Electronics & Technology Today

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Canada's Magazine for High-tech Discovery

January 1988

Make Your Own Video Controller!

Fade audio and video signals

Electronic Warfare and AI

Working With Transistors

Akai's GX-8 Cassette Deck


Microcomputer Speed
Comparison
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BEST

"Dad, you've got to help me."

"Sandy, what's wrong? Are you hurt?"

"No, Dad, I'm fine."

"Where are you?"

"At Pat's. We all came over here to celebrate after the game."

"It's almost 12:30. Isn't it time you called it a night?"

"That's just it. Remember you always told me if I was out never to drive with anyone who's had too much to drink? And not to be afraid to call you if I had no other way of getting home? Well, tonight I'm taking you at your word."

"Stay right there. I'm coming to pick you up."

"Thanks, Dad. Oh, and something else."

"Shoot."

"Are you angry with me?"

"Angry? No, Sandy. Not on your life."

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Our Cover

The video controller project and Akai's GX-8 were photographed by Bill Markwick.

Electronics & Technology Today is Published 12 times a year by: Moorshead Publications Ltd. 1300 Don Mills Road, North York, Toronto, Ont. M3B 3M8 (416) 445-5600 Fax: 416-445-8149

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President: H.W. Moorshead; **Publisher & Executive Vice-President:** V.K. Marskell; **Vice-President – Sales:** A. Wheeler; **Vice President-Finance:** B. Shankman; **Production:** Kevan Buss; Naznin Sunderji; **Accounts:** P. Dunphy; **Reader Services:** K. Parkinson, R. Cree; **Advertising Services:** H. Brooks.

Newsstand Distribution: Master Media, Oakville, Ontario

Subscriptions: $22.95 (one year), $37.95 (two years). Please specify if subscription is new or a renewal.

Outside Canada (US Dollars) U.S.A. add $3.00 per year. Other countries add $5.00 per year.

Postal Information: Second Class Mail Registration No. 3955. Mailing address for subscription orders, undeliverable copies and change of address notice is: Electronics & Technology Today, 1300 Don Mills Rd., Toronto, Ontario, M3B 3M8

Printed by Heritage Press Ltd., Mississauga ISSN 07038984.

Moorshead Publications also publishes Pets Magazine, Computing Now!, Computers in Education, and Government Purchasing Guide.

Circulation Independently Audited by MURPHY & MURPHY Chartered Accountants.

Electronics & Technology Today

Canada's Magazine for High-tech Discovery

Volume 12, Number 1 — January, 1988

Features

Technology

Product Reviews

Projects

INFORMATION

For Your Information

With this issue we begin a new monthly column entitled "The Scientists Tell Me..." It will be a column identifying new and interesting, and sometimes "oddball" news from the world of science and technology. It is compiled, edited and written by David P. Dempster, President of David P. Dempster & Associates, International Technology Transfer Consultants. David was formerly a senior consultant and policy advisor with the Ontario Ministry of Industry, Trade and Technology and traveled extensively, domestically and offshore, identifying, sourcing, and transferring new technologies. He is a member of the Canadian Science Writers Association, The Technology Transfer Society, the Society of Plastics Engineers, and is a Life Member of The Society of the Plastics Industry of Canada. He is a prolific writer whose work appears in numerous journals, both in Canada and abroad.

The Scientists Tell Me...

By David P. Dempster

Ancient Artifacts' Origin Identified Without Harm

Every time an archaeologist picks up an artifact to study, he does so carefully and very gingerly. But now, scientists have developed a new approach that will make life little easier – at least, if the artifact is of basaltic material.

Researchers studying the chemical composition of lava flows have developed a technique that allows archaeologists to determine the origin of basaltic artifacts without harming them.

The process uses X-rays to determine 11 ratios of trace metals in artifacts. These ratios then are compared to those found in lava flows, each of which has its own chemical signature. The artifacts can be analyzed whole, rather than as powdered samples required by previous techniques. People have been doing this with obsidian for a long time, but no one had done it with basalts, says Kenneth Verosub, a professor in the Department of Geology at the University of California, Davis, who heads the investigative team.

Canadian advances in Archaeometry

Canada's own McMaster University is recognized as the current world centre in the development of electron spin resonance (ESR) dating methods in archaeology. Both Dr. Henry P. Schwarcz and Rainer Grun are masters of ESR in dating lower and middle paleolithic industries.

The lower and middle paleolithic ages in human history are characterized by a transition in the use of stone tools: lower paleolithic cultures used broken chunks of flint as tools, but more sophisticated middle-paleolithic cultures had learned flake the stone and to recognize the flakes as superior tools. However, the middle paleolithic age is estimated to have ended 40,000 years ago and, until recently, the standard archaeological dating method, using Carbon-14, was unable to fix dates any earlier than that.

Dr. Schwarcz describes four new methods of dating archaeological materials and fossil human remains that can determine dates earlier than this limit. Uranium-series (U-series) dating can go back 400,000 years, but depends on the presence of the mineral calcite, found in caves and fossil springs.

ESR dating, developed in Japan and Germany and further refined by Grun and Schwarcz, can go back as far as 3 million years ago. The process counts electrons that have been produced in a material by exposure to radioactivity. Again, ESR depends on a particular material, apatite, found in the teeth of large mammals, but fortunately this is a much more widely available material and one that is frequently associated with sites of human habitation.

A third method, thermoluminescence (TL) dating, is similar to ESR in physical principle, and can be applied to the burnt flint of ancient fireplaces. A fourth method, amino acid dating, which works with the proteins found in sea shells and egg shells, has exciting possibilities but currently is considered somewhat controversial.

"These methods represent just some of the potential of the interactions of physical science and archaeology in broadening our understanding of the timing of human evolution," says Dr. Schwarcz, a Geology professor.

And a New System For Checking Gold Bars

If you are planning on disposing of some of your surplus gold bars to the Canadian Imperial Bank of Commence, don't bring in any that contain a core of tungsten rods or other non-gold fillers. CIBC is the bank that recently installed a rather unique piece of equipment which very quickly detects foreign material illegally included in gold bars.

Research leading to the sophisticated device which produces a three-dimensional image of flaws in a material, was initiated in 1980 by the Canada Centre for Mineral and Energy Technology (CANMET), a branch of Energy, Mines and Resources Canada.

A Woodbridge, Ontario-based firm, Techno Scientific Inc. (TSI) is marketing the system called AUFIS – automated ultrasonic flaw imaging system, which they are producing under license from CANMET.

In a recent ceremony at TIS laboratories, the firm demonstrated the AUFIS system for its first customer, the Canadian Imperial Bank of Commerce. The bank will use AUFIS to scan gold bars at its treasury department in Toronto.

CIBC helped fund the development of an early prototype of similar technology, which the bank has used to detect foreign materials in precious metals since 1981. The bank sees this new technology helping them protect bank customers and the bank itself from precious metals fraud.

Actually, detection of foreign materials in gold bars was not the primary purpose envisioned for AUFIS. The system's effectiveness in the application is indicative of its versatility, according to Dr. Mirek Macecek, president of TSI. He states AUFIS has excellent commercial potential for detecting metal fatigue in offshore petroleum rigs, petrochemical plants, aircraft, nuclear facilities, and defence and research industries.

Brain Mapping underway at Los Alamos

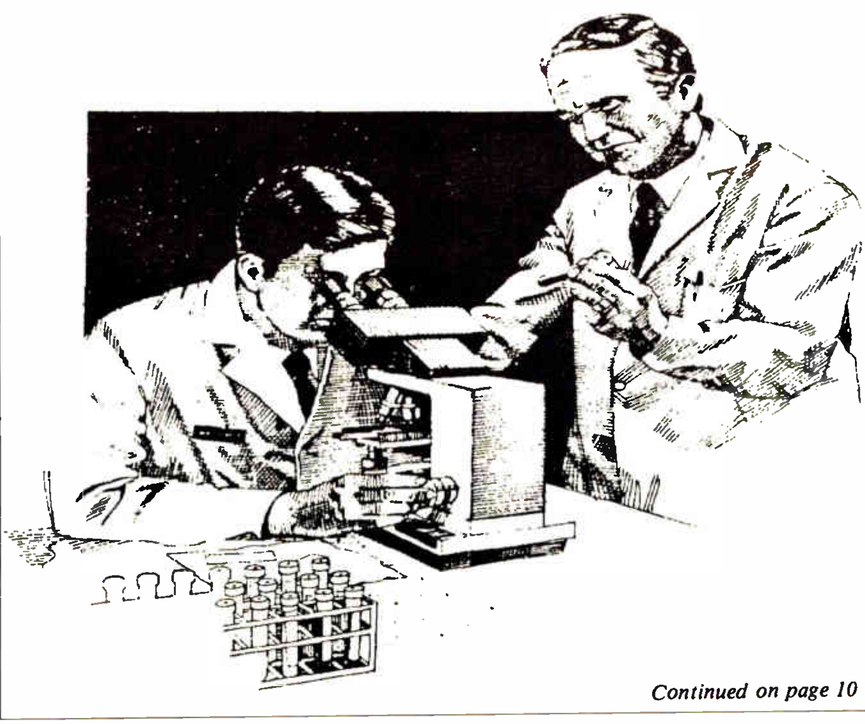
Clinical research of an extremely precise, non-invasive method of 'mapping' the human brain will soon begin at Los Alamos National Laboratory, Los Alamos, New Mexico. The (U.S.) $4 million project will be undertaken in collaboration with the Veterans Administration Medical Center, Albuquerque, New Mexico.

The technical term for the research is magnetoencephalography (MEG), and, it could ultimately have a significant impact on modern medicine.

MEG works on a basic principle of physics: the flow of electric currents produce magnetic fields. In this case, advanced technology measures the miniscule magnetic fields produced by human brain cells.

These fields are one one-billionth the strength of the Earth's magnetic field. They 'flicker' every time brain cells send and receive the myriad of electric signals that whiz through the body's 80-km-long neural network every second. Indeed, magnetic fields loop out every time a flash of electric current emanates from brain cells mentally processing a sound, thought, perception, or movement.

The signals, though very weak, do extend outside the



Continued on page 10

Akai GX-8 Cassette Deck

A feature-packed cassette deck that performs well in this era of digital audio.

By Timothy B. Palmer-Benson

The biggest thing going for Akai's new GX-8 Cassette deck is that it has three sets of heads so that it is possible to monitor the signal as it is being recorded and so ensure that you are making a good recording. Also, it lets you tweak the bias for the best possible performance. There are not many cassette machines out there that can provide these features for a suggested list price of $799.95. Of course, the Akai GX-8 is loaded with a lot of other features as well that are designed to lure a potential user. Features like a real-time counter and automatic tape formula sensing and dbx noise reduction. It has a quartz locked direct drive system, separately regulated power supplies for its audio and noise reduction circuitry and IPLS (Instant Program Locating System) which means the deck can sense a no-signal condition on a tape and thus locate the beginning of a track. The GX-8 also comes with a set of linear crystal, oxygen free copper phone cables and gold-plated input and output jacks. The player weighs 6.5 kg and measures 440 (W) x 111 (H) x 353 (D) mm.

Front panel controls on the GX-8 are laid out in logical fashion except for the fact that the designers have put all tape transport controls on the extreme right hand side of the unit, while the cassette drawer is on the left. When I first began playing with this unit, I had to hunt around a few seconds to look for the cassette drawer eject button. The drawer has that well-oiled feel of a power assisted mechanism, but it cannot be opened or closed, of course, unless the machine is turned on. Next to the drawer is the power switch, a timer switch for use with an optional timer and a headphone socket. Approximately 1.3mW is available for 8 ohm phones.

The transport mechanism is an impressive affair with two big flywheels to drive the closed loop dual capstan system. Akai's separate record and playback super GX heads are grouped together in one housing and are easily accessible for cleaning once the facia of the cassette drawer is removed which is easily done by sliding it upwards. Holes are provided in the drawer frame so that a small Philips type screwdriver can be inserted for tape head alignment.

Signal levels are controlled by a group of knobs in the centre of the front panel under a large fluorescent display. A headphone volume control is provided as well as a double- ganged input level control. There is a separate control for adjusting input balance. The bias control provides a range of -20% to + 20% on either side of selected tape formula. The machine comes set up for Maxell Normal, TDK chrome and TDK metal.

The fluorescent display contains a bar graph type peak level meter that also automatically shows, by the means of dotted lines, the proper recording level for different types of tape and the type of noise reduction being used. The display will show, for instance, that when chrome tape is used, the maximum record level should be +4dB, but that if normal tape is used, the maximum level should be + 2dB. A digital tape counter built into the display also functions as real-time counter, displaying minutes and seconds both in elapsed time and remaining time on a cassette. As with all cassette machines the fluorescent display also shows all tape transport functions, whether Dolby B, C, or dbx is engaged and whether the output mode is in source or tape. Recording mode is displayed in red.

As mentioned earlier, the transport controls are grouped on the right hand side. These finger touch controls allow one to go directly into record mode from play, to go automatically into play after rewind and to create four second blank spaces automatically for the IPLS function. Beneath these controls is a row of push button switches for selecting the three different noise reduction circuits. Selection of tape type is automatic. There are no manual switches to override the system.

The input sensitivity of GX-8 for a 0dB reading is 70mv. This level along with one at -10dB were used for my bench testing. Bias was set at its the two o'clock position because this gave the flattest response for the first two types of TDK tape used, normal and chromium. All noise reduction circuitry was switched out.

With TDK's normal bias tape, response was flat between 30 Hz and 10kHz, as can be seen in the accompanying oscillograph (see Fig. 1; each division represents 3dB, a scale chosen because it can be compared directly

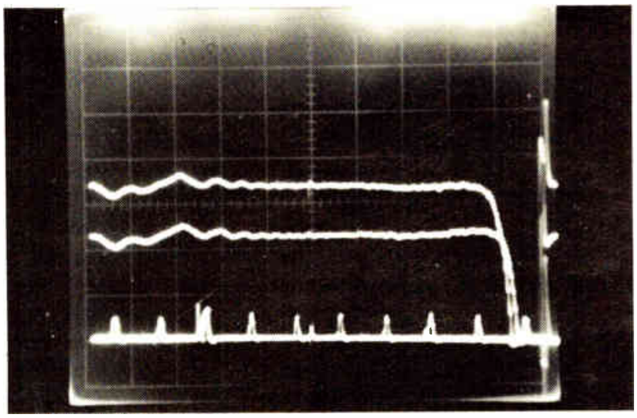


Fig. 1 Frequency response curves of TDK Type 1 tape. Curves are at 0dB and 10dB respectively.

with Akai's own + or - 3dB specifications). The response was much the same at zero and at -10dB. With

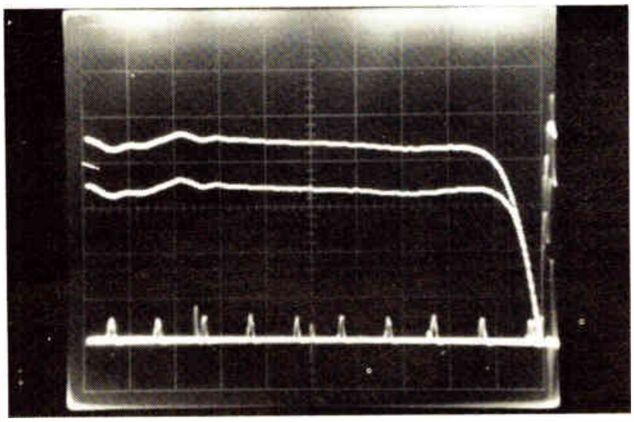


Fig. 2 Frequency response curves using TDK chrome tape. Curves are at 0dB and 10dB respectively.

chrome tape, there is a substantial improvement; response is essentially flat out to 16kHz with a -10dB signal level (see Fig.2). With TDK's metal tape, I had to decrease the bias, i.e. turn the control to the 10 o'clock position to get the flattest response, but once I had done that I obtained the most even and extended response of all three tape types used. Once again, keep in mind the scale used for these measurements and the amplitude response of the Akai GX-8. Some RIAA curves don't look this good!

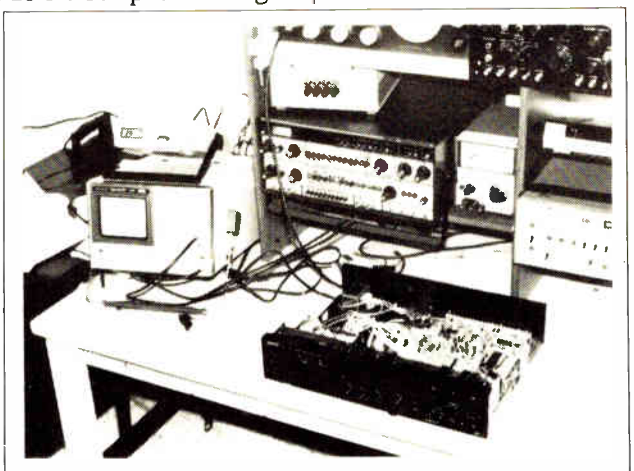


Fig. 3 The Akai GX-8 on the testbench.

Wow and flutter measured 0.12% unweighted and 0.07% DIN, using a calibrated 3,150kHz test tone tape from Standard Tape Laboratories in California. I used a Bruno Volkey wow and flutter meter for these readings. There was negligible speed drift. Total harmonic distortion, reference a 1kHz tone recorded on metal tape at 0dB, measured 0.8% and dropped to 0.6% at -10dB. THD at +6dB, the maximum permitted recording level as denoted by the dots on the peak level meter was 3%. This matches Akai's specification. Fast rewind or fast forward time for a C-60 cassette was one minute and 20 seconds.

Throughout the bench testing, the GX-8's controls performed flawlessly. The logic operated solenoid controls were not fooled by having to go from fast rewind into record or play. When recording begins, the output of the deck automatically switches from source to tape so that one can monitor the quality of the recording immediately. I found the real-time indicator particular useful later on when it came to making some tapes for the car. By using a CD player with a remaining time counter as well, there was ample warning that about a particular selection not fitting onto the remaining tape. The deck was also useful to me when I wanted to play back automatically the first ten seconds of a cassette that I had forgotten to label properly. This scan function can be disabled simply by pushing the play button.

While one may think the bench test results are not as good as they should be in this age of the compact disc, they are representative of good performance in a cassette recorder. Manufacturers are already testing the limits of this media and until DAT or something else gets established, these specifications are about the best that are possible in a home type cassette machine. The Akai GX-8 is capable of producing excellent quality sound provided that a good quality tape is used.

Tim Benson is a freelance audio/video reviewer based in Montreal, Quebec. ■

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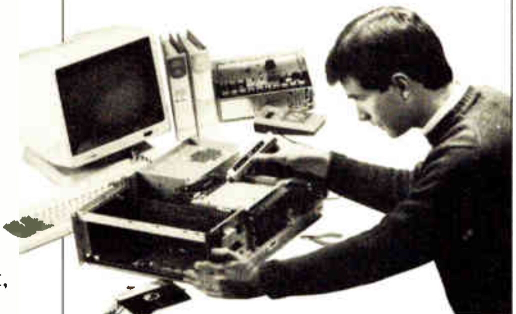

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Main Office: 3939 Wisconsin Avenue, Washington, D.C. 20016 body. As a result, arrays of sensitive sensors placed over and outside someone's head can non-invasively record brain activity from several positions simultaneously. In fact, brain signals can be pinpointed within about eight-hundredths of an inch.

"The ultimate goal is to create a 3-dimensional, functional map of the human brain," says physicist Ed Flynn, a Laboratory Fellow who has helped establish one of the world's most sophisticated MEG units.

"Combined with other techniques, MEG may ultimately show medical researchers how the entire brain is organized", he added. Like other neruo-magnetism units, the facility will be housed in a specially shielded room that buffers equipment from natural magnetic forces. Clinical research is expected to begin by spring. Meanwhile, Los Alamos will continue working to advance MEG technology, such as developing sensors made from new ceramic materials which are superconducting at relatively warm temperatures. Advances in hardware, in addition to software improvements, will be shared with the Veterans Administration Medical Center.

According to one spokesman, MEG's greatest advantage is its ability to show precisely where neural activity takes place. Specific functions can be related to specific areas of the brain.

The technology will allow researchers to specify not only malfunctioning areas of the brain, but also areas important to the recovery of function. Moreover, MEG adds the dimensions of time, indicating what the brain is doing and in what order. It means that doctors will now be able to study the brain's activities in detail previously impossible, short of invasive diagnostic techniques or surgery.

Getting A Rundown On Global Climate — 10,000 Years Ago

Scientists have a fairly good grasp of how global climate has changed over tens of thousands, to hundreds of thousands of years. They also know rather a lot about weather, monitored and charted daily in many parts of the world since the late 19th century. But what is understood about climate change on time scales from years to more than a millennium is limited, and these time scales are arguably the most important to human society.

Some tree species very sensitively record not only annual but seasonal climate change over thousands of years. The problem is, these tree types grow mostly in Earth's temperate zones, and most of the Southern Hemisphere's temperate zone is ocean. Further, global-climate researchers need to monitor climate change in such places as the tropics, where trees don't put down neat, annual rings.

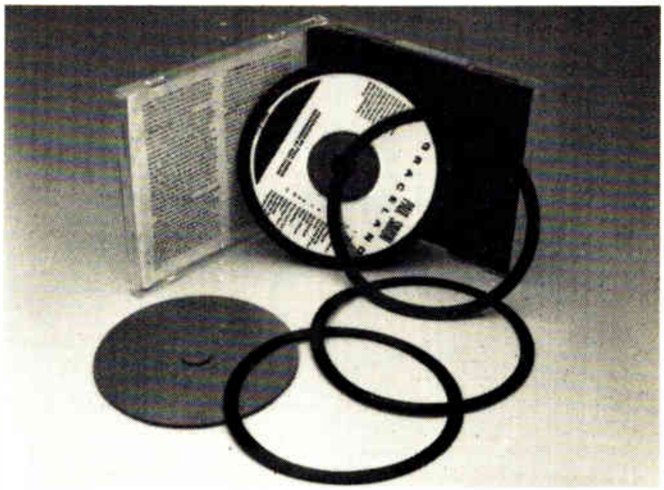
"But it seems to me we face an exciting prospect of breaking out of our geographical limitations and looking at something close to global climate on these intermediate time scales," said Malcom K. Hughes in a paper presented to the 100th annual meeting of the Geological Society of America in Phoenix, Arizona recently. The prospect referred to is integrating what is known from the tree-ring record with what is known from other datable biological and geological records, he said.

Hughes is director of the University of Arizona Laboratory of Tree-Ring Research, the world's largest and foremost center of tree-ring collection and study. The lab was the first of its kind when established 50 years ago by the father of dendrochronology, Andrew E. Douglass. ("Dendro-" from the Greek word for tree and "chronology" meaning the study of time.) UA tree-ring scientists have constructed a more than 8,000-year continuous chronology for trees in western North America.

Already planned is a framework of ideas within which to put all the different records together, says Hughes. He envisions collaboration between tree-ring researchers, ice core scientists, expert interpreters of annual layered coral reefs or deep ocean sediments, and others.

For areas where the tree ring record is poor, the ice core record can be good. This is the case not only at the polar ice caps, but, for example, in the glacier-bearing Andes Mountains of South America or in the glaciated ranges of Tibet. For the ocean-covered tropics, changes in climate are recorded in layers of floor sediment or coral. By piecing all the records together, collaborating scientists could develop global climate maps that show climate change season by season, year by year, over a long period of time, Hughes said.

UA tree-ring laboratory scientist Charles Stockton has drawn a picture of periodic large-scale drought in North America, and UA dendrochronologist Harold Fritts has mapped North American climate change back to the 1600s. Now, global scientists should be able to study the effects of El Nino, the southern oscillation; or how volcanic eruptions affect climate; or the consequences of increased atmospheric carbon dioxide.



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What is it? The Sims CD Rings are an inexpensive and ingenious means of producing cleaner and harmonically fuller sound from all CD players. The rings were recently introduced by Sims Vibration Dynamics.

Each ring is made of a rubber-like compound, and attaches to the back side of any CD with an easy-to-use centering device. Using the principle of centrifugal force, the ring flattens the rotating disc. This in turn reduces rotational flutter and allows the laser to read more bits of information. By measuring a helium neon laser as it reflects off the rotating disc, Sims claims that the laser tracks 30% better with the addition of the rings to the discs.

The cost of the Sims starter kit which includes 10 rings and a centering device is $19.95 Cdn, and the cost of 10 rings only is $14.95.

Aralex Acoustics, Suite 270, 167 West 2nd Ave., Vancouver B.C. V5Y 1B8 (604) 873—4475

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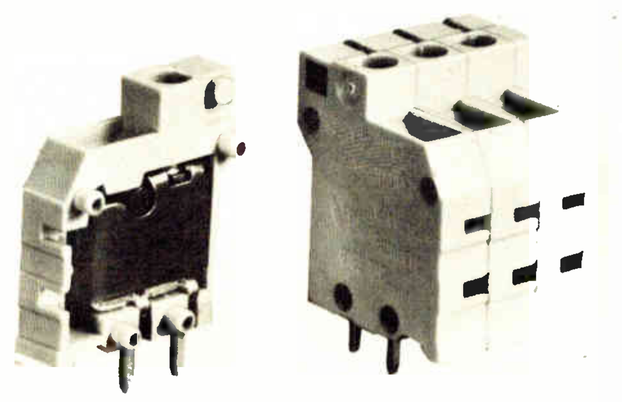

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For more information contact: Electrovert Ltd., 46 Dufflaw Rd., Toronto, Ontario M6A 2W1. (416) 787-0243.

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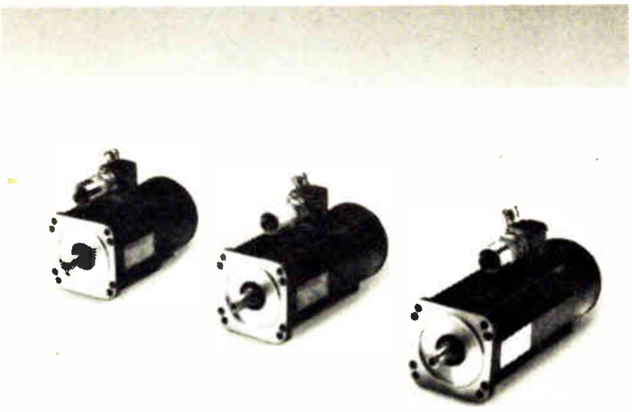

Rare-Earth Magnet Servomotors

A complete line of high-powered brushless AC servomotors, constructed using rare-earth (Sumarian-Cobalt) magnets, is available from Indramat.

