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Electronics NOW

Vol. 69 No. 7

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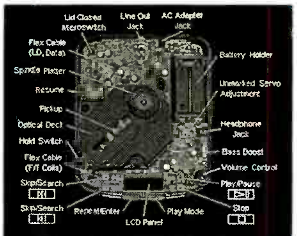

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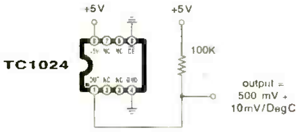

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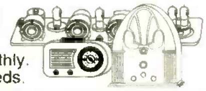

EDITORIAL

Who Are You? What Do You Want?

Fans of the science fiction TV series, *Babylon 5* are sure to be familiar with the above questions. They also know that the answers to those questions proved pivotal to the survival of all of the so-called "younger" races, including Humans, in *B5*'s fictional Universe.

However, this Editorial is not about a TV program or some highly speculative future. Instead it is about us, and it is about you. If **Electronics Now** is to continue as a relevant and meaningful resource we need to know: Who are you? What do you want?

For us to provide articles and information that satisfies the needs of you, our readers, we need to know as much as we can about you. Why do you read this magazine? If you are only an occasional reader, what makes some issues more appealing than others? What parts of the vast and varied electronics hobby are the most interesting to you? How experienced are you in building? Do you spend more time in front of a computer or a workbench? Is electronics also your profession?

In short: Who are you?

But there is more. Are there types of articles we are missing? Are there areas of coverage you would like to see expanded or reduced or eliminated? Do you like our new "Prototype" section? Do you want more articles on the "bleeding edge" of technology? Do you want more articles that cover the basics? Do you want more construction articles? Do you want fewer construction articles? Do you want simpler projects? Do you want more complex projects? Do you want more articles about computers? Do you want fewer articles about computers?

In short: What do you want?

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Carl Laron

Carl Laron
Editor

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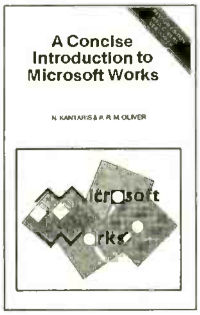

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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Logic Analyzer Corrections

I have received many questions and comments from **Electronics Now** readers regarding my article, "Build a High-Performance Logic Analyzer" in the March 1998 issue. The schematic on page 34 has several errors that should be corrected. On IC1, there are two pins labeled 2. The pin that is connected to C27 should be labeled 13. There are also two pins labeled 26. The pin that feeds signal *RAMWR should be labeled 25. Two pins are labeled 16. The pin that feeds signal *RAMRD should be labeled 19. On IC2, pins 5 and 8 should be connected to pins 2, 6, and 12, which all go to ground.

The representation of J1 has also caused some confusion. The pinout of J1 does not correspond to the layout shown on the schematic. The actual DB25 connector has pins 1 to 13 in a row on one side with pins 14 to 25 in a row on the other side.

There have been several questions about IC1, the Lattice ispLSI1016E.

Write To:
Letters,
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Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

This device can be programmed in the system without the need for a special programmer. The isp prefix stands for In System Programmable. The Logic Analyzer board has provisions for programming the ispLSI1016E on the board. You would need to install an 8-pin SIP header in the location next to IC1, and you need to remove IC8 before programming. A simple adapter cable allows programming of ispLSI devices from the parallel ports of Windows PCs.

The design and programming software is available free from the Lattice Web site at www.latticesemi.com. You can also get the data sheet for the ispLSI1016E and the schematic for the adapter cable. More information about in-system programmable PLDs can be

found on the Alta Engineering Web site at www.gutbang.com/alta (download PLDXPLOR.ZIP) as well as links to the Lattice Web site and many other PLD vendors that offer in-system programmable devices.
ROBERT G. BROWN

Phone Number Information

In the article, "Add a Video Trigger to Your Oscilloscope" (**Electronics Now**, June 1998), the telephone number for the kit supplier, MicroLabs, Inc., was not included. That telephone number is 847-437-4950.
DAN MICHELSON

Thanks!

I have been a subscriber to this publication, and its predecessors, for a long time. In fact, I first became interested in electronics in 1937 when my father told me to get the chemicals out of the basement, and I have made a good career of it ever since. Now I find it is time to slow down.

Anyway, I have a 7-foot-tall, 19-inch relay rack on casters, with extra panels. I will be glad to give this to the first person who can come and pick it up. Will include lots of extras. First call reserves it.
ROY A. NORMAN
223 Shangri La Avenue
Brunswick, GA 31525-1923
Tel: 912-264-1809

More On "Green" Cars

In your "Letters" column in the April 1998 edition of **Electronics Now**, reader Richard Percifield debunks all the myths about the so-called pollution-free automobile. I've been hearing them for years and wondered if I've been on the wrong wavelength.

Even with a 100 percent efficient motor and speed controller and a perfect battery (I wouldn't want to be around one if it shorts out), the electric car will remain a fun project for backyard inventors and engineering schools with big, federal grants. The solution, as Mr. Percifield points out, is a hybrid vehicle.

By the way, the same can be said for wind generators and solar panels. Renewable resource, yes; practical, no.
BOB ZILLER
via e-mail

EN

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

DC Fluorescent Lights

Q *In your Q&A column, September, 1997, you said, "You can't run a fluorescent light on DC." This is not true. I served on diesel electric submarines. We used fluorescent lights on submarines as long as 50 years ago, even though our circuits were powered from 120 volts DC.*

DC fluorescents differ from AC units in three ways. First, a current-limiting ballast resistor must be added in series with the reactance ballast. Second, the tube cathodes must be preheated—using a momentary-start switch—to fire up the tube. Third, to prevent the build-up of deposits at the negative end of the tube, the polarity must be reversed periodically with another switch. — Farnham M. Cornia, Chief Electrician's Mate, U.S. Navy (retired), Toledo, WA

A You're right, of course; we should have said "You can't use an inductive ballast (by itself) with DC power." When the ballast is a resistor or includes resistance, the fluorescent lamp works fine, although the resistive ballast wastes some energy.

A circuit we breadboarded to demonstrate this is shown in Fig. 1. Press the "start" button for 10 seconds to light the lamp. A better circuit would reduce the ballast resistance during starting to heat the cathodes more quickly. Thanks for writing!

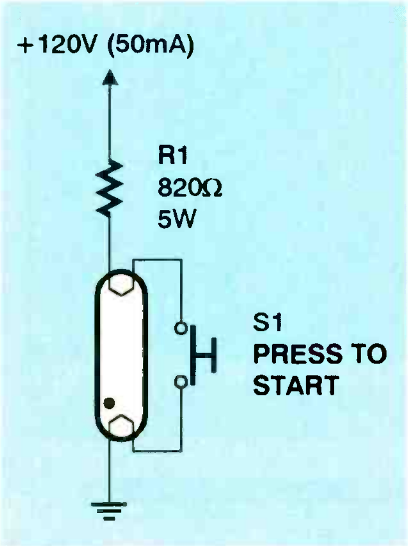

FIG. 1—HERE'S HOW TO power a fluorescent lamp from a DC source. The resistor is used as the ballast. One advantage of this is that there is no flicker or radio interference.

Battery-Low and Battery-OK Indicators

Q *I need a circuit for a low-battery indicator for a battery-operated radio. I'd like to use an LM339 quad comparator chip as a window comparator to control a two-color (common-cathode) LED that will be green when the battery is OK and red when it is low.*

My problem is that all my books show window comparator circuits with a separate power supply from the voltage under test. How can I get around this? The radio in question has a 4.7-volt regulated B+ line. Can the circuit compare this line to the main 9-volt supply, and flip when the main supply gets down to 4.7 volts? — G. B., Angola, LA

A Your last idea is a sound one, but because of the way regulators work, the 4.7-volt regulated line will always be below the main supply; when the voltage falls too low, they'll fall together. Most regulators can only subtract, not add, voltage.

The key to your problem is to compare *part* of the supply voltage to a known standard—that is, drop the voltage with a voltage divider, and compare that to a known, fixed voltage, which you can obtain with a Zener diode.

Figure 2 shows how to do it with a single LED indicator. This circuit compares *two thirds* of the input voltage to a fixed 5.6-volt level regulated by a Zener. Because it's carrying little current, the 1N5232 actually holds the voltage somewhat lower than its rated 5.6 volts; higher-wattage Zeners would be even more inaccurate. You may have to experiment with Zener diodes until you get the results you need. Changing R2 to 10K will save power, but will throw off the Zener voltage even further. Or you can simply connect pin 5 of the LM339 directly to the regulated 4.7-volt line that you already have.

If you want the LED to light when the battery is low rather than when it's

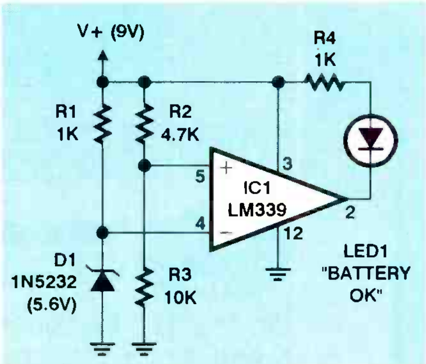

FIG. 2—IN THIS CIRCUIT, the comparator lights the LED only when V+ is above 8 volts.

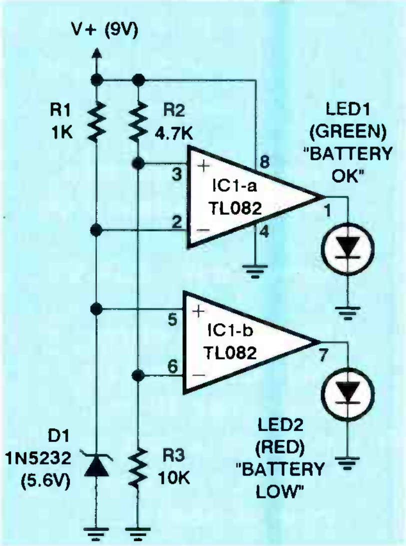

FIG. 3—THE CONDITION OF A BATTERY can be monitored using this circuit. As long as the green LED is lit, the battery is fine. The red LED lights when the battery voltage is low.

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On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

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Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549, Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League, Newington, CT 06111; (http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

OK, swap the positive and negative inputs of the comparator.

Now for your two-color indicator: Because you are using common-cathode LEDs, the LM339, with its open-collector output, is not satisfactory. Instead, use a TL082 dual op-amp wired as two comparators, one with its inputs swapped relative to the other; see Fig. 3. Like a number of other op-amps, the TL082 can drive an LED directly without a current-limiting resistor.

However, even *that* isn't a window comparator, because it doesn't pick out a "window" (*i.e.*, a voltage range)—it just tells you whether the voltage is above or below a certain value. A window comparator tells you whether a voltage is between two specific values. That's where the open-collector outputs of the LM339 come in handy; you can tie two of them to a single load resistor so the output will be high only when both comparators are satisfied (Fig. 4). The

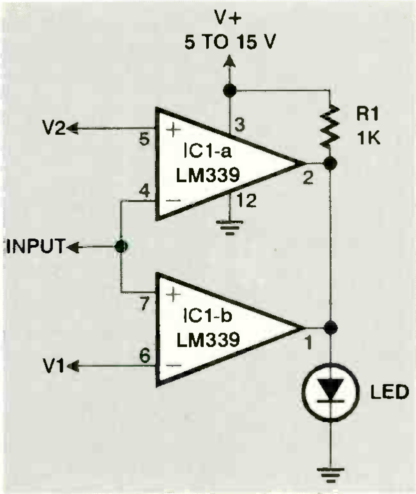


FIG. 4—IN THIS WINDOW COMPARATOR, the LED is lit only when the input voltage falls between V1 and V2.

rest of the time, the current that would go through the LED is shunted to ground by one or the other comparator.

Note that with all of these circuits, the voltages being compared should, in general, be at least 2 volts below V+ and at least 2 volts above ground. If that isn't the case, consult data sheets to make sure the voltages you're using are within the common-mode input range of the op-amp or comparator.

High Voltage Wanted

Q *I have an electronic air cleaner system for which no replacement parts are available. The original unit was powered by a positive-output DC power supply with 120-volt AC input, 7500-volt 3.3-mA DC output. Can I build a replacement power supply using easily available components? — G. K., Tipton, IN*

A Some things are easy to do with common parts, but, unfortunately, generating high voltage safely is not one of them. The trouble with building high-voltage power supplies is that even if you don't get electrocuted (quite possible at 7500 volts and 3 mA), the smallest mishap will fry all the semiconductors in the circuit and you'll have to start over.

Instead, the best choice in your situation is to fix the existing power supply if possible. Second choice is to find a surplus power supply that will fill the bill. The company that made the supply module may still be in business even if the maker of the air cleaner isn't, and a similar unit may still be available through the air cleaner industry.

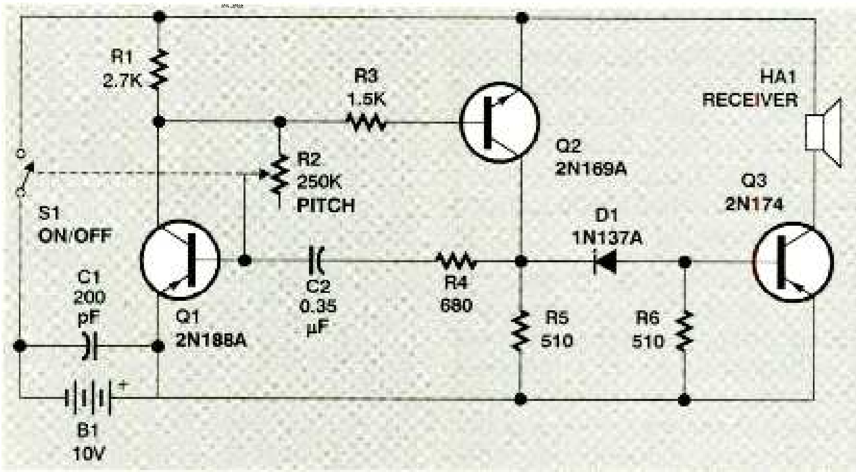


FIG. 5—THIS CLASSIC BELL LABS artificial larynx dates from the 1950s. The device labeled HA1 is the telephone receiver.

Some power supplies used in lasers have specifications similar to what you describe; maybe a laser power supply would work. Three companies that sell surplus high-voltage power supplies are Marlin P. Jones, P.O. Box 12685, Lake Park, FL 33403, Tel: 800-652-6733; All Electronics, P.O. Box 567, Van Nuys, CA 91408, Tel: 800-826-5432; and Herbach and Rademan, 16 Roland Ave., Mt. Laurel, NJ 08054, Tel: 800-848-8001. We suggest you see what they have, but remember that 7500 volts is high enough to penetrate many insulating materials, and at that voltage, a current of 3.3 mA is *potentially lethal.* Don't take chances! It might be time to just replace the whole air cleaner.

Cable Scrambling Mystery

Q *Can you explain why when I view some scrambled cable TV channels I get intermittent sound with the audio taken from the "audio out" terminals of the VCR, but uninterrupted sound with the cable signal supplied directly to the TV set? I thought the circuitry required to separate audio and video signals would be standardized by now and would be the same for both VCRs and TVs. — W. S. A., North York, Ontario, Canada*

A We assume you were viewing them without a descrambler; if that's not so, something's wrong with your descrambler.

Cable TV signals are scrambled by making them differ in some way from the standard signal. Different TVs and VCRs have different amounts of tolerance for nonstandard signals, just as different cars perform differently on bad gasoline. Even if the circuits in all TVs and VCRs were identical, which they aren't, there would still be some differences between resistors, capacitors, and transistors due to manufacturing variation.

Artificial Voice Box

Q *In response to the letter from E. C. in your February 1998 "Q&A," I am enclosing a circuit from the Sourcebook of Electronic Circuits, by John Markus, 1968 (see Fig. 5). I do not fully understand this circuit. Where does the sound come out? Why the odd (10 volts) battery voltage?*

I am a woman and would like to build this or another circuit that would be able to raise the pitch to produce a female voice. I would also like a circuit I could use that would help people understand me better when I used the telephone. — K. S., Marquette, MI

A An artificial larynx, for those who missed the February column, is a device that vibrates the throat so that a person who has no vocal cords can talk. You hold the device to your throat and whisper; the resulting speech is a robot-like monotone, but it's better than not being to speak at all.

The circuit you are asking about is about forty years old. We first saw it in the book *Transistor Circuits*, by Lou Garner, published in 1960, and it wasn't brand-new even then. The transistors are germanium; we're not at all sure the circuit would work with modern silicon transistors. Nowadays, we'd use a 555 oscillator.

The odd battery voltage is due to the fact that the circuit dates from before the standard 9-volt battery. The component labeled "HA1 receiver" is a telephone receiver, *i.e.*, the tiny speaker from a telephone handset; it probably had an impedance of about 600 ohms.

We tried to breadboard an artificial larynx and found it surprisingly difficult. The hard part is not electronic but acoustical—you have to find an output transducer that will vibrate a person's throat effectively without putting too much sound out into the air.

As regards pitch, the most understandable speech will probably result from using a frequency between 100 and 200 Hz, regardless of whether you are male or female. To be recognized as female, you can set the pitch higher (as high as 400 Hz), but understandability will suffer because vocal tract resonances lower than 400 Hz will no longer be picked up. As for an add-on circuit for your telephone, we don't know of anything simple that you can do, other than adjust the pitch for best results over the telephone. We think digital signal processing has a lot to offer, but it's not a matter of building a simple circuit—lots of creative engineering is needed.

Weak-Signal 49-MHz Reception

Q *We give 49-MHz low-power walkie-talkies to people who wander out into the desert so they can call for help, but they get out of range of our vertical whip antenna. We built a single-element quad antenna that provided much better results, but it was still not sufficient. Would a Mini-Circuits 3-stage amplifier put directly on the antenna connections help? Or a set of op-amps like that in your September, 1995 column? — G. S., Essex, CA*

A Op-amps of the ordinary kind definitely won't do the job; many of the newer ones work well at 1.5 MHz, but 49 MHz is far beyond their range. Mini-Circuits RF amplifiers are more suitable, but remember that if you're using a transceiver, you'll have to switch the amplifiers out of the circuit when you transmit. Since 49 MHz is close to the 6-meter ham band, you can use any preamplifier designed for 6-meter ham work.

As for antennas, there are two basic ways to improve VHF reception: make the antenna more directional and raise it higher off the ground. By switching to a

(Continued on page 30)

Prototype

Pulling Quicker Chips Out of Thin Air

When it comes to computer speeds, one of the limiting factors is the architecture of the chip itself. The closer the lines within the chip can be spaced, the faster the signals would travel. However, there's a limit; place the lines too close together for the insulating properties of the substrate, and the signals will degrade.

The insulating property of a material is designated by its dielectric constant. Today's chips commonly use silicon dioxide (SiO_2), which has a dielectric constant of about 4. If a substrate with a dielectric constant of 2 could be developed, computer speeds could easily be increased by a factor of two or more.

Air, of course, is the perfect insulator. It has a dielectric of 1. While chips obviously can't be held together with air, a research team at Rensselaer Polytechnic Institute, Troy, NY is learning how to solve the problem with aerogels, a family of substances that are more air than solid material. They have already successfully created highly porous silica aerogel films that are between 65 and 90 percent air, and that have dielectric values ranging from 2.3 to 1.4.

