blast! By the way, Mitsubishi's 9.5 volt battery pack is unusual in that there is a slide switch built into the side of the pack. When the switch is off, the charging cradle charges the battery up and then automatically disconnects itself but, with the switch on, the battery continues to get a trickle charge and the battery charging indicator stays on.

The high degree of automation in this camera (you don't even have to adjust the white balance level) makes it a piece of equipment that anybody in the family can learn to use with just a few minutes of instruction. One simply points and shoots in most situations. If this is the kind of shooting you'll be doing, then this camcorder will serve your purpose.

Timothy Palmer-Benson is a freelance writer from Ariss, Ontario, who specializes in technical subjects. ■

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Flight Simulators for Micros *Continued from page 27*

I'm informed that "*Crash* is not a word pilots ever use" — whenever you "auger in", Chuck's digitized features will appear on the screen, together with some sort of pithy remark about how you've just dug a hole halfway to China.

As Tony Curtis said in "Some Like it Hot" — "Nobody talks like that."

However, you can ignore all this macho rubbish and enjoy the program for itself. One thing you can't ignore, though, is the program's scheme of copy protection. (We tried to make a backup using a moderately recent version of Quaid's CopyWrite. It didn't just fail; it hung the computer.) Before running the simulator you run the install program, which makes a working copy. On dual floppies this takes about twenty minutes. A hard disk or RAMdisk is highly recommended, but be sure to have a 640 kilobyte machine if you want to go the latter route; 256K will do for floppies or a hard disk. The original "key" diskette has to remain in drive A during startup (the program looks for the key code from the disk in drive A) but a RAMdisk gives the fastest program response. Apparently an unprotected disk is available from Electronic Arts. Just send them a signed card attesting that you won't pass the software around, plus another ten bucks, and you're all set.

This arrangement seems fair enough, all told. Chuck Yeager's Advanced Flight Simulator is worth the trouble. It may not be the most accurate simulation available, but it very probably is the most entertaining.

Frank Lenk is the Assistant Editor of Computing Now! Magazine. ■

Personal Computers In The UK

A look at the computer boom in the UK, both in homes and business.

By Tony Dutton

Since their inception nearly ten years ago, personal computers have found their way into every type of business, scientific and technical environment. They have so captured the imagination of the general public in Britain, for example, that it is a rare shopping mall in that country that does not now have a well patronized computer store. The personal computer market is estimated to be worth many thousands of millions of pounds in unit sales per year.

It is interesting that both adults and children there who started off with simple computer games linked to television sets are now demanding much more sophisticated systems, including modems enabling them to network, via the telephone, with other computers and exchange information over long distance.

In the United Kingdom, system users (system meaning hardware and software together) are rather spoiled for choice. This may sound like an enviable position to be in, but it is also a difficult one if the buyer is not certain of his needs, or indeed, what he is getting for his money.

At Home and School

To the uninitiated, all personal computers look alike. There is a screen like that of a television, a keyboard similar to a typewriter, and a printer, again similar to a typewriter but without a keyboard. Home computer system enthusiasts rarely need the same facilities as even a small company, often using their systems for experimenting with their own programs.

A personal computer that is popular with both home and professional users, including schools and research establishments, is the BBC microcomputer. It was launched in 1981 as a key feature of the British Government's Computer Literacy project. Seven out of every ten micros bought for United Kingdom schools and five out of ten used for medical applications are BBC micros.

In homes and factories, offices and laboratories, the system's user friendliness and ability to solve problems has made it popular enough to encourage the launching of the new BBC Master model.

The Master series provides the latest version of BBC BASIC, the easy-to-use computer language for those wishing to create their own programs. BASIC is an acronym for Beginner's All-purpose Symbolic Instruction Code.

Practical Uses

Micro and minicomputers, particularly those offering graphics facilities, are now as much the tools of those in industry as screwdrivers or wrenches. Another popular system is the Acorn M19 16-bit personal computer. Designed as a low cost but powerful model, the M19 is compact in size.

It runs on an extensive range of popular MS-DOS programs and can be used either as an intelligent workstation on a local network, or as a single user personal computer.

In the micro/mini sector two strong international contenders from the United Kingdom are British Olivetti and Amstrad Consumer Electronics PLC. According to one of the biggest suppliers of Olivetti equipment, Raindrop Data Systems Ltd of London, Olivetti computers command a certain European loyalty because of their European origins.