Their high torque-to-weight ratios make these motors ideal for applications such as robotics, part-transfer, assembly machines and other applications requiring high torque in a small package.

Sixteen different motor sizes are available with continuous torque ratings ranging from 7 lb-in (7lb motor) to 505 lb-in (114 lb motor) at closed-loop operating speeds of up to 6000 RPM.

The servomotors are supplied with brushless tachometer feedback, and options include: integrated incremental encoder, stub shaft for mounting feedback assemblies and an electrically- released brake.

Agnes Flutur, Hymatic Controls Ltd., 3426 Mainway, Burlington, Ontario L7M 1A9. (416) 335-5511.

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Time Interval Analyzer

Capable of 800,000 time interval measurements per second with one nanosecond resolution, the TIA 2001A from Kode evaluates the bit shift, margin and error rate performance of rigid, optical and floppy disk drives and magnetic tape drives. The unit performs a series of time interval measurements, logs how often each measured interval occurs and displays the result as a histogram.

Other features include: delayed enable function for stripping out headers, sync and gaps; automatic segment operation for automatic centering of a selected segment; and an IEEE interface which provides access to all measured and calculated data.

Contact Don Greenspan, Kode, 1515 S. Manchester Ave., Anaheim, CA 92802-2907. (714) 758-0400.

Circle No. 53 on Reader Service Card

New Frequency Counter

The P6000 from Newport Electronics is a microcomputer-based, 6-digit, 1/8 DIN panel instrument which can be configured by five front panel keys or by a personal computer to run as a frequency meter/tachometer, FB/FA frequency-ratio meter, period/period average meter, time interval meter, or totalizer.

The unit allows exceptionally fast low-frequency measurements with 6-digit accuracy by using 1/x reciprocal counting and dynamically adjusting the gate time for any partial signal periods. Measurements above 10Hz can be taken every 150 msec, below 10Hz at every 50 msec plus one signal period. The maximum frequency is 7MHz.

The basic unit includes dual TTL-level inputs with protections to 25V. An optional single or dual channel isolated signal conditioner makes the P6000 compatible with virtually all pulse senors, including low-level magnetic pickups, contact closures, and active sensors with PNP, NPN, or NAMUR output.

For more information contact: Metermaster, 80 Vinyl Court, Woodbridge, Ontario L4L 4A3. (416) 851-8871

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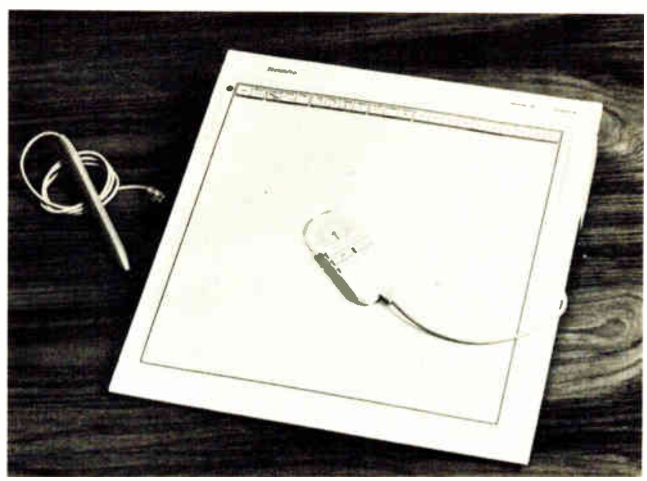

HP SketchPro

The new SketchPro graphics tablet from Hewlett-Packard comes with a complete package of accessories including a lightweight stylus, four-button cursor, serial interface cable and adapter, menu-overlay hold-down/protector, Mirosoft Mouse driver files and setup instructions for major PC CAD software packages.

Inquiries Manager, Customer Support Centre, Hewlett-Packard (Can.) Ltd., 3710 Nahsua Drive, Unit A-E, Mississauga, Ontario L4V 1M8.

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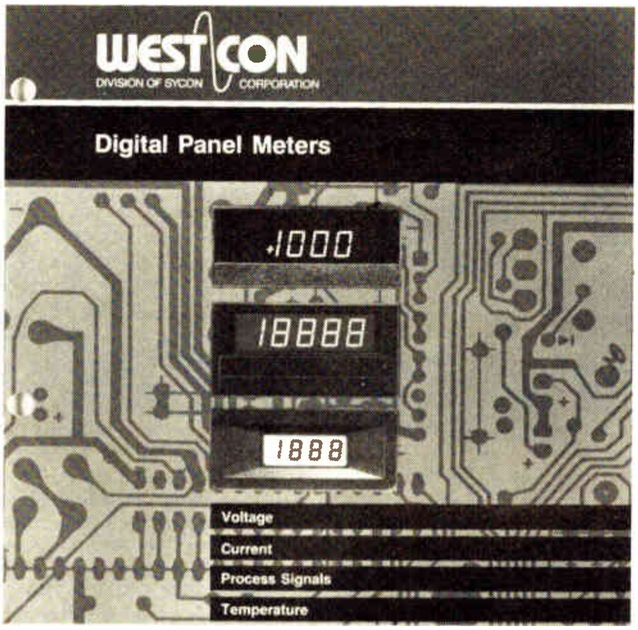

New WestCon Catalog

An all-new 29-page digital panel meter catalog has been issued by WestCon. The catalog contains complete specs on 3 1/2 and 4 1/2 digtit DPMs with a choice of LED, LCD, or gas discharge displays. Over 1000 meters are listed, measuring DC and AC voltage, current, resistance, frequency/rate/flow, temperature and process signals.

The catalog is available, free of charge, by contacting Anna Greashaber, WestCon, P.O. Box 491, 959 Cheney Ave., Marion Ohio 43302 (614) 382-5771.

Circle No. 55 on Reader Service Card

HC 4510 DMM

The HC 4510 Digital Multimeter is a top-of-the-line meter providing 4 1/2 digit accuracy with measurement functions to 1000VDC, 750VAC, 10A AC/DC current, and 20Mohm resistance.

The meter also has diode check, audible continuity check, data hold and "lo bat" indicators, and overload protection on all ranges.

The meter is also equipped with an adjustable stand for easy use in either bench top ro handheld applications.

Jim Peffers, KB Electronics, 355 Iroquois Shore Rd., Oakville, Ontario L6H 1M3 (416) 842-6888.

Circle No. 58 on Reader Service Card

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The AMC-250 from Advanced Motion Controls features 30KHz PWM frequency operation, protection against output shortcircuits, overheating and overvoltage, and adjustable current limit.

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S. Barta, Advanced Motion Controls, 15921 Haynes St., Van Nuys, CA 91406.

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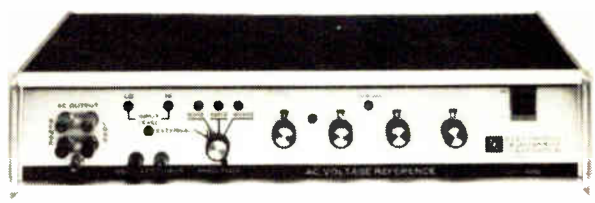

AC Reference/Calibrator

The model 4032 from Electronic Development Corp. is an easy-to-use, lightweight, inexpensive AC voltage calibrator for meters. It also doubles as a reference for A/D converters, amplifiers, RMS converters, AC gain control circuits and oscillators.

In addition, the unit can serve as the AC voltage input to transconductance (AC current) amplifiers. The specs include: amplitude output range of 10VAC, rms; frequency range of 50Hz to 400Hz; accuracy of 0.06% of setting; and harmonic distortion of 0.03%.

Cost of the unit: $945.00(US). Contact: Bob Ross, Electronic Development Corp., 11 Hamelin St., Boston, MA 02127 (617) 268-9696.

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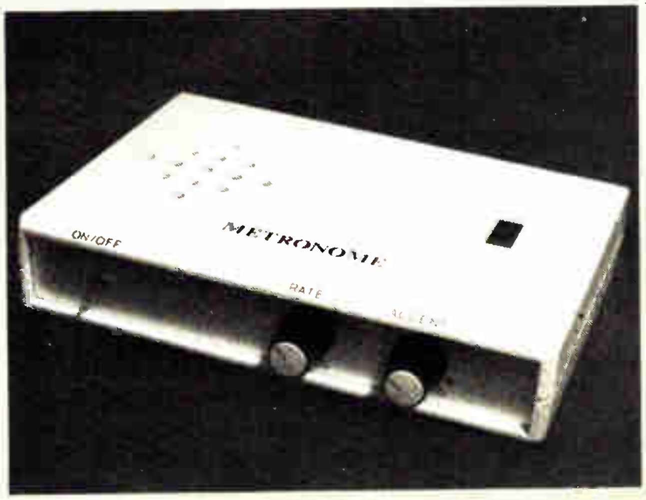

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The Physics Of Music Part 3

An introduction to waves, complex sounds and localization.

By Carol Thomas

In last month's article, the second in this series, we talked about the ear and how we interpret sounds as loud (intensity) or high (pitch), and how we distinguish between different tones. This month we'll get into sound waves, how we hear and localize complex sounds, such as speech, and a little on acoustics, for all you stereo fans.

Sound Wave Review

Sound waves act a lot like the waves you see in the ocean, a wave tank, or your bathtub. Once made, they spread out in concentric circles from their source, and if they bump into something, they bounce off it and go in a different direction. However, the regularity of form of sound waves far surpasses those of water waves.

The sine wave that you might remember from high school trigonometry is a more accurate representation of the shape of a sound wave from a source such as a tuning fork. When you hit a tuning fork against a hard surface, the sound it makes is caused by its vibrations. It alternately compresses and rarefies the air adjoining it, in a sinusoidal manner. A sound wave is simply the progressive movement of such alternate compressions and rarefactions through a compressible medium such as air or water, and all sound-producing sources use this same mechanism.

Frequency

The frequency of the sound wave which hits our eardrums is what causes us to hear the sound as high or low in pitch: the higher the frequency, the higher the pitch. The frequency simply refers to the number of complete cycles of compression and rarefaction in a specific unit of time, usually one second, which allows us to measure sound frequency in Hertz, abbreviated Hz. The frequency is inversely related to the wavelength, and if the frequency of any sound wave, in Hz, is multiplied by its wavelength (the length of one complete cycle) in centimetres, we get the speed of sound: about 344 metres per second.

The range of hearing for humans is usually recognized as 20 to 20,000Hz, or put another way, we can hear sounds of wavelengths from about 1.7 centimetres to over 17 metres. To give you an idea of which sounds correspond to which frequencies, middle C is tuned to about 262Hz, C above middle C has a frequency of 524Hz, and each octave higher doubles the frequency, until we reach the limit of human hearing. You'll often see middle C specified as 256Hz in physics books; this is a handy pitch for acoustics work, but is not concert pitch, a subject for a future issue.

Musical instruments which produce the same note don't sound the same to us: a trumpet's middle C and an organ's are apparently different. This is because musical instruments don't produce pure tones, but instead a *fundamental frequency* plus variations on this frequency, called overtones or harmonics.

The fundamental vibration of a stretched string occurs when the string bounces back and forth, like the tines of our tuning fork, and compresses and rarefies the air adjoining it. If it vibrates 100 times per second, its fundamental frequency is 100Hz. However, at the same time that a string is producing a tone of 100 Hz, it is also vibrating at twice that frequency, and three times that frequency, and so on. These are the harmonics, or overtones, and all instruments produce them, not just strings. Because of the simultaneous production of all these frequencies, in varying degrees of strength, the sound is different in different instruments, and this is what we call *timbre*. The sound produced is no longer a simple wave, but a complex wave, and the strength of the various frequencies which comprise it depends on factors such as absorption and resonance within the instrument producing the sound.

Sound Localization

Because our ears are located on opposite sides of our heads, we don't hear exactly the same sound in each ear, even though the sound comes from a single source. It is this fortunate anatomical quirk that allows us to determine the location of sounds without ever having to give it conscious thought. As a by-the-way, this is also why our species has developed stereophonic equipment, which would, of course, not be necessary if humans had only one ear, or two ears on one side of our head.

The localization of sounds comes from four differences in how each ear hear a certain sound. The ear which is closer to the sound will hear it earlier, and hear it louder than the other; pure or near-pure tone frequencies may be out of phase at the two ears; and, sounds made up of complex combinations of high and low frequencies, such as speech, will arrive at each ear with differing amounts of distortion because of differences in absorption, reflection and bending patterns of the different frequencies.

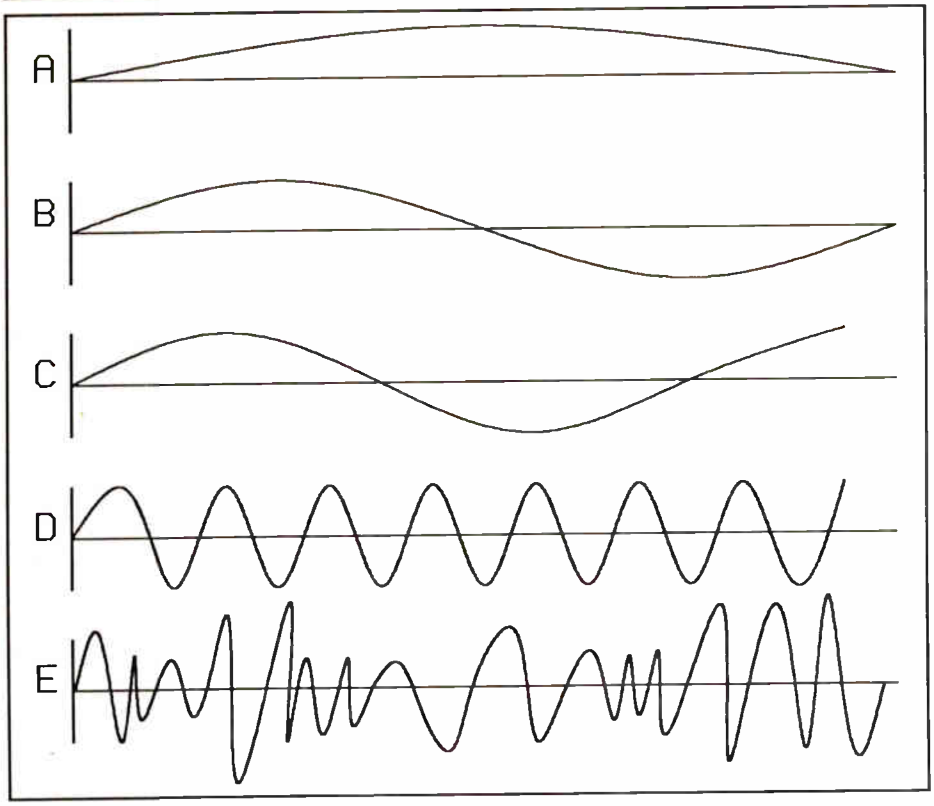

Fig. 1. In (a) a string has been set in motion to provide the fundamental. In (b) it has divided in half, giving the second harmonic (the octave). In (c) and (d) further subdivisions produce the 3rd and Nth harmonics. All of these sum at once to produce the complex waveform of (e). The harmonics would not necessarily be of equal amplitude in an actual sound.

Way back in 1920, researchers in this field demonstrated that time of arrival of a sound was more important in localization than its loudness in each ear. A sound coming from the side of the head takes about 0.65 additional milliseconds to reach the distant ear, while one three degrees from the sagittal plane (straight ahead of us) requires 0.27 milliseconds. Since we can interpret as little as 0.03 millisecond differences directionally, this means we can discriminate sounds that are only just over three degrees apart.

Because of the time differences between arrivals of a sound in each ear, the sounds heard are slightly out of phase. The eardrums receive the air compressions with a delay corresponding to the phase difference. It is still not entirely known whether it is this phase difference or the time difference which allows detection of the source of a sound. Either way, it is limited by the frequency of the signal: frequencies above 1,500Hz cannot be localized as accurately as those below 1,500Hz.

To localize high-frequency sounds, we use the sound's intensity (loudness) difference in each ear. Although intensity decreases only six decibels for each doubling of distance, it is significant because high frequencies don't bend around the head to get to the more distant ear as well as lower frequencies do; they tend to get blocked off, reflected or absorbed by the head. (Think: next time you hear an ear-piercingly high-pitched noise, your head may be absorbing that racket.) It appears that for frequencies with wavelengths longer than the distance between the ears, i.e. above 1,500Hz, intensity differences are more important that temporal ones.

The timbre of a sound, or the complexity of its wave pattern, is a composite of the three variables just described: intensity, time difference, and phase difference. This may mean that it is not an independent method of sound localization. However, since the ear nearer to a sound will hear more of the higher frequencies, the complex sounds of speech will be differentially attenuated in each ear. Humans' particularly good ability to locate a speaker may be partly due to a learning process that occurs when we are very young, whereby we learn to interpret differing timbres as spatial localization. Very complex sounds may be the only ones which we actually have to learn to interpret in this way.

Intelligibility and Speech

Speech is a combination of high and low frequencies, and its intelligibility is more affected by background noise that our hearing of single frequencies (pure tones) is. The Articulation Index (AI) has been used as a measure of speech intelligibility, with 1.0 on the scale representing perfectly clear speech, and 0.0 the entirely indecipherable opposite extreme. At an AI of 0.5, individual syllables are about 70 per cent intelligible and complete sentences almost 100 per cent so.

The auditory spectrum from 200 to 6,100Hz can be divided into 20 bands, each of which contributes equally to speech intelligibility. Loss of any frequencies will result in some intelligibility loss, which can be stated in terms of the AI. The AI is determined by adding up the contributions of each of the 20 bands, based on the amount of signal above the threshold of hearing.

The AI can also be used to predict the effect of various noises and bandwidth restrictions on the intelligibility of speech, especially in the case of electronic transmissions, where the bandwidths and background noise level can be determined in advance.

A simpler calculation than the AI is the Speech-Interference Level (SIL). The SIL is the arithmetic average of the sound- pressure levels in each of three bands: 600 to 1,200, 1,200 to 2,400, and 2,400 to 4,800Hz. If the level in the 300 to 600Hz band is at least ten decibels greater than the level in the 600 to 1,200Hz band, it is also included in the mean. The SIL is useful for predicting intelligibility in noisy environments such as offices.

Yet another measure of noise effects is the Noise Criterion curve, called the NCA curve. This curve considers the entire gamut of effects of noise, such as annoyance and damage as well as speech interference, and is basically a maximum-tolerance level for various conditions. NCA curves are

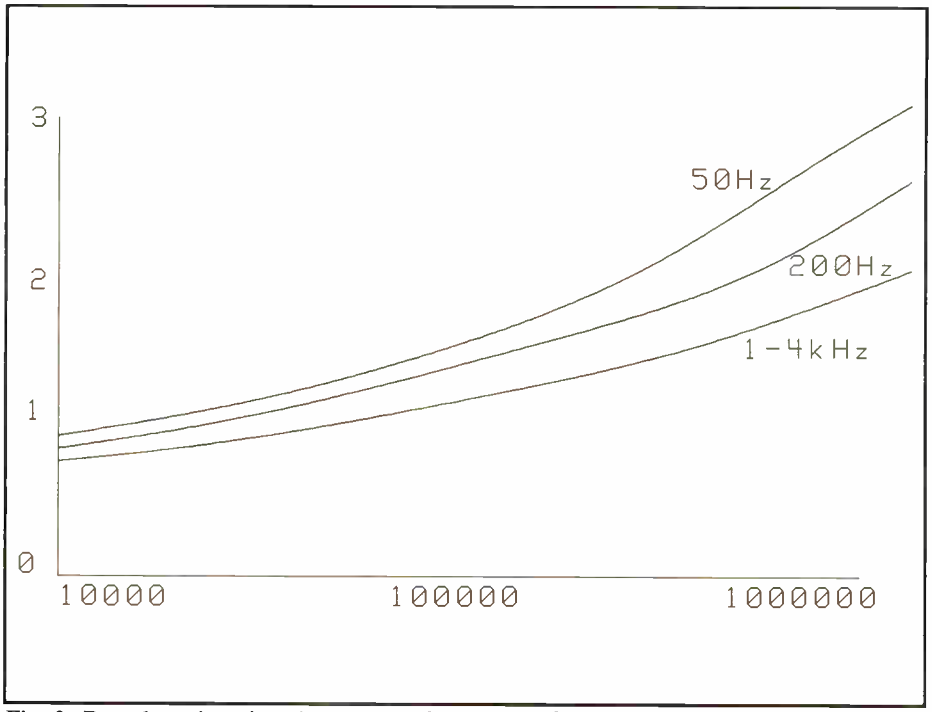

Fig. 2. Reverberation time in seconds for various frequencies and room volumes (in cubic feet). The longest reverb time occurs for low frequencies in large rooms.

used by acousticians interested in reducing the effects of noisy workplaces.

Acoustics

...did I say acousticians? One field of interest to any of us who listen to music (I think I mean all of us), is acoustics. Although the science of acoustics includes everything related to the production and transmission of sound and how this is related to our sense of hearing, I'm talking now about the acoustics of rooms, or *reverberation*.

Once sound waves are produced, we know they travel outward from their source in concentric circles, until they reach a solid object. They will then bounce off the object and continue to travel (and bounce off objects) until their intensity is reduced so far that they are no longer audible. This repeated reflection is termed reverberation. Similarly, a single reflection of a sound off an object, which is distinct from the original sound, is what we call an echo.

If the walls of a room are of a very hard substance, such as marble, and are thus good reflectors, any sound made will persist for an appreciable time after the original sound stops. In some environments (like your office), this is undesirable, and is solved by covering part of the walls with some sound-absorbent material, usually a porous substance like cloth or rough plaster. Some of the motion of the air molecules which constitutes the sound is then converted to heat in the material, and less sound is reflected back.

If a sound whose intensity is a million times the intensity of the faintest possible sound is produced in a given room, the time it takes that sound to die away to inaudibility is called the *reverberation time* of the room. For a medium-sized auditorium, a good reverberation time would be one to two seconds. The approximate reverberation time of a room is given by the expression:

$$T = 0.015V/kA$$

where T is the time in seconds, V is the volume of the room in cubic metres and kA is the total absorption of all the materials in it. The total absorption is computed by multiplying the area, A, in square metres, of each kind of material in the room, by its absorption coefficient, k, and adding these products together.

The absorption coefficient is just the fraction of the sound energy that a given material will absorb at each reflection. So, an open window has an absorption coefficient of 1.0 (you don't get much sound reflected from that!) while marble has a coefficient of 0.01; it absorbs only one per cent of the sound energy at each reflection. Another way of expressing absorption in the imperial system is the *sabin*; one sabin represents one square foot of surface which absorbs all the incident sound energy.

When a sound, especially one which goes on for some time, reverberates in a room, its apparent intensity increases, as we hear not only the original sound, but also its reflections. The longer the duration of the original sound, the greater its intensity will be if it is not completely absorbed. The reflected sound has its energy reduced at each reflection, therefore the succeeding increments of reflected sound become progressively smaller, until they disappear entirely. A steady-state condition occurs when the walls are absorbing the same amount of energy as the sound source is producing. When the original sound stops, some time is required for the sound energy to be completely absorbed; for example, a 60 decibel sound in a damped room can take over two seconds to be completely dissipated.

Reverberation can interfere with the intelligibility of speech, because instead of one sound being heard, the sound being made plus the reflections of previous sounds are all heard together. The overlapping speech sounds mask and interfere with each other, and under conditions of very long reverberation time, speech can become practically unintelligible.

For you concert lovers, the optimum reverberation time for à theater or concert hall can be calculated as a function of the volume of the room for different frequencies of sound. The reverberation time increases as the frequency decreases.

In the next article, we'll be looking at the characteristics of various musical instruments and how they produce their individual sounds.