Thinner Than Air

Aerogels, discovered in the 1930s, are unique in chemistry. Their constituent pores and particles are both smaller than the wavelength of visible light. Silica (silicon dioxide) aerogels consist of bonded silicon and oxygen atoms joined into long strands and then into beads randomly linked together with pockets of air between them. They can be fabricated to be less dense than air and are excellent sound, heat and electrical insulators.

"We have a process to make aerogel films under ambient temperature and pressure conditions that enables us to integrate the deposition of aerogels into

RENSSELAER RESEARCHER JOEL PLAWSKY is shown here removing an aerogel-covered wafer from a climate-controlled spin coater.

semiconductor processing," says Joel Plawsky, associate professor of chemical engineering at Rensselaer. "This is important because the next generation of devices will have to use dielectric materials with much lower dielectric constants than the thermally grown SiO_2 currently used to avoid propagation delays and excessive crosstalk."

The Rensselaer aerogels were announced and displayed in November 1997 when members of the Center for Advanced Interconnect Science and Technology (CAIST) gathered on the Rensselaer campus to hear reports. An interdisciplinary university consortium, CAIST was established by industry to improve interconnects, the minuscule system of wires and insulation that carries messages on a chip. The team of Plawsky and colleagues Peter Wayner and William Gill from Rensselaer's Isermann Chemical Engineering Department demonstrated that it can control porosity and thickness of their aerogel. Their new films apparently do not create problems by absorbing water during processing. They also stand up well to high temperature.

The importance of aerogels as a possible solution to lowering the dielectric constant can be seen in the research race underway. At the December 1997 IEEE International Electron Devices Meeting in Washington, DC, Texas Instruments (TI) eported that it has demonstrated the successful combination of copper wiring with a similar aerogel substance it calls xerogel. Illustrating the importance of this new type of insulator, TI estimated that within a decade combining xerogel with copper wires and new designs could result in devices that are several times faster than today's best chips.

Researchers say aerogels will probably be used once device dimensions shrink significantly below 0.25 microns. (Gate lengths using 0.18-micron technology have been announced by several manufacturers.) "At that point they will be married with copper conductors to achieve speed increases perhaps a factor of 10 higher than current microprocessors," Plawsky says.

Other Applications

These aerogel materials are not limited to dielectrics. "We can make 'active' devices from them by growing semiconductor nanoparticles inside," Plawsky explains. "We generally modify the surface of our materials with organic functionality to make the material resistant to water. Such modification can also be used to make sensors, nanoreactors, and other items."

There are many problems remaining for researchers. "As chemical engineers our primary interest is how chemistry and processing combine to produce a material with a given set of properties," Plawsky says. "Our research focuses on how to control the material properties and how we can develop mathematical models that incorporate the details of the chemistry and the processing in order to predict the performance of the material."

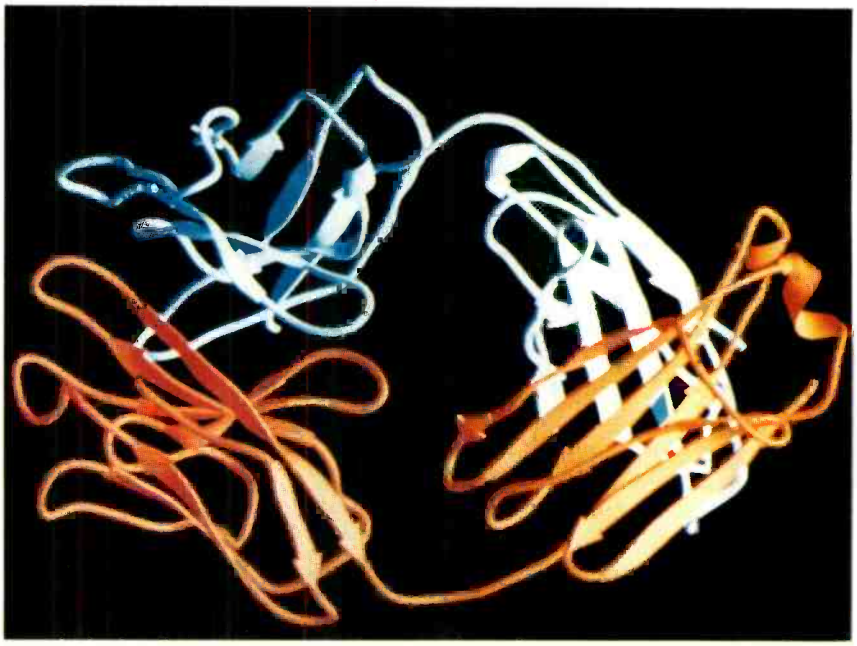
The next step in the research is to determine how the aerogel materials interact with metallization layers such as copper. Plawsky said that, in particular, they are interested in whether copper diffuses into the aerogel and how to control it. "We are also interested in whether copper adheres to the aerogel and how to control the surface properties of the aerogel and copper to enhance the adhesion," he said.

Aerogels have distinct properties that are attractive in a number of technologies. One inch of aerogel, for instance, provides insulation five times better than six inches of fiberglass. Indeed, aerogel was used in the Mars Pathfinder mission to provide a lightweight, highly insulating environment to protect Sojourner's electronics from the harsh, cold climate on the surface of Mars. NASA also plans to use silica aerogel material, the lowest density solid substance in the world, to collect comet dust samples on the Stardust mission to comet Wild-2 in early 2004.—DOUGLAS PAGE PT

"Anti-Virus" Space Research

Respiratory Syncytial Virus is a life-threatening infection that attacks the respiratory airways and lungs in infants and young children. Nearly four million children ages 1 to 5 are infected every year in the U.S., and approximately 4000 of them die. The virus is considered by physicians to be the most serious disease for infants in the United States.

However, help might be on its way. NASA and industry biotechnology researchers have taken an important step toward developing a treatment for this potentially heartbreaking illness. "Through NASA funding research in



USING DATA OBTAINED BY GROWING ANTIBODY CRYSTALS on the space shuttle, researchers have been able to create a molecular model of the antibody to a life-threatening virus that affects millions of infants and young children.

space and on the ground, and the application of space technology, we have determined the three-dimensional atomic structure of a potentially very important therapeutic antibody to this virus," said Dr. Daniel Carter, president of New Century Pharmaceuticals (Huntsville, AL), whose own six-week-old daughter caught the respiratory infection. Fortunately his daughter recovered, although the hospital had no treatment to offer her

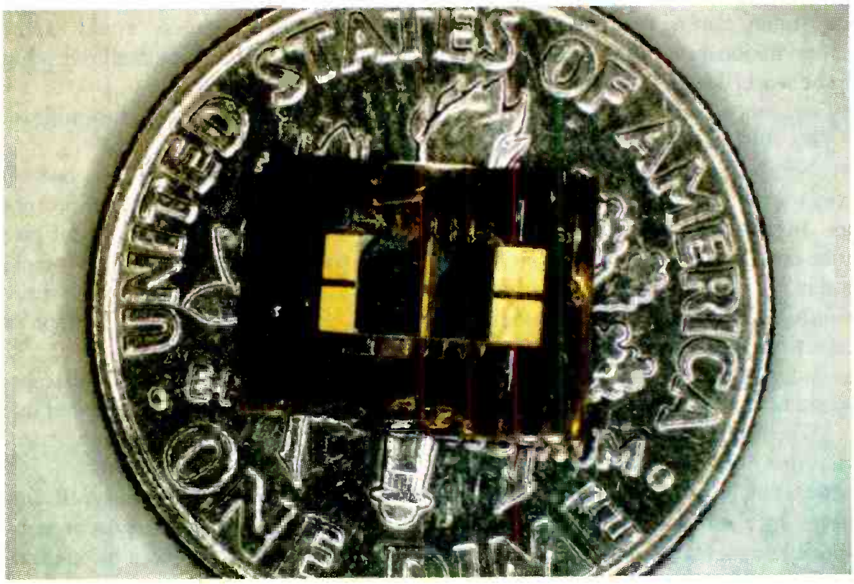
Carter's research team used the viral antibody to grow antibody crystals aboard the Space Shuttle Columbia. In the weightless environment of space known as microgravity, the antibody crystals grew larger and were of better quality than those previously grown on Earth. Using highly specialized X-ray equipment and computers, scientists at New Century Pharmaceuticals located the key positions of individual atoms in the crystal structure and constructed a model of the antibody. Knowledge of its molecular structure will permit scientists to understand key interactions between the antibody and virus, facilitating development of treatments for the disease.

"Currently there is no vaccine against the virus," said Simon McKenzie, chief executive officer of Intracel Corp. (Issaquah, WA), which developed and produces the antibody. "Since this antibody neutralizes all known variants of the virus, therapeutics developed from it should have a major impact on lowering the mortality rate caused by the disease."

The joint research effort by government and industry is sponsored by the NASA Microgravity Research Program's Biotechnology Office at the Marshall Space Flight Center in Huntsville. PT

Magnetically-Actuated Microrelay

A new type of magnetically-actuated microrelay that can be batch-produced using micromachining techniques could have applications in automobile electronics, test equipment, and other areas where low actuation voltages are required. The devices, which are smaller than a dime, have set records for their low contact resistance and ability to switch large current loads.



AS THIS PHOTO SHOWS, Georgia Tech's new microrelay is exceptionally small, yet it offers some large advantages.

Developed by researchers at the Georgia Institute of Technology, the microrelays can be integrated onto circuit boards because their fabrication techniques are compatible with standard microelectronic processing. The design allows similar configurations to be used for both normally-on and normally-off relays, as well as for multipole relays.

"The significant issue in using a magnetically-actuated relay is that you can achieve larger forces and a greater air gap between contacts when compared to electrostatic relays," explained William P. Taylor, who developed the devices as a researcher in Georgia Tech's School of Electrical and Computer Engineering.

The Georgia Tech microrelays operate at less than five volts, which would allow them to be driven by digital logic circuits and used as part of equipment for which higher voltage could be undesirable. Their contact resistance of less than 100 milliohms and the ability to switch currents of up to 1.2 amps set a new record for microrelays, Taylor said. The microrelays range in size from 3mm by 4mm up to 7mm by 8mm, and are less than 200 microns in height.

In addition to their reduced size, the devices offer cost advantages. "The advantage is that every step you take uses photolithographic techniques to build 100 or 599 relays on a wafer instead of just one relay," according to Taylor. "At the end of the process, you just cut them up like you would semiconductor chips. This provides some real economies of scale and should help lower production costs."

Fabrication begins with a silicon wafer that has been oxidized. The researchers then deposit a seed layer and electroplate a lower magnetic core, adding an insulating polymer mold above that. Then a coil is electrodeposited and coated with an insulator. The remainder of the fabrication is completed by alternating steps of polymer mold deposition and electroplating.

"By doing it this way, many devices can be built on the same wafer at the same time, so there is no need for hybrid assembly," Taylor stated. "Everything is assembled on the same wafer." PT

Next Generation Internet

NASA and Cisco Systems, Inc. of San Jose, CA are collaborating to test and demonstrate Next Generation Internet (NGI) hardware and software. Support for the NGI was expressed by John Mogridge, chairman of Cisco's Board of Directors. "The Next Generation Initiative is a wise and far-sighted investment that will enable our campuses and national research labs to continue to be world-leading drivers of technology and innovation."

By 2002, research and development by NASA and five other federal agencies on the NGI initiative could result in information flowing over the Internet 100 to 1000 times faster than today's speeds, according to NASA engineers. The federal agencies are conducting research that could interconnect "core sites" with other high-speed lines.

"We want to guarantee levels of service that will eliminate slowdowns and network stagnation that users sometimes have to endure while waiting for Internet images, movies, and other services," said Christine Falsetti, NGI Project Manager at Ames. "Technical advances will spin off from NGI, and industry will put improvements into the 'old' Internet to make it work better and faster."

"Our work should eventually allow users to do things that they can't do today via the Internet," she said. For example, consumers might be able to see high-quality video programs *on demand* and use high-quality teleconferencing via the Internet as a result of this work, according to Falsetti.

Ames Research Center is leading NASA's portion of the federal project to develop the NGI. In addition to NASA, the principal federal agencies involved in the NGI initiative include the National Science Foundation, the Defense Advanced Research Projects Agency, the Department of Energy, and the National Institute of Health. PT

CEMA Reports on Digital Radio

Concluding its six-year evaluation of Digital Audio Radio (DAR) systems, the Consumer Electronics Manufacturers Association (CEMA) recently filed its final report with the Federal Communications Commission (FCC). The DAR Subcommittee examined nine proposed technologies for broadcast digital audio radio. Of all the systems tested, only the Eureka-147/DAB system offers the audio quality and signal robustness that listeners would expect from a new DAR service in all reception environments.

The other systems had significant problems:

1. The IBOC (in-band, on-channel) systems as presented and tested are not feasible at this time due to deficient performance in the areas studied—audio quality, performance with channel impairments, RF compatibility, and extent of coverage.
2. The IBAC (in-band, adjacent-channel) system cannot be deployed due to interference with the current spectrum occupancy of the FM band.
3. The VOA/JPL (Voice of America/Jet Propulsion Lab) system at S-band frequencies is subject to continuous and/or repeated outages due to blockage.

"Despite these results, last spring we halted advocacy of any system at the request of the broadcasters who said they needed more time to correct the flaws of the IBOC system. We look forward to broadcasters demonstrating in the near future a system that will work," said Gary Shapiro, CEMA president. The report "Technical Evaluations of Digital Audio Radio Systems: Laboratory and Field Test Results, System Performance, Conclusions" is available through the FCC or CEMA's Web site: www.cemacity.org/pubs/dar.htm. PT

Quantum Computing 101

While common digital computers are based on electron conductivity, quantum computers will manipulate individual atoms to perform many calculations at once by taking advantage of quantum physics. In June, Los Alamos scientists published one of the first books on this subject: *Introduction to Quantum Computers* (World Scientific Publishing Co.).

The text reviews the very brief history of quantum computing, starting with the 1994 discovery of the first quantum algorithms that can provide fast factorization of integers. The authors illustrate essential concepts and algorithms that make it possible for a quantum computer to solve problems impossible for digital computers. PT

Intelligent Highways

Intelligent Transportation Systems (ITS) are meeting the challenge of major road reconstruction in New York City. Work on the Prospect and Gowanus Expressways in Brooklyn, New York was facilitated by the implementation of the Traffic Command Center (TCC). Located in a renovated warehouse near the project and connected via fiber-optic cable to the various electronic devices on the two expressways, the TCC coordinates the ITS components and mitigates the effects of construction activities and incidents on traffic in the construction area. The Prospect and Gowanus Expressways are major arteries for Brooklyn and Queens, and connect directly to other highways to Manhattan, Staten Island, and northern New Jersey.

Personnel in the TCC detect incidents and direct appropriate action to clear the roadway and restore traffic flow in the vicinity as quickly as possible. The use of Traffic Observation Devices (TODs), video-camera surveillance (CCTVs), and dedicated tow trucks has reduced response time and accident clearance by more than half. Variable Message Signs (VMS), Highway Advisory Radio (HAR), and a toll-free telephone system are used to notify the public of current road and traffic conditions and to direct motorists to alternate routes. The TCC is in operation 24 hours a day year round.

"This is the first time we've seen an Intelligent Transportation System built to help motorists through a highway renovation," stated Mark Kulweicz, Traffic Engineering Director, AAA New York. ITS could become a routine part of major construction projects, according to Kulweicz.

This project has worked so well that NYSDOT would like this "smart" highway system to be permanent and is exploring ways to make this happen. "Traffic is moving safely and smoothly through the construction area with only minor delays. In some areas, the traffic is actually moving better than before," said project manager Harry Kamamis. A key question that needs to be resolved, however, is who will pay for the cost of its ongoing operation. PT

BY SAM GOLDWASSER
SERVICE EDITOR

CD Player and CD-ROM Drive Maintenance

WHILE IT IS TEMPTING TO SUSPECT THE MOST EXPENSIVE COMPONENT (LIKE THE LASER) WHEN YOUR TRUSTY CD PLAYER OR CD-ROM DRIVE REFUSES TO COOPERATE, THE MOST COMMON CAUSE IS ACTUALLY A DIRTY LENS, WITH THE next most likely causes being simple mechanical problems like a bad belt, dirt, and gummed-up lubrication. This month we are going to cover general inspection, cleaning, and lubrication. After all, a little tender loving care may be all that is needed to get your unit up and running.

Inside A CD Player or CD-ROM Drive

Before we begin, it would be useful to familiarize ourselves with the insides of some typical units. We'll also define some terms to minimize any chances of confusion as we proceed with the rest of our discussions on CD player/CD-ROM-drive repairs.

Let's begin by taking a look at a couple of typical mechanisms: An RCA RP7903A portable CD player with the top cover removed is shown in Fig. 1. Note how everything is squeezed into a package only slightly larger than the CD itself. When a CD is loaded, it conveniently blocks access to everything below it—which is a real pain when it comes time for servicing!

Figure 2 shows a Teac CD-532S CD-ROM Drive, a popular design used in late model (1998) low-cost high spin-rate units. This one is a 32× model with a SCSI interface. It is interesting to note that the 32× rating really means that it spins at constant speed roughly equivalent to a 13× rate, and the 32× transfer rate is only achieved for data located near the outer edge of the disc.

Although there are many variations on the basic theme, every CD player or CD-ROM drive has a power supply, logic/control board or boards, and an optical deck—which is the heart of the unit. The optical deck includes all those components directly associated with loading, spinning, and reading the disc.

An optical deck from a Sony D2 portable CD player is shown in Fig. 3. This is very typical of what is found in a variety of consumer-grade portable as well as full-size CD players and older CD-ROM drives. It uses a gear mechanism for moving the pickup.

Figure 4 shows the very simple optical deck from a Philips CD-206 CD-ROM drive. It uses the less-common rotary type positioner (more on that later).

The optical decks in changers are similar but there will be an additional mechanism for selecting the discs from the carousel or cartridge.

The following summary identifies the major parts of the optical deck. Note, however, that not all models will have all of these items.

Loading Drawer: Most portable and many lower cost CD players or CD-ROM drives do not include this convenient feature. Of the ones that do, most are motor driven; however, some must be pushed in or pulled out by hand. One common problem with the loading-drawer mechanism is loose or oily belts that result in the drawer either not opening or closing at all, or opening or closing only partially. There also might be mechanical damage such as worn or fractured gears or broken parts. Another possibility is that the drawer switch might be dirty, causing the drawer to decide to open or close on its own. Finally, the motor might be shorted, have open or shorted windings, or even have a dry or worn bearing.

Spindle Table or Platform: When the disc is loaded, it rests on this platform, which is designed to automatically center the disc and minimize runout and wobble. Common problems here include dirt on the surface, a bent spindle, or dry or worn motor bearings.

Spindle Motor: This is the motor that spins the disc. Most often, the spindle platform is a press fit onto the spindle motor. There are two common types: a miniature DC motor that uses brushes similar to the motors found in toys and other battery-operated devices, and a brushless DC motor that uses Hall-effect devices for commutation. Common problems with these motors include a partially shorted commutator (brush type), a shorted or open winding, and dry or worn bearings.