One of the company's more powerful minicomputers is the Olivetti M28R which can serve eight to 12 people and offers one of the largest range of disk capacities on the market, from 30 to 140 Mbytes. The largest model in the range, the 140 Mbyte M28R- 140, gives an access time of 28 Ms and is designed for special applications which require a large amount of capacity.

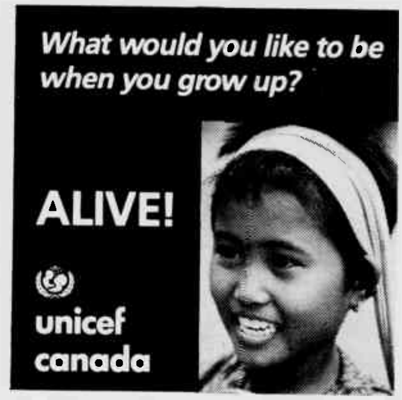
A major development in the market is the Amstrad range of word processors and computers. Amstrad Consumer Electronics PLC, which entered the computer market with a home machine in July 1984, now has a significant share of United Kingdom sales and a 35% share of the markets in Europe, Australia and New Zealand. Its PCW 8256 word processing machine, launched in the autumn of 1985, has been an international success.

New Range

Recently, Amstrad unveiled its 1512 range of IBM compatible computers. There are four models, each with either a monochrome or colour monitor: single drive, double drive, hard disk drive with 10 Mbytes, and hard disk drive with 20 Mbytes.

The PC 1512 range comes complete with a bundle of useful software comprising Digital Research's GEM Graphics Environment Manager, a built-in mouse (indicator) pointing system as well as Desktop, GEM PAINT and GEM BASIC software.

To ensure that the PC 1512 package is as comprehensive as possible, Amstrad has added three hardware expansion slots so that the user can interface with IBM and compatible modems, networks and extra printer ports as well as many other hardware applications. ■



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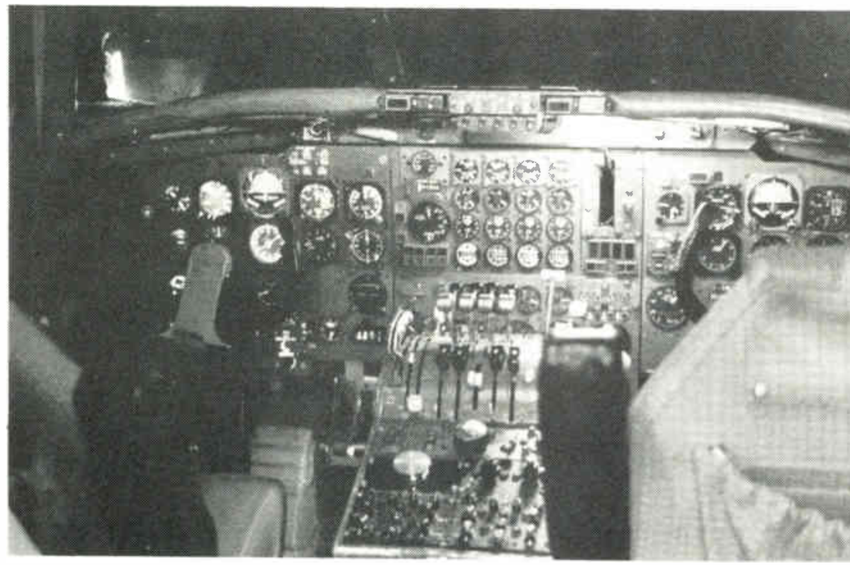
system, such as the mechanical feedback applied to the steering wheel by a servomotor; perhaps its force was out of proportion to the visual feedback from the wide screen.

The most surprising thing about the car simulator was the apparent motion that pushed and pulled you from side to side as you went around curves. Despite the fact that you were sitting in an ordinary seat fastened to the floor, the large high-res display and the steering feedback *convinced* you that there actually was centrifugal force.

But criticisms of motion simulation in trainers are few and far between, with all flight simulators being fitted with motion bases. The research done at institutes like UTIAS have made them just about perfect.



Someone should buy a flight simulator, put it in an arcade, and rent time on it. It'd be the world's best video game, and at several million dollars the most expensive, but we'd be steady customers.

Ed Zapletal is the Assistant Editor of Electronics and Technology Today. Photos by Bill Markwick. ■