Carol Thomas is a freelance science writer from Toronto. ■

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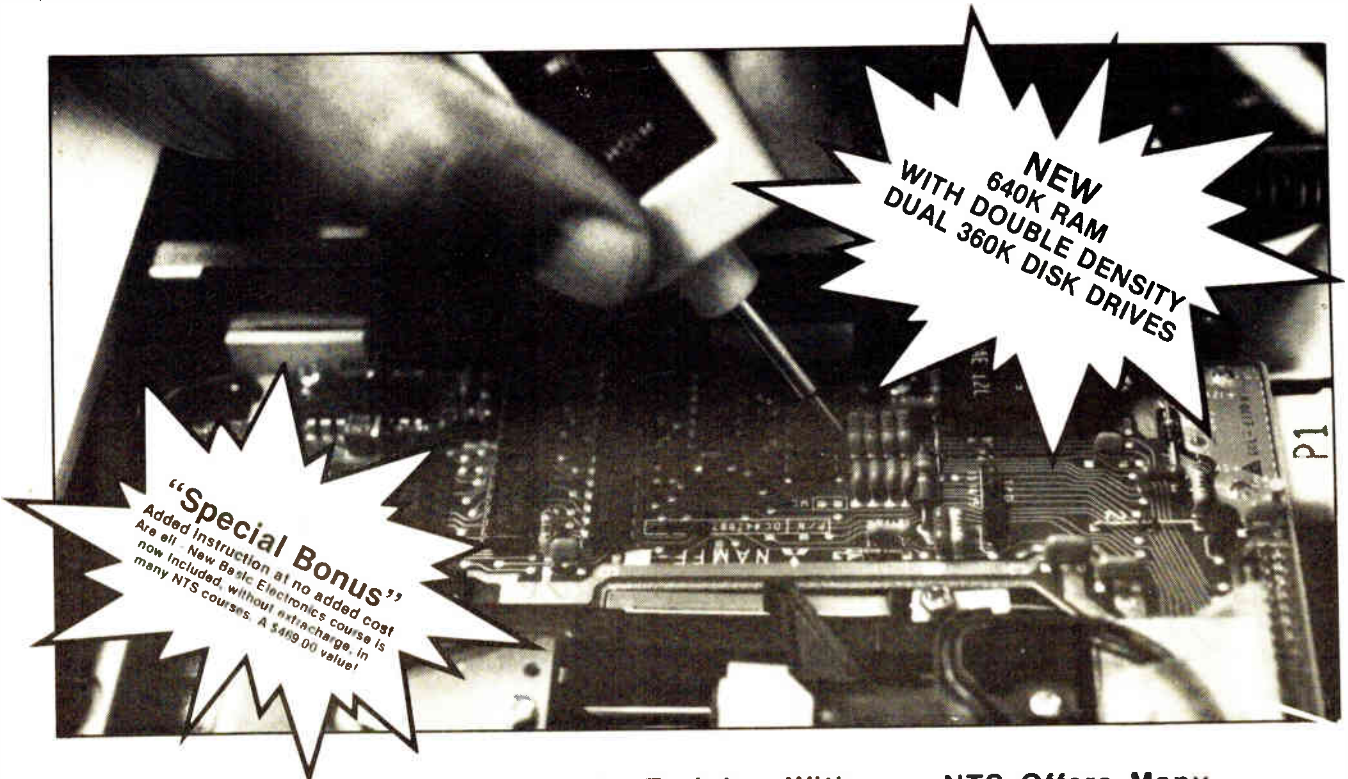

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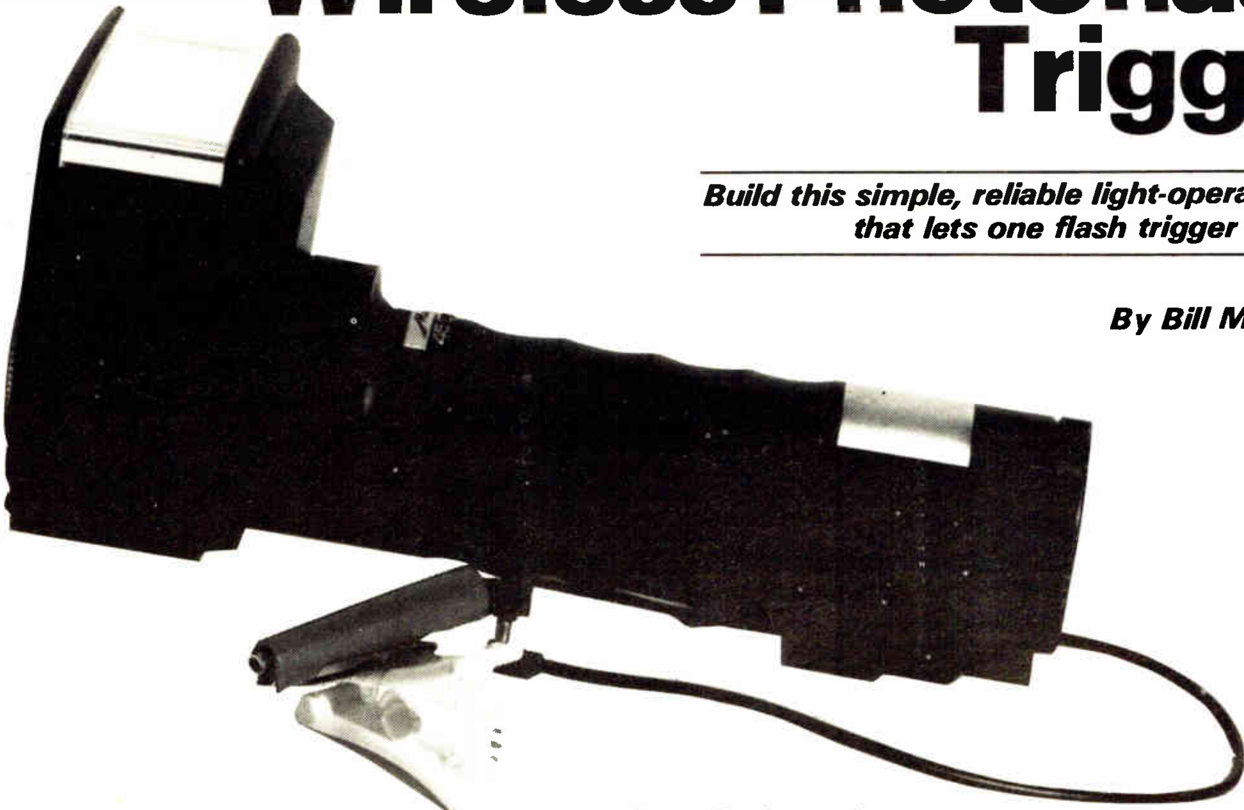
Wireless Photoflash Trigger



Build this simple, reliable light-operated unit that lets one flash trigger another.

By Bill Markwick

Using one photoflash has some big disadvantages in photography, despite all the hard-sell advertising to the contrary. No matter how smart the flash's electronics are, a single burst of light causes severe shadows on the subject's opposite side, or dark backgrounds as the light intensity falls off with distance.

Two flash units can go a long way toward solving these problems, especially if the second unit is softened by bouncing it off a wall or white card (to prevent two sets of shadows). The difficulty here is in hooking two flash units together. Will they affect each other's circuitry? If not, you still have the nuisance of running cords across the room.

This photoflash trigger project couldn't be much simpler, and it solves a number of problems. It merely plugs into the second flash's sync cord, and will trigger it when the main flash goes off. It's wireless, and it gets along with any type of flash circuitry.

The Circuit

The circuit schematic is shown in **Fig. 1**. The opto- device is a Motorola MRD3010 light-activated triac. It's normally used for applications such as controlling lamp dimmers according to the ambient light, and it just happens that the sensitivity and voltage rating are perfect for what we want.

The triac is like a pair of diodes in inverse parallel, except that it's normally non-conducting until triggered by a signal on the gate lead, or in our case, a strong enough light on the device lens.

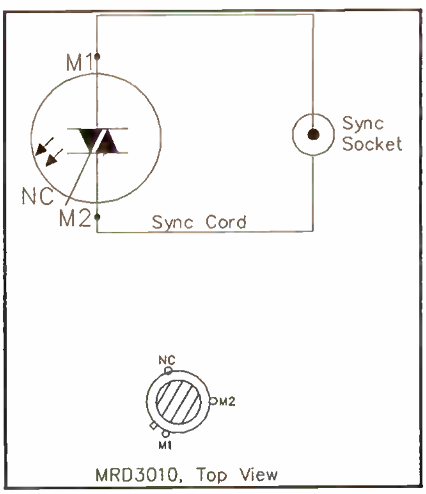


Fig. 1 (top) The schematic of the flash trigger; note that the third lead of the triac is not used and can be cut off; (bottom) the pinout of the MRD3010 triac.

Since a triac conducts in either direction, there is no problem with polarity; it will work properly even if you reverse the leads. The MRD3010 has a maximum voltage rating of 250V, more than the triggering voltage of flash units.

In the upper part of **Fig. 2** is the triggering circuit used by almost all low-cost portable flash units. The main high-voltage supply is reduced to about half by two resistors and charges a small capacitor, usually in the range of 0.02u to 0.1u. When the camera contacts close, the capacitor's charge is dumped into the primary winding of a small high-voltage coil; its secondary winding provides a short pulse of about 4kV. This pulse is applied to the xenon flash tube, where it ionizes the gas, making it conductive enough to discharge the main capacitor and produce a burst of light.

In the lower part of Fig. 2 is the electronic trigger used on the more expensive flashes. A solid-state circuit buffers the triggering capacitor from the sync socket, reducing both the volt-

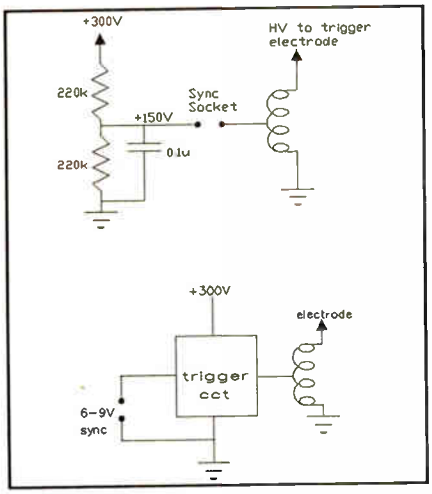


Fig. 2 (top) the firing circuit found in most low-cost flashes, and (bottom) the isolated low-voltage type.

age and the current applied to the camera shutter contacts.

The MRD3010 is happy with either of these systems. Incidentally, if you can't locate a Motorola dealer, we got our triac (under $3) from Electro-Sonic, 1100 Gordon Baker Rd., Willowdale, Ont. M2H 3B3, (416) 494-1555.

Construction

We couldn't locate any sync-socket connectors, so we bought a flash extender cord from a camera store and cut off the required socket end, leaving a few inches of wire. The triac is soldered to the wire, using tape or plastic sleeving to insulate the joints. Note that there is no connection to one of the triac leads and it can be cut off.

We then drilled a hole in one end of a plastic pen top, dropped in the triac until it protruded, and filled the pen top with epoxy. It was then epoxied to a large plastic paper clip to allow convenient mounting to various things.

Use

Just plug it into the remote flash. The main flash will trigger it in a short enough time that for practical purposes, the flashes can be considered to fire simultaneously.

The trigger is quite sensitive; we had it working reliably at about 30m distance.

If the remote flash causes even more shadows, try bouncing it from the ceiling, the wall, or a large white card.

Disadvantages

Well, there are limits to the simplicity route. The trigger will respond to *any* flash; if you use it at a wedding or similar, other people's flashes will soon discharge your remote for you. Secondly, it isn't reliable in sunlight. Bright light of any sort will fire it if it's strong enough. The more adventurous of you might try cardboard snouts or baffles or filters.

Triacs also have the characteristic of latching; once they start to conduct, they stay conducting even if the gate or light signal is removed. They don't turn off until the current falls below a certain minimum. This didn't cause any problems with our unit, because firing the triac discharged the flash completely and reduced the current to zero. If it does latch, the symptom will be a neon ready light that refuses to come on; if this happens, just disconnect the sync cord for a moment to let the triac switch off. ■

Continued from page 12 **For Your Information**

Omnicrom Color Copy System

Convert black and white artwork, photo copies, or laser printer output into multi-color images using the Omnicrom 2000.

Omnicrom can produce multi-colored proofs, color printing, foil stamping, laminating, report cover binding, signage, overhead projectuals and color overlays.

All that is required, apart from the Omnicrom unit, is a "zoom" photocopier to use as a camera to resize and copy originals up to 11" x 17". The Omnicrom unit carries a price of $1595 for the 12" model and $1095 for the 9" model.

For complete technical information on the Omnicrom system contact: Trans Art Supplies, 720 King Street, Toronto, Ontario M5V 2T3. (416) 363-6156.

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Nicolet Digital Scope

The new Nicolet 310 digital scope can capture and save 176 waveforms on its dual 3.5" floppy disk system (43 waveforms on a single 5.25" drive).

Because the data is stored in IBM/PC file format, users can recall waveforms on a PC without the hassle of computer interfacing. PC software is provided free of charge for printing waveform values and for formatting data for use with LOTUS 1-2-3 or Nicolet's WAVEFORM BASIC data analysis package. For testing in harsh, dusty environments, the portable 310 may be purchased with a rugged Bubble Memory Cartridge.

The 310's Advanced I/O options link it over the IEEE- 488 (GPIB) and RS232 interfaces to digital plotters for hardcopy records, and to computers for further data manipulation.

The price is $7295.00 (Cdn). For more information contact: Nicolet Instrument Canada Inc., 1-1200 Aerowood Dr., Mississauga, Ontario L4W 2S7. (416) 625-8302.

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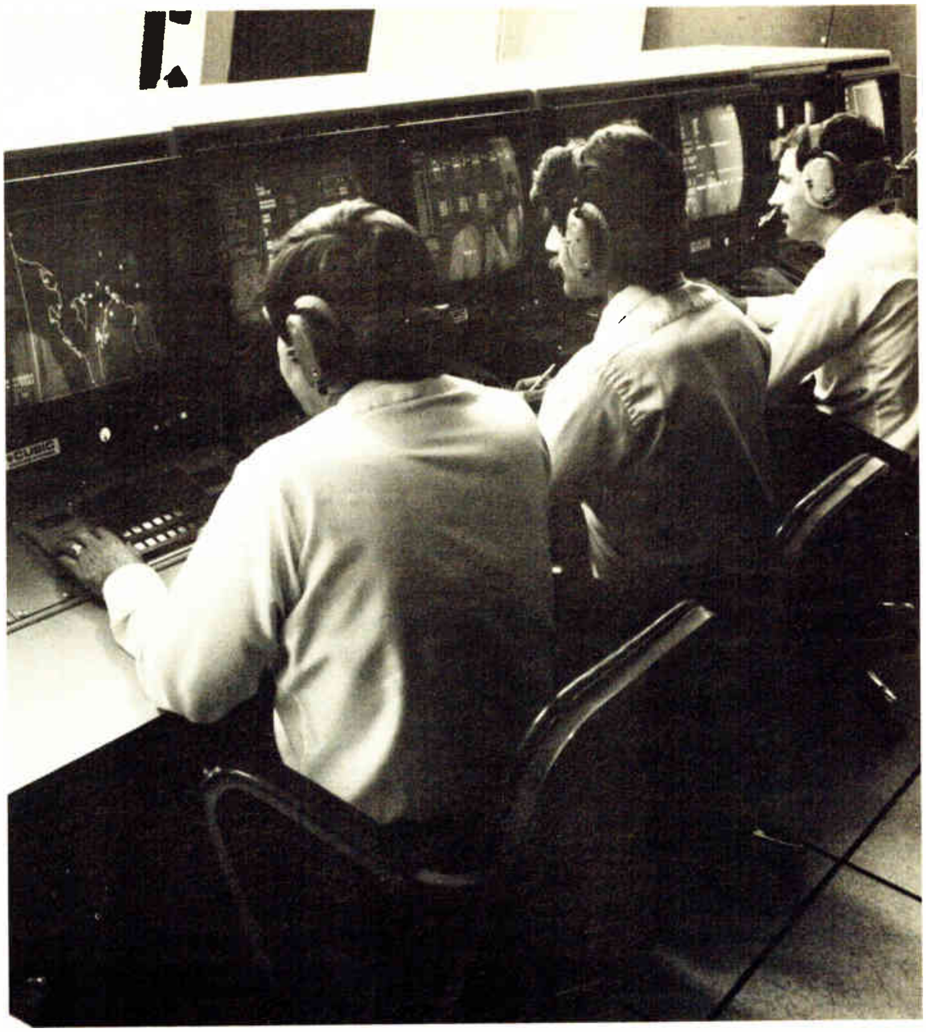
Electronic Warfare In The World Of Intelligent Machines



Using AI for more than just peaceful purposes.

By K. Tahir Shah

One day in June of 1967, a wave of fighter and fighter bomber aircraft of the Israeli air force, packed with their electronic counter-measure gadgets, flew over the clear and bright skies of the Mediterranean. They were heading towards, Egypt, and avoiding detection by the long range radar network, they penetrated to destroy the Egyptian air force on the ground. The outcome of that war was a verification of the generally accepted military principle, that victory in a modern war will go to the side that can best control the electromagnetic spectrum. That was twenty years ago. Now it is true more than ever.

Star wars of tomorrow will be fought by electronics and computers; controlling decoding, jamming and avoiding those little chunks of electromagnetic waves moving back and forth at the speed of light. It will be the battle of intelligent computers and the electromagnetic spectrum. Today's war machines are heavily dependent on electronics and computer technology due to their design complexities, ultra-high speed and performance requirements which no human can match. At the same time, communication between various sub-systems of a defensive or offensive system is more important than ever. Other system functions, such as detection and tracking of enemy aircraft, ships or missiles, are an essential part of the warfare.

Electromagnetic Manipulation

Electromagnetic emission or radio waves of many different wave lengths are used for communication. The basic concept of electronic warfare is to exploit the enemy's electromagnetic emission in all of the electromagnetic spectrum in order to provide "intelligence" or information on the enemy's abilities. This includes the enemy's order of battle, his intentions and the capabilities to use counter-measure etc.

Before we proceed any further with this discussion, an important semantical issue needs clarification. The word "intelligence" is used widely in two well known contexts. Since we are dealing with both of these contexts, it is vital that we have two semantically unrelated uses.

One noted use of this word is in the context of human, animal and machine capabilities, such as language understanding, proving theorems, creating art and music and infinitely many other tasks requiring complex processing of information. The other use of this term is in the context of military, political and economic information which has specific interpretation and meaning vis-a-vis some well defined objectives.

In the first case, "intelligence" is referred to knowledge processing from which all human intellectual capabilities are derived. In the second case, it is the knowledge itself which is referred to as the intelligence, the information of some kind which is meaningful only in a particular context. To summarize, human and machine intelligence is derived from knowledge processing while the other, e.g., military intelligence is a goal-oriented interpretation of the knowledge or data.

Coming back to electronic warfare, there is an interesting mathematical formula which we can used to understand why electronic counter-measures are important. According to the Lanchester equation, the effective military strength of a force is proportional to the product of the effectiveness of its weapons and the square of its number. Such a force, when faced with a numerically superior force of N - to - 1 ratio, it is necessary to counter this with a weapon which is N square times more effective than the enemy's weapon in order to achieve equality.

This equation is used to analyze the force divider or force multiplier effect in a given combat situation. It is achieved in practice by command, control and communications (C3) systems through the localized concentration of forces and asymmetry in weapon power. That is, a favorable imbalance is achieved at a small section of battle field by increasing the quantitative and qualitative firepower. For example, asymmetry is achieved in a local engagement by employing air-delivered weapons against a tank for higher effectiveness ratio.

When C3 systems are employed as force multipliers they become the target of enemy attack. Neutralization of C3 has a force divider effect and it is accomplished by the use of C3 countermeasures (C3CM). Exploitation, deception, jamming and destruction of C3 hardware are methods generally employed for C3 counter measures. The electronic warfare can be considered as a subdomain of C3 countermeasures. In the tactical and rapid deployment force, the quality of real time decision making (especially in command, control and communication systems) can influence significantly the outcome of an engagement. Both types of systems are inherently mobile. The tactical conflict, as well as rapid deployment, are characterized by rapid changes and thus impose strong limitations on their C3 systems affecting the ability of respective human elements to perceive over all situations and reach a decision in real-time. It is in this situation that computer based intelligent systems for decision making are useful.

AI Techniques In Warfare

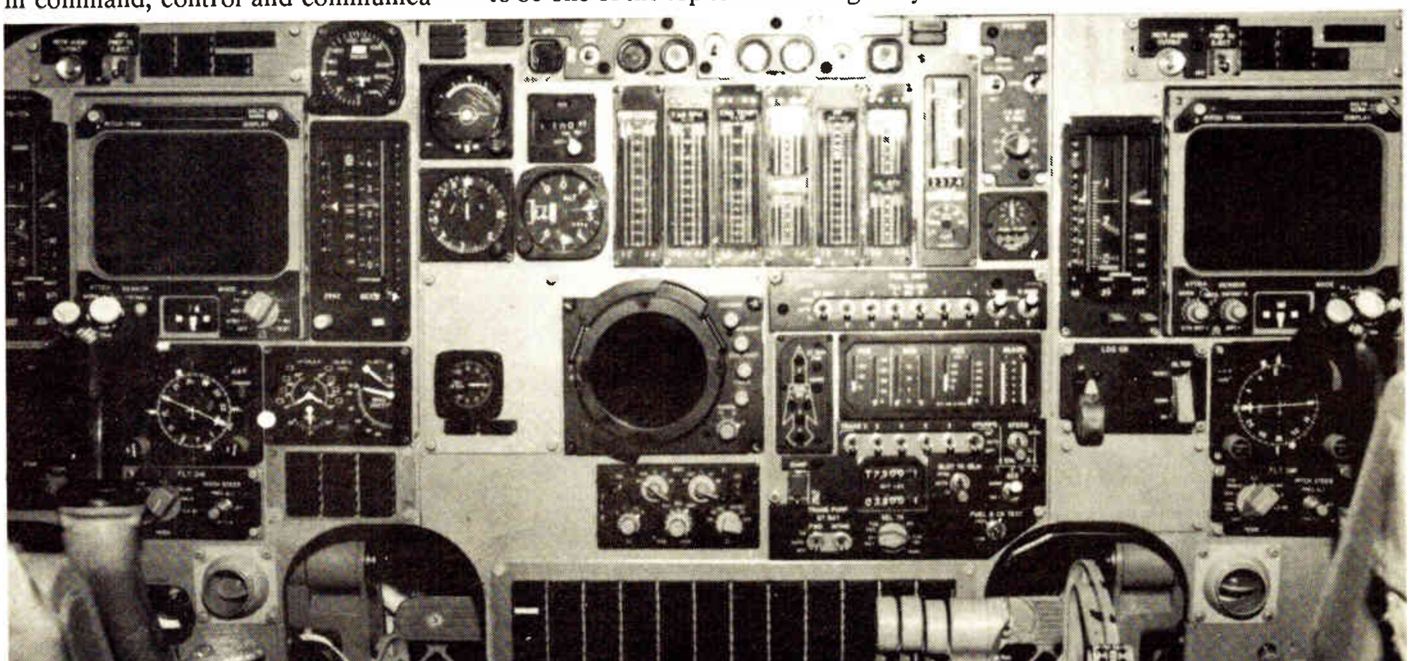
The expert systems based on artificial intelligence techniques differ from conventional computer systems. The expert systems are capable of inferring like humans and thus go far beyond than just presenting data in a convenient form. Since military application of artificial intelligence is mostly classified research, I would like to speculate on two specific domains of AI applications in electronic warfare only on technical grounds. The two application areas are:

> Automatics interpretation of sensor data into useful C3CM intelligence, and ultra-high precision signal-to-noise separation for possible application to the detection of stealth objects.

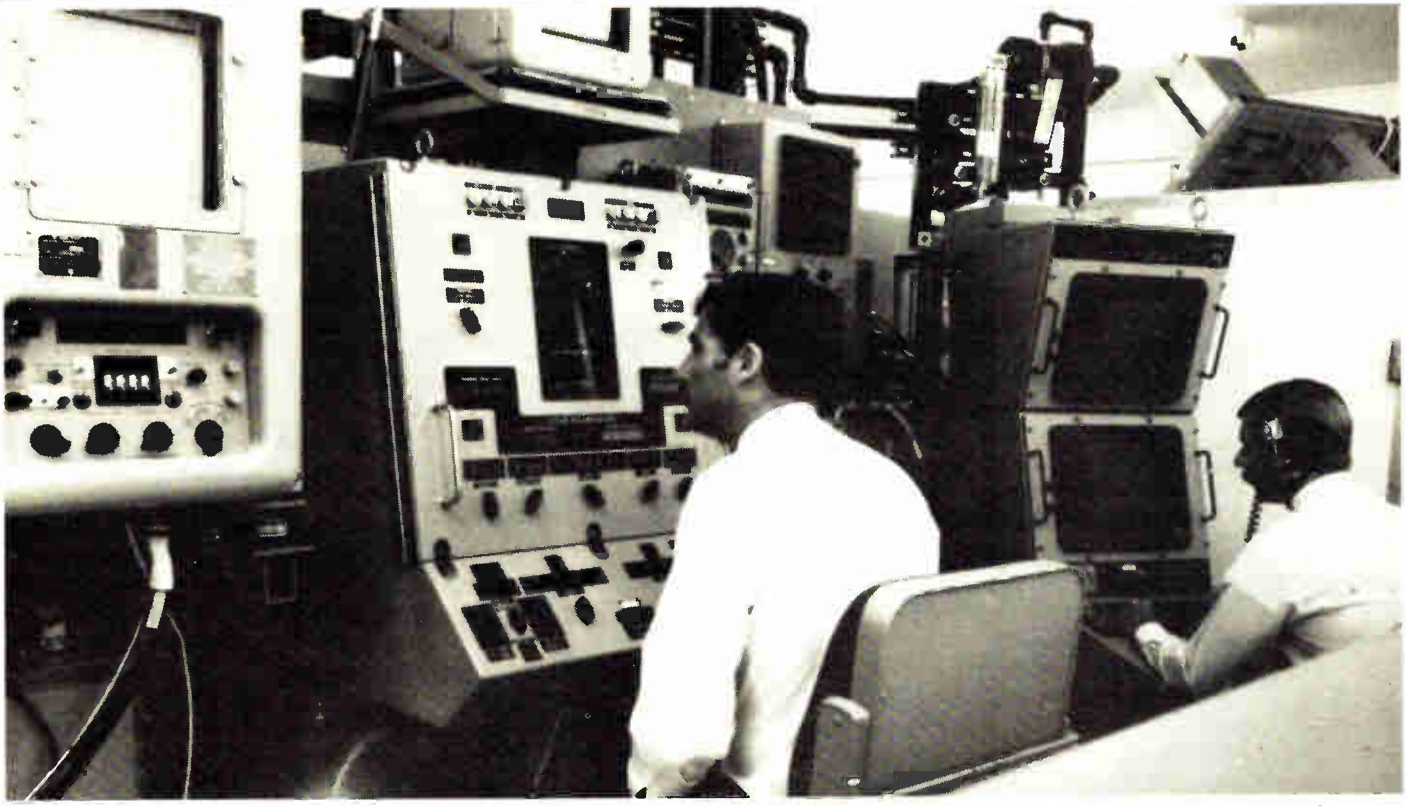
Artificial intelligence is considered to be one of the top ten technologies by the U.S. Department of Defense for the 1980's. It is an interdisciplinary science with its origin in logic, theory of knowledge, computation theories and cognitive psychology. Intelligent systems can, for example, learn from experience, prove or refute a hypothesis using facts, and other similar tasks.

AI has progressed from a laboratory science to an expanding technology only in the last few years. Rule based expert systems were the first intelligent systems introduced commercially. A large number of expert systems used in military science are of this type. An expert system is an intelligent program which has knowledge in a narrow domain along with knowledge manipulation facility, called an inference engine. There are many generic categories of expert systems with skills in such tasks as:

> -Interpretation: Infer situation description from the sensor data,
>
> -Prediction: Infer likely consequences of given situation,
>
> -Diagnosis: Infer system malfunctions from the observed data,
>
> -Planning: Designing actions for future achievement of goals,
>
> Monitoring: Comparing collected state data with the desirable values and inferring alarm states



Currently one of the world's most advanced military aircraft, the Rockwell B-1B is controlled by an enormously complex on-board computer system.



Naval training simulators such as the one above, provide crews with actual situations for using weapon systems, reducing the cost of training on actual equipment.

-Control: Interpreting, predicting, monitoring and planning system behaviors.

Several applications of AI in the Electronic Warfare field have been identified, for example:
The fusion of multi-sensor data as a decision aid to threat analysis systems.
In intelligent C3 (C31) and C3CM systems to act as an expert advisor to decision makers, reconnaissance, surveillance and intelligence data processing and assessment, Sensor resource allocation and planning, information retrieval and routing

There have been many expert systems built during the last decade for military use. Some of the known expert system one may find in AI literature are:

DART: This system gives advice to the analyst on the identification of critical enemy C3 network nodes and assists in the processing of messages related to battle situation.