Clamper: The clamper is usually a magnet on the opposite side of the disc from the spindle motor that prevents slippage between the disc and the spindle platform. The clamper is lifted off the disc when the lid or drawer is opened. Alternatively, the spindle may be lowered to free the disc. A common problem here is the clamper not engaging fully, thus permitting the disc to slip on the spindle because of a mechanical problem in the drawer-closing mechanism.

Sled: This is the mechanism that the optical pickup is mounted upon. The sled provides the means for moving the optical pickup across the disc during

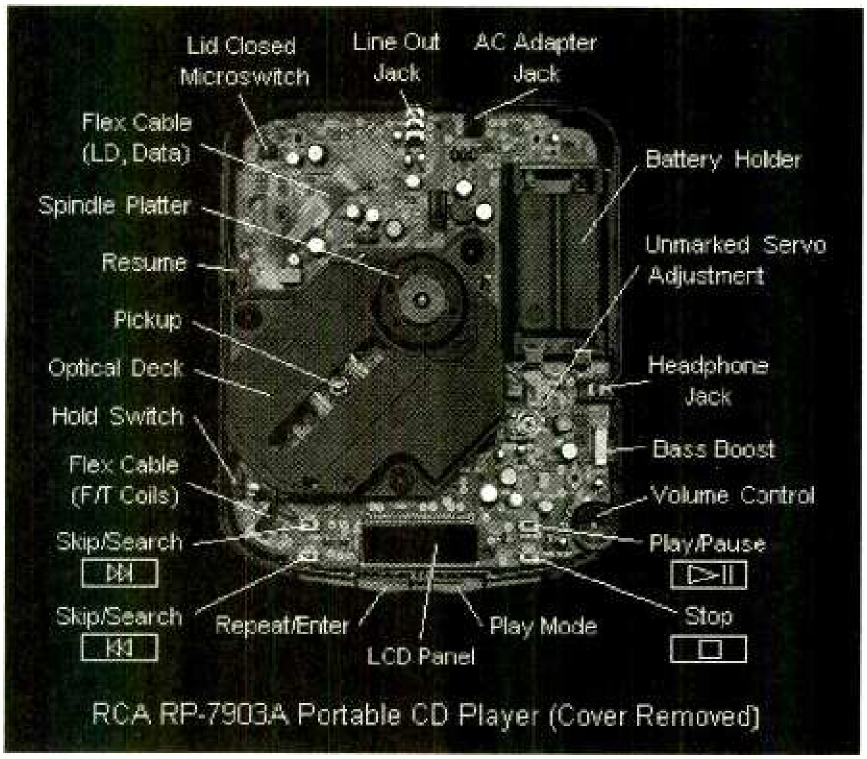


FIG. 1—LIKE MOST MODERN PORTABLES, there's not a lot of room inside this RCA RP7903A.

normal play or to locate a specific track or piece of data. The sled is supported on guide rails and/or bearings and is moved by either a worm or ball gear, a rack-and-pinion gear, a linear motor, or rotary positioner similar to what is found in a modern hard-disk drive. Common problems include dirt, gummed up or no lubrication, and damaged gears.

Pickup Motor: The entire pickup moves during normal play or for rapid access to musical selections or CD-ROM data. The motor is either a conventional miniature permanent-magnet DC motor (with belt or gear with worm, ball, or rack-and-pinion mechanisms) or a direct-drive linear motor or rotary positioner (with no gears or belts). Common problems include a partially-shorted motor, shorted or open winding, and dry or worn bearings.

The Optical Pickup

Next, let's turn our attention to the optical pickup, which is usually a self-contained and replaceable (though generally very expensive) subassembly. The good news is that, despite the fact that it is a precision opto-mechanical device, optical pickups are remarkably robust and are not that easily susceptible to mechanical damage.

Laser Diode: This is a near infrared (IR) emitting device that usually operates at 780 nm, which is just outside the visible range of 400 to 700 nm. The power output is no more than a few milliwatts, and is further reduced to 0.25 to 1.2 mW at the output of the objective lens. A photodiode inside the laser-diode case monitors optical power directly and is part of a feedback loop that maintains the laser output at a constant and extremely stable value. Common problems here include a bad laser diode or sensing photodiode, causing a reduction or loss of the laser output.

Fixed Optics: These consist of the collimating lens, diffraction grating (only found in three-beam pickup), cylindrical lens, beam splitter, and turning mirror. Note that not all of these will necessarily be present in a given pickup; the functions of these components were discussed in a previous installment of this series. The good news here is that, outside of damage caused by a serious fall, there is little to go bad. Actually, that is very good news as it is usually very difficult to access any of the fixed-optics components, and even if you could, there is no easy way to realign them. Fortunately, except for the turning mirror, it is unlikely that they would ever need cleaning, and even the turning mirror is usually fairly well protected and remains clean.

Objective Lens: This is a high-quality plastic focusing lens, very similar to a good microscope objective with a focal length of 4 mm. Common problems with it include dirty lens, dirt in the lens mechanism, and damage from improper cleaning or excessive mechanical shock.

Photodiode Array: This is the sensor that is used to read back data and control beams. Common problems are bad photodiode(s) resulting in improper focus or absence of focus and weak or missing RF signal.

Focus Actuator: Since focus must be accurate to 1 micron (1 μm), a focus servo is used to keep it on target. The actuator is actually a coil of wire in a permanent magnetic field much like the voice coil of a loudspeaker. The focus actuator can move the objective lens up and down (closer or farther from the disc) as needed based on-focus information taken from the photodiode array. Common problems here are a broken coil or damaged suspension (caused by mechanical shock or improper cleaning techniques).

Tracking Actuator: Like focus, tracking must also be accurate to 1-μm or better. A similar voice-coil-type actuator moves the objective lens from side to side, based on tracking feedback information taken from the photodiode array. Note: On pickups that have rotary positioners, there may be no separate tracking coil as its function is taken care of by the positioner servo.

Common CD-Player Problems

While there are an almost infinite number of distinct things that can go wrong with a CD player, any set of symptoms can be classified as either a hard failure or a soft failure. A hard failure includes such things as door opening/closing problems, discs not being recognized, no sound, unit totally dead, etc. Soft failures include skips, continuous or repetitive audio noise, search or track-seek problems, and random behavior.

Both types of problems are common. The causes in both cases are often very simple, easy to locate, and quick and inexpensive to repair. Here is a short list of the most common causes for a variety of tracking and audio or data readout symptoms:

- Dirty optics—lens, prism, or turning mirror.
- Drawer loading belts—worn, oily, flabby, or tired.

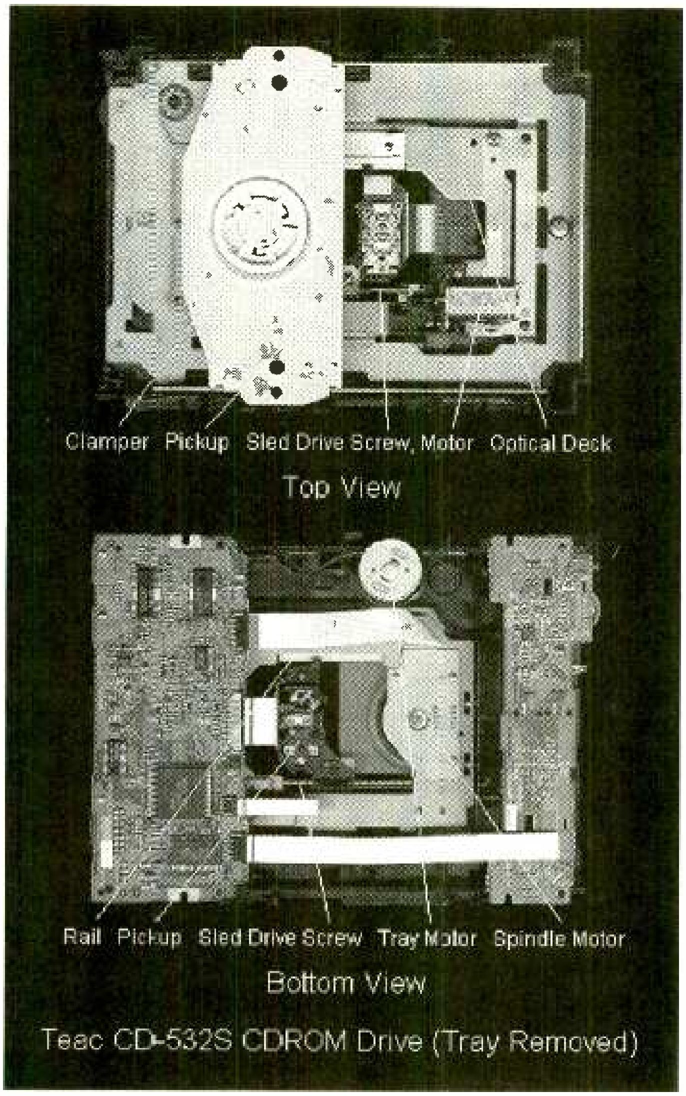


FIG. 2—THIS TEAC CD-532S is a modern, 32X CD-ROM drive, though that maximum transfer rate is only reached for data located at the edge of the disc.

- Sticky mechanism—dirt, dried up/lack of lubrication, dog hair, sand, etc.
- Broken (plastic) parts—gear teeth, brackets, or mountings.
- Electronic servo adjustments needed—focus, tracking, or PLL.
- Intermittent limit or interlock switches—worn or dirty
- Bad connections—solder joints, connectors, or cracked flex-cable traces.
- Motors—electrical (shorted, dead spot) or mechanical (dry/worn bearings).
- Laser—dead or weak laser diode or laser-drive (power) problems.
- Photodiode array—bad, weak, or shorted segments, or no power.
- Bad heat-sensitive electronic components.
- Bad or missing optical pickup shield ground.

The following two areas cover the most common types of problems you are likely to encounter. Consider them first in any situation where operation is intermittent; if audio output is noisy, skips or gets stuck; or if some discs play and others have noise or are not even recognized consistently:

The first is a dirty lens, which is particularly likely if the house the drive came from is dusty, if the player was located in a greasy area like a kitchen, or if there are heavy smokers around. Cleaning the lens is relatively easy and may have a dramatic effect on player performance.

The second thing to look at is a mechanical problem. Dirt, dried up lubrication, and damaged parts often cause erratic problems or total failure. One typical symptom is that the first part of a CD may play, but then get stuck at about the same time location.

Luckily, both of these can be taken care of easily.

General Inspection, Cleaning, and Lubrication

The following should be performed as general preventive maintenance or when erratic behavior is detected. The lens and its suspension, turning mirror, drawer mechanism, spindle, and sled drive should be checked, cleaned, and/or lubricated if necessary and appropriate (but read our comments on the lubrication of CD players, which follow shortly, before drowning your unit in motor oil or WD40!).

You will have to get under the clamp to access the lens and spindle on drawer loading models, but the lens and its suspension, at least, should be readily accessible on portable CD players with pop-up doors. These types can collect a lot of dust, dirt, and even fingerprints! Realistically, you probably won't do any of this for component CD players, CD-ROM drives, or other drawer loading models until something goes wrong! (I don't blame you—getting one of those out from the tangle of entertainment-center wiring, dusting it off, removing the cover, disassembling the unit to whatever level is needed, and so forth can be a royal pain.)

Cleaning the objective lens and turning mirror (if accessible) are the most important general maintenance tasks that can be done. Even minor contamination of their optical surfaces can easily result in 50% reduction in the returned signal—and all sorts of problems.

When cleaning the objective-lens assembly, be careful and gentle. The lens is suspended by a voice-coil actuated positioner that is relatively delicate. A CD-lens cleaning disc is nearly worthless except for the most minor dust as it will not completely remove grease, grime, and condensed tobacco smoke products (yet another reason not to smoke!), and could make matters worse by just moving the crud around.

First, gently blow out any dust or dirt that might have collected inside the lens assembly. A photographic type of air bulb is fine, but be extremely careful using any kind of compressed-air source. Next, clean the lens itself. It is made of plastic, so don't use strong solvents. There are special cleaners, but isopropyl alcohol is usually all that is needed for CD players and VCRs. (91% medicinal alcohol is acceptable, but pure isopropyl is better. Avoid rubbing alcohol, especially if it contains any additives.) Sometimes, a drop of water will be needed to dissolve sugar-based crud. There should be no problems as long as you dry everything off (gently!) reasonably quickly. DO NOT LUBRICATE! You wouldn't oil a loudspeaker, would you?

You generally cannot get to the bottom surface of the lens, but this isn't nearly as exposed as the top surface, so that usually isn't a problem. Do not use strong solvents or anything with abrasives—you will destroy the lens surface rendering the entire pickup worthless.

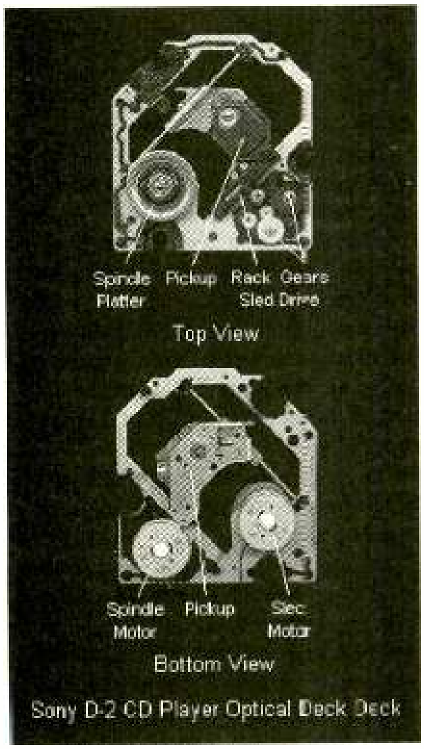


FIG. 3—A GEAR MECHANISM is used to move the optical pickup in this Sony D2 portable player. The pickup itself is typical of what you'll find in consumer units.

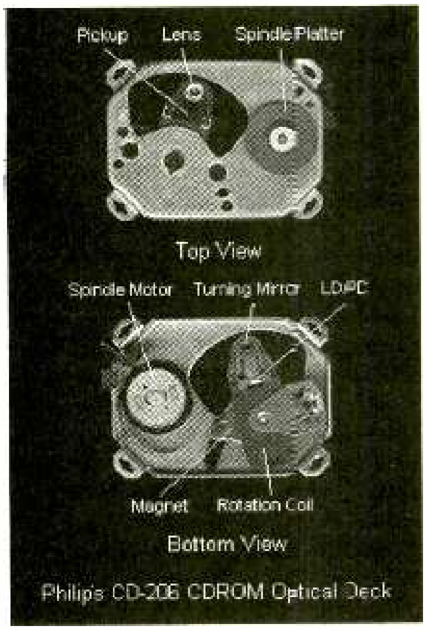


FIG. 4—HERE'S THE VERY SIMPLE optical deck used in a Philips CD-206 CD-ROM drive. This unit uses a rotary-type positioner.

Now, inspect the lens. When clean, the lens should be perfectly shiny with a blue tinge uniform over the central surface. Minor (barely visible) scratches will probably cause no harm, but any major scratches might result in erratic tracking or total inability to even read the disc directory. The pickup (or lens assembly) will need to be replaced in such cases.

Next we'll deal with the turning mirror or prism. If you can get to it under the lens without disturbing anything, clean it as well using the same procedure. Cleaning this might be at least as important as the lens. Unfortunately, the turning mirror may not be accessible without major (and difficult) disassembly. However, for Sony pickups (also used in Aiwa and some other brand players), it can be accomplished relatively easily.

Note: The turning mirror is not silvered so don't expect a normal mirror appearance—it looks just like a piece of glass. However, it is coated to be an excellent reflector for the 780 nm IR laser light.

Next, check the lens suspension for free movement and damage. Then check the spindle bearing (this is primarily likely to cause problems with repetitive noise). There should be no detectable side to side play. A seriously worn bearing will require replacement of the spindle motor.

To access the drawer mechanism and sled drive in component units, you will probably need to remove the optical deck from the chassis. It is usually mounted by 3 long screws (one of which may have a grounding lug—don't lose it). In portables and CD-ROMs, the bottom panel of the unit will need to be removed. Try not to let any of the tiny screws escape! A good set of jeweler's screwdrivers is a must for portables.

Check the drawer mechanism (if present) for free movement. Test the belt for life—it should be firm, reasonably tight, and should return to its original length instantly if stretched by 25% or so. If the belt fails any of those criteria, it will need to be replaced eventually, though a thorough cleaning of the belt and pulleys with isopropyl alcohol (dry quickly to avoid damaging the rubber) or soap and water may give it a temporary reprieve. Also, check the gears and motor for lubrication and damage and correct as necessary.

Next up is the sled drive. Check the components that move the pickup including (depending on what kind of sled drive your unit has) the belt, worm or other gears, or slide bearings. These should all move freely (one exception here: if there is a lock to prevent accidental damage while the unit is being transported, the pickup might not move freely or very far). Inspect for damage to any of components that might impede free movement. Lubricate, repair, or replace as appropriate.

Finally, before going any farther, try to play a disc to assess the results of your efforts thus far.

Lubrication

The short recommendation here is to NOT add any oil or grease unless you are positively sure it is needed. Most moving parts are lubricated at the factory and do not need any further lubrication over their lifetime. Too much lubrication is worse than too little. It is easy to add a drop of oil but difficult and time consuming to restore an optical pickup that has taken a bath.

Never, ever, use WD40 or anything similar! Despite claims to the contrary, WD40 is not a good lubricant. Legend has it that the WD stands for Water Displacer—which is one of the functions of WD40 when used to coat tools for rust prevention. WD40 is much too thin to do any good as a general lubricant and will quickly collect dirt and dry up.

A light machine oil like electric-motor or sewing-machine oil should be used for gear or wheel shafts. A plastic-safe grease like silicone grease or Molylube is suitable for gears, cams, or mechanical (piano-key) mode selectors. Never use oil or grease on electrical contacts.

Unless the unit was not properly lubricated at the factory (which is quite possible), don't add any unless your inspection reveals the specific need. In a CD player or CD-ROM drive, there are a very limited number of failures specifically due to lubrication.

Note that in most cases, oil is for plain bearings (not ball or roller) and pivots while grease is used on sliding parts and gear teeth. If the old lubricant is gummed up, remove it, and clean the affected parts thoroughly before adding new oil or grease.

(Continued on page 30)

EQUIPMENT REPORT

CYBEX SWITCHVIEW 4-PORT KVM SWITCH

An inexpensive keyboard-video-mouse switch box lets you control up to four PCs using a single keyboard, monitor, and mouse.

CIRCLE 15 ON FREE INFORMATION CARD

There are plenty of computer-network administrators and other power users who must tend to more than one computer at once; that's a given in the high-tech business world of the late 1990s. In fact, these days it is not uncommon to find homes with multiple systems.

One thing that network administrators and home users often have in common is the lack of desk space. There's usually barely enough room for all the computers, not to mention a monitor, keyboard, and mouse for each one as well. Fortunately for network administrators, they have long had the luxury, and the corporate checkbook, to afford switch boxes that allow multiple computers to be controlled using a single keyboard, monitor, and mouse.