ASTA: It helps identify the type of radar that generated an intercepted signal. The system analyzes radar signals in light of the general knowledge it has about the physics of radar and the specific knowledge it has about the particular types of radar systems.

ATR: detects and classifies military targets from sensor images.

HANNIBAL: performs situation assessments in the area of communications intelligence. It identifies enemy organizational units and their communication order of battle by interpreting data from sensors that monitor radio communications. These data include information about the location and signal characteristics (e.g., frequency, modulation, channel class, etc.) of the detected communication. The knowledge representation scheme in is the so-called black board architecture using multiple specialists.

Royal Navy ES: An expert system for evaluating electronic warfare tasking plans is built at the Admiralty Research Establishment, in the United Kingdom. It is a knowledge based system which provides advice on naval resource allocations.

Computational Models

The effectiveness of (military) intelligence depends on two factors. The availability of correct and complete data, and the correct and complete conceptual model of interpretation to convert this data into an effective intelligence.

In practice, complete date is not available due to many reasons. For example, in tactical and rapid deployment situations there is not enough time to obtain a complete situation picture. Since there are a large number of choices possible for data interpretation, the conceptual model is not necessarily optimal and in some cases does not represent the situation correctly.

The data interpretation is a human expertise at present. To copy with incomplete and sometime misleading data, human experts rely on indirect and unrelated information and the knowledge about the "world" to deduce relevant intelligence (in the second sense as defined above) through a series of cause-to- effect relationships. During this process it is possible to discard faulty and inconsistent data. The state transformation may not be strictly a logical rule, such as resolution principle in PROLOG (a subset of predicate logic), but it could be a "common sense" argument or other inference rule (e.g., property inheritance).

To achieve a reasonably good interpretation of data into intelligence, a complete model of the world is required. This model must include such factors as; human intentionality, planning methods, organizational principles, short and long term goals, and the information on hardware physics.

The goal oriented interpretation of the data, from sensors and other resources, is different from the usual semantics. The usual semantics do not depend on goals but the over all model of the world. To develop an expert system which can automatically convert data into intelligence, a computational model of C3 countermeasure intelligence is to be investigated. One must remember that goal definition is essential in defining military intelligence of any kind in this model. A collection of data may be useless in some context but which can be of vital importance in another context with different goals.

In a simple situation, even under severe stress, an expert may be able to reach a correct decision regarding intelligence, but in a complex situation it is easy to confuse and discard valid data while interpreting irrelevant ones. There is another problem with humans. Each expert's model of the world is dependent on his/her own experience and the understanding of the situation. This problem can also be reduced by agreeing upon some well tested models. Thus a machine interpretation of data into intelligence will not be dependent on many human factors.

Putting It All In Use

A similar computational model (with casual relationships) can possibly be useful in the detection of low visibility radar (stealth) objects. When the radar echo is weak and difficult to detect, other information should be used to deduce the presence of a stealth object.

For example, infrared emission and other radio transmission, not related directly, can be fed into an expert systems real time knowledge base. The expert system then deduces the existence of an object which is not observable directly through radar. When signal intensity is very close to the noise level and both having the same characteristics, then the one possible way to detect it is to deduce the presence of the signal through inference. Usually statistical methods are not good to filter a signal out of such a noise level. This situation occurs when the signal resolution is such that the noise can either suppress or enhance a signal leading to a false conclusion.

Although, one may set signal threshold in a standard statistical way, a chain of casual inferences can reduce the number of false signals and false suppressions.

K. Tahir Shah is a consulting scientist in artificial intelligence and a freelance writer from Mississauga, Ontario. ■

Video Controller

A simple unit which provides a video fader and an audio mono/stereo mixer and fader.

By Robert Penfold

Home video production appears to be an increasingly popular hobby and seems likely to gain a larger following than home movies of the film variety ever managed. Methods of production are very different to the old film techniques, and there is no absolute equivalent to splicing pieces of film together to edit the individual scenes into the finished product. The accepted technique with videos is to copy the scenes from tapes placed in one recorder to a single tape in a second recorder where the full video is built up.

This can actually be done without the need for any extra equipment apart from the connecting lead, albeit rather crudely. More professional results can be obtained with the aid of a video controller of some kind, and the most basic type is just a video fader. The idea is to fade down the signal at the end of one scene, and them fade it up again at the beginning of the next scene. This gives what is generally a better effect than an abrupt cut from one scene to the next, and it is a technique that is much used by professional program makers.

For best results an audio fader should also be fitted to suit the unit, so that the sound signal can be faded in unison with the video signal of desired. The normal approach is to have separate video and audio fader controls so that the two signals can be controlled in precisely the required manner, but to use slider controls mounted side-by-side so that they ar easily operated together when necessary. For greater versatility an audio mixer should be included, so that background music or a commentary are easily added to the original sound track.

The System

This video controller uses the arrangement shown in the block diagram of **Fig. 1**. The top set of three blocks form the video fader, which is separate from the audio section of the unit apart from a common on/off switch and battery supply. Although an audio signal can be faded up and down using nothing more than a simple potentiometer connected to act as a variable attenuator, things are far less straightforward with a video signal. This is due to the fact that a video signal is really a mixture of two signals. The main one is the positive modulation signal which varies the brightness of the spot which is scanned across the screen to produce the image. This is the signal which must be attenuated in order to fade down the picture. The other part of the signal is the negative-going synchronization pulses. There are two

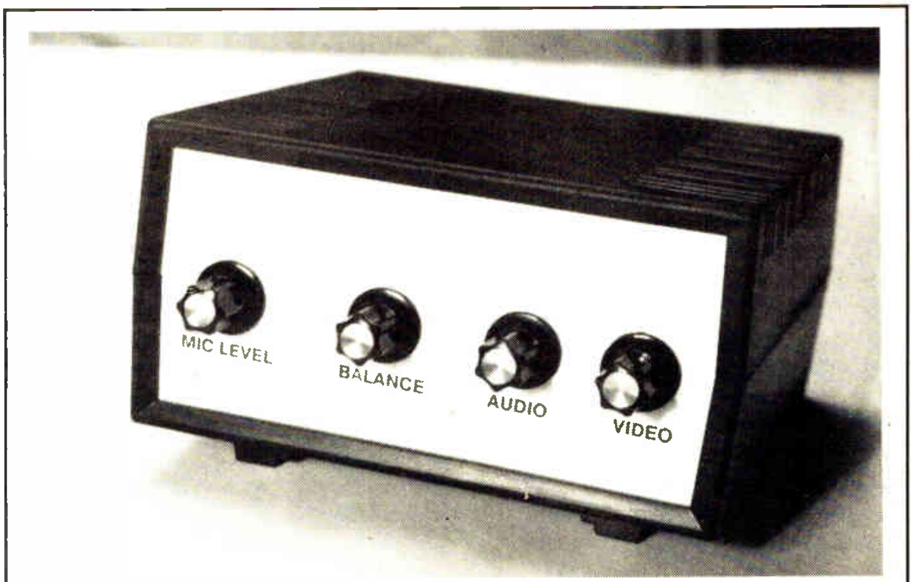


Fig. 1. The block diagram of the Video Controller.

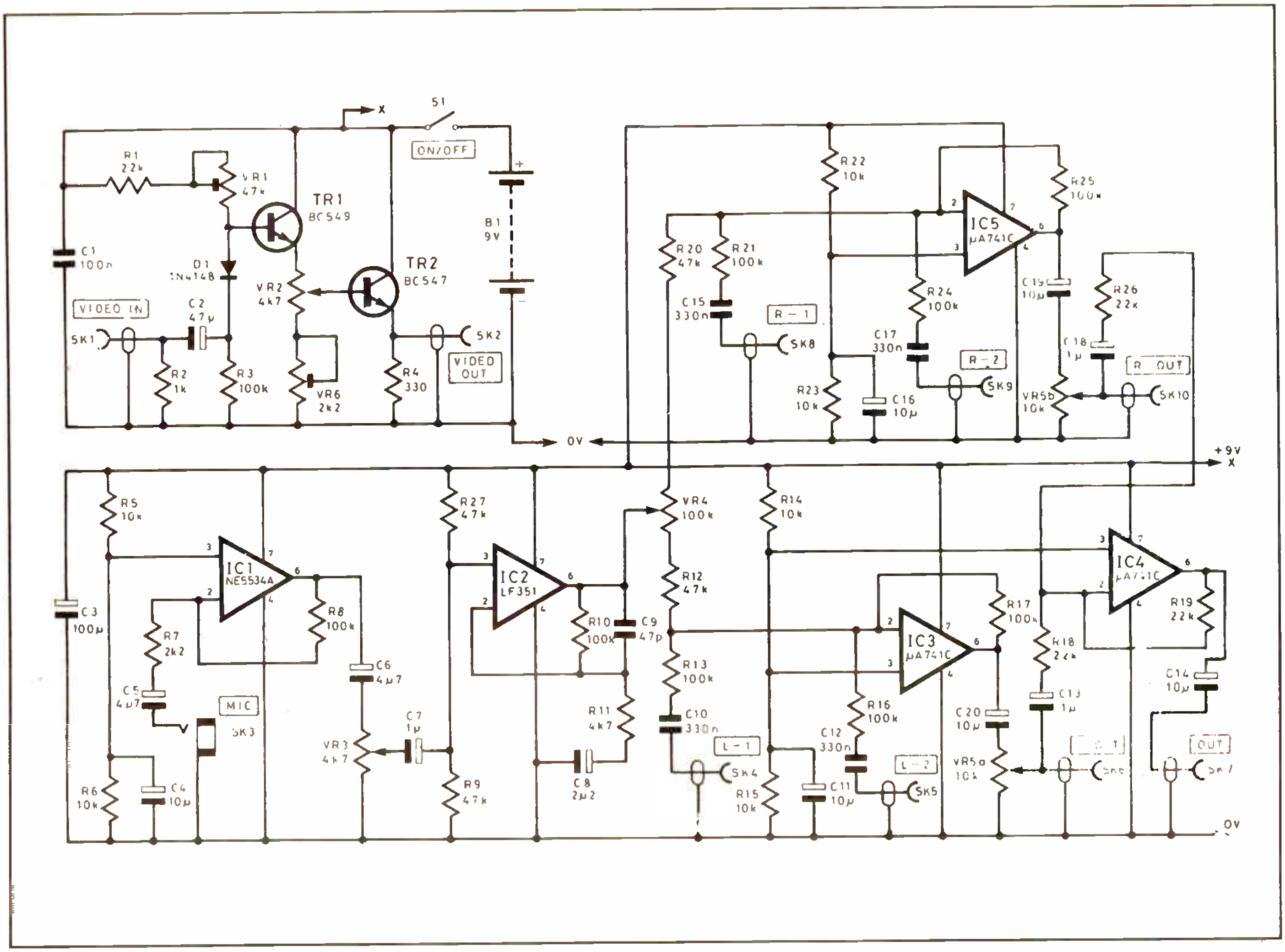


Fig. 2. The circuit schematic. See the text for substitutions for parts that may be difficult to locate.

types of synchronization pulses, the frame pulses at a frequency of 60 Hz, and the line synchronization pulses which are shorter and at a much higher frequency of about 15kHz. This second frequency may seem to be too low at first sight. However, it should be remembered that although there are 60 frames per second, a system of interlacing is used, and two frames are needed to product one complete picture. In the present context the important point is that a simple attenuator will not just fade down the modulation signal, but will also affect the synchronization pulses. It will give the desired fading effect, but there is a strong likelihood of proper synchronization being lost before the picture is fully faded down. At best this would give a grossly distorted picture, and at worst synchronization would be lost completely with the picture breaking up as a result. There are quite complex fader circuits which split the signal into its modulation and synchronization pulse elements, process the modulation signal, and then recombine the signals. It is not essential to do things in this way though, and it is possible to devise a circuit that will fade out the main picture signal while leaving a perfectly adequate modulation signal.

In this case the general scheme of things is to use some preprocessing ahead of a variable attenuator to ensure that the faded signal retains a sufficiently strong synchronization signal.

A buffer amplifier at the output of the video section ensures that the unit has a low enough output impedance to drive a composite video input properly. Note that the unit will only work with a composite video signal, and it can not be used with a UHF or VHF signal.

Audio Section

The audio section includes a two-stage microphone preamplifier which incorporates a microphone level control. There are three mixer stages, which can make the unit look a bit confusing at first, but the extra mixer is needed because the unit is designed to give both mono and stereo outputs. The microphone signal is fed to both inputs of the stereo mixer, and a channel balance control is included here. There are two high level inputs for each channel of the stereo mixer circuit, but there are no level controls for either of these. It has been assumed that the output controls of the tape decks (or whatever equipment feeds these inputs) will be used to get the signal levels right. Of course there would be no difficulty in adding volume control style variable attenuators at each input if desired.

Parts List

See text for parts substitutions.

Resistors
(.25 OR .5 watt, 5%)

R1	22k
R2	1k
R3	100k
R4	330
R5,6,14 15,22,23	10k
R7	2k2
R8,10,13,16,17 21,24,25	47k
R11	4k7
R18,19,26	22k

Potentiometers

VR1	47k trim
VR2	4k7 linear
VR3	4k7 audio
VR4	100k linear
VR5	10k dual audio
VR6	2k2 trim

Capacitors

C1	100n
C2	47u 16V
C3	100u 10V
C4,11,14 16,19,20	10u 25V
C5,6	4u7 63V
C7,C13,C18	1u 63V
C8	2u2 63V
C9	47p
C10,12,15,17	330n

Semiconductors

TR1,2	BC549 or 2N3904
IC1	NE5534A (see text)
IC2	LF351 (see text)
IC3,4,5	741
D1	1N4148 or 1N914

Miscellaneous

SK1,2 4,5,6,7	phono socket
SK3	3.5mm jack, or to suit mic.
S1	SPST switch
B1	9V batt. (see text)

Case such as Radio Shack 270-250 (used in cover photo), knobs, battery connector, shielded wire, hookup wire, 4-40 nuts and bolts.

A dual gang potentiometer can be used to control the output level from both channels of the mixer. It is the outputs from this main fader control that constitute the stereo output signal. The third mixer stage is simply used to combine the stereo output signals to provide a mono output. If the mono output is used, then obviously the microphone balance control is superfluous, and will have little effect.

Video Circuit

The circuit diagram for the video stages of the unit appears in **Fig. 2.** There is nothing much to the preprocessing circuit which is basically just a diode and potential divider circuit which ensures that suitable voltages are fed to the video fader potentiometer VR2. Transistor TR1 acts as a buffer amplifier which provides a low enough output impedance to drive the fader circuit properly. VR1 and VR6 are adjusted to give a good control characteristic from VR2. This avoids having the fade- down introduced over a short length of track towards the middle of VR2's adjustment range.

By having the fade-down introduced over virtually all VR2's adjustment range it is much easier to precisely control things and to have a very slow fadeout is desired. It also gives a better match with the audio fade-down control. The effect on the picture as the signal is faded out is much the same as turning down the brightness control of a television contrast as the signal is attenuated.

Audio Circuit

The audio stages are somewhat more complete, as can be seen from the preamplifier and mixer circuit diagram which appears in Fig. 2. IC1 acts as the preamplifier stage, and this is a special low noise operational amplifier which operates here in the inverting mode. It has a voltage gain of about 45 times and gives an input impedance of 2K2. The circuit will work using a less expensive device in the IC1 position, including the standard uA741C type. The NE5534A is much to be preferred though, as the output from a microphone is at a very low level, and noise from the preamplifier can be excessive when using a device which offers anything less than excellent noise performance. The noise level is actually about 20dB lower (one-tenth in terms of voltage) using the NE5534A instead of an ordinary uA741C or a similar device.

The input characteristics of the microphone input are suitable for most types of microphone. Low or medium impedance dynamic types will work well with the unit, as will any types that have similar output properties. With some low impedance types it may be better to reduce R7 to 1k so as to give slightly increased gain. The unit will work with high impedance dynamic microphones and similar types, but better results are likely with these if R7 is raised to about 22k in value. This reduces gain and boosts the input impedance.

Crystal microphones are unsuitable for use with this project.

Potentiometer VR3 is the microphone gain control, and this is followed by the second stage of the microphone preamplifier. This is a non-inverting circuit based in IC2, and it provides a voltage gain of approximately 22 times. Its output feeds straight into the channel balance control, VR4.

The stereo mixer uses IC3 and IC5 as conventional summing mode mixers, one in each stereo channel. These have unit voltage gain and provide an input impedance of about 100k at each input. VR4 forms part of one input resistance for each channel, and it gives approximately unity voltage gain from the output if IC2 to the output of each mixer, but only when it is at a central setting. By adjusting VR4 so that the wiper is right at one end of its track or the other, the two input resistances become unequal. One becomes just the 47k of the fixed input resistor, while the other become this 47k plus the full 100k of VR4's track (totalling 147k).

The gain of each mixer circuit is equal to 100k divided by the input resistance. Therefore at the extremes of its settings VR4 boosts the microphone signal in one channel by about 6dB, and reduces it by a few dB in the other channel. This does not permit the microphone signal to be panned from full-left to full- right. In terms of position in the sound stage, as little as 6dB difference between the two channels is adequate to place a signal well over to one side or the other. VR4 can therefore be used to pan the microphone signal over to one

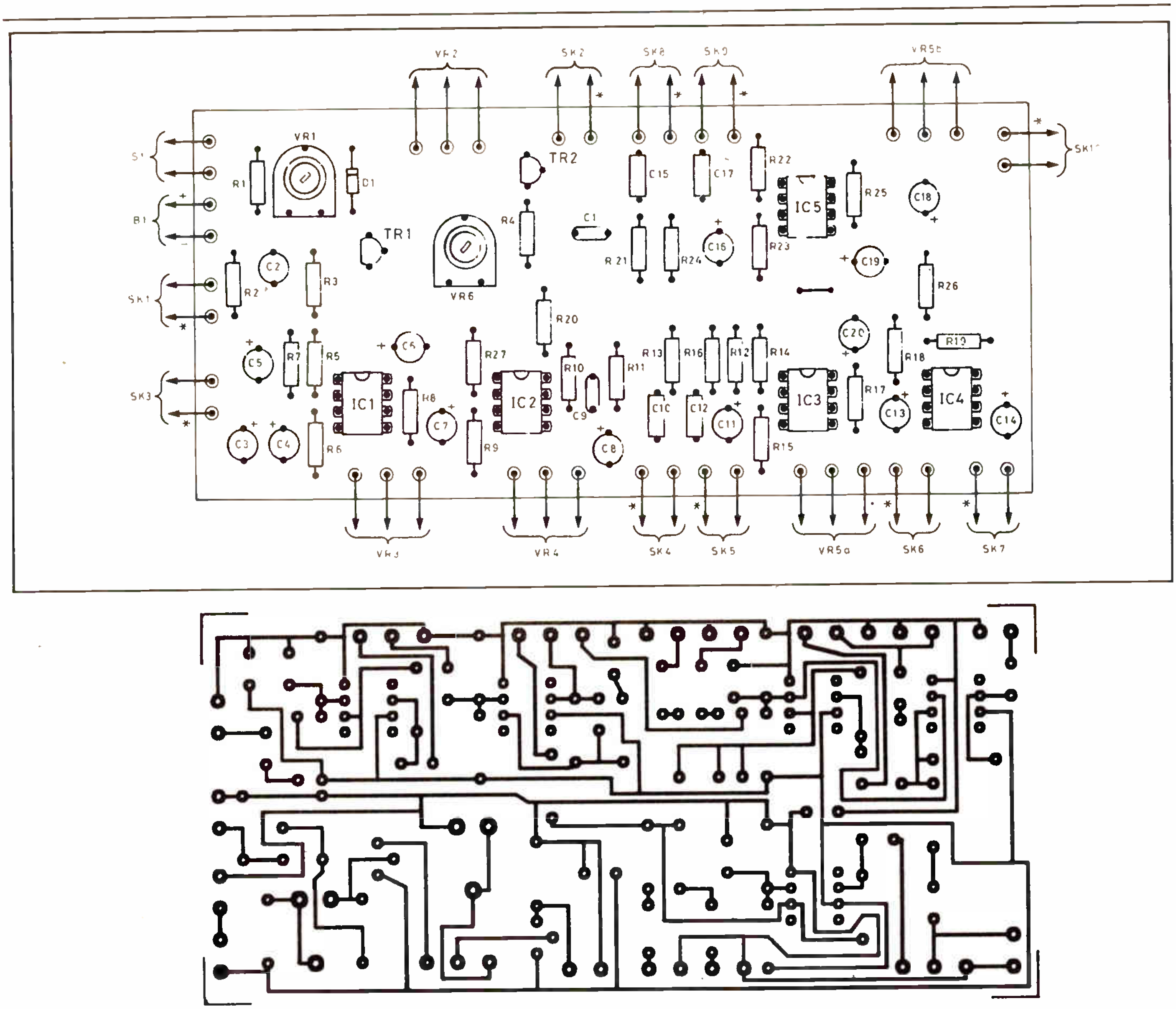


Fig. 3. The component location and printed circuit board. The asterisks on the location diagram mark the ground connections.

side of the sound stage if desired, instead of using it to balance the signal for a central image. The main audio fader control of VR5 and the stereo outputs are fed directly from its wiper terminals. The two signals are combined into the mono output by IC4 which acts as another summing mode mixer circuit.

Power is provided by a nine volt battery, and as the current consumption is quite high at around 17 milliamps an alkaline 9V battery is a good idea.

Parts Substitution

As mentioned above, the 5534 op amp can be replaced with a 741 general-purpose type at the expense of noise (though video sound is less than hifi anyway). This also applies to the 351, IC2.

Presets VR1 and VR6 should be fairly close to the stated value; a 5k linear taper (Radio Shack, etc.) is ideal for VR2. VR3 can be any value from 5k to 50k, preferably with an audio taper, though a linear tap will work (though the volume jumps up suddenly from zero). VR4 is an easily obtainable 100k.

The 10k dual audio taper is an ideal value, but it's rather hard to find one; many component stores don't have a good stock of duals. Complicating this is the fact that the pot's sliders are used as outputs (L-Out and R-Out on the schematic). If you use an easily obtainable pot, such as Radio Shack's 100k dual, the output resistance will be ten times higher than we'd like. This higher impedance might be susceptible to noise, but it's a possibility if you want to try it. Another way is to use Radio Shack's 1k dual linear balance control as a volume pot. It works, but the control range will be somewhat compressed compared to an audio taper.

Construction

Details of the printed circuit board are provided in Fig.3. None of the integrated circuits are MOS types, but I

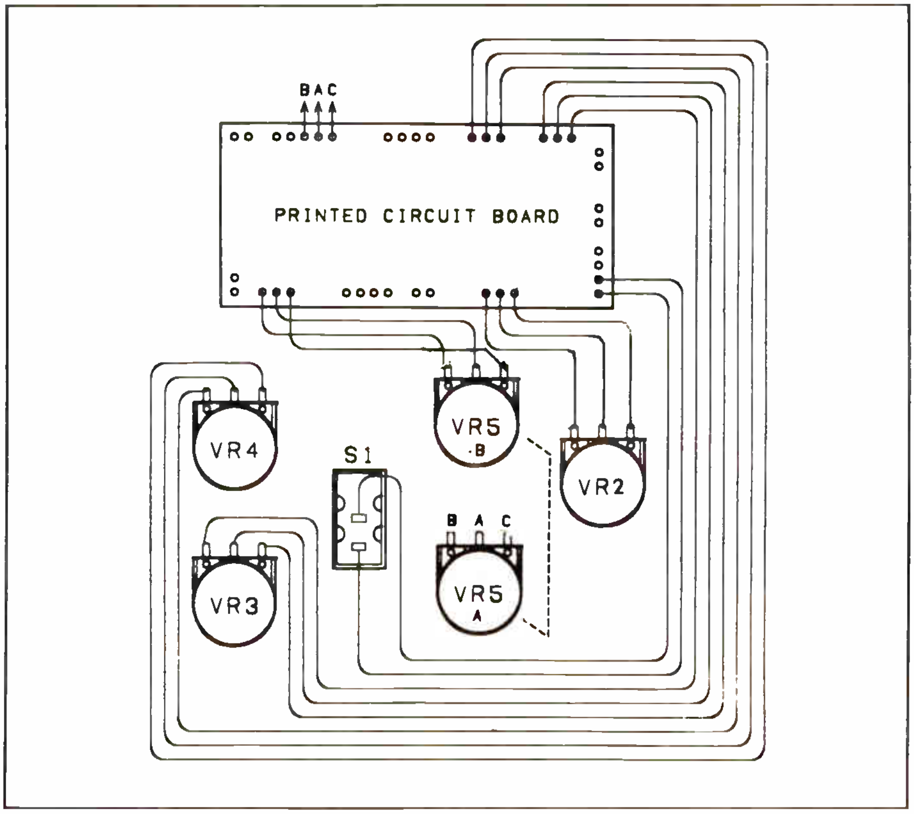


Fig. 4. The interwiring of the controls. Note that the dual pot VR5 is shown as separate sections for clarity.

would still strongly advocate the use of a holder for IC1 at least. The NE5534A is rather more expensive than the average operational amplifier. The capacitors must all be miniature printed circuit mounting types if they are to fit onto the board neatly and without difficulty.

Be careful not to omit the single link wire which is situated about half way between IC3 and IC5. A piece of wire trimmed from a resistor lead can be used for this link. Be careful to fit the integrated circuits and the polarized components the right way around. At points where connections to off-board components will be made only single-sided pins are fitted to the board at this stage.

From the electrical point of view the exact layout used is not too important, and it is really a matter of arranging the components in a manner that makes the unit easy to use. Phono sockets were used for all the input and output sockets, apart from SK3 (the microphone socket) which is a 3.5 millimetre jack type. If necessary though, these can be changed to any types which fit in with your particular audio and video equipment. You might find it better to use BNC connectors for SK1 and SK2 for example. The phono jacks can be separate units, or the type with 8 jacks mounted on a phenolic board.

The completed printed circuit board is mounted on the base panel of the case using small nuts and bolts. An extra nut on the bolt shaft can hold the board clear of the case. Make sure that it is mounted where it will not come into contact with any of the front panel mounted components when the top/front panel is fitted into place. Also be careful to leave sufficient space for the battery somewhere in the case.

Wiring

There is a substantial amount of hard wiring needed to complete the unit. It is probably best to start with the wiring to the sockets, and this is fairly straightforward. The only point to watch is that each ground terminal on the board connects to the appropriate tag on its corresponding socket. The cable which connects the board to SK3 must be a shielded type (with the outer braiding carrying the ground connection) as the microphone input is very sensitive to stray pick up. It is advisable to use shielded lead for the connections from SK1 and SK2 to the board. This is to prevent radiation of the video signal and stray pick up in the microphone preamplifier wiring. It is also advisable to keep the wiring to VR2 as far away from the microphone preamplifier components as possible. It is not essential to use shielded cable for the connections to the other sockets, but it is probably best to play safe and do so for any leads that are more than about 25 millimetres long.

The wiring to the controls is shown in **Fig. 4**. I would recommend the use of twin shielded cable for the leads which connect to VR3, VR4 and VR5. In the case of VR4 there is no track connection to the negative supply rail that can be connected to the outer braiding in order to provide screening. Connecting the braiding to the wiper (middle) terminal of VR4 will give effective screening of the other two leads though, and these are the ones that are sensitive to stray pick up.

Adjustment and Use

Exactly how the unit is wired into your system will obviously depend on precisely what equipment is in use. All the connecting leads should be of the appropriate shielded variety. There should be no difficulty in testing the audio mixer section of the unit, and this does not require any setting up or adjustment before it is ready to use.

There are two trim pots (presets) to be set up in the video fader section and initially VR1 should be adjusted to a roughly mid- point setting. VR6 should be set at maximum value (turned fully clockwise). The unit may well work perfectly satisfactorily with the presets at these initial settings, but it might be found that there is still some picture evident when VR2 is fully backed off. VR6 should then be adjusted in an counterclockwise direction just far enough to fully blank the screen of the monitor. VR1 is given any setting that provides a good fade-up characteristic. A little experimentation is called for here, and with some systems virtually any setting of VR1 will give good results. ■

AR-140 DMM Kit

An affordable, five-function, digital multimeter that you can assemble from a kit.

By Edward Zapletal

If you've always wanted to build your very own DMM but have hesitated because you thought the parts were hard to get – hesitate no more. The AR-140K from American Reliance contains all the bits necessary for building an excellent quality DMM, right down to the LCD display, PCB and case. If the kit form isn't for you, though, you could buy the AR-140 in its assembled state as well.

Why Build Your Own?

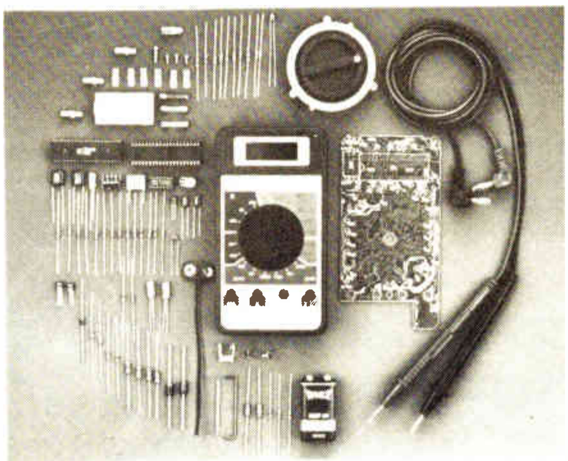
Regardless of whether you're an electronics expert or a novice, the bottom line is the same: building kits is just downright fun. Both enjoy the satisfaction of building a professional-looking piece of test equipment, but the novice gets an added bonus: hands-on experience in electronic fundamentals. What better way to learn about voltage, resistance, and current?

What You Get

The AR-140K, in its completed form, is capable of performing measurements in DCV, ACV, DCA, Resistance, as well as doing diode checks. You can expect 1000 hours of use from the standard 9V battery, and there is overload protection on all ranges except the 10A DC range. The 3 1/2 digit, 0.4-inch LCD display is equipped with "LOBAT", "–", and decimal annunciators. Probes are also supplied.

To aid in the construction of the meter, a comprehensive manual is supplied which contains the circuit diagram on a large fold-out sheet for easy reference. In addition to this, there is yet another fold-out sheet displaying resistor and capacitor ID charts, legends to the LCD display connections, ICs, diode, and transistors.

The assembly portion of the manual is divided into seven parts, with the components for each portion packaged in a marked, separate envelope for easy identification. A complete parts list is also included and this should be checked against all components before construction is started. Other sections include: theory of operation, general trouble-shooting, and tools required. Apart from your soldering iron, all you'll require is a pair of diagonal cutters, long-nose pliers, and a screw driver.



The printed circuit board is a double-sided affair with component locations clearly marked. The case is a standard AR-140 DMM case with the necessary openings for the rotary switch, probes etc.

Meter Specs

Five DC voltage ranges are available on the AR-140K with accuracies of ±0.5% at 200mV, ±1% at 2, 20, 200, and 1000V. Overload protection is listed as being 700VDC and 500VAC at 200mV level, with 1000VDC and 750VAC on all other ranges. Input impedance on all ranges is 10M.

AC voltage can be measured in two ranges, 200v and 750V, in frequencies ranging from 40Hz to 500Hz. Accuracy is ±1.2% on the lower range, and ±1.5% on the higher. Overload protection is 1000VDC and 750VAC rms, with an input impedance of 9M on all ranges. AC voltage is measure as the average value of the input AC signal and the result is the equivalent rms value for a sine wave.

Six resistance ranges are possible from 200 ohms to 20M. Accuracy here is ±1% in the five lower ranges and ±1.2% on the 20M range. Overload protection in the resistance mode is given as being 300VDC and 250VAC rms on all ranges.

Last, but not least, the six DC current measuring functions of the meter go from 200uA up to 10A. Accuracy, here, is ±1% with a voltage drop at full scale of 250mV in the lower five ranges and 350mV on the 10A range. Overload protection is provided only on the lower five ranges by way of a 2A fuse. There is no overload protection on the 10A range.

Bottom Line

The price of the AR-140K is a reasonable $70. However, you will find that the assembled version costs about $5 less. The reason: packaging and handling costs for the loose components. Yes, it used to be that you could save a little if you assembled it yourself, but, the high-tech robotic assembly methods in use today have pretty well put end to this. For die- hards though, this small price discrepancy will be insignificant in comparison to the satisfaction that they'll get from building their own meter.

The AR-140K DMM is available from BCS Electronics, 980 Alness St., Unit 7, Downsview, Ontario M3J 2S2. (416) 661-5585. ■

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American Reliance DMM

The AR-360D from American Reliance is a 3 1/2 digit DMM which measures Dissipation Factor in addition to direct readout of capacitance. This greatly enhances teh reliability of capacitor measurements because DF directly relates to a capacitor's leakage current.

Capacitors can be measured from 0.1pF up to 20,000uF, and their leakage can also be determined for greater validity. The unit includes: leather carrying case; spare fuse; test leads; and operator's manual. The 360D comes with a full one year parts and labour warranty.

For more information contact: BCS Electronics, Units 6- 7, 980 Alness Street, Downsview, Ontario M3J 2S2. (416) 661-5585.

Circle No. 63 on Reader Service Card

Quantec Programmer

As a plug-on mate for the Q-2000 Universal Programmer, the Q-2003 will allow fast and reliable programming of Bipolar PROMs.

The unit operates on either stand-alone or remote modes for easy interface to a PC or development system. No personality modules are required as device selection is software selectable on the instrument itself, or when running with a PC and Quantec's Q-2000 PC interface program. Files can be uploaded or downloaded from the Q-2000/2003 in a number of various formats including Intel Hex, Motorola Exorcisor, etc.

For more information on this and other Quantec products contact: Interfax Systems; Toronto (416) 671-3920; Montreal (514) 336-0392; Ottawa (613) 726-8888 and Vancouver (604) 430-1410. Or, Quantec Systems Inc., 500 Alden Rd., Unit 8, Markham, Ontario L3R 5H5. (416) 477-6950.

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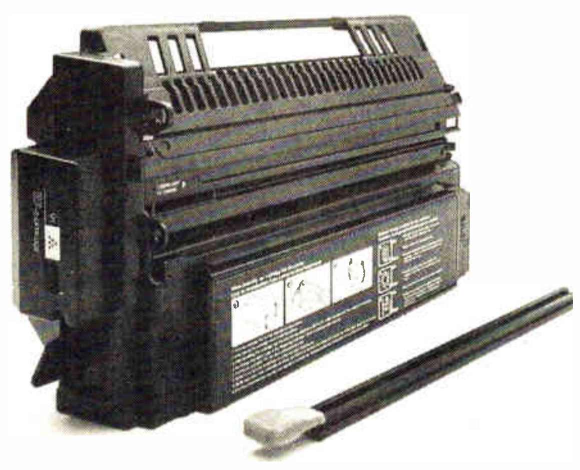

Recharged Laser Printer Carts

Canadian Laser Products Inc., offers a complete recharging service to those who use Canon EP, PC 70 and 80 series micrographic equipment and Canon Personal Copiers.

The process involves completely dismantling, cleaning and replacing the parts that are subject to wear (without drilling holes). Recharged carts provide print quality, as well as quantity of pages, equivalent to new cartridges. Recharged cartridges are available.

Canadian Laser Products Inc., 400 Matheson Blvd., Unit 28, Mississauga, Ontario L4Z 1N8.

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Hygrothermometer

A new portable digital hygrothermometer from AOIP provides instantaneous measurements of relative humidity and temperature in the air.

The unit is ideal for environment checks needed in industries sensitive to humidity and temperature such as engineering, computer rooms, maunfacturing facilities, and calibraton labs etc.

The hygrothermometer is capable of measuring temperature between -20 to +60°C accurate to ±0.6°C, and humidity from 3 to 100% ±3%. Resolution is 0.1% on both humidity and temperature readings.

For more information contact: Morriss Gordon, Omnitronix Ltd., 2410 Dunwin Dr., Unit 4, Mississauga, Ontario L5L 1J9. (416) 828-6221.

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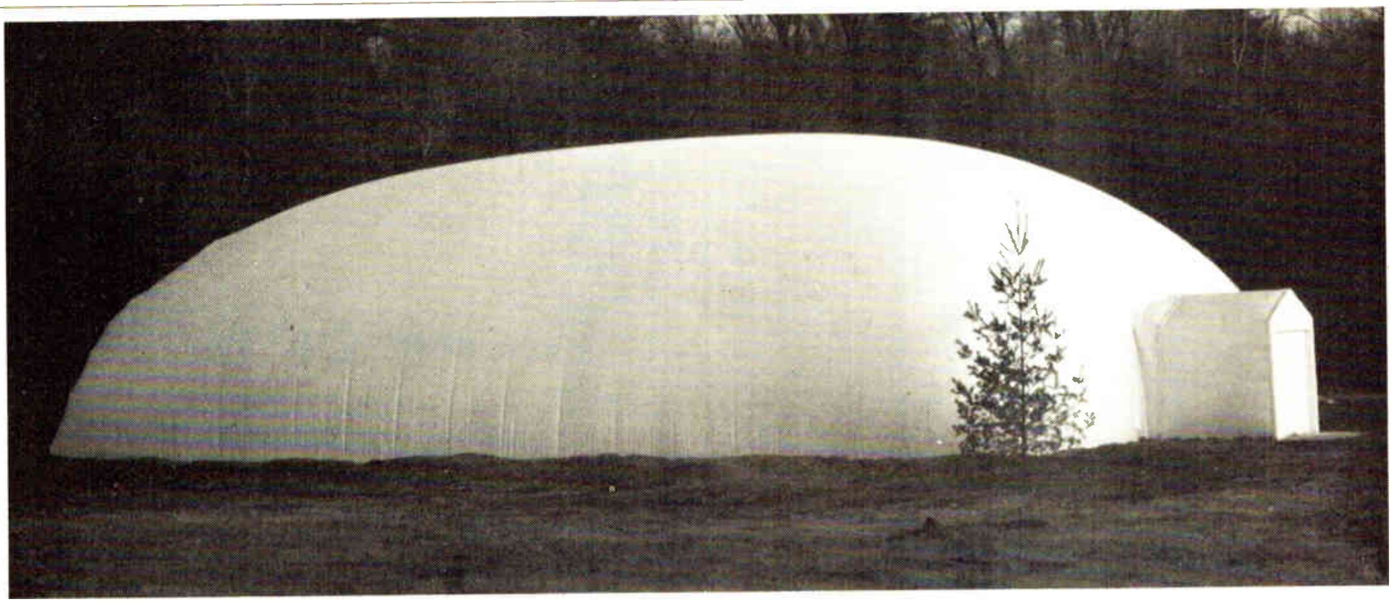

New EMI Test Facility

The Standards Approval Group Inc., of Mississauga Ontario, has recently begun operations at its new EMI test site in the Caledon Hills, north of Toronto.

The area has very low radio interference levels because of its rocky environment, which screens out most radio broadcasts and other outside electromagnetic interference (EMI). The low level allows technicians working on sensitive testing analyzers to interpret signals from antennae monitoring computer equipment, with greater accuracy.

Established in 1986, the Standards Approval Group has had a corporate mandate to assist manufacturers of electrical and electronic products acquire necessary government approvals, to market their products. The company has years of experience in testing and modifying all types of electronic data processing and telecommunications equipment. In addition, the company also offers a "one-stop shop" certification service to its customers, with fast product turnaround and cost-effective product analysis.

For more information on the services provided by the Standards Approval Group contact Duane Sharp or Michael Ivezic at: 120 Matheson Blvd. E., Suite 104, Mississauga, Ontario L4Z 1N5. (416) 890-2801.

Circle No. 60 on Reader Service Card

New Semiconductor Replacement Guide

A newly updated and expanded ECG Semiconductors Master Replacement Guide is available from Philips ECG.

The new guide lists almost 4000 ECG solid-state devices used as replacements for domestic and foreign types in entertainment, commercial, and industrial equipment, as well as 230 new types added since the last update.

Included are such devices as: transistors; high voltage rectifiers and triplers; small signal switching, zener and microwave diodes; rectifiers from 1 to 2200A; SCRs and TRIACs; thyristors; the list goes on.

For your copy of the ECG catalog or more information on ECG semiconductor products contact: J. Lovat, ECG Can., 1928 St. Regis Blvd., Dorval Que.bec H9P 1H6 (514) 685-5800 or 685-5804 (FAX).

Circle No. 61 on Reader Service Card

Brother Laser Printer

The Brother HL-8 Laser Printer features the lates laser engine and a standard 1MB buffer memory. The buffer memory expands to 3MB, more memory than is generally available in laser printers. Print speed is eight pages per minute and there is a changeable graphics resolution capability from 75 to 300 DPI.

The HL-8 is capable of emulating the Diablo 630, Twinriter, IBM Proprinter XL, Epson FX 80, and HP LaserJet/LaserJet Plus. Five resident fonts, each available in bold, italic, and bold italic, can be selected in double or quadruple size. Additional typestyles can be selected via optional font cartridges.

For more information contact: Mrs. A. Goldman, National Advertising Mgr., Brother International Corp., 1515 Pitfield Blvd., Montreal, Quebec H4S 1G5. (514) 334-5590.

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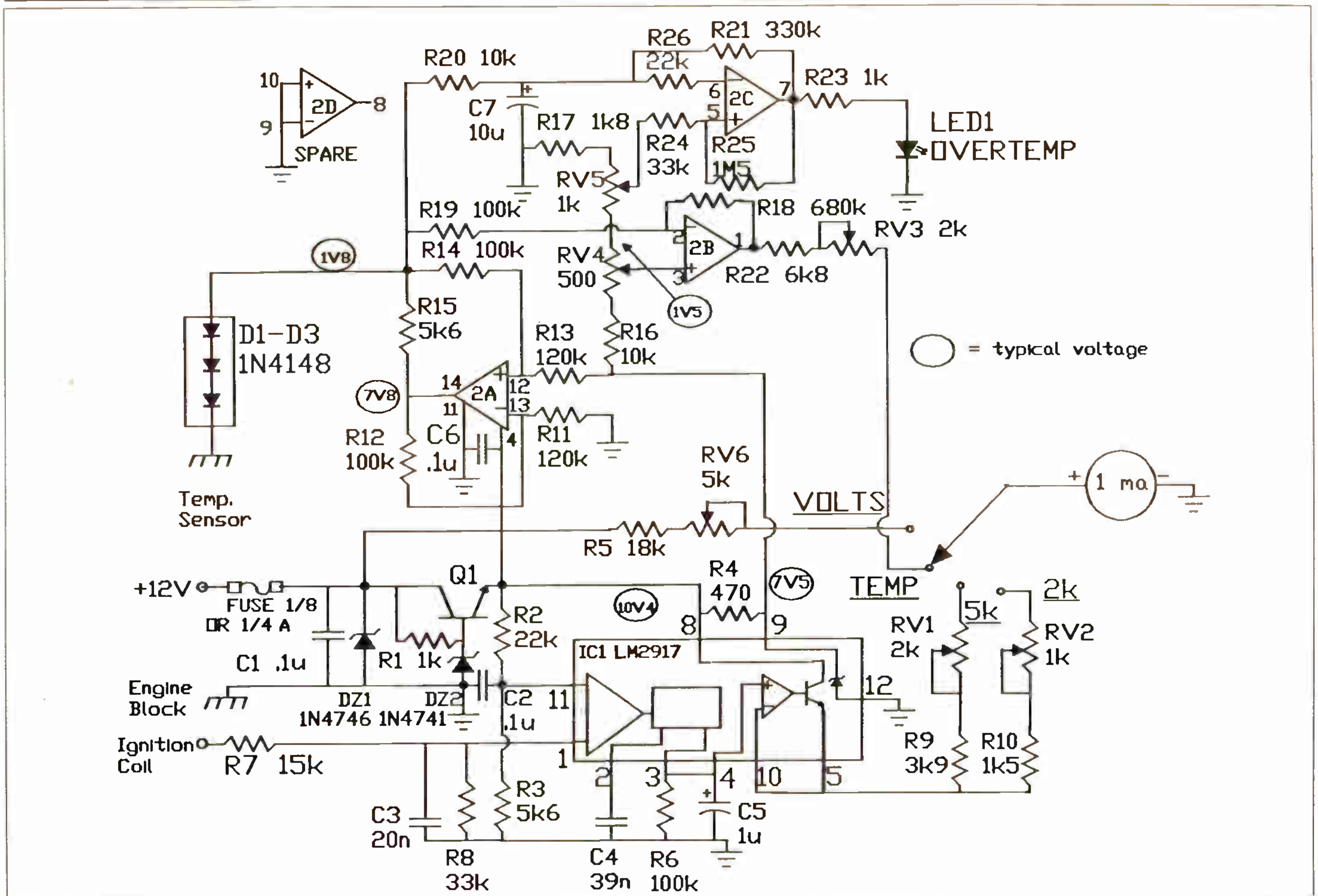

In our November issue, the schematic diagram of the Automotive Multifunction meter was less than clear because of (a) a new drafting system that deleted some of the symbols, and (b) hasty proofreading. Our apologies to the author and to readers who had difficulty with this one. The corrected schematic is shown above. Also, the various leads such as 12V, ground, sensor, etc. can be put through a multi-lead connector for convenience.

Pro Mouse

If you work with demanding applications such as desktop publishing or CAD, Sak Data Products has introduced the ODIN 1 Professional Mouse from Moniterm. The resolution is 320 dots per inch, with mechanical tracking and optical encoding for reliability. The accompanying bus board installs in a standard half slot of an IBM PC, XT, AT PS/2 or compatible, leaving the serial port free. For further information, contact Sak Data Products Ltd., 4500 Dixie Road, Unit 12B, Mississauga, Ontario L4W 1V7, (416) 624- 6763.

Debugger for Intel Micros

Applied Microsystems Corp. has introduced VALIDATE Soft-Scope, a source-level debugger for INtel's 16- and 32-bit microprocessors. Soft-Scope is designed to work with the 8086, 8088, 80186, 80188 and 80286 microprocessors, including a version which supports the virtual protect mode of the 80286. It can be used to debug code written in C, Pascal, PL/M, Fortran, and PSS's Jovial on any PC or compatible with MS-DOS 3.0 or above. Contact Allan Crawford Associates – Marketing, 5835 Coopers Ave., Mississauga, Ontario L4Z 1Y2, (416) 890-2010.

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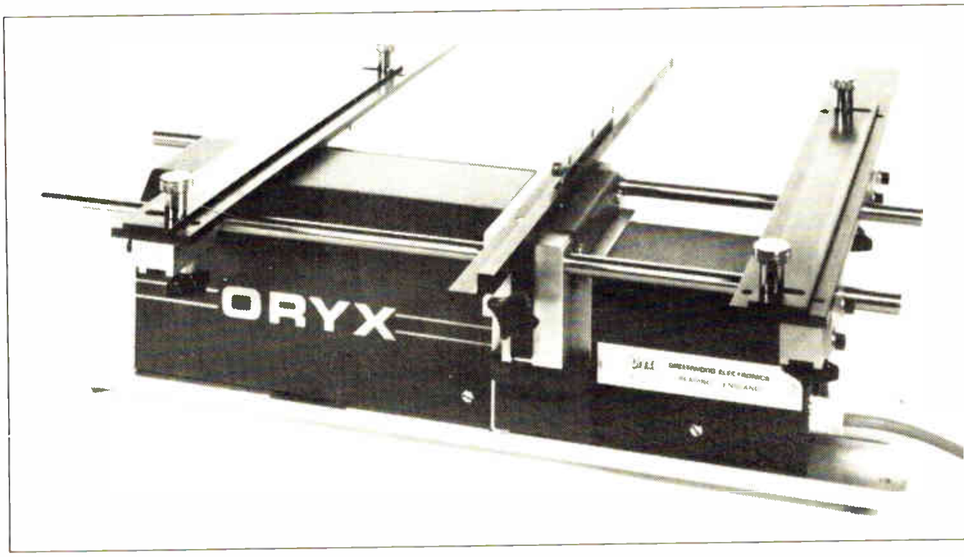


Oryx PCB Cutter

With the introduction of surface mount technology, there is an increasing need to cut assembled printed circuit boards. The Oryx PCC is designed specifically for accurate cutting of both assembled and bare PCBs.

Cutting is achieved by a guarded, high-speed diamond abrasive wheel that minimizes the shock to components. Adjustable supports enable boards up to 18" square to be cut, and assemblies with components on both sides can be cut with underside components mounted to within 0.16" of the edge.

A variety of grades and widths of cutting wheel are available and the unit will cut virtually all known PCB materials. The unit also comes with a power take-off that drives an optional dust collection system.

For more information on the Oryx PCC contact: Tom Harlan, Harlan Associates, 3612 Silverside Rd., Wilmington, Delaware 19810.

Circle No. 75 on Reader Service Card

Hands-On Primer

Simple trigger circuits from transistors

By Owen Bishop

Circuits which are triggered into action are usually done so by a relatively small change in voltage at some part of the circuit. The essential point about a circuit that is triggered (as opposed to one that is merely switched on or off) is that reversing the condition which triggered the action does not cause the action to cease.

Schmitt Trigger Circuit

One of the classical triggering circuits is the Schmitt Trigger.

First set up the circuit of Fig. 1 on a piece of "breadboard". In this circuit you can vary the voltage at the base of TR1 from 0V to 6V by simply adjusting VR1.

Start with the wiper of VR1 nearest to the 0V end (fully anticlockwise). Now turn the knob slowly clockwise and watch what happens to the lamp LP1.

At first it is not lit, because the base voltage is too low and the base current is too small. As VR1 is turned the lamp starts to come on and brightens gradually. After a little more turning it is fully lit and further turning does not make it any brighter. The transistor is said to be *saturated.*

If you reverse the direction of turning just as the lamp begins to come on, it immediately goes out again. The change in voltage simply turns the lamp on or off, acting in a similar way to an ordinary switch.

Now set up the circuit of Fig. 3 in which there is an extra transistor between VR1 and TR1. This is one form of the type of circuit generally referred to as a Schmitt Trigger. Start with VR1 fully anticlockwise, as before. In this position the lamp is on. Since TR2 is off, its collector voltage is high and current flows through resistor R3 to the base of TR1, turning it on. This switches the lamp LP1 on, too.

Turn the potentiometer VR1 slowly, as before. At a certain point the lamp LP1 goes out suddenly, even though it was previously glowing at full brightness.

This circuit has a much more definite "on-off" switching action than the one in Fig. 1. This is the first distinguishing feature of the Schmitt Trigger.

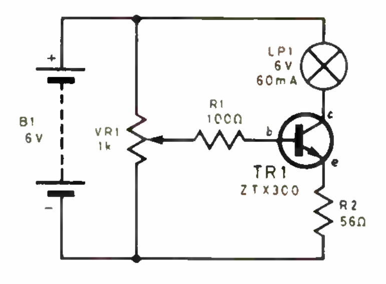


Fig. 1 Circuit demonstrating simple switching action of a single transistor.

As soon as the lamp goes out, stop turning VR1. Now slowly turn it back again. The lamp does not immediately light again. You have to turn the knob an appreciable distance before the lamp lights. Once turned off, the lamp

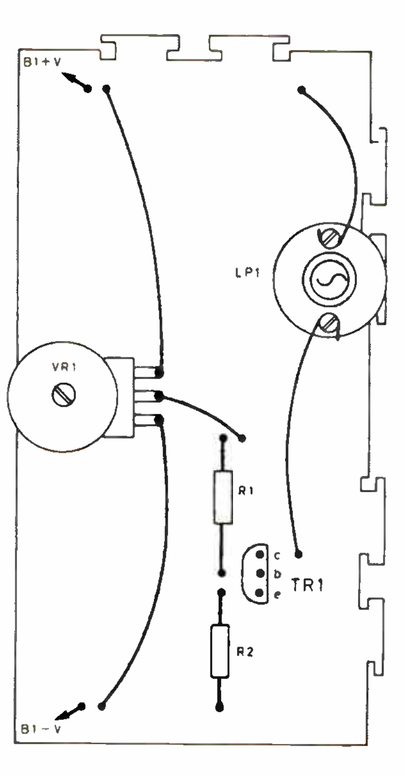


Fig. 2 Breadboard layout of circuit in Fig. 1.

stays off until the control has been reversed by a fairly large amount.

This is the second important feature of the Schmitt trigger circuit. Note also that, when the lamp comes on again, it is at full brightness.

How It Works

A better understanding of the circuit action of Fig. 3 can be obtained by studying Fig. 5 and Fig. 6.

With transistor TR1 fully on and the lamp LP1 shining brightly, Fig. 5 a current of about 60mA flows through LP1, TR1 and R2. The potential difference across resistor R2 is V = 1R = 0.06 x 56 = 3.36V (approx. 3.4V).