Cybex Computer Products is one of the best-known manufacturers of these keyboard-video-mouse, or KVM switches, but they have always been industrial-grade units that were too expansive and too expensive for any sort of casual purchase. However, that is no longer true as that manufacturer has entered the home market with two entry-level switches with entry-level prices: The SwitchView SV-2 two-port unit sells for $169 and the SwitchView SV-4 four-port unit sells for $249. The SV-4 is the focus of this equipment report.

Cybex SwitchView SV-4

SwitchView incorporates the same features that have always made Cybex's high-end gear desirable, including two status lights for each channel, push-button or keyboard-controlled switching, and hot-pluggable operation, but there are some important differences that make the new units more practical and accessible for home set ups. For example, while Cybex's high-end gear uses custom cables, SwitchView uses standard cables that you can get from Cybex or any other computer-supply outlet. Also, industrial Cybex boxes are too big for most home settings, but SwitchView measures a small 8.1 inches wide by 2.7 inches high by 5 inches deep.

A single SwitchView SV-4 can switch signals from up to four computers. Multiple SwitchViews can be ganged together to control up to 64 computers. SwitchView allows a PS/2 style or Microsoft IntelliMouse to control any combination of serial-, PS/2-, or IntelliMouse-equipped computers. The one limitation is that the maximum video resolution is 1024 x 768 at 80 hertz.

The back panel of the SwitchView SV-4 is where all of the cables connect. The user's keyboard, monitor, and mouse plug into jacks labeled "user console." Four additional sets of jacks labeled A through D connect to the systems that will be controlled from the user console. Each set of jacks include connectors for a keyboard, monitor, and mouse. PS/2 and serial connectors are provided for mice; keyboards that do not have a PS/2 connector will require an adapter. The cables that connect the PCs to SwitchView are the standard extension cables for each type of peripheral.

SwitchView receives power from the equipment it's connected to, so no external power supply is needed. Its front panel features two LEDs for each channel, one green and one amber, and a channel-select button. A green LED lights whenever SwitchView detects that an attached computer has been turned on, and the unit will automatically switch to control the first computer that's turned on.

Any computer that is turned on will light a corresponding green LED, indicating that the channel is available. Pressing the channel-select button scrolls through the available channels, with an amber LED indicating which system is selected. SwitchView maintains the proper signals to each system so that none of them think that peripherals have been disconnected. SwitchView even has an automated scan mode that cycles through and displays each connected system for a certain amount of time.

Because SwitchView receives and relays keystrokes, it is easy to make it interpret special commands. Two quick taps on the Control key put SwitchView into Command Mode. Once in that mode, special keystroke combinations will make the unit switch channels, go into the automatic scan mode, or even set the time duration of the scan mode.

If you (or your small company) own multiple computers, you know how much space and money buying multiple keyboards, mice, and especially monitors can consume. The Cybex SwitchView SV-4 can supply a practical alternative in many situations. If your needs are less demanding, you might want to look into its little brother, the SV-2 two port system. For more information on either, contact the manufacturer (Cybex Computer Products Corporation, 4912 Research Drive, Huntsville, Alabama 35805, Tel: 205-430-4000, Web: www.cybex.com) directly, or circle 15 on the Free Information Card. EN

BY JEFF HOLTZMAN
COMPUTER EDITOR

XML: Who Controls The DTD?

YOU MAY HAVE CAUGHT THE BUZZ ABOUT XML (EXTENDED MARKUP LANGUAGE). WHAT IS IT? WHAT IS IT GOOD FOR? HOW DOES IT DIFFER FROM HTML? WHAT DIFFERENCE WILL IT MAKE—IF ANY? THOSE ARE ALL GOOD QUESTIONS, AND WE'RE GLAD you asked. To answer them, we'll take a kind of "outside-in" approach, by comparing HTML, SGML, and XML.

If you've had any exposure to the Internet, you probably have an intuitive notion of what HTML (Hyper Text Markup Language) is. Basically, HTML is a language for specifying the layout of Web pages. Any given HTML document contains two broad categories of information: content and markup. In HTML, markup specifies how content appears. For example, you can specify various levels of headings, emphasize (with bold or italic) portions of the content, or display several content items as a list. In HTML, markup is contained between angle brackets, <like this>; everything else is content.

The problem with HTML is its simplicity. It can only do a limited range of things, and as it evolves, different products interpret its markup differently, or in some cases, not at all. Eventually, one might suspect, a set of standards would be reached, and vendors would be able to create compatible applications that conform to those standards. From that point of view, the problem is not just the rapid rate of evolution, but the idea that there are probably an infinite variety of ways it could evolve to meet different needs.

There are deeper problems as well. HTML only concerns itself with appearance and presentation. HTML doesn't touch the question of structure. It turns out that there are lots of interesting and useful things that can be done when you concern yourself with both.

FIG. 1—COMING SOON to a browser near you: XML.

SGML

In the larger scheme of things, HTML is an application of SGML (Standard Generalized Markup Language). SGML is not a markup language, like HTML. Rather, SGML is a *metalanguage*, that is, a language for specifying other markup languages, like HTML. In other words, SGML is markup language language.

SGML is an ISO standard; it grew out of research dating back to the 1960s. Ordinary people don't use SGML; large publishing organizations do. Typically, it is used to organize large publishing projects such as airplane maintenance manuals and encyclopedias.

The way you do anything useful with SGML is by creating a Document Type Definition (DTD). The DTD specifies what the elements of a document may be, and how they relate to one another. HTML, in fact, is nothing more than an SGML DTD; an often very loosely interpreted DTD, but a DTD nonetheless. The HTML DTD does nothing but specify the set of tags, such as <h1>, <em>, and so forth, that make up a Web page. Microsoft and Netscape may choose to render (present) <h1> in different ways, but the fact is that they're both working off the same set of tags, that is, the same DTD.

Sort of. Actually, they're not, and that's why different Web pages display differently—or not at all—in different browsers.

So, what's the solution? You could add more tags, but that is a poor choice. More tags mean continuing political battles over standards, *ergo* continuing incompatibilities. A more general solution is the real answer. Enter XML.

XML

So where does XML fit in? XML is not a DTD like HTML. XML does not specify the ultimate tag set to end all tag sets.

XML is like SGML on a severe weight-loss program. As the XML FAQ states, XML is more like SGML-- than HTML++. SGML is an 18-wheeler; XML is a Ferrari. That's enough analogies; you get the idea.

XML is a simplified subset of SGML with the following characteristics.

- It greatly increases the (potential) power and variety of Web (and other) documents.
- It disentangles evolution from the standardization process.
- It "democratizes" the DTD creation process. If you need a specialized capability, create a DTD for it, and write some specialized code to handle it. You needn't be afraid that you'll break someone else's browser or plug-in.
- It is extensible. The earliest extensions concern themselves with more varied hyper-linking and better link man-

LISTING 1—PRESENTATION TAGS

```
<pre>
  <mrow>
   <mrow>
    <msup>
     <mi>x</mi>
     <mn>2</mn>
    </msup>
    <mo>+</mo>
    <mrow>
     <mn>4</mn>
     <mo>&invisibletimes;</mo>
     <mi>x</mi>
    </mrow>
    <mo>+</mo>
    <mn>4</mn>
   </mrow>
   <mo>=</mo>
   <mn>0</mn>
  </mrow>
</pre>
```

LISTING 2—CONTENT TAGS

```
<pre>
  <apply>
   <plus/>
   <apply>
    <power/>
    <ci>x</ci>
    <cn>2</cn>
   </apply>
   <apply>
    <times/>
    <cn>4</cn>
    <ci>x</ci>
   </apply>
   <cn>4</cn>
  </apply>
</pre>
```

agement (using XLL, a developing Extended Link Language), and with portable style sheets (using XSL, a developing Extensible Stylesheet Language).

• Code to write XML parsers and processors can be much simpler than corresponding SGML code, which greatly lowers the barrier to entry for smaller companies and specialized applications. It also gives established SGML tool vendors a leg up on the competition as XML is a strict subset of SGML.

In a sense, it can be useful to think of XML as a portable, self-documenting database format. Any XML processor can read any conforming XML document and be able to decode the schema or structure of that document. It may not be able to do anything with that structure, but it will be able to understand it.

Continuing the database analogy, the DTD is really the schema. The DTD can be contained within the document, or referenced externally. An HTML DTD reference usually looks something like this, <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2//EN">, and appears as the first line of an HTML file.

On the other hand, it is not required that an XML document have a DTD. In that case, it has an *implicit* DTD, which is simply the structure defined by the tags in the document. If it does have a DTD, the DTD may be contained within the document or externally referenced (or both).

By the way, the XML spec uses two terms that seem to confuse lots of people: *valid* and *well-formed*. A well-formed XML document basically has properly formed and nested tags. A valid XML document is simply a well-formed document that has an explicit DTD. An invalid document is not necessarily *incorrect*; it just doesn't have an explicit DTD.

What can you do with XML?

The answer is easy; the ramifications subtle. Using XML you can create your own specialized markup languages to handle your own special needs, without worrying about breaking the other guy's stuff. Does that mean Microsoft and Netscape can achieve a lasting peace? In and of itself, not really.

An example can help flesh out the issues. One of the first applications of XML is a language called MathML. Like XML itself, MathML is a product of the World Wide Web Consortium; as such it is vendor independent. As of this writing, MathML is not an official standard, but it's close.

At the most basic level, the purpose of MathML is to provide a standard means of embedding mathematical expressions in Web pages so that scientists and engineers can communicate without converting everything to GIF images.

GIFs are bad; they take up space and use bandwidth, but even worse, the conversion process discards information. MathML provides a means of specifying presentation, without discarding the semantic content, *i.e.*, the *meaning* of the expression. That in turn provides maintainability, reusability, cut-and-paste-ability, and other benefits.

In that sense, MathML is "two, two, two mints in one." The MathML DTD in fact defines two orthogonal sets of tags, one specifying presentation, the other specifying content. Listing 1 shows the presentation tags, and Listing 2 shows the content tags for this equation: x^2 + 4x + 4 = 0. Both sets of tags would be contained in a single document.

Except in very simple cases, people will not edit those tags by hand. Graphical equation editors will provide a user interface; behind the scenes, MathML gets generated, stored, transferred, and possibly converted, say to PostScript or TeX for hardcopy, or to Braille, or to audio format for hearing-impaired users. (Perhaps a new market for equations on tape will emerge.)

All those output conversions are both possible and practical because of the robust, unambiguous nature of MathML.

Getting there didn't happen overnight. Over the years, there have been several attempts at producing something that could do what MathML can (or will shortly be able to) do. Those attempts provided fodder for the current activities. These are the organizations officially listed as participating in development of the current spec: Adobe, the American Mathematical Society, Design Science, Elsevier Science, The Geometry Center at the University of Minnesota, HP, IBM, INRIA, SoftQuad, Waterloo Maple Inc., and Wolfram.

That's some pretty distinguished company. Does this mean we'll be able to take MathML models out of Mathematica and plug them directly into Maple? That would be nice. The companies would distinguish the products by the quality of their editors and rendering engines.

But what happens when Wolfram wants to implement something that's not covered by the spec? Does the company have the reserve to wait for standardization to occur, or does it create its own extension and forge ahead?

Conclusions

So, what *can* you do with XML? You could define your own markup DTD. Then, to do anything with it, you would have to create your own edit engine, and your own rendering engine. That's just great if your XML dialect is something nobody else really has much of an interest in.

But what if there are interested parties? Say, for example, that you want to create an XML dialect for electronics symbols. **Electronics Now** could create its own for publication in this magazine, but what about all the other magazines? What about companies that design and build electronic devices? What about

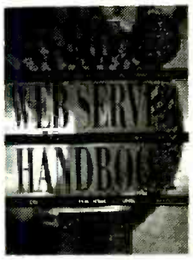
(Continued on page 30)

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

The Web Server Handbook

by Pete Palmer and Adam Schneider, with Anne Chenette
Prentice Hall PTR
One Lake Street
Upper Saddle River, NJ 07458
Tel: 800-382-3419
Web: www.prenhall.com
$39.95



CIRCLE 338 ON FREE INFORMATION CARD

Many people assume that setting up a Web server is expensive and complicated—needing expensive equipment and consultants. However, almost anyone can set up a Web server, even with little or no experience.

Beginning with the absolute basics, readers are shown how to set goals for a Web server, choose hardware and software, choose the right Internet provider, and get a Domain name, and IP address. The handbook goes on to explain how to build the Web site, step-by-step; how to add pictures, forms, and interactivity; and how to test, maintain, and update a site. It covers all the software needed including Windows 95, Windows NT, Macintosh, and UNIX. Finally, methods of publicizing a site and making it secure are covered.

With this information, anyone can build an attractive site customized to fit the user's needs. This book even features quick-reference guides to many important tools for Web-site operators, including HTML, Perl programming, TCP/IP networking, and basic UNIX.

The included CD-ROM, compatible with Windows, Macintosh, and UNIX systems, contains the Internet's most popular Web servers, including those from Apache, CERN, and NCSA; a 60-day trial version of the WebSite Windows NT Web Server; and dozens of helper applications, and Web pages with built-in links to extensive on-line resources.

The Design and Development of Fuzzy Logic Controllers

by Byron Miller
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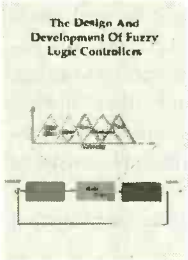


CIRCLE 339 ON FREE INFORMATION CARD

With this book, readers can get all the technical information needed to create fuzzy-logic controllers. Using assembly, C, ladder logic, or other languages, users of fuzzy logic can create devices capable of controlling processes ranging from anti-lock brakes to robotic motors. There are complete instructions for creating controllers from scratch, as well as numerous examples.

All aspects of controller development are discussed: requirements, design considerations/tradeoffs, performance issues, and controller-validation techniques. The author presents a design methodology for controllers. There is also a discussion of fuzzy-logic implementation using traditional ladder-logic-based Programmable Logic Controllers (PLCs), such as Allen-Bradley's SLC-500.

Emphasis is on using off-the-shelf processors, like the 6811, 8051, 8086, and 68000 to make fuzzy-logic implementation cost effective. High-performance controllers using Analog Devices ADSP2100 Digital Signal Processor (DSP) are discussed.

Fuzzy-logic history, theory and applications, traditional control theory, controller analysis and implementation, choosing when to use fuzzy logic, and creating closed-loop controllers are among the topics covered. Simulation source files for all examples are provided. A comprehensive list of hardware and software vendors is included.

Home Automation Products Catalog

Home Controls Inc.
7626 Miramar Road
Suite 3300
San Diego, CA 92126
Tel: 800-CONTROL or 619-693-8887
Fax: 619-693-8892
Web: www.homcontrols.com
Free

CIRCLE 340 ON FREE INFORMATION CARD

Over 40 new items are featured in this expanded 70-page, four-color catalog. It provides the latest products to automate your home: from power-line carrier products, security systems, RF and IR devices, telephones, intercoms, drapery controls, A/V equipment, and surveillance cameras, all the way to intelligent two-way whole-house controllers.

HAL2000 is one such operating system for the home with state-of-the-art continuous speech recognition. With this one program, homeowners can control all the automation devices in the house—by voice. At home, users can speak into any microphone connected to the computer or into any telephone, telling the computer to turn the sprinklers on or close the garage door. From far away, with a simple telephone call and a security code, users can speak to the computer and tell it to turn on lights or set the thermostat.

In addition to the products presented, there are illustrations and explanations of how home-automation, video, and other systems work. Books and manuals on home automation and related subjects are also available.

1998 IC Master Catalog

Hearst Business Communications, Inc.
645 Stewart Avenue
Garden City, NY 11530
Tel: 516-227-1300
Fax: 516-227-1453
Web: http://hearstelectroweb.com
$195

CIRCLE 341 ON FREE INFORMATION CARD

With these three easy-to-use volumes, readers can review the latest product information, scan hundreds of manufacturer-supplied supplemental data pages, identify alternate devices, and verify manufacturer contact information. The *1998 IC MASTER CATALOG* contains specifications for over 100,000 current ICs, including 13,000 new ones.

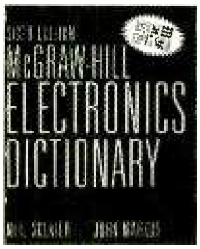
Data is organized in ten Master Selection Guides. The updated Alternate Source Directory lists over 120,000 pin-for-pin equivalents, and it includes NTE and Philips ECG parts. Additional information is provided in the Part Number Index, the Military Parts Directory, the Application Notes Directory, and the Manufacturers & Distributors Directory.

Also available is the enhanced *1998 IC MASTER CD-ROM for Windows* ($235); it contains all the product information found in the printed version, and adds discontinued ICs—specifications for more than 135,000 devices on one disc! Users are able to link directly to datasheets on IC manufacturer's Web sites for selected advertised devices.

Subscribers to either the printed catalog or the CD-ROM version have full access for one year to IC MASTER online: http://icmaster.com. The Web site offers the complete IC MASTER database, which is continuously updated, and includes devices discontinued over the last five years.

McGraw-Hill Electronic Dictionary, Sixth Edition

by Neil Sclater and John Marks
McGraw-Hill, Inc.
11 West 19th Street
New York, NY 10011
Tel: 800-2MCGRAW
$55



CIRCLE 342 ON FREE INFORMATION CARD

Comprehensive, accurate, and easy-to-understand, the sixth edition contains more than 14,000 entries—words, phrases, acronyms, and abbreviations from all sectors of electronics. Terms taken from physics, electrical engineering, mathematics, chemistry, biology, and computer science are included. There are over 800 new definitions. More than 220 new illustrations have been added, bringing the total illustrations to over 1200.

The dictionary now covers fundamentals of electricity, electronics, and basic electronic circuits; solid-state-device design and fabrication; passive-component design and manufacture; circuit-board fabrication and component assembly; electronic-product and -system packaging; computers, peripherals, and software; scientific and medical instrumentation; industrial instrumentation, controls, and robotics; telecommunications and fiber optics; radio, television, and consumer-entertainment products; military/aerospace systems, including radar, sonar, and satellites; and marine and automotive electronics.

Analog Dialogue, Volume 31-2

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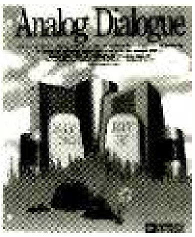
Wilmington, MA 01887
Tel: 800-ANALOGD or 617-937-1428
Fax: 617-821-4273
Web: www.analog.com/publications/magazines/Dialogue/dialog.html
Free



CIRCLE 343 ON FREE INFORMATION CARD

This magazine focuses on issues affecting real-world signal processing. The authors are engineers, technical writers, and managers from Analog Devices. The cover story in this issue discusses Lithium-Ion batteries, and a new battery-charger controller that guarantees ±1% final battery-voltage accuracy.

Other articles discuss products, such as 14-Bit Monolithic ADCs, the 200-MHz 16 × 16 Video Crosspoint Switch IC, and Quad-SHARC DSPs. Part IV of an ongoing tutorial, "Selecting Mixed-Signal Components for Digital Communication Systems" features receiver architecture considerations, and Part II of "DSP 101" explores the question of why use a DSP. The column, "Ask The Applications Engineer" focuses on Op Amps Driving Capacitance Loads.

Robot Store

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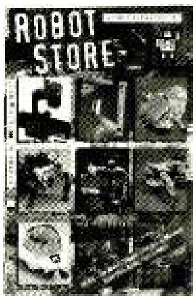
Web: www.RobotStore.com
Free



CIRCLE 344 ON FREE INFORMATION CARD

Robot builders require a special set of skills. Starting with a dream, the hobbyist has to be able to do the mechanical assembly, as well as to understand and implement the electronics and the logic necessary to have the robot interact with the world.

The most recent catalog from Mondo-tronics contains over 225 robot kits and accessories aimed at builders of all experience levels. At the beginning of the booklet, there's a helpful guide suggesting some robots to build at different skill and age levels. Each skill level (beginner, intermediate, and advanced) is broken down into projects appropriate for ages 7 to 12, 12 to 15, and 15 and up.

This guide also briefly explains what principles each project teaches. The Hyper Peppy for the youngest beginner teaches basic mechanical skills, while the Rug Warrior Pro Kit, their most advanced kit, teaches advanced electronics, C programming, and subsumptive behavior. This robot is used at universities world-wide.

In addition to kits, the catalog includes robot arms and legs, wheeled platforms, muscle wires, shape-memory alloy (SMA) devices, BASIC stamps and boards, software and animatronics, robotics books, and videos that feature robots. EN

Q & A

continued from page 12

quad you've done the first; now try the second. Raise the antenna until there is always a clear line of sight between the transmitter and the receiver.

Going beyond that, though, we wonder whether it is wise to entrust people's lives to low-power radios that weren't designed for great reliability. If you need radios for safety, don't skimp. Depending on your situation, Family Radio Service or business band VHF transceivers would probably be a lot more reliable.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication) and give your full name and address (we'll only print your initials). *If you are asking about a circuit, please include a complete diagram.* Write to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. Due to the volume of mail, we regret that we cannot give personal replies. EN

SERVICE CLINIC

continued from page 23

In general, do not lubricate anything unless you know there is a need. Never 'shotgun' a problem by lubricating everything in sight! Considering the damage you might do, you might as well literally use a shotgun on the equipment!

Wrap Up

That's all for now. The general maintenance procedures we've outlined here should actually cover the majority of CD player and CD-ROM drive problems you will encounter. Next time we will get into some specific electronic problems (such as what to do if your CD player does a credible impersonation of a brick!).

In the meantime, if you have any specific problems or questions, you can reach me by e-mail at sam@stdavids.picker.com. For general information on electronics troubleshooting and repair visit my Web site at http:// www.repairfaq.org/ or go direct to: http://www.repairfaq.org/REPAIR/ F_Repair.html for a new, expanded, and greatly enhanced set of repair guides and other electronics troubleshooting and design information. EN

COMPUTER CONNECTIONS

continued from page 26

the educational establishment?

The point is that we could quickly end up embroiled in a standards war. And it's really the same kind of war as the Microsoft/Netscape browser wars. The issue is who controls the DTD.

Despite the hype, I think XML is a valuable technology. I don't think it's going to be a user-level panacea, because there are still too many opportunities for market wars to take place.

XML's value is more infrastructural. It's like a very low-level API that everyone can write to. Even if (when) differences emerge, the facilities of the environment itself provide a means for working out those differences.

I sure hope so, anyway.

That's all the room we have for now, so we'll see you next time. Until then, you can stay in touch via e-mail at jeff@ingeninc.com. EN

TOD T. TEMPLIN

BUILD AN S-VIDEO DISTRIBUTION AMPLIFIER

Connect up to four S-video devices to one source with this easy-to-build unit!

Whether you are a true videophile or just an avid electronics enthusiast, you are probably aware of the fact that almost all new video devices—including such things as Digital-Satellite Receivers (DSS), Digital Video-Discs players (DVD), Digital-Video Camcorders (DVC), Hi-8 and Super-VHS video-cassette recorders, and Laser-Disc players—come equipped with S-video signal connectors. The "S" stands for "separated," meaning that the video signal has been split into two separate channels—one for the luminance or basic black-and-white picture, and one for the chrominance or color information. If your monitor or television supports S-video inputs, then it is capable of displaying signals from those devices. The resulting display will be higher in resolution and truer in color fidelity than the video signals available at either the composite video output, or worse yet, the RF-modulated output of the device. If you have S-video capability but aren't using it, you might be missing half of the picture—at least in terms of resolution—not to mention the full capabilities of the equipment that you paid top dollar for.

It has been the author's experience that each of the above-listed devices has but a single S-video output jack. Imagine the difficulty in such a situation of wanting to record the S-video signal from a DSS receiver simultaneously on two separate S-VHS recorders and to display the picture on an S-video monitor. With only one output available on the DSS receiver, the only way to do that task would be to use the composite output from the DSS unit for one recorder. The monitor would then have to be hooked up to the video pass-through connector of the second recorder.

Problems such as that are a thing of the past with the Video Distribution Amplifier described here. This device is also handy to send S-video to a monitor in a second room, dubbing S-VHS or Hi-8 video tapes to multiple recorders, connecting various components together in a home theater, or at any time that multiple S-video signals are required. The design includes adjustments to compensate for losses of signal strength or high frequencies that might occur in long cable runs.

A Short History of Color TV. To really understand why S-video is the better choice for connecting video components together, you need to understand the differences between S-video and composite video. To do that, a brief and somewhat simplified review of television history is in order. Not everyone today remembers, but in the beginning, television was monochrome (black and white). That original television signal was comprised of the horizontal and vertical synchronizing pulses plus the monochrome signal.

In the late 1940s, CBS laboratories proposed a color system that used a sequential-scanning scheme. The CBS method broke down a color picture into separate red, green, and blue layers. The separate layers were transmitted in order, one after the other, and displayed sequentially on a monochrome screen. To reconstruct the color image, a motor-driven synchronized rotating "color wheel" that had red, green, and blue filters was placed in front of the monochrome picture tube. The color wheel rotated at 1800 rpm, blending the three sequential images into a full-color picture.

The CBS engineers proposed transmitting 750 horizontal lines with a 3-to-1 interlace. That resolution meant that the three-color layers had to be sent at a rate of 1/180 second per field in order to make a single color frame at $^1/_{60}$ second. With a rate of 60 complete color frames per second, the resulting video signal would need a video-channel bandwidth of 25 MHz. Such a signal would need a new set of wide-bandwidth television channels. For experimental purposes, the FCC established and allocated the UHF television band that is still in use today.

The CBS system produced separate full-bandwidth RGB signals, and displayed 720 active horizontal lines with nearly 1000 lines of resolution. Compare that with the 480 display lines and 335 lines of resolution of a standard TV signal; in essence, CBS was showing a viable high-definition color-television system with World War II-era equipment.

Unfortunately, the CBS system had some serious drawbacks, including the mechanics of the color wheel (recalling the days of mechanical television of the 1920s), the expense of new transmission equipment, and the fact that everyone would need to buy a new television to receive the color picture. What was really needed was a signal standard and a method of transmission that would let a color-television signal be compatible with the existing monochrome signal and not require any new channels or additional channel bandwidth. Those requirements would let all of the existing black-and-white televisions already in use continue to be viewed while offering an orderly and less expensive transition to color broadcasting.

Enter the engineers from RCA laboratories. They had two tricks up their sleeve that CBS didn't have. First (and most importantly), they had invented the first true color picture tube. Having actual red, blue, and green phosphors in the screen meant that no color wheel was needed. Secondly, they proposed a broadcast standard that combined both the color and monochrome signals into a single complex signal that could be carried by a single coaxial cable. What's more, the proposed signal could be transmitted by equipment already in use on a 6-MHz TV channel. That signal could still be received on existing black and white televisions as well as the new color receivers. It is that system that was eventually selected by the National Television Standards Committee (NTSC), adopted by the FCC, and is still in use today. Although it is scheduled to be phased out by the end of the next decade as a part of the transition to digital TV, NTSC color TV will probably be with us for years to come.

If you are interested in a more detailed description of the history and development of color TV, an excellent article on the subject was published in the July 1995 issue of our sister publication, **Popular Electronics**.

Anatomy of a Color-TV Signal. Let's look at how the NTSC signal is put together. Color-television signals are made up of three main pieces of information (red, green, and blue images). Monochrome television, in contrast, only needs brightness infor-

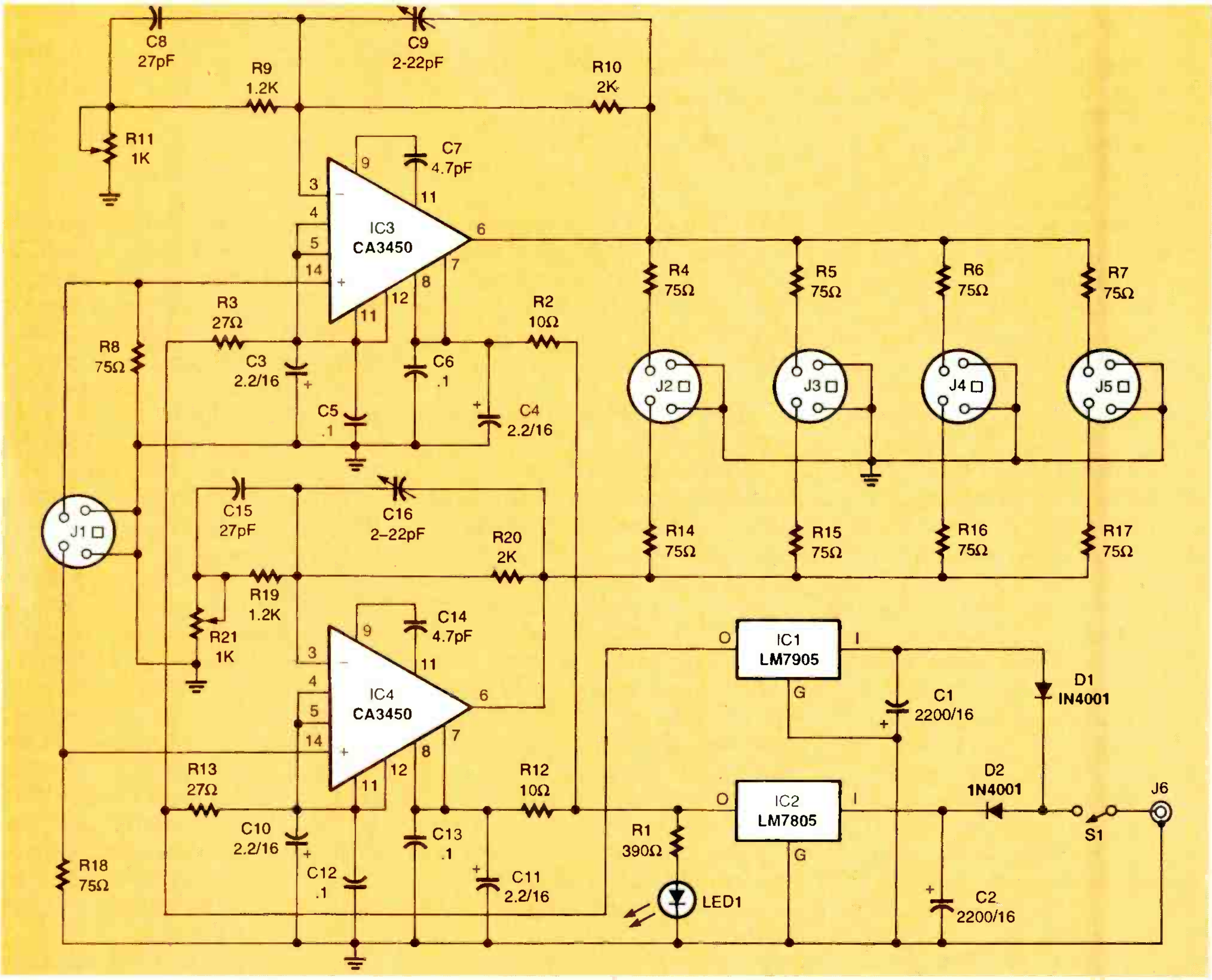


Fig. 1. The Video Distribution Amplifier lets you connect up to four S-video devices to a single S-video source.

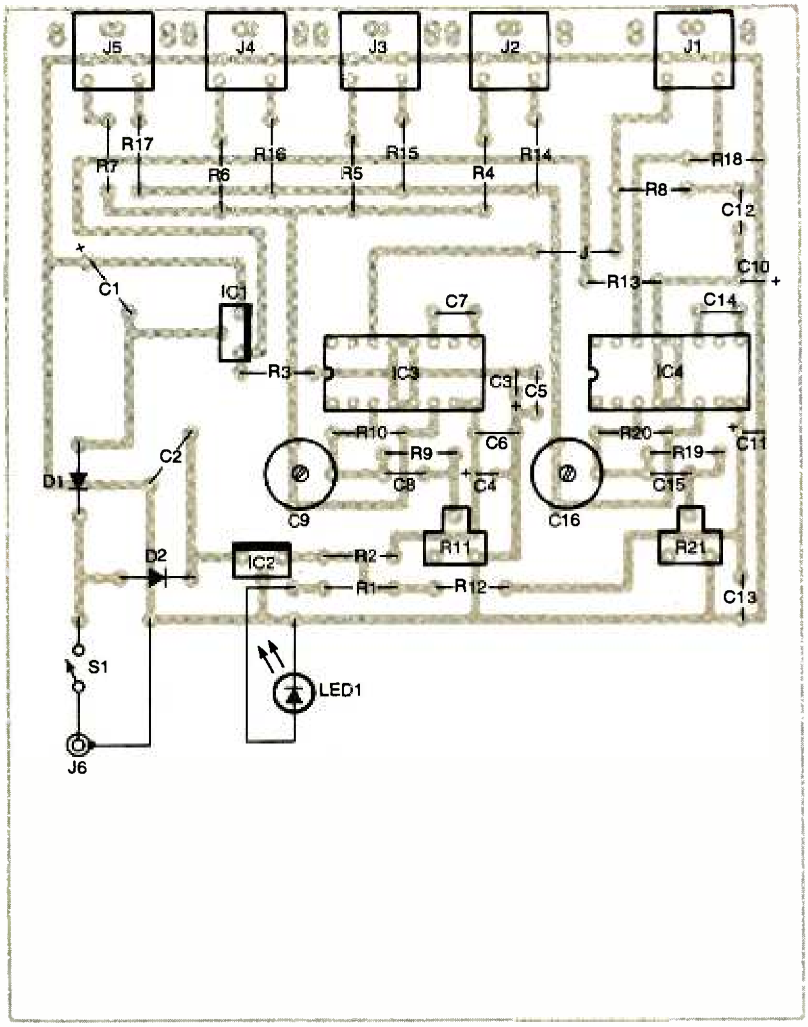


Fig. 2. Use this parts-placement diagram when building the Video Distribution Amplifier board. Don't forget the jumper wire near R13.

mation. An encoding process is used to send the red, green, and blue information simultaneously on a single coaxial cable or to transmit it on a single TV channel. In a color television or monitor, a decoding process is then used to separate the complex signal back into the three separate signals. The process must also be done so that monochrome displays can produce a monochrome picture from the color information.

To accomplish that feat, four techniques are used: matrixing, bandwidth limiting, two-phase modulation, and frequency interleaving. We'll look at each technique and show you how the picture quality is affected.

The first technique, matrixing, is the process of mixing the red, green, and blue outputs of a color camera (or other RGB source) in a linear cross-mixing circuit. The output of that circuit produces three new signals called M, I, and Q. Each new signal is a different linear combination of the original red, green, and blue signals.

The M signal, also called the *luminance* signal, is made by simply adding 30% red, 59% green, and 11% blue together to make white. That particular combination, when displayed on a monochrome TV, looks nearly as good as if the original signal had come from a monochrome camera.

The I and Q signals are called the *chrominance* signals. Those signals represent how the color information in a scene differs from the M (luminance) signal. The I and Q signals are required by a color receiver to decode the color information in a picture. Sometimes called *difference* signals, the I signal is made by adding 60% red, –28% green, and –32% blue. The Q signal is made by adding 21% red, –52% green and 31% blue. The negative values, needed for the math to come out right, are created by passing the signal through a simple phase inverter. The relationships between the signal percentages are chosen so that when red, green, and blue are added to produce white, the values of I and Q add to become zero. For example, if a color camera were used to shoot a black and white photograph, the I and Q signals both would have values of zero, while the M signal would have a value representing the brightness of the photograph. Even a color receiver that is presented with values of zero for I and Q would produce a monochrome picture from the M value signals. A monochrome receiver, having no way to recover the I and Q from a color signal, for the most part ignores them.

The apparent resolution of a television picture depends on the bandwidth of the signal—the greater the resolution, the greater the needed bandwidth. Television produces an apparent resolution of about 80 horizontal picture elements (lines) for every 1 MHz of bandwidth. A television channel is 6 MHz wide, but 1.25 MHz is lost in the vestigal sideband—a sacrifice to the RF carrier that carries the video signal. That leaves 4.75 MHz of bandwidth to carry all of the picture and audio signals. Of that, the picture signal is allowed 4.2 MHz, or about 335 lines of resolution per picture height. But from a subjective point of view, the human eye is not as sensitive to color details in a picture as it is to luminance detail. That biological tidbit lets the bandwidth of the chroma signal be limited so that the majority of the bandwidth goes to the luminance signal. Moreover, the eye is even less sensitive to detail in the green/blue part of the color spectrum than the orange/yellow part. So the I signal (mostly orange/yellow) is passed through a low-pass filter, limiting its bandwidth to 1.5 MHz. The Q signal (mostly green/magenta) is low-pass filtered to

0.5 MHz.

Now that we have the three signals, we need to combine them into one composite signal that can be broadcast or carried down a single coaxial wire. Not only that, but the decoding circuit in the television receiver must be able to separate out the individual signals from the composite signal without too much interference.