Potentiometer VR1 is turned to increase the voltage at the base of TR2. TR2 does not begin to turn on until its base is 0.6V higher than its emitter (which is at 3.4V, the same as the "upper" end of resistor R2). So TR2 remains off until the voltage at VR1 exceeds 4V (3.4V + 0.6V).

As soon as TR2 begins to turn on, the voltage at its collector falls, see Fig. 6. TR1 receives less base current and begins to turn off. The current through LP1, TR1 and R2 is reduced.

Reduction of current through resistor R2 reduces the p.d. across it. The voltage at its upper end begins to fall. Consequently, without turning VR1 any further, the p.d. between the base and emitter of TR2 is greatly increased. This turns it "hard" on turning TR1 hard off, extinguishing the lamp. This type of circuit has a sharp "snap" action, giving a quick response for a small change of voltage at VR1.

As we start to turn VR1 to switch the lamp on again, there is no current through resistor R2, so its "upper" end is at 0V (Fig. 6). There is 4V p.d. between the base and emitter of TR2, so it is firmly on. Reducing the voltage slightly at VR1 has no effect.

In order to turn TR2 off, we have to turn VR1 until the voltage at its wiper is only 0.6V. As soon as this point is reached, TR2 starts turning off, the voltage at its collector rises, TR1 starts turning on, current starts to flow through LP1, TR1 and R2 and a p.d. appears across R2. The voltage at the "upper" end of R2 rises, making the p.d. between the base and emitter of TR2 much less than 0.6V. TR2 snaps off, TR1 snaps on and the lamp comes on.

It is therefore said that this circuit has a "snap" action for turning the lamp on and off. It also has a differential between the voltage required at VR1 for turning the lamp off (4V) and voltage required for turning it on (0.6V).

Light Triggered Switch

A circuit diagram for a simple Light Triggered Switch is shown in Fig. 7. A stripboard layout is shown in Fig. 8, with an additional transistor to drive an audible warning device (see Fig. 9).

This circuit switches on a lamp whenever it detects a fall in the level of illumination. It could turn on a small lamp when it begins to get dark each evening.

It can also be used to detect when a beam of light has been broken, for example when a person walks between a source of light and the sensor of the circuit. The lamp can be placed at a distance from the rest of the circuit, so a remote warning can be given.

The light switch Fig. 7 is a Schmitt trigger circuit using a pair of resistors to control the current to the base of

Parts List

Resistors All .25W 5% carbon

R1	100R
R2	56R
R3,5	1k

Potentiometers

VR1	1k carbon track lin.
VR2	10k carbon track lin.

Semiconductors

TR1,2,3	2N4401 npn

Miscellaneous

R4, Cadmium Sulphide photo cell. Available from Electro Sonic, 1100 Gordon Baker Rd., Willowdale, Ontario (416) 494-1555. Part number 600-95003.

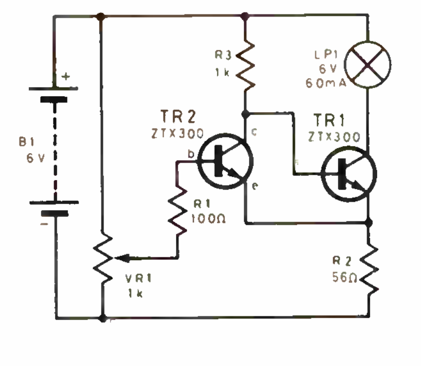


Fig. 3. Circuit with Schmitt trigger action.

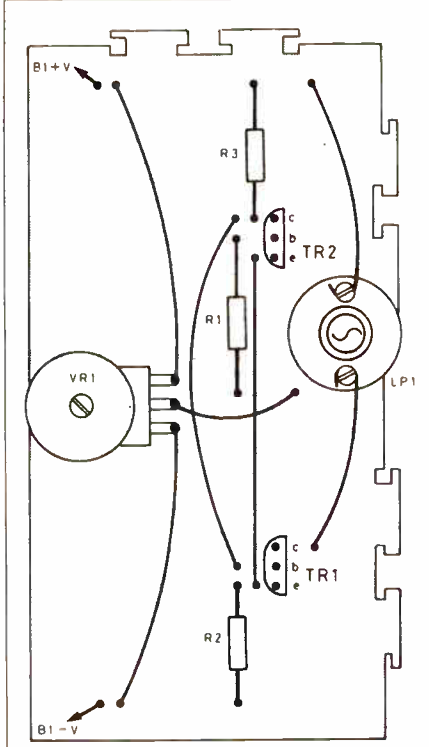


Fig. 4. Breadboard layout for demonstrating Schmitt trigger action of Fig. 3.

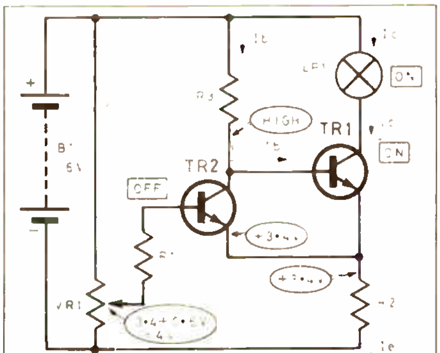


Fig. 5. Circuit depicting the action of the Schmitt trigger during lamp switch-on.

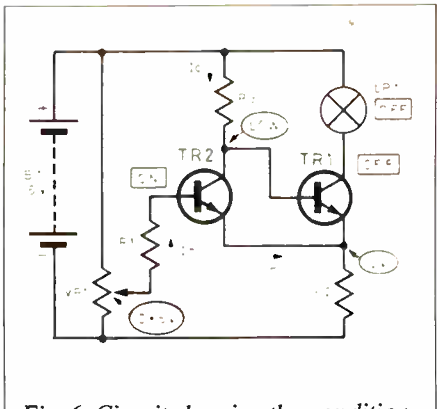


Fig. 6. Circuit showing the condition of the Schmitt trigger during lamp switch-off.

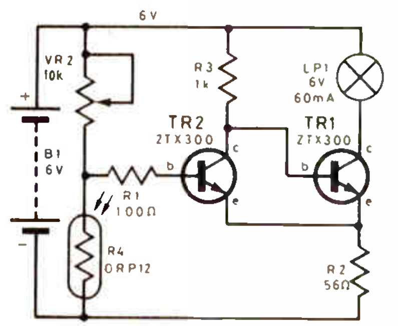


Fig. 7. Circuit modification to Fig. 3. to give a simple Light Triggered Switch.

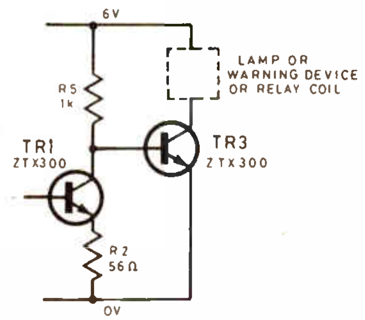


Fig. 9. Modification of Fig. 3. to allow switching of a larger current. For even greater currents use a power transistor in place of TR3.

TR2. One resistor R4 is a light-dependent resistor (LDR). It has high resistance in the dark, and its resistance decreases as the level of light falling on it is increased. The other resistor VR1 is used for setting the level at which the circuit triggers.

Construction

The Light Triggered Switch circuit may be constructed using a piece of 0.1in. matrix stripboard having 10 strips x 24 holes.

The components layout for the stripboard is shown in Fig. 8. No special construction techniques are used, except care should be exercised when soldering the transistors in position.

Apart from ensuring the transistors are inserted with their leads in the correct order, be sure to make the break in the underside copper strip at point D16. Also, remember to insert the wire link. Use solder pins to anchor the lead-off wires to the board.

No problems should be experienced in setting the circuit up and getting it to work. When it is switched on, turn VR1 until the lamp lights; then turn it slowly until it just goes out.

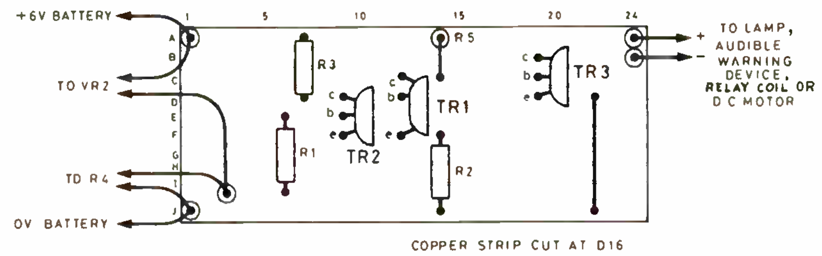


Fig. 8. Stripboard components layout for the Light Triggered Switch.

If you now place your hand over the LDR to shade it, the lamp should come on again. It should go out when you take your hand away.

It can switch on a lamp at dusk, for example, and turn it off the next morning. The advantage is that, having switched a lamp on at dusk, it will not switch it off again should the sky temporarily clear and light intensity increase for a while.

You can use the circuit in other way. Turn VR1 until the lamp lights, then until it just goes out. Now turn VR1 back a little way, but not far enough to switch the lamp on again. You should be able to find a setting of VR1 in which the lamp comes on when the LDR is shaded, and then stays on, even when you take your hand away. It could be used to detect when an intruder breaks a light beam. Once triggered, the lamp remains on after the beam is restored by the person moving out of he beam.

More Power

The Schmitt trigger circuit must have a resistor (R2) between the emitter of TR1 and the 0V line. This cuts down the amount of current that flows through the lamp, so it does not shine at its full brightness.

To make it shine really brightly we use the Schmitt circuit to switch a third transistor, as shown in Fig. 9. The third transistor TR3 switches the lamp fully on.

A small audible warning device could be wired in place of the lamp LP1, or, you could substitute a small relay to operate an AC-powered lamp, bell or motor. ■

Fibre Optics

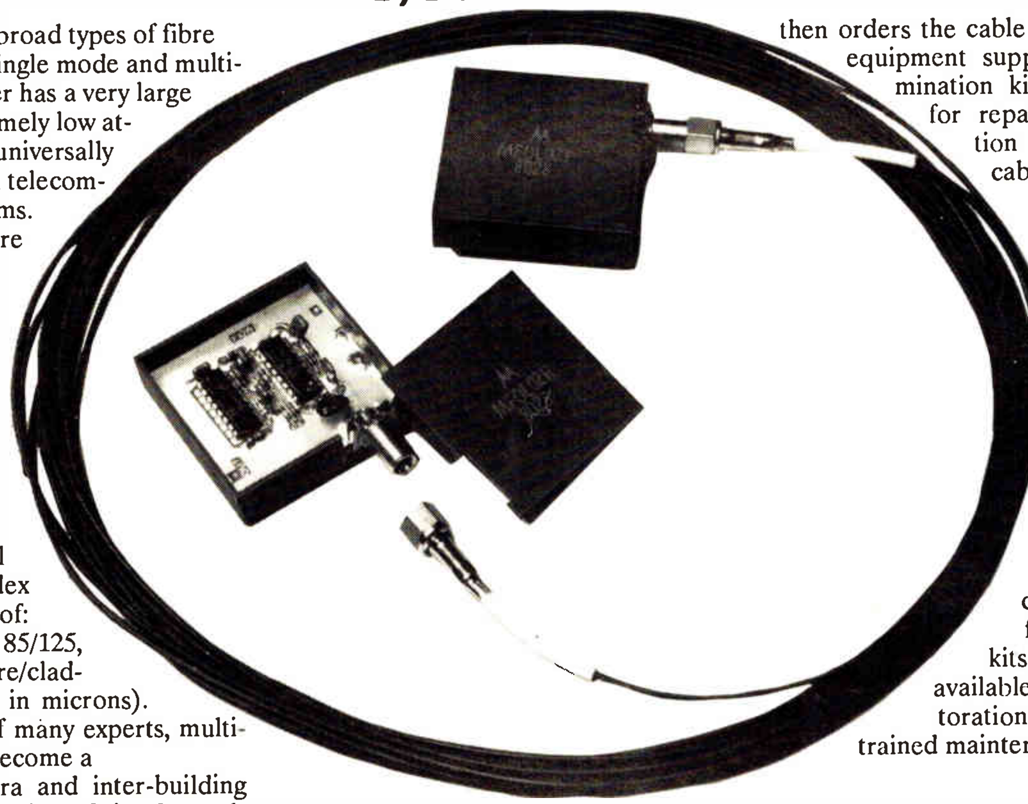
The ins and outs of installing fibre optic assemblies.

By Dr. H. Virani

There are two broad types of fibre optic cable: single mode and multimode. The former has a very large bandwidth, extremely low attenuation and is universally used in long-haul telecommunication systems. Multimode is more appropriate for short-haul data/-voice communication requirements.

There are various types of multimode fibre. The predominant type being all glass, grade-index fibre in sizes of: 50/125, 62.5/125, 85/125, and 100/140 (core/cladding dimensions in microns). In the opinion of many experts, multimode fibre will become a standard for intra and inter-building installations. Selection of size for multimode fibres is not critical to a successful installation. Like the choice between 25, 24 or 22 gauge copper wire for twisted pairs, there are customer preferences and performance distinctions but fibre size is not a major installation decision. In fact, of the two most popular connector types, the same connector can be used on 50, 62.5 and 85 micron core fibres, and only an insert change is required to accommodate the 100/140 size. These fibres are available in all types of cable: indoor and outdoor; single fibre (simplex); dual fibre (duplex); and up to hundreds of fibres within a single cable sheath (Fig. 1).

Outdoor cable is available with special jell filling; steel jacketing for rodent protection; for aerial, buried or duct installations; and with a variety of sheath materials.



Connectors

There are basically two popular types of connectors used on multimode cable: SMA type and BICONICAL (Fig. 2).

Despite advances in the art of fibre optic connectors, the problems involved in properly terminating this thin filament of glass should not be underestimated. Because of th difficulty of field termination with either of the standard connectors, it is highly desirable to have connectors factory installed. This is easily handled and has worked quite successfully.

The customer typically "walks off" the distance between the two devices to be interconnected (either through the use of blue prints or physically walking this distance), adds a safety factor of perhaps 10% (to permit circumventing obstructions, etc.), and then orders the cable direct from the equipment supplier. Field termination kits are available for repair and restoration of a damaged cable, however, a cable disruption is highly unlikely.

Once installed, fibre optic cable is no more likely to be damaged than the common, copper, twisted-pair cables. However, field termination kits and training are available for on-site- restoration by relatively untrained maintenance personnel.

Test Equipment

There is a large variety of test equipment available for fibre optic systems. Some of these devices are extremely sophisticated and used primarily by telecommunication carriers where attenuation and bandwidth are highly critical to the proper functioning of a system. For short-haul fibre optic cable installations, relatively inexpensive fibre optic test equipment is available. A standard attenuation test may by all that is required to install and maintain a link. In the event that an installed fibre optic cable develops a break or discontinuity, instruments are available for locating the fault. Such instruments are quite expensive even for short-haul multimode systems but it is also possible to obtain assistance from a fibre optic supplier or rent such equipment in the unlikely event that it is needed.

Installation

One thing should be made clear about the installation of fibre optic cable. Although it is glass, it need not be handled like fine crystal glasses. The fibre is quite flexible and many fibres are available that can be tied into a loose knot without any permanent damage to the fibre.

Furthermore, fibre optic cables are provided with a high strength member (that is also dielectric) that allows the cable to be subjected to heavy pulling tension during installation. Perhaps the only caution that need be exercised is that the fibre should not be pulled around very sharp corners.

By comparison with pulling in copper cables, either multi-twisted pair or coaxial cables, fibre is much easier to install. Because of its small size it can be pulled through relatively small openings with ease. Also because of its small size, it has a small surface and thus creates very little friction when pulled in relatively confined space. It is extremely light so the reel of cable may be easily handled in one hand as opposed to the heavy and cumbersome copper cables.

In most indoor fibre optic cable installations, which are typically less than a thousand feet in length, it is usually recommended that the customer installs it themselves. The customer can order a factory terminated cable supplied on a light-weight reel (which allows it to be air expressed for emergency delivery at relatively low cost) and install it with no previous experience.

The cable may be laid in a raceway which contains either communication or power cables (remember that fibre optic cable is immune to EMI/RFI). The fibre optic cable may also be installed under a raised floor where the only precaution is that the cable may require crush protection and the use of a split plastic conduit may be recommended. The conduit also will aid in the "pulling- in" and more importantly protect the fibre against subsequent rearranging of large cumbersome copper cables. Finally, the fibre could be laid in a cable tray with other fibres and is preferably left loose, not attached to other cables or to the tray itself.

Perhaps the easiest installation method for fibre optic cable is to simply lay the fibre over a dropped ceiling providing almost a line-of-sight direct connection between the two pieces of equipment. When installing the fibre optic cable over a dropped ceiling some care must be taken to avoid pulling around sharp corners, ceiling hangers, metal studs and around areas of continuous maintenance activity (for example, away from heating vents or lighting fixtures).

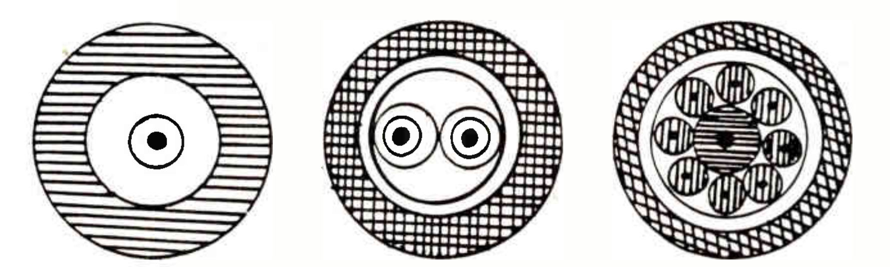


Fig. 1 A graphic representation of some various fibre configurations.

In some installations where there is a great deal of activity in the above ceiling area, a split-plastic conduit may be desirable. Fibre optic cable laid on a dropped ceiling meets building code requirements without the expense of metallic duct, trays, or conduit.

In vertical installations, fibre optic cable may be installed in an elevator shaft or a pipe chase. Since an elevator shaft is typically filled with electromagnetic energy from the rotating electrical motors that are used to move the elevator, fibre optic cables are ideal for installation without the large expense of shielded copper cable. Cable ties may be desirable to maintain the cable in an out-of-the-way position. Ties should not be crimped too tightly. Most fibre optic cables can be self-supported (without any hangars to relieve the weight of the cable itself), for a distance of up to 300 ft. or approximately 30 stories in a highrise building.

The installation of fibre optic cable outdoors is a more complex situation. In the first place, most outdoor cable installations involve greater distances, multiple buildings, and thus more planning and support. Of course, the user must have the right- of-way to install the cable. While it is the responsibility of the user to obtain such right-of-way, many local contractors can assist the user in dealing with the proper authorities. The actual physical installation of the cable may be done on telephone poles, buried, or run in ducts or conduits.

In the planning for installation of cable outdoors, the three methods of laying the cable as described above will largely determine the type of cable to

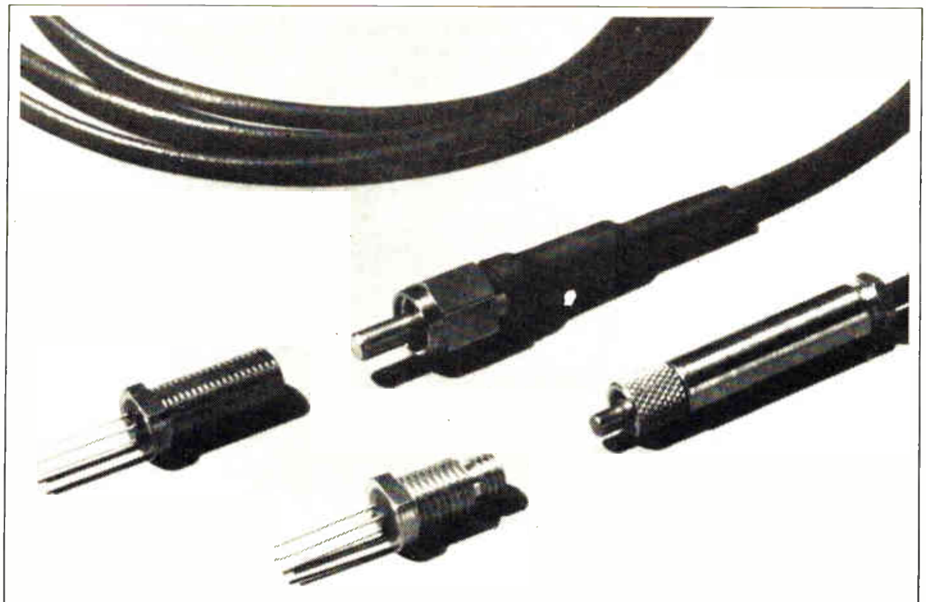


Fig. 2 The two types of popular connectors: SMA and biconical.

be selected. This selection should be done with the assistance of experienced fibre optic cable specialists. They can assist in selecting the right type of fibre, cable, sheathing, diameter, connectors, splicing, and all accessories. In many "campus" fibre optic installations, it is desirable to terminate the outdoor cable at a patch panel providing manual reconfigurability for restoration or rearrangement. Patch panels, patch cords, termination panels and termination boxes are available through most cables and equipment suppliers.

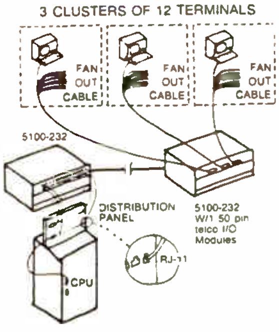


Fig. 3 Terminal clusters linked together with fibre technology.

Cable splicing is simplified using specialized test equipment, such as the LLD-220 from Performed Line Products.

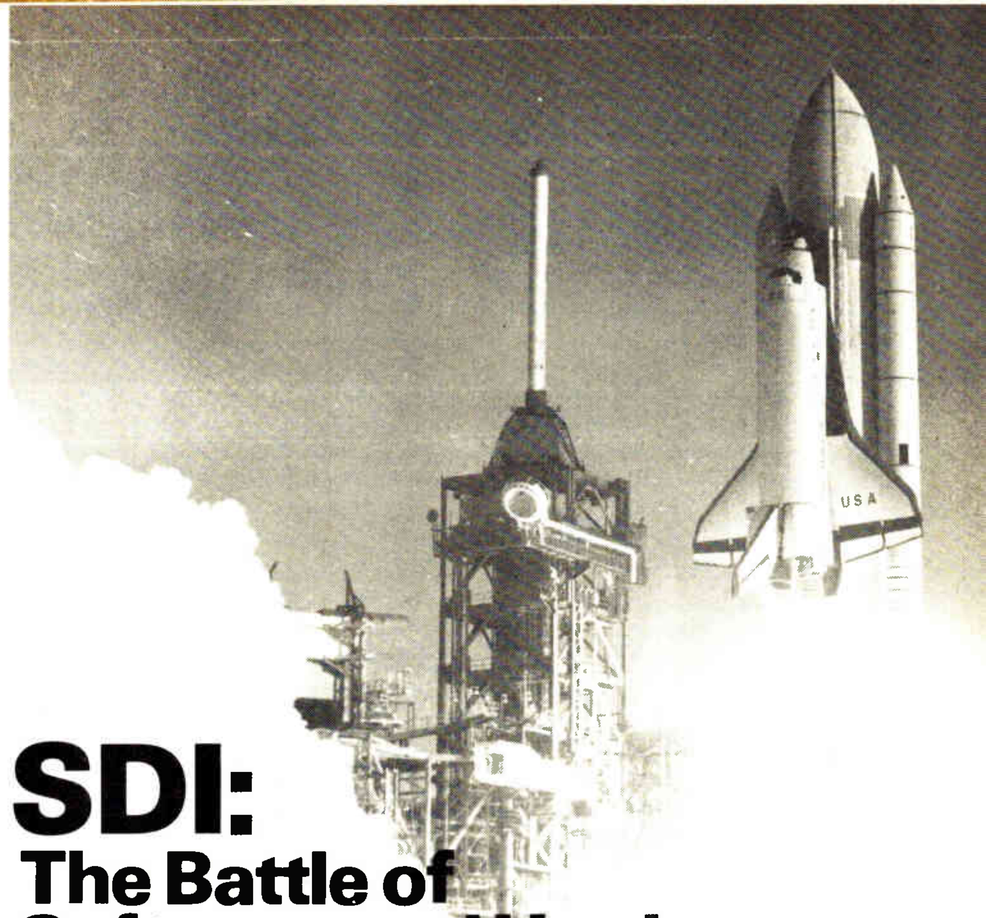
A typical indoor installation of fibre optic cable would be used to inter-connect a pair of RS232 fibre optic multiplexers. In this system, one multiplexer would be mounted in the computer or data processing room within a 19 in. rack. Each individual asynchronous channel on the rear panel of the multiplexers would be connected through a DB25 connector and a standard RS232 cable to a port on the computer distribution panel (see Figure 3).

This portion of the installation is similar to that of a standard statistical multiplexer operating on copper cable. The fibre optic cable would be connected on the real panel of the multiplexer. The multiplexer is then provided with a standard SMA-type connector which mates with the SMA connectors that are factory installed on the cable. It is desirable to provide a fairly large radius, say 10 ins., of the fibre after connection to the multiplexer to prevent any undue stress or inadvertent pulling on the fibre which may disturb or damage the connection. The fibre could then be run down beneath the raised computer floor to a suitable riser that would provide access to the space above the dropped ceiling. Alternatively, the fibre could be run upward directly through an opening in the dropped ceiling. It is also possible to run the fibre optic cable, together with copper cables, through a suitable conduit that is terminated at the equipment rack to provide access out of the computer room and into a cable tray, raceway, or continuation of the conduit. Once the cable is pulled in, it is simply attached to the multiplexer at each end taking care that the transmit fibre at one end is connected to the receiver at the opposite end. In general, most fibre optic systems will have a sufficient system gain, so that the short distances normally traversed within a building will provide excess loss margin.

Summary

The installation of fibre optic cable is neither difficult nor time consuming. There are many suppliers for all of the system components, Motorola, GTE, Corning, HP to name a few, required for a complete turnkey installation. Training courses for personnel are readily available and experienced installation companies are available for large system requirements. Fibre optic systems are widely used throughout the telephone industry and accumulated experience with fibre optics is mounting fast. Leading edge users have committed themselves and are enjoying the benefits of this highly attractive technology.

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



SDI: The Battle of Software and Hardware

In this issue, we begin a forum of discovery and debate on the subject of SDI. Comments are invited.

By K. Tahir Shah.

A Foreword: the year was 1968. Outside the Italian resort city of Trieste, hidden beneath pine trees and overlooking the Adriatic sea, a newly built concrete and steel structure was teeming with activity. This was the new home of the United Nation's International Centre for Theoretical Physics. That June, the world's most precious asset, some three hundred scientists, including a dozen Noble Laureates, gathered there to discuss contemporary physics. Great names of this century, names which are to remain in the history of science forever: Werner Heisenberg, Paul Adrien Dirac, Francis Crick, Hans Bethe and others, came to share their experience of discovery. Many of the participants were honored with the Noble prize in later years such as Abdus Salam, Steven Weinberg and others. As a young research fellow at the Centre, I had the opportunity to meet, listen and discuss with these giants of modern science.

What impressed me most was the simplicity and the modesty of these great people who have contributed so much to out civilization, so different from the commonly conceived image of the scientist sitting in isolation from the rest of mankind. They were always willing to discuss, scrutinize, discard, and refine their ideas. From them I learned that science progresses from open discussion. *Nil sine dialogo* – without discussion, nothing.

The purpose of this regular section is to initiate a reader writer dialogue in the hope that our readers will come forward and discuss, criticize and put forth new ideas – in the true spirit and traditions of science. The science of today, the technology of tomorrow, and the impact of science and technology on our life are some of the issues we will confront.

Since 1983 we have heard about the Star Wars project of the U.S. government. What is the Strategic Defense Initiative and what new technologies are involved? I am, therefore, dedicating our first debate topic to SDI. Please feel free and write to me your comments, concerns, questions and how you see SDI technologies effecting our future. Some of these letters will be published in later issues of E&TT.

Minerva, the roman goddess of wisdom, the daughter of Jupiter, king of gods, was the embodiment of wisdom, purity and reason and the patron of all arts, handicrafts and trades. This section of discovery and debate is named after her.

Minerva and Star Wars

"... I call upon the scientific community in our country, those who gave us nuclear weapons, to turn their great talents now to the cause of mankind and world peace, to give us the means of rendering these nuclear weapons impotent and obsolete." – March 23, 1983, U.S. President Reagan's public statement on Star Wars.

The story of star wars is older than it is known to the public. It goes back to 1967 when Mr. Ronald Reagan, as a newly elected Governor of California, made a visit to the University of California Lawrence Livermore Research Laboratory. He was given a tour of the facility by Professor Edward Teller, a co-founder of the laboratory and a major proponent of the hydrogen bomb in the 1950s. The Livermore facility, with its credible reputation in weapon development and long involvement in defense projects, was already manipulating exotic ideas. Teller mentioned the possibility of new kinds of weapons, such as high powered lasers, which can shoot down attacking ICBMs. In those days, the only anti-ballistic missile (ABM) defense idea being pursued was by the Air Force, for shooting down missiles with a bullet. The idea was dropped later on. Using a laser beam or a high energy particles beam was certainly an exotic idea in those days.

However, with the progress in laser technology and the experience gained by building and operating large particle accelerators, it became not only attractive but seemed feasible. That is what had happened. When Reagan became the President of United States, physicist Edward Teller became one of the key figures in selling the star wars concept to his administration. Teller's passionate involvement in weapons of wonderland and his fairly close association with the President finally led to the star wars announcement.

Since that day of March, 1983, when the U.S. scientific and engineering community was called upon to make a major intellectual effort and to change U.S. nuclear strategy, there has been a continuous debate on all aspects of this new and somewhat alluring concept of ballistic missile defense. It apparently seemed for a brief period that the epoch of nuclear warheads and ballistic missiles was coming to an end. The so-called Mutual Assured Destruction (MAD) and detente were going to be the obsolete doctrines of the past.

SDI is born

Shortly after Reagan's speech, the Defense Technologies Study Team (DTST), later called the Fletcher Panel, was formed to reexamine the readiness and the potential technologies with respect to ballistic missile defense. The Fletcher Panel concluded that since none of the problems could be solved with the existing technology, it suggested a major development effort would be needed over an extended period of time. The project was named Strategic Defense Initiative (SDI), and an organization was formed to deal with all research and development on the ballistic missile defense namely, the SDI Organization (SDIO).
In recent months, the debate over the technical feasibility of the Strategic Defense Initiative has focused on two main issues; the software to operate an integrated ballistic missile defense system and the physics of directed energy weapons. The battle over hardware and software is still raging and will continue for some time.
In 1985, at least two well-known scientists were casualties. They resigned, because both of them felt that it is not possible to deliver what SDIO had promised. The issue of reliable software lead to the resignation from the panel of Dr. David L. Parnas, a Lansdowne Professor of Computer Science at the University of Victoria, B.C.; the question of X-ray lasers led to the resignation of Dr. Roy Woodruff, the former director of the X-ray laser project at Lawrence Livermore Laboratory.
In the sequel, I would like to address the software issue while describing the SDI system complexity and the physics of directed energy weapons.
Every ballistic missile defense system must perform at least the following tasks to achieve its goal of neutralizing an attack.
- Target acquisition, *ie*, search for and detection of attacking missiles and warheads.
- Tracking of these objects while determining their precise trajectories.
- Discrimination between real warheads and decoys which are sent to confuse a defensive system.
- Interception, *ie*, the defensive system must be able to point correctly and fire, leading to the destruction of incoming targets.

The technologies

In the SDI concept there are two classes of technologies involved.
The directed energy weapons (DEW). Under this category comes kinetic kill weapons, electromagnetic guns, short wave length lasers, *(ie X-rays and possibly Gamma-rays lasers), microwave weapons, neutral and charged particle beam and long wavelength chemical lasers.*
The supporting systems. All other systems which are not DEWs, come under this category such as sensors, computer and command, control and communication (C3), and the software to run all of these supporting systems.
The development of new sensor technologies is required by the high performance requirement of the signal acquisition in active tracking radars and passive infrared devices. The computer technology and the science of artificial intelligence is critical to all phases of a ballistic missile defense system.
For a ballistic missile defense system, the technologies are evaluated on the basis of their optimal use in a particular flight-phase of the attacking ICBMs. This is because in each of its flight phases, a missile produces different degrees of detectable radiation and its contents of military value, such as number of warheads, decoys and countermeasure equipment, are different. In the initial phase of a flight from the ground silo (or submarine) to orbit, a ballistic missile carries all of its "assets". There are two kinds of factors which effect the detection and the operation of the directed energy weapons. For example, the intense heat produced by the attacking rocket propulsion system is used to detect its flight by the space-based short wave length infrared sensors. The interference effect caused by the Earth's atmosphere on lasers and the Earth's magnetic field effect on the charge particles beams, creates some limitations on the DEW's operation. This is the other influencing factor, which is favorable to the attacking missile.

Detection

The changes in the flight phase affects ease of detection and consequently the value of the target from a defensive point of view. Typically, boost, post-boost, mid-course and reentry are four relevant flight phases. The boost phase, the earliest flight segment lasting to about five minutes, generates an intense heat which can be detected very easily by a space based detection and warning satellite. This part of the flight is considered to be very important because all decoys and warheads are still posed as a single target. However, it is safe at least up to 200,000 feet or so, because laser and particle beam weapons stationed in space are less effective due to their interaction with the high density atmosphere. In this boost phase, the infrared tracking of missile plumes will have to be supplemented by other means to support the sub-microradian aiming requirements.
In the post boost phase the offensive missile spreads MIRV (Multiple Independent Reentry Vehicles) along with decoys and chaffs. Still, the detection is relatively easy because of the heat generated by the maneuvering motors. Once chaffs, warhead and decoys are released and they cool down to background temperature, it is very difficult to detect them by the heat and short wavelength infrared sensors. Only the long wavelength infrared radiation remains to be of any use for detection. Usually, this situation is typical of a mid-course phase lasting between 15 to 20 minutes. In this phase more complex detection and discrimination technology is required.
The next flight segment is reentry into the atmosphere. Because of the intense frictional heat generated by warheads moving in the atmosphere at high speed, the detection and discrimination process is easier. Chaffs and light weight decoys burn up in the atmosphere, leaving only warheads. At this point, extremely quick detection and interception is required as the

Continued on page 57

flight lasts only 30 seconds to about 100 seconds before a warhead hits its target.

The APS Report

On November 20, 1983, the American Physical Society (APS) commissioned a study to compile and make technical information available to the public. The science and technology of the directed energy weapon was the subject of their scrutiny. The seventeen member commission presented a 424-page report this year. It was reviewed by an APS Council Review Committee as well as by the Department of Defense. The report is unclassified now and is published recently. The APS commission concludes "... the Study Group finds significant gaps in the scientific and engineering understanding of many issues associated with the development of these technologies... At present, there is insufficient information to decide whether the required extrapolations can or cannot be achieved. *We estimate that even in the best of circumstances, a decade or more of intensive research would be required to provide the technical knowledge needed for an informed decision about the potential effectiveness and survivability of directed energy weapon systems.*" The report confirms that the physics, the software science in general and artificial intelligence in particular, and many related computational capabilities need a decade or more of progress before they can be applied to directed energy weapons.

The complexity of the star war software reflects in the following statement in the APS report "... The tracking and discrimination of tens of hundreds of thousands of objects during the mid-course phase poses formidable challenges to sensors and battle management computers. If discrimination requires birth-to-death tracking of all threat objects, these problems become even more demanding... Given the present number of Soviet boosters and their capability, the offense can deploy half a million or more threat objects (reentry vehicles, decoys etc.)... Even an 80% effective boost phase defense would leave 100,000 or more objects entering the mid-course phase...".

The Software Issue

Given the complexity and the size of a directed energy weapon based ballistic missile defense system, the software issue is, its reliability and the errors that are likely to remain in any SDI operational software system. This is a fundamental issue because the reliability and effectiveness of the ABM shield against incoming ICBMs depends on its performance as a whole. Assuming that all hardware will become available in the future and that they function properly, the task of designing an error free software remains more than a challenge, especially without any comprehensive and exact knowledge about the characteristics of future weapons.

There is a direct relationship between the size of a software and its reliability. As in any engineering system, the more components it has, the more chances there are for its failure. The number of errors appear to increase almost exponentially with the size of the software. There is a general belief among software experts that there is always some residual errors left in a system of any non-trivial functionality, whatever one may do to remove them. The only way it seems to avoid them, is to prove program correctness, which of course is not possible at present any systems, except those very small in size.

It is estimated that for SDI support software there will be some 30 million lines of code. The Safeguard ballistic missile defense system developed during the period 1969-75 by Bell Laboratories, contains 2,261,000 lines of code including 789,000 lines for the real-time operation. It is common in the software industry to measure the size of a system by the number of lines it contains. The biggest problem is not its size, but the conceptual complexity and the vagueness of its model-of-the-world. In such circumstances, the real-world simulation is almost impossible. Nobody knows what situation will arise in the future. In the world of counter-measures and counter-counter-measures, making assumptions about the model-of-the-world is a matter of guess work. This problem becomes more prominent as one talks about expert systems. For ordinary industrial and commercial expert systems, the knowledge is acquired by interviewing experts in a given domain. In star wars,

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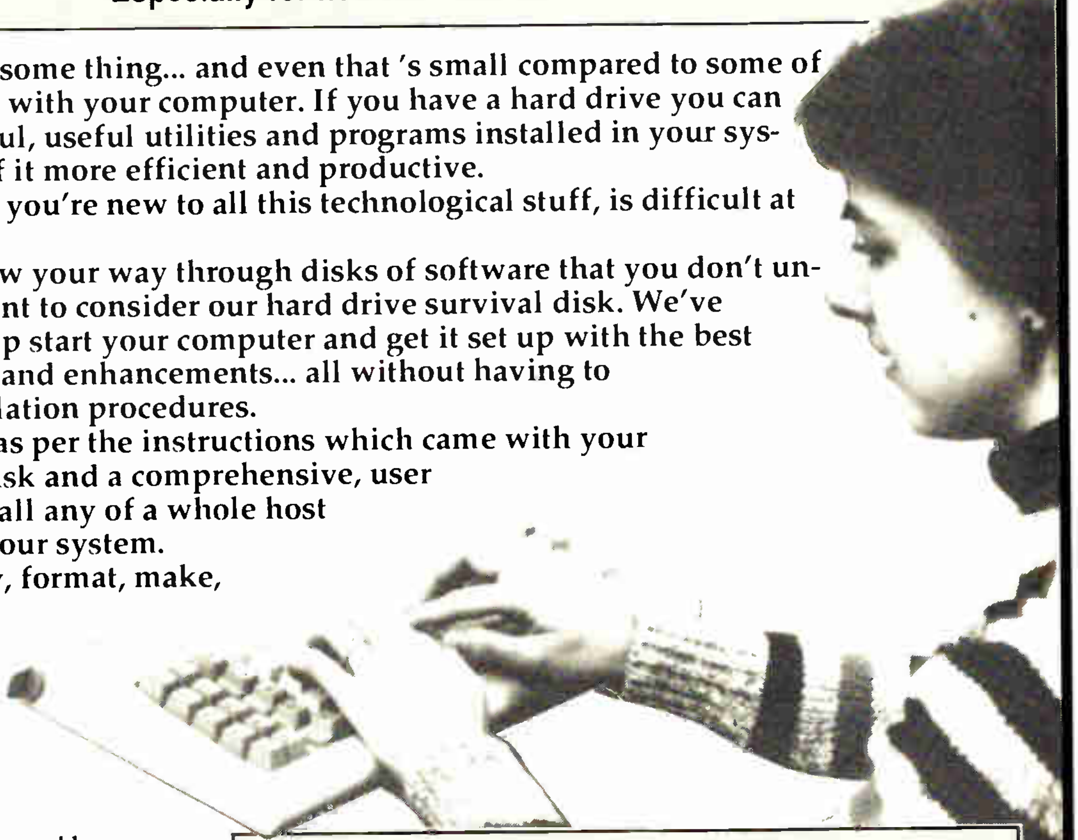

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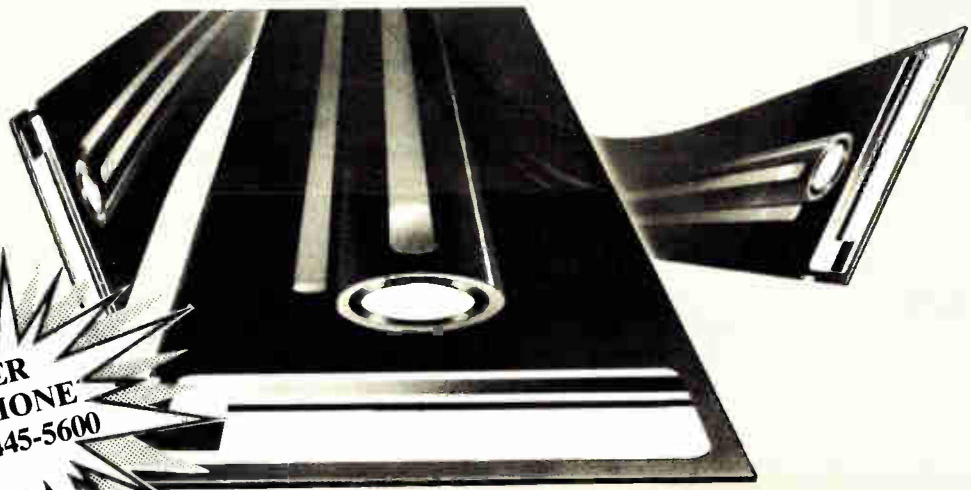

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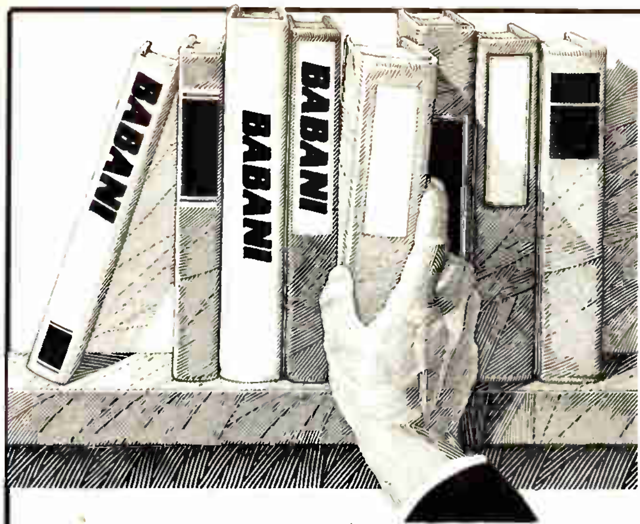

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The projects in this book consists of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electronic points control and many more.

BP194:: MODERN OPTO DEVICE PROJECTS **$9.00**
This book provides a number of practical designs for beginners and experienced project builders. These projects utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright LEDs and passive IR detectors.

BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS **$7.80**
F.G. RAYER, T.Eng.(CEI),Assoc. IERE
Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

BP71: ELECTRONIC HOUSEHOLD PROJECTS **$7.00**
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Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer' intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

BP90: AUDIO PROJECTS **$7.80**
F.G. RAYER
Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls and matching and miscellaneous prospects.

BP44: IC 555 PROJECTS **$10.00**
E.A. PARR, B.Sx., C.Eng., M.I.E.E.
Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

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

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BP84: DIGITAL IC PROJECTS **$7.80**
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This book contains both simple and more adanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. to help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be build and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

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BP103: MULTI-CIRCUIT BOARD PROJECTS **$7.80**
R.A. PENFOLD
This book allows, the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

BP107: 30 SOLDERLESS BREADBOARD PROJECTS - BOOK 1 **$9.00**
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A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featued in this book have been specially deisgned to be built on a 'Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

BP106: MODERN ON AMP PROJECTS **$7.80**
R.A. PENFOLD
Features a wide range of constructional projects which make use of opamps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

CIRCUITS

BP127:HOW TO DESIGN ELECTRONIC PROJECTS **$9.00**
Although information on stand circuit blocks is available, there is less information on combining these circuit parts together. This title does just that Practical examples are used and each is analysed to show what each does and how to apply this to other designs.

BP122: AUDIO AMPLIFIER CONSTRUCTION **$6.75**
A wide circuits is given, from low noise microphone and tape head preamps to a 100W MOSFET type. There is also the circuit for 12V bridge amp giving 18W. Circuit board or stripboard layout are included. Most of the circuits are well within the capabilities for even those with limited experience.

BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 **$9.00**
R.A. PENFOLD
70 plus circuits based on modern components aimed at those with some experience.

BP179: ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS **$12.00**
The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge the gap.

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F.G. RAYER, T.Eng.(CEI),Assoc,IERE
Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

This book contains something of particular interest for every class of enthusiast - short wave listener, radio amateur, experimenter or audio devotee.

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E.A.PARR **$11.80**
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BP118: PRACTICAL ELECTRONIC BUILDING BLOCKS - BOOK 2 **$7.80**
R.A. PENFOLD
This sequel to BP117 is written to help the reader create and experiment with his own circuits by combining standard type circuit building blocks. Circuits concerned with generating signals were covered in Book 1, this one deals with processing signals. Amplifiers and filters account for most of the book but comparators, Schmitt triggers and other circuits are covered.

BP83: VMOS PROJECTS **$7.80**
R.A. PENFOLD
Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

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Microcomputer Home Study

Two views of the NRI microcomputers and microprocessors correspondence course.

By Frank White

(*Editor's note: In his original manuscript, Mr. White gave numerous worked-out examples from the course. For reasons of space, it was necessary to condense the review to the following points.*)

Recently I completed a home study computer course with "high distinction". I am now a fully certified computer technician. I even have a fancy diploma to prove it. The problem is, while I now know more about electronics, I don't seem to know that much more about computers today than I knew two years ago when I began the course.

Doubtless you have seen the course advertised in this magazine and other popular computing journals. Although this evaluation applies specifically to the NRI program, I suspect it could apply generally to the two or three other similar correspondence courses that are available in the United States and Canada.

I selected the NRI program because it is well advertised and seemed to meet my goals. I was looking for something more than a programming course. I wanted to learn how computers work. I wanted to improve my understanding of these remarkable mechanical extensions of our brains.

I chose a correspondence course because I had no other choice; it was training by correspondence or no training. Living in a rural community forty miles away from the nearest metropolitan area has its pluses, but educational and cultural facilities are not among them. Moreover, nighttime driving in Canadian winters discourages even the hardiest among us.

Structure and Format

At first glance the NRI program seems to provide a nice balance between passive textbook learning and active hands-on practical applications: forty-nine reading lessons are combined with ten discovery kits. In the process you assemble your own computer. The reading material is sent in batches of two or three booklets at a time with three, sometimes two, lessons per booklet. Each lesson is, on average, 25 to 35 pages in length. For each of the first 45 of 49 reading lessons students are required to answer ten multiple choice questions by penciling in coded boxes on a card. The card is returned to NRI, and two to three weeks later you receive the results. A score of less than six out of ten is unsatisfactory and you must repeat the same test. Additional booklets are sent as you finish the lessons you have previously received.

The procedure with the kits is similar. The first kit is sent after completion of reading lesson seven. Thereafter they are sent intermittently. The computer components kit is sent last of all, after lesson 45, and conditional upon the successful completion of all previous assignments. The kits contain instructions, background reading material and the parts required to build or assemble equipment and to do the hands-on assignments. Students are again required to answer correctly at least six of ten multiple choice questions for each of the ten lessons.

You proceed at your own pace. Support service and help is there if you need it, by phone or mail. NRI provides replacement parts on request at no extra cost, within reason, of course.

So why didn't it work for me, a capable, interested and motivated student?

Criteria for Evaluation

My professional training and teaching experience have convinced me that a course of study is best conceived, designed and presented as an integrated whole. A properly balanced and integrated course of studies has four fundamental characteristics:

1. Clear definition of broad learning goals that answer the question - What should the student know or be able to do at the conclusion of this program that he/she did not know or was unable to do at the beginning?
2. Within the framework of these broad goals, development and presentation of highly specific, measurable instructional objectives for each lesson, again in terms of the results to be achieved.
3. Effective design and delivery of course content to ensure the achievement of goals and objectives.
4. Appropriate course evaluation to measure the extent to which the learner has achieved the objectives.

Flaws of the NRI program

Evaluated in terms of these criteria, the NRI program, in my estimation, does not measure up. Here are its deficiencies:

1. NRI's course is not a unified, integrated, coherent whole because it is modular in design;
2. There is no clear statement of course goals or measurable lesson objectives;
3. Lesson content and presentation is verbose, not indexed to permit easy searching and retrieval, insufficiently supported with informative illustrations, provides no conceptual model of how a computer works, sometimes overlapping and repetitious, sometimes dated or irrelevant, and, to top it all, the central piece of equipment, the computer, is not sent until towards the end of the course; and
4. Evaluation is inadequate and fails to give the learner sufficient useful feedback about performance.

 Continued on page 54

Let's look at some of these inadequacies in greater detail.

NRI's course is not a unified, integrated, coherent whole because it is modular in design.

Upon receipt of the first batch of booklets it was evident to me that the curriculum had not been developed as an integrated whole. Instead, what we have is a set of modularly designed lessons loosely strung together and called a course. By modular I mean that the same lessons are used repeatedly in several different courses; the lessons I studied as part of a computer course are undoubtedly used for other NRI programs as well.

Modular curriculum design may have certain administrative and cost-saving benefits, but only at the sacrifice of course integrity or wholeness and program balance. It is the learner who loses. NRI's modular approach is, in my opinion, a design error and a major flaw of the program.

What is the evidence to support my contention of course unevenness and disunity? Consider this example of curriculum imbalance. Of the 45 reading lessons on which students are tested, fully 18 lessons pertain to the fundamentals of electronics. That's forty per cent of the tested reading course work! One hundred and eighty questions on electronics. Furthermore, 68 of the 100 questions asked in the training kits are also about electronics. In total, then, 248 of 550 questions are about electronics. An astonishing 45% of the course content!

Does one really need to know that much about electronics in order to understand how computers work? I think not. NRI's course content is obviously distorted. One gets the impression that rather than having asked themselves - What do our students need to know and how shall we help them to know it? - NRI people seem to have asked something more along the lines of: what lessons do we already have available from our other programs that we can fit in to a computer course? That may not have been how the course was put together, but it seems that way. How else does one explain the electronics bias?

What about the remaining 31 lessons on computers? Unfortunately, things don't improve. If anything, they get worse. Consider these facts. Of the remaining 270 questions on the reading material, 110 are devoted to only four topics, none of which deserve this emphasis. Here is the breakdown:

- Introductory & concept definition: 20 questions (7.4%)
- Computer arithmetic: 30 questions (11.1%)
- Boolean algebra and logic circuits: 30 questions (11.1%)
- Assembly language: 30 questions (11.1%)

So, the unevenness continues. Worse still, although there is an effort at rational lesson organization, they are not organized as a coherent whole and course overlap and content duplication occur. Once again, this is a result of modular curriculum design.

Training kit material is no better. The question breakdown for 100 questions is as follows:

- Electronics: 68 questions, BASIC language: 1, Computer keyboard: 7, Assembly language: 2, MS-DOS: 5, Computer architecture: 8, WordStar: 2, Computer arithmetic: 1, CalcStar: 2, Misc: 1, Easy Writer: 3.

Conclusion

In retrospect, NRI, and I suspect, others providing similar kinds of correspondence courses, must do the following to correct the flaws:

1. Tighten up, if not abandon entirely, modular program design to provide a course that is an integrated, unified, coherent whole.
2. Formulate course goals and lesson objectives that are clear, concise, measurable and attainable.
3. Revise and rewrite course material so that it is designed to achieve goals and objectives, places less emphasis on electronics, is concise and clear, is profusely illustrated with well-labeled diagrams, provides a framework or model of the computer to enable students to integrate new learning, teaches by analogy, that is, by relating the unknown to the known, provides for systematic review, facilitates the retrieval of information through provision of indexing, and introduces the computer equipment early in the course.
4. Evaluate learning in a way that provides meaningful and useful feedback to the student; evaluation based on the extent to which students achieve measurable goals and objectives.

In addition to this, NRI should consider using the new technology, such as video cassettes and computer software, including CD-ROM technology, in the presentation and delivery of lessons.

NRI Replies

Mr. William Coleman, NRI's Director of Development, replied to author White's review:

Dear Mr. White:

I am very sorry that our course did not measure up to your expectations. While we have many satisfied students and successful graduates, it disturbs us when any of our students are unhappy with their course. And, while I do not entirely agree with your assessment of our course, I do respect your opinions and constructive criticisms. I see you did complete the course which is a sign it did have some rewarding or educational value.

I would like to thank you for taking the time to offer us your suggestions. Some of your suggestions will be considered during the next revision. Some simply can not be considered, such as providing the computer at the front of the course.