The electronics are technically complex, but basically the I and Q signals are modulated onto two subcarriers of the same frequency that are 90° out of phase with each other. Having two signals at the same frequency but out of phase by 90° is called *quadrature modulation*. The frequency of the subcarriers is 3.579545 MHz (we'll use the common abbreviated value of 3.58 MHz for the rest of the discussion). The subcarriers are 3.58 MHz *above* the main video carrier, but because the subcarrier modulators used are of the double-balanced type, their carriers are suppressed, leaving only the sidebands in the composite signal. The 3.58-MHz value was chosen

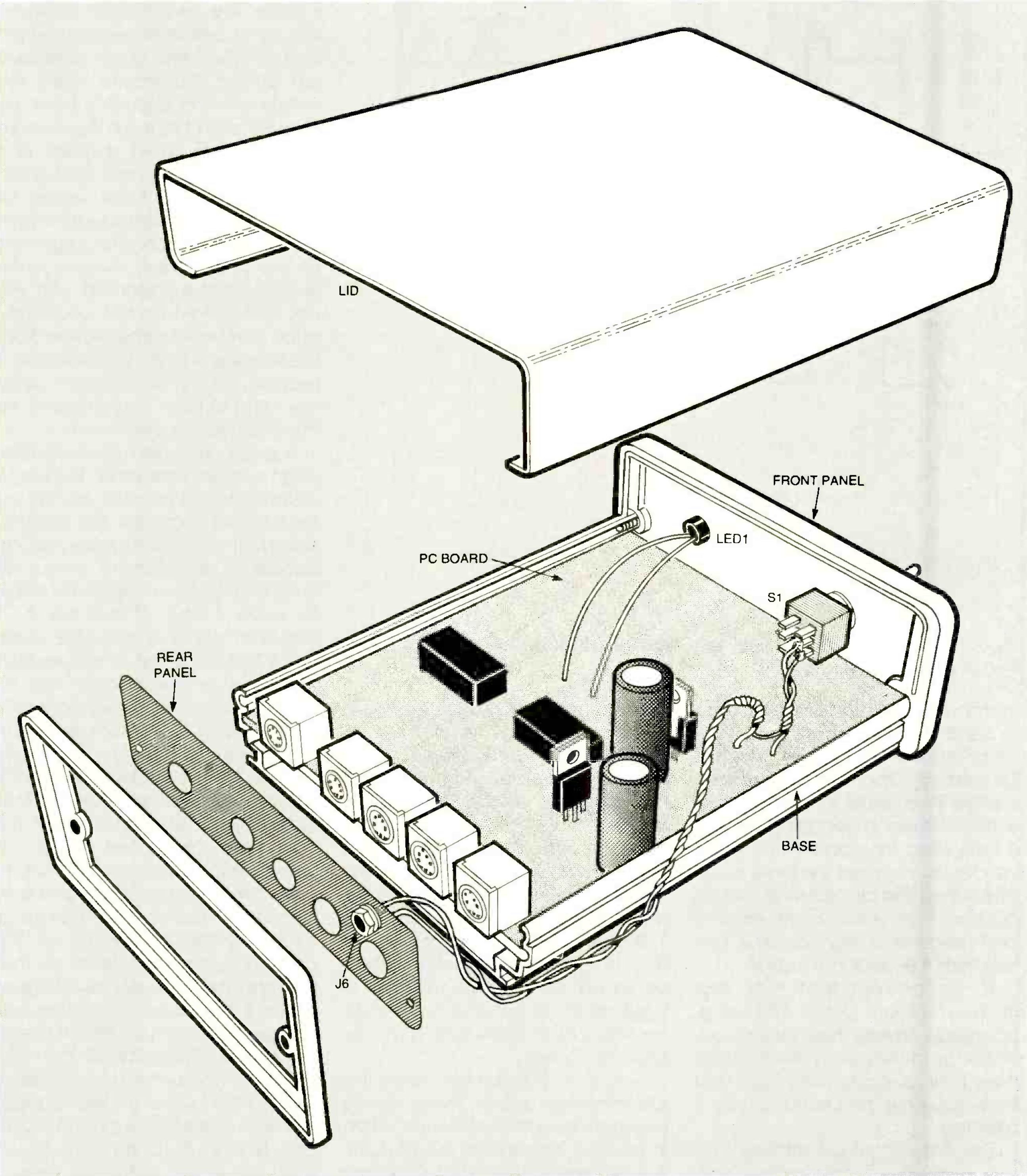


Fig. 3. The Video Distribution Amplifier fits neatly into an all-metal case.

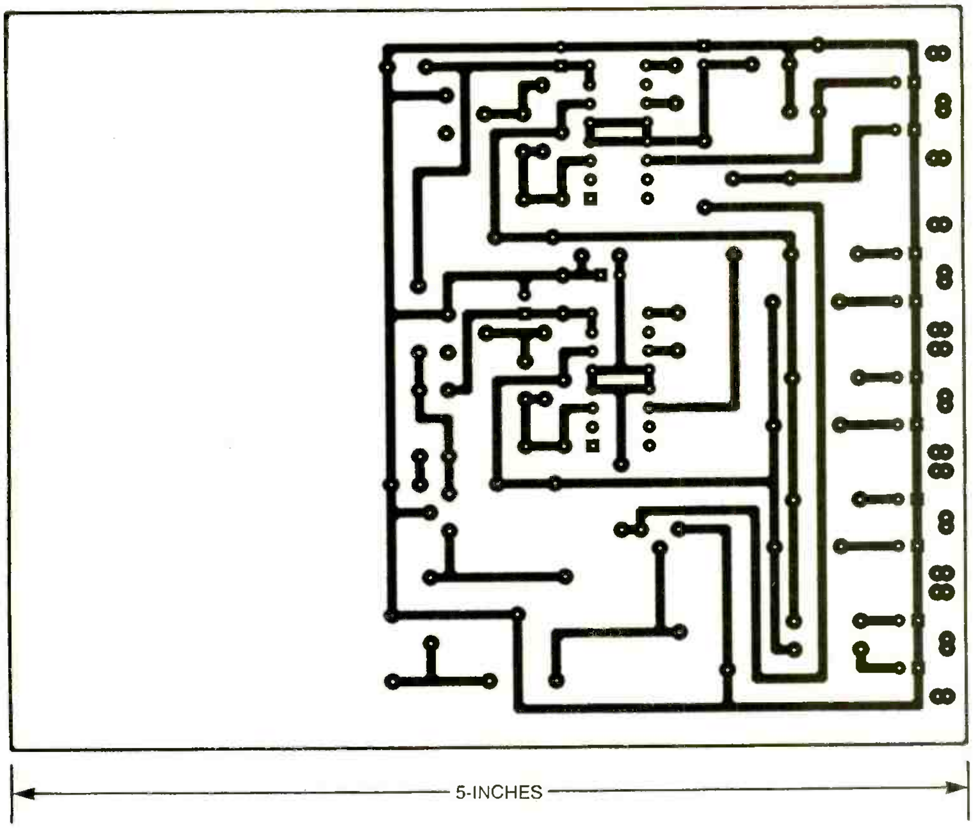


Fig. A. Here's the foil pattern for the Video Distribution Amplifier. A single-sided layout is both easy to build and helps prevent cross-talk between the two amplifier channels.

because it is an odd multiple of one half of the horizontal scan rate (455 × ½ × 15,734). The resulting relationship between the energy of the luminance signal and the energy of the chromanance signal has a tendency to concentrate at alternating points of the combined signal spectrum. That interleaving of the signals reduces the interference between luminance and chrominance signals. As an added bonus, the positioning makes it somewhat easier to separate the two signals in the decoding process. In the real world, however, the interleaving of the two signals causes intermodulation, resulting in the undesirable NTSC picture artifact known as *dot crawl*. In addition, non-linearities in the chroma-processing circuits (during both encoding and decoding) can cause distortions know as *differential phase* and *differential gain*.

To decode the chrominance signal at the receiver or monitor, a 3.58-MHz oscillator must be synchronized in both frequency and phase with the original signal. Synchronizing information, consisting of a 3.58-MHz burst that is 8 cycles long, is added to each horizontal line just after the end of the horizontal-sync pulse. That reference is known as the *color burst*.

A Better Picture? We have been using the NTSC system for almost 50 years. Modern televisions equipped with digital-comb filters as well as very stable and linear circuitry do produce very acceptable color pictures. But what if we had a simple way to eliminate some of the compromises made to transmit the NTSC signal? Doing that would greatly improve the picture resolution and reduce the undesirable artifacts resulting from the encoding/decoding process.

Well, there is a way—it is called the Y/C or Separated Video connection, and it is just that. Two separate signal paths are used to send video between components. One cable carries only the luminance signal, while a second cable carries only the chrominance signal. The signals are never combined, so no interleaving distortion occurs, and no low-pass filtering is required to keep the signals within a 4.2-MHz bandwidth. The S-video input on a television or monitor bypasses much of the video-processing circuitry, such as the comb filter. The result is a higher-resolution picture from devices like Hi-8, S-VHS, DSS, DVD, DVC, computer-graphic cards and laser discs, where the signals originate separately as Y and C and are not combined as they would be if they were to be broadcast over the airwaves.

Circuit Description. The Video-Distribution Amplifier uses two identical amplifier circuits that share a common power supply. Refer to the schematic diagram in Fig. 1 during the following discussion of the circuit.

Alternating current from a wall-mounted transformer is applied to J6, with S1 turning the unit on and off. A simple half-wave rectifier circuit consisting of D1 and D2 is used to change the AC power to DC. Since the circuit needs a split-type power supply, that method makes creating the proper voltages easy and does not require a center-tapped transformer. Capacitors C1 and C2 smooth out the large amounts of resulting ripple; hence the reason for their extremely high value. The direct-current voltage is regulated by IC1 and IC2. The positive voltage supply has an LED connected to it to act as a power-on indicator. The current flowing through LED1 is limited by R1.

Since both amplifier circuits are the same, one for the luminance and one for the chromiance, only one will be described; the other behaves in the same way. The S-VHS signal is input via J1 to IC3. The op-amp chosen for IC3 is specifically designed to be a high-speed

PARTS LIST FOR THE S-VIDEO-DISTRIBUTION AMPLIFIER

SEMICONDUCTORS

IC1—LM7905 5-volt negative voltage regulator, integrated circuit
IC2—LM7805 5-volt positive voltage regulator, integrated circuit
IC3, IC4—CA3450 video-line driver op-amp, integrated circuit
D1, D2—1N4001 silicon diode
LED1—Light-emitting diode, red

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—390-ohm
R2, R12—10-ohm
R3, R13—27-ohm
R4–R8, R14–R18—75-ohm
R9, R19—1200-ohm
R10, R20—2000-ohm
R11, R21—1000-ohm potentiometer

CAPACITORS

C1, C2—2200-µF, 16-WVDC, electrolytic
C3, C4, C10, C11—2.2-µF, 16-WVDC, electrolytic
C5, C6, C12, C13—0.1-µF, polyester film
C7, C14—4.7-pF, polyester film
C8, C15—27-pF, ceramic disc
C9, C16—2-22-pF trimmer

ADDITIONAL PARTS AND MATERIALS

J1–J5—Mini-DIN jack, 4-pin
J6—Power jack, center-pin
S1—Single-pole, single-throw toggle switch
IC sockets, enclosure, 9-volt 300-mA AC wall-mount transformer, wire, hardware, etc.
Note: The following items are available from T3 Research, Inc., 5329 N. Navajo Ave., Glendale, WI 53217-5036: Etched PC board, $12.00; Metal case, $16.00; Complete kit of all parts, PC board, case, and wall-mount transformer, $69.00. Please include $3.00 for shipping by priority mail. Wisconsin residents must add appropriate sales tax. MasterCard and Visa credit cards are accepted for purchases.

video driver with a large signal range. It has a bandwidth of about 200 MHz, an output impedance of less than 4 ohms, and is capable of delivering a drive current of up to 75 mA.

Video signals are normally, by convention, 1 volt from the tip of the sync pulse to the peak of the white level when fed across an impedance of 75 ohms. That means that both the source impedance and the load impedance of the amplifier's input must also be 75 ohms. To insure proper impedance matching between the amplifier's output and the amplifier's load, the shielded cable used to carry the output signal must also have a 75-ohm impedance. Since the circuit needs to have unity gain from the input to the output, the actual gain of IC3 must be set to 2. The reason for amplifying the video signal has to do with impedance matching. The output impedance of the Video Distribution Amplifier is set by R4–R7. The input impedance of the device that the Video Distribution Amplifier is driving has a 75-ohm resistor between its input and ground, resulting in a divider network between the two devices. For practical purposes, the output impedance of IC3 can be considered to be zero ohms. Thus, any device connected to any of the four outputs will only see a 75-ohm source resistance to ground. That eliminates any interaction between devices that are connected to the output of the Video Distribution Amplifier. Even if one or more outputs are shorted, there is little effect on the other outputs. In addition, the unused outputs can be left open with no adverse effects on the outputs being used.

To insure a good low-frequency response, the Video Distribution Amplifier was designed with direct coupling; that is, there are no coupling capacitors in the signal path. That is important when working with video signals because the sync pulses, as well as the video itself, are DC referenced. The input signal is sent directly to the non-inverting input of IC3. The input impedance of the circuit is set by R8 to 75 ohms. The feedback resistor combination of R9, R10, and R11 from the output (pin 6) to the inverting input (pin 3) sets the gain of IC3 to 2. The value of R11, the gain pot, was chosen so that the overall gain of the circuit can be adjusted slightly above and below unity. The high-frequency response of the circuit is set by C8 and C9. Adjusting C9 allows either boosting or cutting of the high frequencies. Normally, C9 is adjusted for a flat frequency response. If a long cable run is needed, C9 can be set to provide some high frequency boost to overcome the natural tendency of shielded cable to roll off the high frequencies. In practice, C9 provides a gently sloped boost/cut action starting at about 2 MHz and reaches a maximum of about 1.5 dB at 10 MHz. Internal phase compensation for IC3 is set by C7. As mentioned previously, the 75-ohm output impedance is set by R4–R7 for each of the four outputs.

Construction. Because of the very high frequencies involved, a properly designed printed-circuit board is required. A foil pattern has been included if you wish to etch your own board. Alternatively, a PC board can be purchased from the source given in the Parts List.

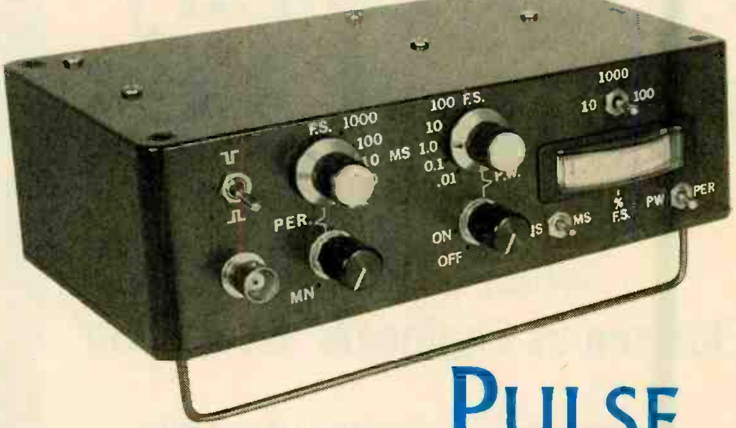
If you use the foil pattern or purchase a board from the source mentioned in the Parts List, use the parts-placement drawing in Fig. 2 for locating the various components. Mount the components as close as possible to the surface of the PC board. Double-check the polarities of the diodes and the electrolytic capacitors before soldering them in place. It is also a good idea to use sockets for IC3 and IC4.

Inspect the completed board for any mistakes or errors. There is one jumper wire near R13. The completed board should be mounted in a metal chassis in order to shield it from any possible stay RF pickup. Drill appropriate holes for J1–J6, S1, and LED1. Suggested locations are shown in Fig. 3. Once everything is wired up, you're ready to test and align the Video Distribution Amplifier.

Alignment and Use. If you have a signal generator capable of providing a calibrated video-multiburst pattern, connect it to the amplifier. Using an oscilloscope, set the gain (R11 and R21) for unity and the frequency response (C9 and C16) for a flat response on each circuit. Of course, that type of test gear is rarely found on a hobbyist's workbench. As an alternative, simply set the gain pot to a position of about

(Continued on page 48)

BUILD A PORTABLE PULSE GENERATOR



Add this economical, easy-to-build instrument to your test bench, or carry it in your tool kit.

SKIP CAMPISI

If you enjoy doing digital- or analog-circuit-design work, or if digital troubleshooting is one of your priorities, you will probably agree that a good, wide-range pulse generator would come in very handy. Commercial units are available, of course, but being in the range of several hundred dollars, the cost of a decent unit is prohibitive for many.

Most function generators have a pulse mode of operation that is created from their squarewave output by adjusting the duty cycle and DC offset. That function is limited to how fine of a duty-cycle adjustment you can make. For example, generating a one-microsecond pulse at a one-second repetition rate is practically impossible when using that method. Another problem is that the repetition rate is set by frequency rather than time period, making a mental calculation necessary for the correct time-period display. Further, most commercial pulse and function generators are line operated, making portability a problem.

The Portable Pulse Generator presented in this article has been designed to avoid those problems by using standard components that are readily available and quite affordable. The unit is powered by a single 9-volt battery, and for true portability has a time-period display. The device makes an excellent companion to the "D.I.Y. Function Generator," which appeared in the August, 1997 issue of **Electronics Now,** for generating any type of waveform.

The instrument is divided into two parts: the actual pulse generator itself and an analog time-period display. You have the option of constructing either section by itself—each can be a standalone project—or combining both parts into one unit. If you would like to include a duty-cycle display, you can add in the "Duty-Cycle Monitor" circuit described in the May 1997 issue of our sister publication, **Popular Electronics**.

How it Works. The pulse-generator section supplies 5-volt pulses that can range from 1 microsecond to 100 milliseconds. The time period (repetition rate) is independently adjustable bewteen 10 microseconds and 1 second. The pulse-width section and the time-period section each have their own five-position range switch and fine-adjust controls. The 5-volt amplitude of the pulses is only under no-load conditions.

A specially-designed output stage safely sources or sinks up to 100 milliamperes to or from the load. The output was designed without any form of short-circuit protection in order to achieve very high speeds. Output protection can be easily implemented; we'll show you how later. Typical rise and fall times for the output are about 25 nanoseconds, and either a positive- or negative-going pulse can be used. Direct interfacing to standard TTL or CMOS logic using 5-volt supplies is quite easy.

The time-period display section uses some unusual techniques to provide an analog display of either the period or pulse width. A 0–100 microampere analog panel meter provides the display, and simply indicates 0%–100% of the full-scale range selected. This section has its own individual range controls to cover 1.0 microsecond through 1.0 second with a typical accuracy of a couple of percent of full scale,

About the Circuit. The generator's circuit, shown in Fig. 1, is a simple, basic design. The circuit uses two ICs, four transistors, and a handful of passive components, all of which are commonly available.

The heart of the circuit is IC1, a TLC556 CMOS dual timer. That version of the timer is used because it is *much* faster than a standard bipolar 556 timer. The two independent timers in the one package are both needed for the Portable Pulse Generator. One timer section is set up as an astable multivibrator that supplies a basic squarewave. That squarewave sets the "period" function of the generator.

The overall period of the waveform is selected by S2 in five steps: 0.1, 1, 10, 100, and 1000 milliseconds. Fine adjustment is done with R4. That lets the period be continu-

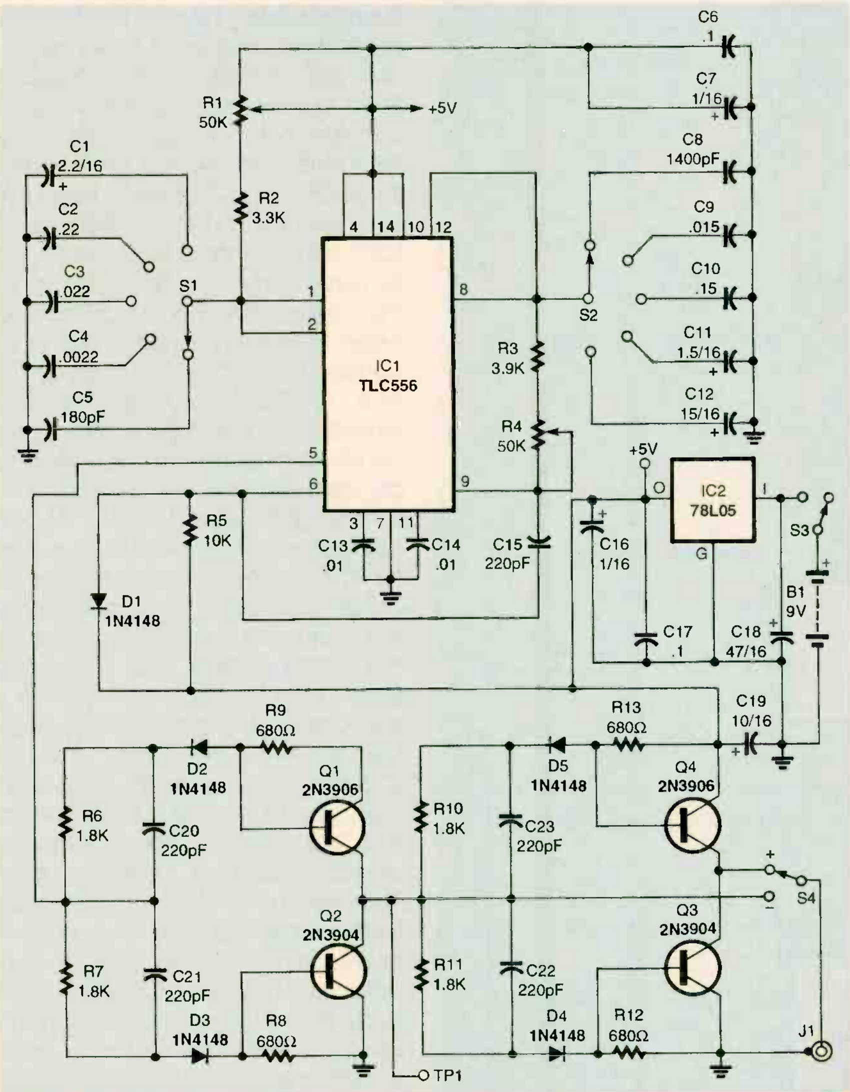


Fig. 1. The Portable Pulse Generator is built around a TLC556 dual CMOS timer chip. Very accurate results can be obtained with careful selection of the various timing components.

ously adjusted from 10% to 100% of the period selection. The output of that section (IC1, pin 9) is applied through C15 to the trigger input of the other section of IC1.

The second timer section of IC1 is configured as a monostable multivibrator. The signal from pin 9 through C15 to pin 6 triggers the pulse output at pin 5. The pulse at that output has a repetition rate set by the astable oscillator and a pulse width set by S1 and R1. The use of S1 is similar to S2 in that it sets the overall pulse width of the waveform in five steps: 0.01, 0.1, 1, 10, and 100 milliseconds. Similar to R4, R1 allows continuous adjustment of the pulse width from 10%–100% of the selected range. The final waveform is then applied to the output-driver section.

An inverter circuit made from Q1 and Q2 has a very fast rise time (less than 10 nanoseconds). A second identical inverter circuit is made from Q3 and Q4. Those two inverters let the final output be either a positive-going or a negative-going pulse. The polarity of the output pulse is selected with S4.

A standard coaxial cable that is less than 3 feet long and terminated with short-clip leads will make a good output cable when connected to J1. For more stringent applications, the output is quite capable of driving a 50-ohm terminated cable. That will be explored later.

A 78L05 5-volt regulator, IC2, is powered by B1, a standard 9-volt battery. That supply is quite suitable for normal operation. However, if you plan on driving heavy loads or 50-ohm lines, you should consider replacing B1 with a set of six series-connected AA cells. That arrangement will give you higher efficiency and less internal resistance. The on-off switch, S3, can be ganged with R1 in order to save space on the front panel.

About the Display. The input for the time-period display circuit, shown in Fig. 2, comes from TP1, the generator's inverting output from the collectors of Q1 and Q2. If you are building the display as a stand-alone instrument, the input needs a negative-going pulse of the proper width to be measured. The maximum positive voltage should be 5 volts with the minimum no higher than 100 millivolts.

The semiconductors were specially selected for this unusual, analog/digital hybrid-circuit design. CMOS ICs are used throughout to keep current drain to a minimum. Those type of integrated circuits are sensitive to electrostatic discharge (ESD) as is IC1. Analog-panel-meter display M1 can be any type of 0- to 100-microamp meter that you would like to use.

The input pulse coming from TP1 goes directly to IC3, a CD4013 CMOS dual flip-flop. The flip-flop is configured in its "toggle" mode. Either the output of IC3 or the original pulse width can be selected by S5. The selected pulse is applied to Q5, a 2N5117 dual matched-pair PNP transistor, which is configured as a high-speed, gated current mirror. That current-source "integrator" turns on when the pulse signal is low, charging C24 or C25. Whichever capacitor is charged is selected by S7-a, which determes whether the display will be in microseconds or milliseconds.

When the pulse goes high, the current source turns off and the voltage present on C24 or C25 represents the pulse width's integration period. At that point, one of IC4's one-shots is triggered. Its three-microsecond output turns on one of the analog switches in IC5. A "sample" of the voltage on C24 or C25 is sent to C27, a "hold" capacitor, through buffer amplifier IC6-a. The voltage held by C27 drives M1 through IC6-b. As soon as the sam-

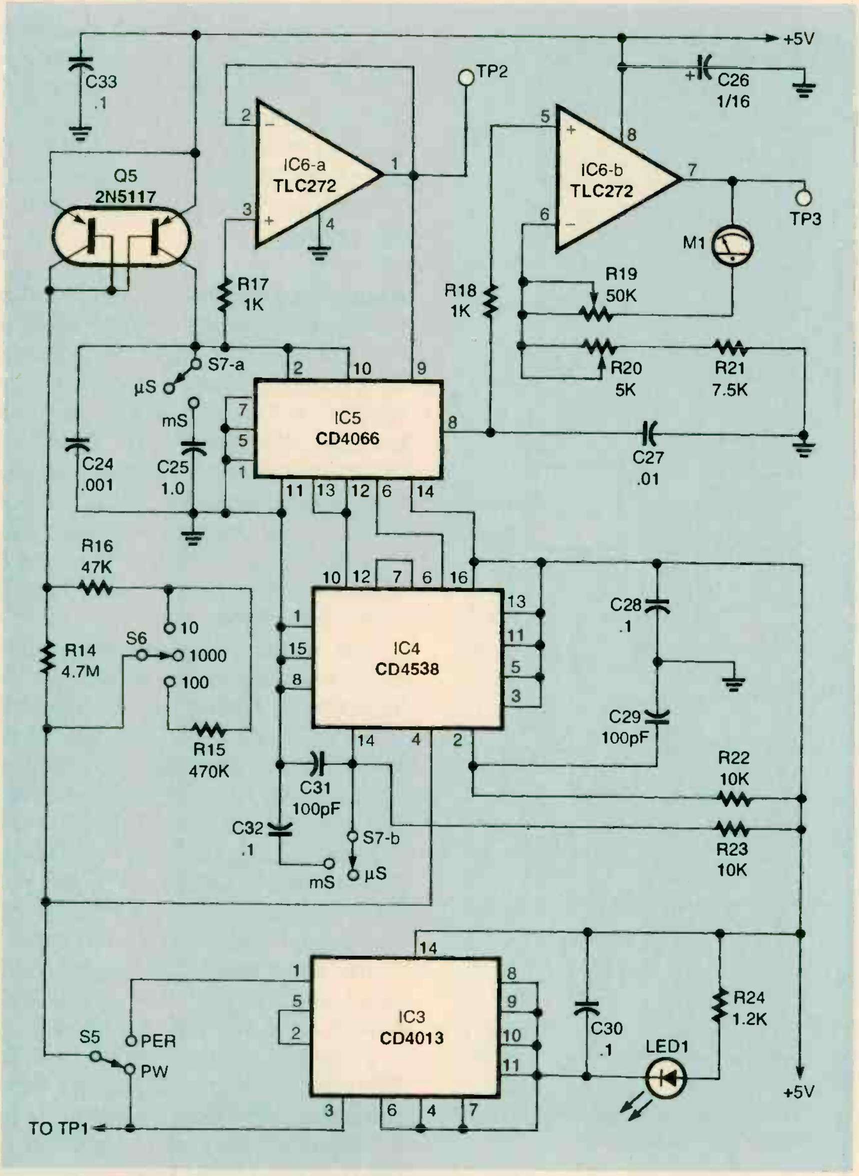


Fig. 2. The display portion of the Portable Pulse Generator is simple and accurate. It can be built as a part of the generator, or can be built as a stand-alone project.

ple is taken, the other half of IC4 is triggered, producing a reset pulse to two of the analog switches in IC5. Those switches, wired in parallel, discharge C24 or C25 rapidly, making the circuit ready for the next pulse. The reset pulse is three microseconds long when S7-b is in the microsecond position; it is one millisecond long when S7-b is in the millisecond position. That gives enough time for C24 or C25 to fully discharge.

Meter M1 is a part of the feedback loop for IC6-b, which converts the hold voltage from C27 to a current that drives the meter. With a 100-microamp display, the meter is read directly as a 0%–100% display of the full-scale range selected by S6 and S7. The meter is protected from over-range currents by R19, and R20 lets the meter be calibrated for precise displays.

The timing diagram in Fig. 3 shows how the display circuit works with the controls set to generate and measure a pulse train with a 15-microsecond period and a 5-microsecond pulse width. Those settings readily demonstrate the integration, sampling, and reset functions of the display circuit. With a dual-trace oscilloscope, the two waveforms can be seen by connecting the scope's probes to TP1 (the inverting-pulse waveform) and TP2 (the sampling waveform).

Construction Tips. Circuit-board fabrication and layout techniques are not critical for the Portable Pulse Generator. The entire circuit can be built on perfboard using standard construction techniques. It is important, however, to keep the lead lengths short. Another important consideration is to keep the passive components as close to their respective ICs as possible in order to prevent cross-coupling of signals. The range capacitors Cl–C5 and C8–C12 can be mounted directly on S1 and S2. In that case, an unused lug on the switches can be used as a ground connection.

It might be difficult to find a capacitor with the value specified for C8. As an alternative, test a group of 1500-pF units and select the one that has a value closest to the 1400-pf value that is needed (remember that capacitors have a wide tolerance). For the best possible accuracy, the actual value of C25 should be exactly 1000 times the value of C24. Also, the values of R14, R15, and R16 should be exact decade multiples of each other. One way to do that is to use parts that are held to tight tolerances. If those are either too expensive or difficult to find, once again select parts from a group of components using an accurate meter to measure the actual values of the parts.

As there are many controls involved, designing the front panel might be difficult. If you wish, you may follow the layout of the author's unit as shown in Fig. 4 for a suggested front-panel layout. Many connections will need to be made between the PC board and the front-panel components, so good initial positioning will let the leads remain as short as possible.

A 2¼-inch by 4¼-inch by 7$^3/_8$-inch plastic enclosure will hold everything with room-to-spare. A simple "tilt stand" can be made from a length of heavy-gauge coat-hanger wire and held in place with $^1/_8$-inch plastic cable clamps on the bottom of the case.

Once the case has the controls mounted in it, and the board has been double-checked for wiring accuracy and proper component polarities, install the board on spacers in the case and connect all of

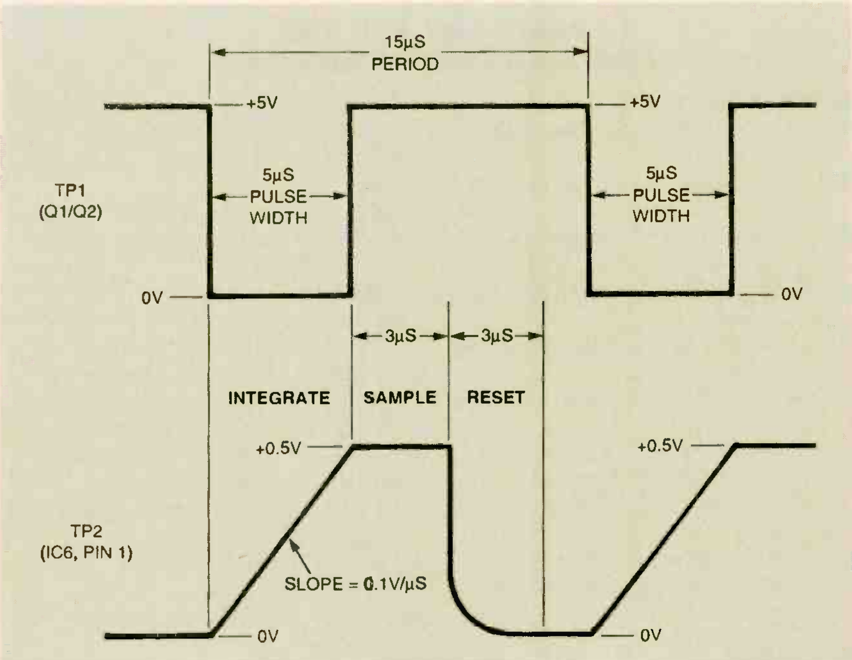


Fig. 3. When the Portable Pulse Generator is set to deliver a 5-microsecond pulse that repeats every 15 microseconds, the overall operation of the circuit can be seen on an oscilloscope.

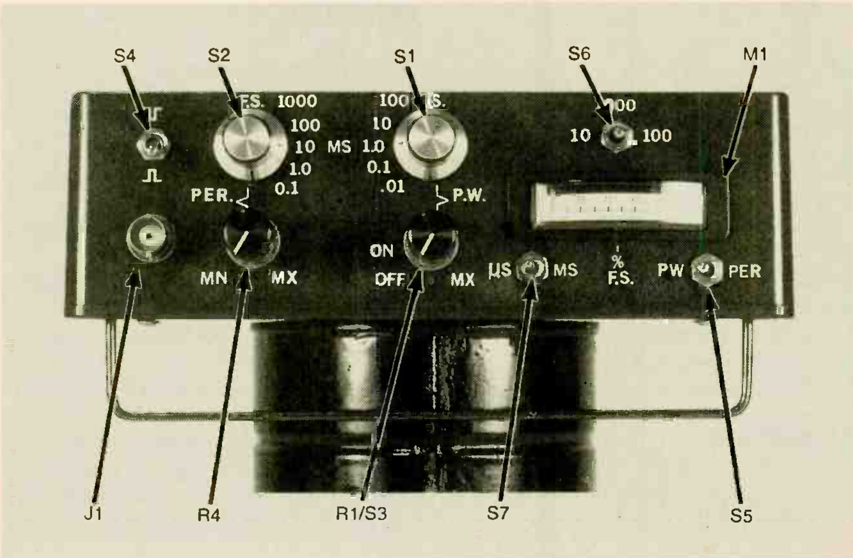


Fig. 4. As with any piece of test equipment, a simple and logical layout of the front-panel controls is a must. Here is the author's layout showing where the various controls were mounted.

the panel components to the board. Install a fresh battery in its holder, and the Portable Pulse Generator is ready for testing and calibration.

Setup and Calibration. Before turning on the power, set the front-panel controls as follows: S1 to 1 millisecond, R1 to its "off' position, S2 to 1 millisecond, and R4 to full clockwise. For the display portion of the circuit, S5 should be set to "PERIOD," S6 to "1000," and S7 to "microseconds." Set R19 and R20 on the board to their midpositions.

Connect an oscilloscope probe to TP1 and set the scope controls to display a 5-volt squarewave with a 1.0 millisecond period. Turn on power to the unit and advance RI to its mid-rotation position. The oscilloscope should be showing a rectangular waveform with a one-millisecond time period. The squarewave's amplitude should be 5 volts. If no waveform is present, check pin 9 of IC1. If the squarewave is present at that location, double the value of C15 and check TP1 again. If necessary, C15 may be increased to about 600 pF before the overall performance of the circuit starts to fall off. If, on the other hand, there is no waveform present at pin 9, check for any wiring errors or replace IC1.

With the oscilloscope probe on TP1, adjust R4 for an exact one-millisecond time period. Now set S6 to 100 microseconds. That will put M1 in an overload condition. Rotate R19 back and forth until MI reads somewhere on scale. Advance R19 so that MI's pointer needle "pegs" gently against its full-scale stop. That setting will prevent M1 from seeing any high-current overloads by forcing IC6-b's output to operate near its maximum positive value. Set S6 back to 1000, and adjust R20 so that M1 displays exactly 100% (100 microamperes). As R19 and R20 might interact, recheck both of those last adjustments and readjust as necessary for best results.

Leaving S6 set at 1000, set S1 to 0.1 millisecond. Adjust R4 for a waveform time-period display on the oscilloscope of exactly 100 microseconds. The reading on M1 should now be 10% (10 microamperes). If not, there is an offset-voltage error in the meter. It is easily corrected by changing the *mechanical* setting of M1 for a 10% reading. If you make that adjustment, it will then be necessary to start the display calibration over again.

Now we will set the Portable Pulse Generator to create the waveforms shown in Fig. 3 to see how well the unit is working. Set the front-panel controls as follows: SI to "0.01 milliseconds," R1 to midrotation, S2 to "0.1 milliseconds," R4 to midrotation, S5 to "pulse width", S6 to "10," and S7 to "microseconds". Adjust R1 for a display of 50% on M1, which indicates a pulse width of 5 microseconds. Set S5 to "PERIOD" and S6 to "100." Adjust R4 to display 15% on M1 for a time period of 15 microseconds. In order to obtain correct measurements, always set the generator controls for a longer time period than the desired pulse width *before* attempting any measurements!

With the oscilloscope attached to TP1, the waveform should be the same as Fig. 3. You should see a nice negative-going pulse 5 microseconds wide that repeats every 15 microseconds. Set S5 to "PULSE WIDTH" and attach the oscilloscope probe to TP2 (pin 1 of IC6). You will now be able to see the entire integrate/sample/reset waveform sequence.

Examine the waveform at TP3, located at pin 7 of IC6. You should see a perfectly straight, horizontal line that represents the DC-output voltage. There might be some small "glitches" occurring at the points where the circuit switches on or off. If the line has a ramp-like appearance, IC5 might be too "leaky." Most accuracy problems can be solved by replacing IC5 with a good unit.

Using a standard, good-quality coaxial cable such as RG-58 or RC-174 with a BNC connector at each end, connect J1 directly to the oscilloscope. The cable should be less than 3 feet in length for best results. The 15-microsecond waveform should be seen. Switching S4 back and forth will change the polarity of the pulse. With a high-quality, high-speed scope, you can also see the very fast (about 25 nanoseconds) rise and fall times of the pulse. Rotate R1 and R4 back and forth to see that there is a linear change in time period and pulse width.