Frank, as our catalog says on page 11, the micro course will train you to be a bench or field technician. It is also a valuable training aid if you were going to sell computers, for example. It clearly implies that the course is not a programming course or a computer literacy course. To be a complete computer electronic technician course, it needs to have a considerable amount of electronic training. We would be foolish to offer an electronic technician course without offering the electronics basics from which the course is built. Most of our students seek additional electronic training, not less.

We do not think our course is "modular" in design. Nor is it loosely strung together. I do not know why you object to lessons being used in other courses. The course starts you out in basic electronics and ends up with a logical approach to microcomputer repair.

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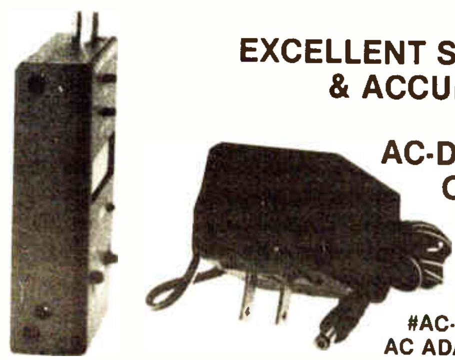

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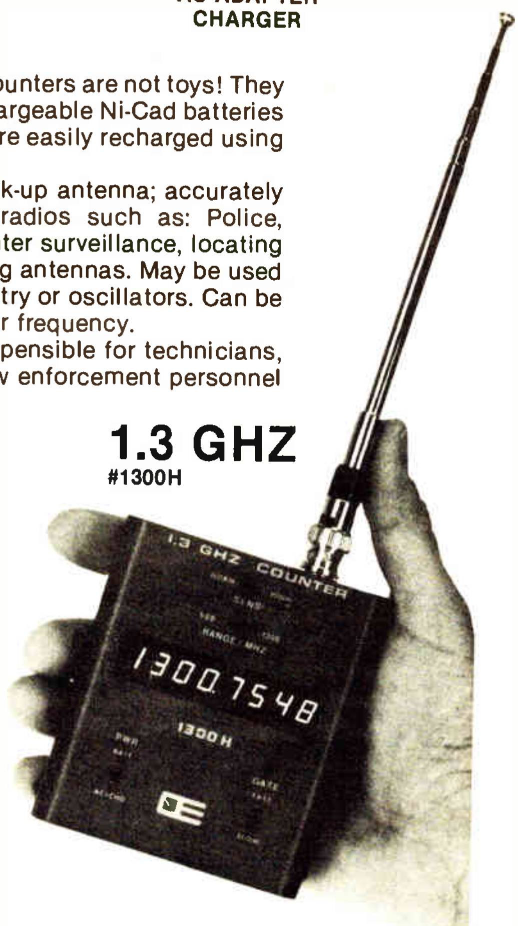

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Flight Simulators and Eye-tracking

The eye-tracking helmet provides a high resolution visual display only where the pilot is looking.

By Carol Thomas

Aircraft simulators are used to train pilots in both commercial and military fields, at great savings and reduced risk to the pilots-to-be. What has been used for this purpose in the past is an array of video screens or large domes and gimballed projectors, either of which is expensive and provides low image resolution. However, the latest development, by CAE Electronics Ltd. of Montreal, is a helmet which the pilot wears which shows computer-generated visual images of the simulated surroundings.

This helmet, called the Fiber-Optic Helmet Mounted Display (FOHMD) system, displays a detailed stereoscopic visual image of everything the pilot would see in the cockpit and outside the plane. It uses advanced head and eye tracking techniques to follow the movement of the pilot's head and pupils, and changes the image accordingly.

One of the newest parts of the helmet is the eye tracker, developed by researchers at the University of Toronto. A team headed by Professor Richard Frecker and Professor Moshe Eizenman, at U of T's Institute of Biomedical Engineering (IBME), developed the tracker, which provides a high-resolution "area of interest" insert within a large, low-resolution field of view. The image-generating computer reads where the pilot's eye fixation is, and generates the high-resolution image only in that area. Previously, only a central section of the field of view was in high resolution.

"We create the illusion that the entire display is in high resolution," said Terry Williams, Co-ordinator of the Eye Tracking Project at CAE. Since peripheral vision input does not appreciate high resolution, the pilot does not consciously notice that the entire field of view is not at the same resolution.

The system uses a low-level beam of invisible infra-red light shone onto the eye. The reflections, changing as the pilot's eye moves, are captured by multi-element arrays, and the information is digitized and processed in real time by a fast signal processing unit. The difference in position between the light reflected from the cornea and the centre of the pupil shows the instantaneous direction of the pilot's gaze. Developments by the IBME team have also significantly increased the speed of signal processing.

Because of the constraints on their head motion in high G- force situations, pilots tend to make large eye movements. The eye tracker can record and analyze accurately up to 500 eye positions per second. Since the human eye can make a 10 movement in 50 milliseconds, previous trackers, which only did 60 scans per second, produced a noticeable delay in the system, which is now absent.

The helmet itself weighs about two kilograms, mostly due to the weight of the optical package, and is custom-fitted to each user. The images come through fiber-optic cables from the main computer, and are corrected by relay-combining optics for size and scale. The helmet display system consists of two 7.5 cm diameter window displays mounted in front of the eyes like eyeglasses, with an optical interface to the fiber-optic cables. The display is semi-transparent, permitting cockpit controls and indicators to be viewed normally, with an instantaneous field of view of 64 vertically by 135 horizontally.

"Simulated flight environments are very important both because of the cost savings, and because it gives an opportunity for pilots to experience dangerous situations and manoeuvres which could be life-threatening in real life," Mr. Williams said.

John Patterson, Manager of Public Relations at CAE, added that "most commercial training is done in the simulator because now the fidelity has reached the point where it can be trusted for training." Commercially, simulators are generally used for the purpose of teaching pilots how to fly new types of planes, he said, while in the military, they are used to fly through a mission in advance, or practice landing, for example, at a new airport.

The cost savings by using the helmet and eye tracker rather than screens and projectors could be up to one order of magnitude, according to Professor Eizenman, since the current installation can cost up to $20 million.

The helmet, which was under development for four and a half years, is currently in use at Williams Air Force Base in Arizona, where the eye tracking system is still being integrated. Preliminary testing should be completed in approximately nine months.

"It might be the way to go in the future," said Professor Eizenman. "The Air Force, as well as everybody else, is very hopeful about it, but there are many hurdles yet to overcome."

Carol Thomas is a freelance science writer from Toronto. ■

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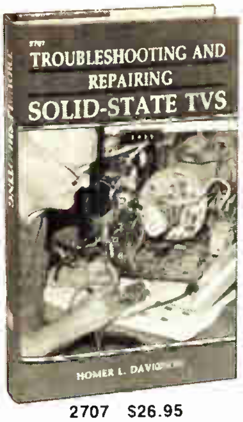

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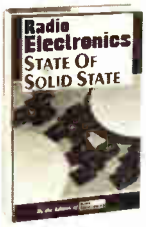

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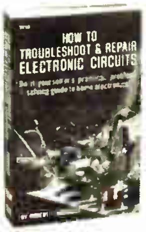

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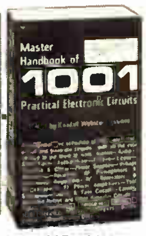

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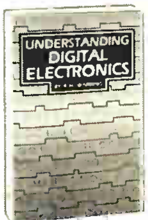

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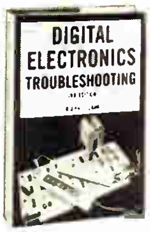

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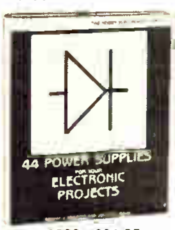

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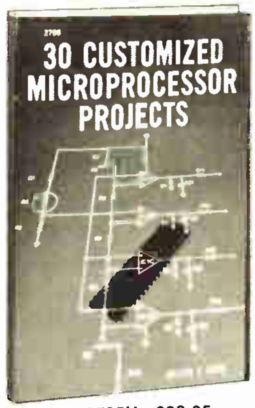

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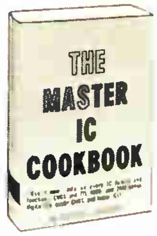

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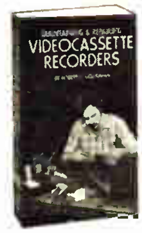

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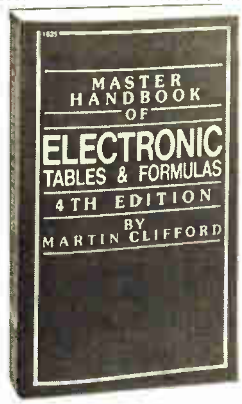

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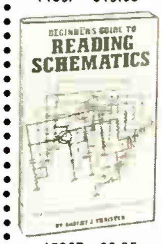

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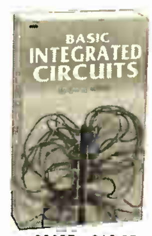

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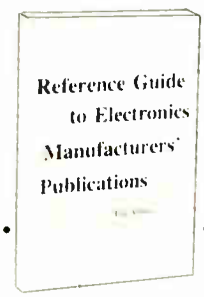

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All books are hardcover unless number is followed by a "P" for paperback electronic course? Computers and the peripherals that work with them are all electronic devices which use electronic components and circuits.

I agree with you that you do not have to have an in-depth knowledge of electronics to understand how computers work. However, just knowing how computers work does not give you the knowledge you need to be a good computer technician.

I am surprised that you did not notice the amount of electronics training in the course when you read the catalog. We give complete descriptions of all lessons and kits.

You also mention dated and irrelevant materials that are unrelated to your interests. Much of what we cover is needed by anyone who is training to become a computer technician. It is obvious that this was not your intent. Our catalog clearly points out that the objective of the course is to teach you to service and repair computers. Our ads also state this.

While I am sure that some lessons may be somewhat wordy, I do not feel this is as bad as you say it is. Our writing style has been developed over a long time to be especially well-suited for people studying at home. It is intentionally "conversational" in style to make readers feel more at ease with the lessons. We receive many letters from students and graduates telling us about how much they like our writing style. And, when a learner is enjoying the learning experience, comprehension is much easier.

I am certain there are places where we can improve our explanations. We are constantly revising and improving our lesson materials to make them better. We closely monitor student exam results and letters to try to pinpoint areas where students are having trouble.

I agree with you that an index would be a big help. However, we have not been able to find a practical way to do this. We frequently revise and rewrite lessons to up-to-date and improve them. And, we have many students that for one reason or another take several years to complete their course. Often the lessons and kits are changed along the way. We are on the sixth version of the computer kits in 8 years. We have also made numerous lesson revisions and rewritten the first 18 lessons of the course.

As far as sending the computer at the beginning of the course is concerned, it is just not practical. For one thing, you are not ready for it then. Remember, we are training you to become a technician. Another, and perhaps the most important reason, is that we would probably be out of business within a year. Our courses must be affordable, and most or our students cannot pay for the course all at once. They need to pay for it in reasonable monthly payments. Now, if we were to send out $1000 worth of material at the beginning of the course, with only a small down payment, we would have to go into the finance business. Also, many states have cancellation laws that are based on lesson completion rates. These laws allow the student to cancel at once and owe us only $75. This creates serious financial problems.

We would very much like to offer a computer literacy course that would teach people how to use a computer and would include word processing, spread sheet, file management, etc. However, we have not done so due to the requirements of a computer at the front of the course.

We would also like to use the latest state-of-the-art computer in our training. But, and I believe you will agree, the cost of adding such a machine would raise the course tuition far above what most people could afford. It also takes us about a year to develop training materials for a new machine.

The same problem exists for much of the new educational technology such as CD ROM, video, CAI. It is simply not affordable for the average student. The best educational course is worthless if no one can afford it.

We are also currently reviewing our lesson questions to see how we can improve them. I personally do not like negatively phrased ("the following is not"...) or true/false questions, nor do I like "tricky" questions. However, some questions that may appear to be tricky questions may really be intended to make you think.

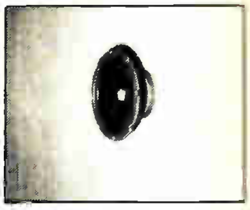
We feel that our course is a good effective training course. We have many satisfied graduates who are successfully using the training in their careers. However, we always feel there is need for improvement and we will be making improvements in some of the areas you discussed in your letter.

Thank you again for taking the time to send us your constructive criticisms of our course. I am only sorry that you feel you gained nothing from it.

Sincerely yours,
William Coleman
Director of Development

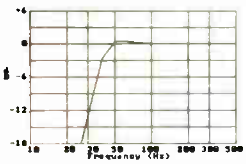
■

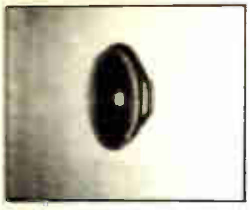
LOUDSPEAKER



CROWN 8" WOOFER

Magnet Weight	20 oz
Nominal Power	80 W
Impedance	8Ω
Resonance	49 Hz
Re	5.23Ω
Qms	3.39
Qes	0.53
Qts	0.46
Vas	1.8 cu.ft.
Box Design	Ported
Box Volume	3.1 cu.ft.
Port Diameter	3 in.
Port Length	1 in.
F3	39.2 Hz
FB	43.9 Hz





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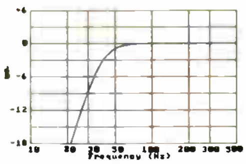
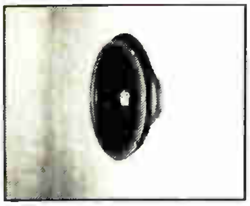
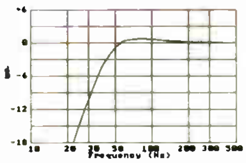
Magnet Weight	20 oz
Nominal Power	100 W
Impedance	8Ω
Resonance	31 Hz
Re	5.47Ω
Qms	4.35
Qes	0.38
Qts	0.35
Vas	7.2 cu.ft.
Box Design	Ported
Box Volume	3.98 cu.ft.
Port Diameter	4 in.
Port Length	3.9 in.
F3	39.4 Hz
FB	35.3 Hz





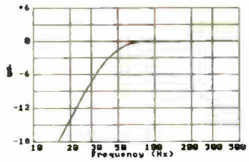
CROWN 12" WOOFER

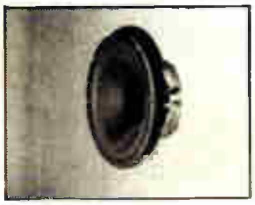
Magnet Weight	28 oz
Nominal Power	100 W
Impedance	8Ω
Resonance	30.5 Hz
Re	5.08Ω
Qms	5.40
Qes	0.39
Qts	0.36
Vas	11 cu.ft.
Box Design	Ported
Box Volume	5 cu.ft.
Port Diameter	4 in.
Port Length	1.8 in.
F3	44 Hz
FB	37.7 Hz



CROWN 15" WOOFER

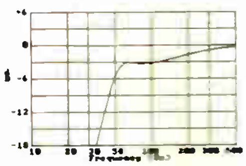
Magnet Weight	40 oz
Nominal Power	150 W
Impedance	8Ω
Resonance	20 Hz
Re	6.3Ω
Qms	4.08
Qes	0.37
Qts	0.34
Vas	26.7 cu.ft.
Box Design	Closed
Box Volume	5 cu.ft.
Port Diameter	N/A
Port Length	N/A.
F3	41.9 Hz
Qt (System Q)	0.759





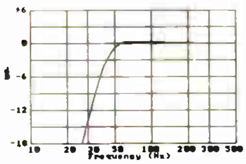
PRO 12" WOOFER

Magnet Weight	90 oz
Nominal Power	150 W
Impedance	8Ω
Resonance	49.5 Hz
Re	5.6Ω
Qms	5.53
Qes	0.27
Qts	0.26
Vas	3.7 cu.ft.
Box Design	Ported
Box Volume	3 cu.ft.
Port Diameter	5 in.
Port Length	2.8 in.
F3	55.2 Hz
FB	52.4 Hz



PRO 15" WOOFER

Magnet Weight	90 oz
Nominal Power	200 W
Impedance	8Ω
Resonance	46.5 Hz
Re	7.1Ω
Qms	5.10
Qes	0.48
Qts	0.44
Vas	8.5 cu.ft.
Box Design	Ported
Box Volume	10 cu.ft.
Port Diameter	10 in.
Port Length	3.2 in.
F3	43.2 Hz
FB	45.0 Hz



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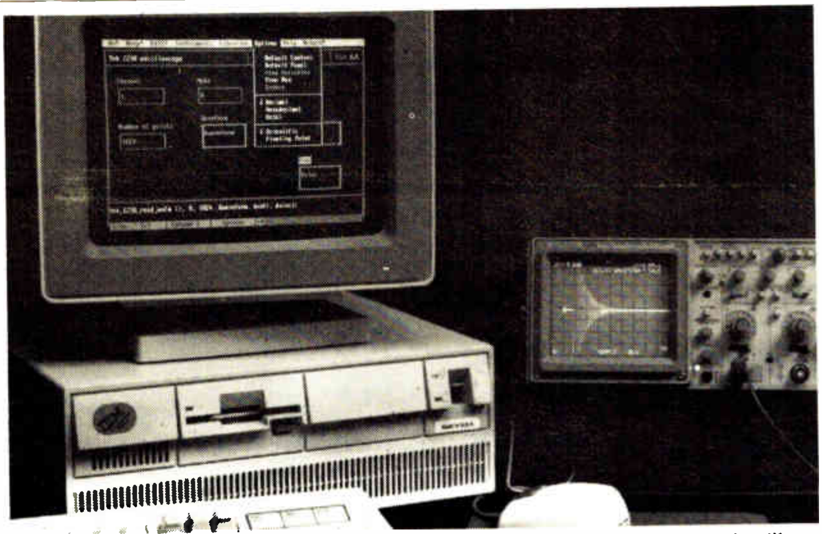
LabWindows



National Instruments announces a new scientific and engineering software system for the IBM PC, XT, AT and PS/2 family of personal computers.

LabWindows features an interactive environment and several libraries for developing software for applications involving data acquisition, reduction, analysis, presentation and instrument control.

The initial release of LabWindows supports applications development using Microsoft C and Microsoft Quick BASIC. Because there is no new language to learn, the user can generate sequences of code by invoking pulldown menus and selecting library functions and parameters with a mouse or keyboard.

The instrument library lets the user perform high-level programming of GPIB instruments without knowing specific details of the instrument or of GPIB programming. A function panel can simulate the front panel of a GPIB instrument and allows the user to program the instrument as though they were using its front panel.

LabWindows also provides a data analysis library, graphics library, and a data formatting library. A library of advanced routines is available as an option and includes digital signal processing, matrix and vector arithmetic, advanced statistics, and curve fitting functions.

The package carries a price of $695 in its standard configuration, and an optional add-on package with advanced graphics and data analysis libraries will be available in the first quarter of 1988 for $1250.

Contact David Green, Allan Crawford Associates Marketing, 5835 Coopers Avenue, Mississauga, Ontario L4Z 1Y2 (416) 890-2010.

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Continued on page 59

Billion-Byte Disc Drive

Control Data has recently announced the computer industry's first billion-byte, eight-inch data storage device.

The Sabre 1230 quarter-rack disc drive has a total capacity of 1,236 million bytes and features a transfer rate of 24.19MHz (3.02MB/sec), an average seek time of 16ms an uses both thin film media and thin film heads. Optional interfaces available will be SMD, IPI-2, or SCSI.

The Sabre 1230 was recently shown at the Fall COMDEX show in Las Vegas.

WordPerfect Course

Waterloo Distance Education Inc., has announced the release of an interactive course on WordPerfect from FlipTrack Learning Systems.

The course is contained in 4 audiocassettes and takes the first time user through creating, editing printing and merge printing a variety of documents.

Waterloo Distance Education Inc., 279 Weber St., #17, Waterloo Ontario N2J 3H8 (519) 884–4340

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Continued from page 43

there are no experts who have gone through the experience of many star wars and "survived" to tell us what the "rules-of-thumb" are to deal with that kind of situation.

Thus, the fundamental issue is that there is no way to construct a model-of-the-world which fully represents the expected star war scenario realistically. One encounters this same dilemma in the DEWs hardware design.

What is needed to solve this problem? I think research on the psychology of warfare leading to the conceptual model of measures and counter-measures would be useful. Application of such a model, whether to star wars or some other situation of conflict, can be of great help in the design of a system for unpredictable conflict situations. Essentially, there is a need of a conceptual model (in computational-terms, a paradigm) on how an enemy will use countermeasures; a kind of model where two wise men are trying to fool each other. Obviously, it will involve many orders of interaction between the two parties, involving countermeasure, counter-counter-measure and so on.

The SDIO Panel on Computing, realizing all these problems, proposes to solve the software reliability problem in many different ways. For instance, they want improvement in computing hardware so that there is no need to use programming tricks in lieu of processing power. They also want to increase redundancy and the use of distributed architecture. Thus, basically their philosophy is now conceding that "All systems of useful complexity contain software errors". The fundamental question now is "how to design this system such that errors are first minimized and then tolerated". The computing panel does not expect that traditional software engineering can meet the requirements of the Strategic Defense Initiative Battle Management System, and they recommend new and innovative approaches. The final outcome is that the Reagan administration has to decide whether they want a less-than- perfect anti-ballistic missile shield. Obviously, that was not the original promise.

Hardware gaps

Coming back to the battle of hardware, according to the American Physical Society report, all existing candidates for DEWs require many orders (powers of 10) magnitude improvements in power output and beam quality before they can seriously be considered for ballistic missile defense systems. The same kind of improvement is required for most of the supporting technologies, *eg*, sensing, tracking and discrimination etc. The much debated nuclear-pumped X-ray lasers are currently under active research. The APS commission considers the X-ray laser potential in ballistic missile defense uncertain. On the other hand, particle beam devices for either neutral or charged particles is considered to be more attractive due to the existing knowledge and operational experience of particle accelerators. However, a significant improvement beyond their present level of performance is required without any doubt.

Again, the same caution is prescribed for the supporting technologies such as rapid steering of optical beam, or tracking with high precision. The proposed supporting technologies are recommended for study as well, before they can be considered for the ballistic missile defense. On the other hand, the technical problem for countering DEWs, including a direct attack on them, is less difficult and does not require many orders of magnitude improvement in their performance as is the case with the directed energy weapons. For the Soviets, the problem of countering SDI is less difficult than its development and deployment by the American.

Now we come to the requirements for directed energy weapons to be a successful defensive system. For boost and post-boost phase operations, sufficient weapon energy, beam quality, pointing accuracy and retargetability to deliver lethal doses of energy within the available time is vital. Also, an accurate detection and localization system is required. The requirements during the mid- course phase are detection, reliable means of discrimination and tracking of very large number of object simultaneously, as well as rapid retargeting and sufficient energy from the DEW to destroy many targets. The American Physical Society committee does not expect directed energy weapons to play any important role in the terminal phase of the missile trajectory.

Orbital elements

With respect to space-based or orbital elements a fairly large number of nuclear reactors and other means of electrical power supply are required for housekeeping functions. Also, during an engagement adequate burst power is essential. Space-qualified reliability of all components and subsystems on the space platform, notwithstanding long periods of dormancy, is essential.

The system survivability is one of the major issues. All directed energy weapons must be able to operate in a hostile environment during a conflict. The DEWs must be integrated in an overall system that includes a survivable command, control and communication and intelligence system.

After examining all these issues in detail, the commission has reached the following major conclusions.

For chemical lasers the output powers at acceptable beam quality need to be increased by at least 10 times for Hydrogen Fluoride/Deuterium Fluoride lasers, and 100,000 times for Iodine lasers for use as an effective kill weapon in the boost phase. At least 20 million watts of power is needed for the least demanding strategic defense application. Chemical lasers face a special set of problems arising from vibrations and the exhaust of the burnt fuel in space. Similarly, the pulse energy from Excimer lasers needs improvement 10,000 times over that currently achieved value. Many other advances are needed to achieve the required repetitive pulsing of these lasers at full scale. The ground-based Excimer lasers must produce at least 100 megajoules of energy in a single pulse or pulse train with a total duration between several and several hundred microseconds. For thermal kill 1 billion watts of average power would be required. Not only that, a ground-based free electron laser should produced an average power about one billion watt and peak powers of 0.1 to 1.0 trillion watts, but for SDI application several physical concepts need validation.

Similarly, nuclear-explosion-pumped X-ray lasers require validation of many of the physical concepts before their application to SDI can be evaluated.

The neutral particle beam (NPB) accelerators must be scaled up by 100 times in voltage and duty cycle. There is another problem with the charged particle beam due to its deflection in the Earth's magnetic field. High- energy electron beam requires propagation in laser-created plasma channels in order to avoid beam deflection. The laser needed for the creation of plasma channels requires development. Also, other factors are in need of scaling-up by many order of magnitude, such as accelerator voltage, pulse duration and the average power.

The dynamic phasing of arrays of telescopes requires extensive hardware and software development in order to obtain large effective aperture optical systems. The large primary mirrors are vulnerable in space-based optical systems and there is need for a cooling system and very low absorption coatings. To deal with the weather problem and cloudy times, ground-based laser systems for ballistic missile defense applications need geographical multiplicity and techniques for correcting atmospheric propagation aberrations. The APS commission concludes that the ground-based laser systems will require either linear or nonlinear adaptive optics of a very sophisticated nature in order to pre-compensate the laser beam for atmospheric aberrations caused by atmospheric turbulence and by thermal blooming induced by the laser itself. This technique requires an extensive computational capability and software of high complexity. Detection and acquisition of ICBM launches will pose stringent requirements for high detection probability and low false alarm rates. ■

Continued from page 56

Toshiba 5100 Portable

Toshiba's high performance, 16MHz, 80386-based portable computer features the following: a built-in EGA display with a high resolution gas plasma screen and EGA/CGA ports; four grey scales with 640 x 400 bit-mapped graphics; 82-key keyboard with embedded numeric and dedicated cursor keys; RS232, selectable parallel printer/5.25 inch floppy disk drive are included as well as a port for an optional, external 101-key AT style keyboard. The power supply operates at 110/240VAC and is autosensing. MS-DOS 3.2 is also included.

Options include an internal 1200 Baud Hayes-compatible modem, external 5.25 inch floppy drive, expansion card and chassis which houses up to 5 IBM-compatible cards.

The price? $11,499.00.

Contact: Julie Tipton, Marketing Specialist, Computers, Information Systems Division, 191 McNabb Street, Markham, Ontario L3R 8H2.

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