PARTS LIST FOR THE PORTABLE PULSE GENERATOR

SEMICONDUCTORS

IC1—TLC556 CMOS dual timer, integrated circuit
IC2—78L05 voltage regulator, integrated circuit
IC3—CD4013 CMOS dual flip-flop, integrated circuit
IC4—CD4538 CMOS dual one-shot, integrated circuit
IC5—CD4066 CMOS quad analog switch, integrated circuit
IC6—TLC272 CMOS op-amp, integrated circuit
Q1, Q4—2N3906 PNP transistor
Q2, Q3—2N3904 NPN transistor
Q5—2N5117 dual matched-pair PNP transistor
D1–D5—1N4148 silicon diode
LED1—Light-emitting diode, red, low-current

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R4—50,000-ohm potentiometer, panel-mount
R2—3300-ohm
R3—3900-ohm
R5, R22, R23—10,000-ohm
R6, R7, R10, R11—1800-ohm
R8, R9, R12, R13—680-ohm
R14—4.7-megohm (see text)
R15—470,000-ohm (see text)
R16—47,000-ohm (see text)
R17, R18—1000-ohm
R19—50,000-ohm potentiometer
R20—5000-ohm potentiometer
R21—7500-ohm
R24—1200-ohm

CAPACITORS

C1—2.2-µF, 16-WVDC, tantalum
C2—0.22-µF, polyester
C3—0.022-µF, polyester
C4—0.0022-µF, polyester
C5—180-pF, mica or polystyrene
C6, C17, C28, C30, C33—0.1-µF, ceramic-disk
C7, C16, C26—1-µF, 16-WVDC, tantalum
C8—1400-pF, mica or polystyrene (see text)
C9—0.015-µF, polyester
C10—0.15-µF, polyester
C11—1.5-µF, 16-WVDC, tantalum
C12—15-µF, 16-WVDC, tantalum
C13, C14—0.01-µF, ceramic-disk
C15, C20–C23—220-pF, ceramic-disk
C18—47-µF, 16-WVDC, electrolytic
C19—10-µF, 16-WVDC, tantalum
C24—0.001-µF, polyester or polystyrene (see text)
C25—1-µF, polyester (see text)
C27—0.01-µF polyester
C29, C31—100-pF, ceramic-disk
C32—0.1-µF, polyester

ADDITIONAL PARTS AND MATERIALS

B1—9-volt battery
J1—BNC female connector
M1—0–100-µA panel meter, analog
S1, S2—Rotary switch, single-pole, 5-position
S3—Single-pole, single-throw switch, integral to R1 (see text)
S4, S5—Single-pole, double-throw, toggle switch
S6—Single-pole, double-throw, center-off, toggle switch
S7—Double-pole, double-throw, toggle switch
Case, spacers, wire, solder, hardware, etc.

Note: One suggested source of hard-to-find components, including Q5, is: Johnson Shop Products, P.O. Box 2843, Cupertino, CA 95015; Tel: (408) 257-8614.

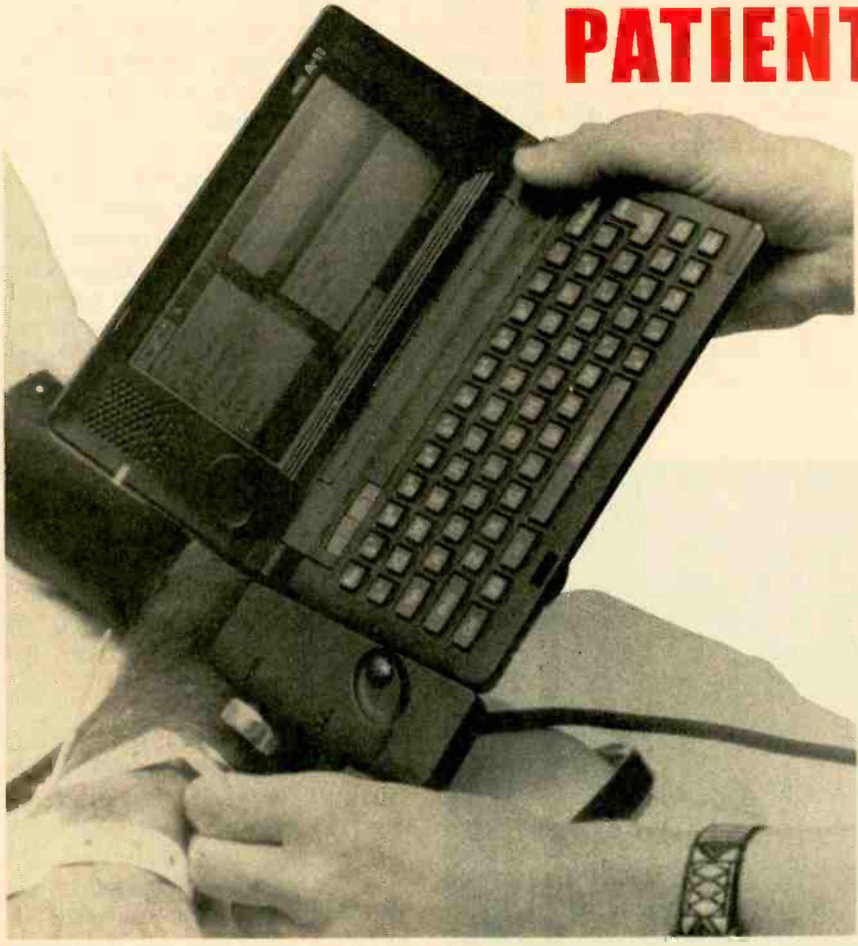
Going Further. As we said before, short-circuit protection is easy to add to the output-driver stage of the Portable Pulse Generator. One possible method is to install resistors of about 22 ohms each in series with the emitters of Q1–Q5. A simpler method is to install a second output jack that is connected to J1 with a 100-ohm resistor between the center terminals of both jacks. The second jack can be used as a protected output, with J1 remaining as a direct output. Of course, peak output-pulse voltage will drop accordingly by using those methods.

A standard coaxial cable will provide an excellent output signal from the Portable Pulse Generator—even without impedance matching. From a practical point of view, most applications only need a pair of standard clip leads that have been connected to either a BNC connector or a dual-binding-post adapter. However, if you require the ultimate in impedance matching to your load, the additional output jack mentioned before can be used once again.

Keeping in mind the power supply requirements and the load that will be driven by the Portable Pulse Generator's battery, select the cable impedance that will be needed to drive the output load. Select an appropriate jack for the additional output jack—a BNC female jack for 50-ohm lines; a female "F" jack for 75-ohm lines; etc. Then connect the proper source resistor (50 ohms, 75 ohms, etc.) between the center conductors of J1 and the new output jack. Connect the proper cable between the new output jack and the load, and terminate the cable at the load with the proper (50 ohm, 75 ohm, etc.) terminating resistor.

You can also use a 300-ohm line with a standard 300-ohm "twin-lead" cable and 300-ohm source and terminating resistors. The jack on the generator can be a standard RCA phono jack, with clips on the other end of the twin-lead wire. The generator's 9-volt battery is enough to drive that type of load. But keep in mind that, when using terminated lines, the peak voltage to the load will be only 50% of the output voltage at J1!

(Continued on page 48)



PATIENT-FRIENDLY MEDICAL TECHNOLOGY

New and emerging technologies are going a long way toward reducing patient stress while providing doctors with the information they need faster and even more safely.

BILL SIURU

Anyone who has ever had to undergo a medical test or procedure is familiar with some of the aggravations that add stress and strain to an already trying situation. Those include long waits for the "blood work" to come back from the lab, multiple needle sticks while the nurse looks for a vein, lost medical records, etc. Well, those and similar annoyances might soon be a thing of the past as researchers are working on developments that are aimed at making a hospital stay less stressful on the patient. Even better, they are making it possible for doctors and other caregivers to get the information they need faster than ever, and in some cases even to reduce patient risk.

Biocavity Lasers. Scientists at the Sandia National Laboratories and the National Institutes of Health are developing a laser technology that could bring major changes in the way blood samples are analyzed. Called a "biocavity laser," the new technique could mean the delays between the time the nurse draws the blood and when the doctor gets the results could be a thing of the past. It can also be used as a tool to find cures and treatment for sickle-cell anemia, AIDS, cancer, and other blood-related ailments.

The new analysis device uses a VCSEL (Vertical-Cavity Surface-Emitting Laser) that produces millions of tiny laser beams from a postage-sized area. Unlike current laser-analysis techniques where laser beams pass through blood cells to yield information, blood samples are inserted directly into the biocavity laser. There, samples become part of the lasing process, sort of a "lab-on-a-chip," where blood is brought into the micro laboratory and results read on the spot. Life-critical blood analysis could be done virtually instantaneously using a hand-held biocavity laser. It is possible to take a blood sample containing millions of cells and extract information about each cell in a few minutes.

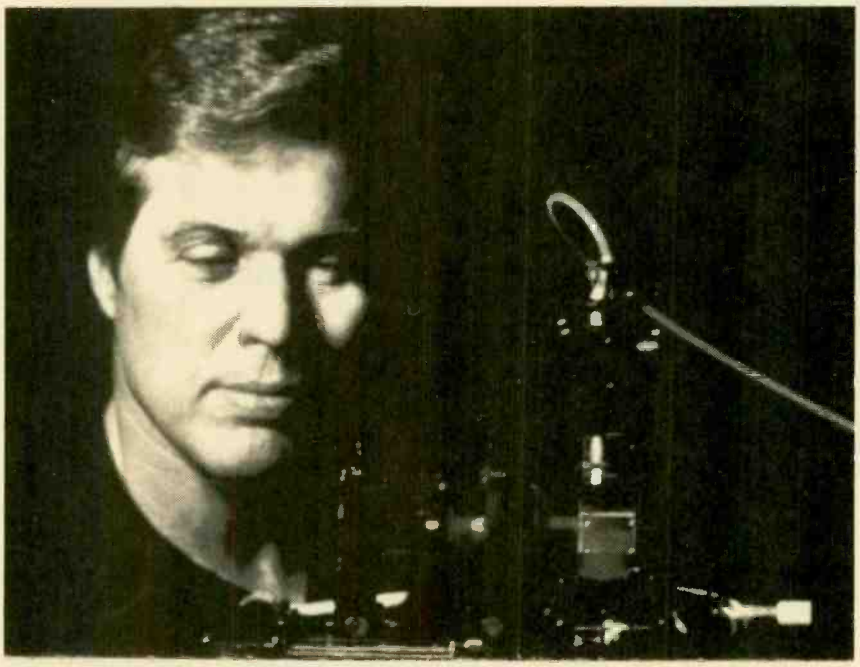
When using the device, the image of the blood particle is magnified because the laser light reflects many times through the sample. That greatly increases the chances of positive, errorless identification. Also in most cases, cells do not have to be killed and stained—the most typical laboratory procedure. Instead, researchers can watch changes in cells as they occur in "real time."

A small, no-frills system that can distinguish between cells in a sample using a laptop computer could cost from $5,000 to $15,000. A more complete laboratory setup would cost about $70,000. While the VSCEL can be used to study any plant or animal cells that are small enough to fit into the cavity, it will be first used to study hemoglobin concentration in individual cells.

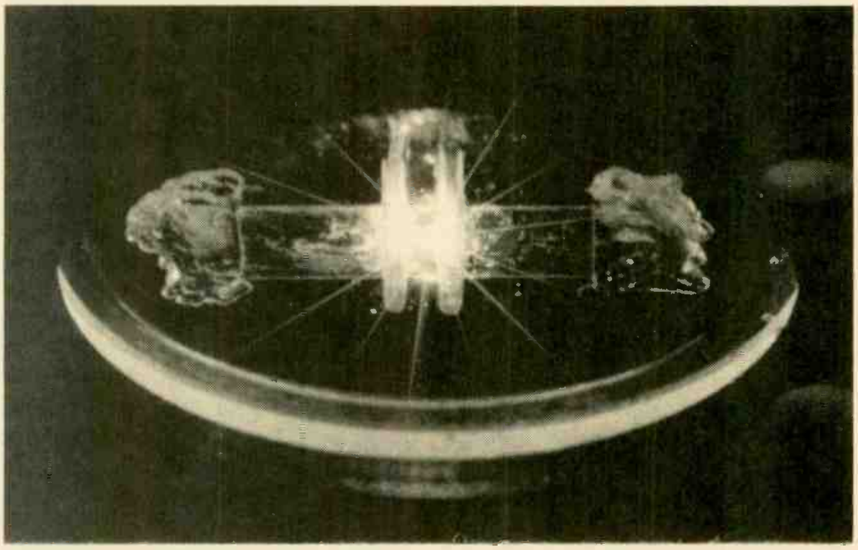
Other future applications could include portable units for analyzing toxic materials that could invade the blood stream from a terrorist's biological or chemical attack. To help design new drugs, blood could be analyzed to see how it reacts when the drugs are introduced.

The Venoscope. How many times have you had a nurse or medical technician make multiple "sticks" before a vein was finally located? That's lots of fun, isn't it? Well, a new device, the Venoscope from Applied Biotech Products, could ensure that the vein is found the first time. The Venoscope is a "transilluminator" that aids healthcare professionals in accurately assessing venous networks when drawing blood or starting an IV. The bottom line is not only more comfort for patients, but also less risk of exposure to infection and cost savings in terms of wasted nursing time and materials.

Using a dual light source to transilluminate the veins from two sides, the device can determine the vein's direction of travel, size, and condition. The Venoscope will work on all patients including chubby toddlers, the obese, and those whose veins were neither visible nor palpable.



Project manager Paul Gourley examines a semiconductor diode laser's beam used to excite the VSCEL biocavity laser. The VSCEL releases an invisible infrared beam which carries information about cells to a detector.



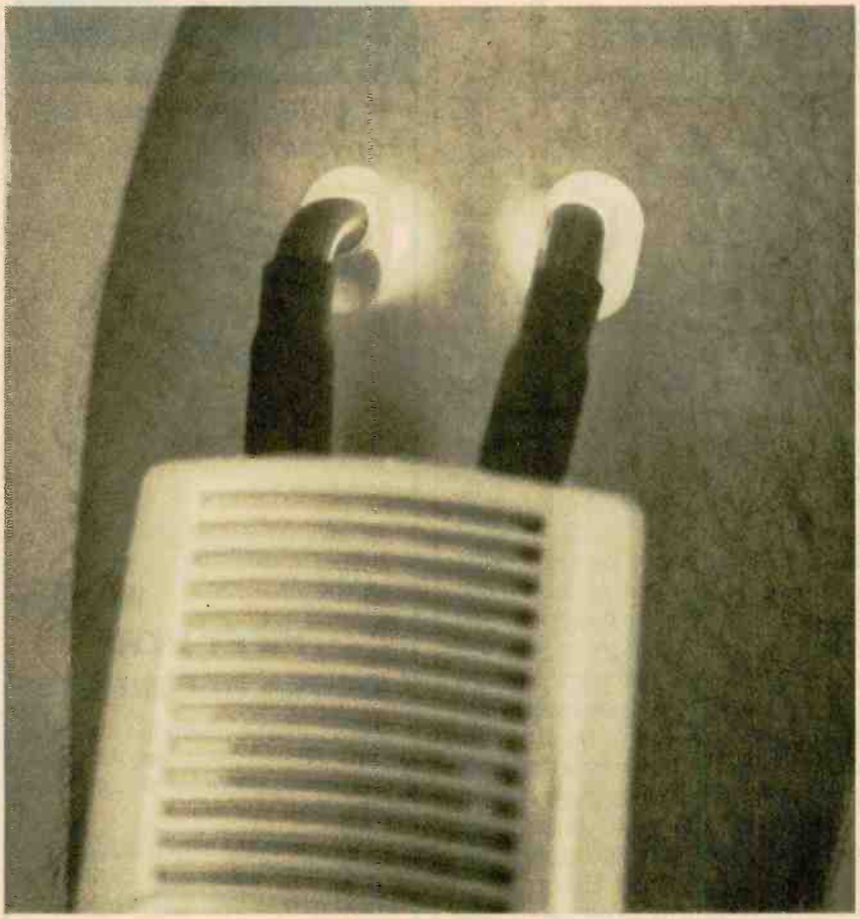
A biocavity laser—a VSCEL capped by a glass plate enclosing a blood sample—is excited by a pumped laser. The VSCEL device can produce information about millions of blood cells in a few minutes.

The battery-powered Venoscope, which costs under $500, is used in a darkened or at least dimly lit room so the veins surrounding subcutaneous tissue can be more easily seen. The Venoscope is held flush against the patient's skin, then it is slid along until a dark line appears between the fiber-optic arms, indicating that a vein has been found. A deeper vein will have a shadowy appearance, while a superficial vein will appear clear and relatively sharper. After marking the vein's exact location, the Venoscope is removed, the lights are turned back on, and the needle is inserted.

WristRecord. While it actually happens very, very infrequently, one of the great terrors of a hospital stay is what happens if a patient's records are accidentally switched with those of another? Needless to say, the results could be catastrophic. What if doctors performed a procedure on the wrong patient? What if anesthesiologists administered an anesthetic to which the patient was allergic? What would be the consequences of a nurse giving a patient the wrong medications?

Ichor's WristRecord could virtually eliminate any possibility of that happening, greatly easing the minds of patients. Combining the latest Windows CE palmtop computers and smart-card technology, which stores information at remote locations, the WristRecord keeps vital medical information where it's most accessible to health care professionals—right on the patient's wrist.

Patients wear a wristband containing a memory disk that is the size of a watch battery. The health-care professional carries the labcoat-pocket-sized hand-held computer equipped with Ichor's CoreData CE software, which is used to retrieve, add to, or change patient information stored on the memory disk. Health care workers touch the "reader" on the side of the tiny computer to the memory disk on the



The Venoscope uses a dual light source to transilluminate the veins from two sides of the device, making them easier to find.

wrist to magnetically transfer and update information.

With the system, essential medical information doctors and nurses need for each patient's care would move seamlessly with a patient through operating rooms, labor and delivery suites, emergency rooms, and medical wards. As patient care continues, case data can also be downloaded into regular networks for hospital record keeping and billing.

The WristRecord has applications beyond the hospital setting. Many individuals, such as organ-transplant recipients, diabetics, and some cancer patients, though not in the hospital, are still "tethered" to it. Therefore, up-to-date records must be readily available when they visit the hospital. Also patient's might visit several physicians who prescribe different medications. Computerized wristbands could keep each member of a patient's caregiver "team" abreast of everything in a patient's regimen, preventing conflicting instructions or the prescribing of drugs that taken in combination could be harmful.

Originally developed by researchers at the Medical University of South Carolina (MUSC), the WristRecord is now being offered commercially by Ichor Corporation for use in hospitals as well as home health-care, and nursing-home environments. The system is very affordable. The reusable wrist device with a memory capacity of 8 KB of compressed data costs about $10. The hand-held computer and reader costs around $500.

Optical Coherence Tomography. Biopsies—surgical procedures to remove "suspect" tissue for clinical examination—are commonly done during diagnosis for cancer and heart diseases. Researchers at the Massachusetts Institute of Technology (MIT) and Massachusetts General Hospital have developed an alternative, non-invasive technique called optical coherence tomography (OCT). OCT produces a tomograph—a clear picture of a cross-section of body tissue—alleviating the need for a surgical biopsy. Using laser light, OCT magnifies tissue so individual cells can be viewed without any damage to the tissue. The technique would be particularly attractive as an alternative to hazardous procedures, such as biopsies of brain and coronary artery tissues.

OCT uses optical-fiber technology where string-like optical fibers guide light waves to control a beam of light over long distances and around bends. OCT could be compared to ultrasound: With ultrasound, waves of sound are sent out and echoes are reflected back from an object—such as a fetus in the womb; using those reflections, a visual image is constructed. In OCT, on the other hand, light takes the place of sound. In that procedure, a beam of infrared light is shone into tissue structure and back reflections are measured from different positions and used to form an image of the terrain within.

The infrared light used in OCT is introduced to tissue using a small catheter, or endoscope, which can be inserted virtually anywhere in the body. Because of OCT's high resolution—ten times greater than either clinical MRI (Magnetic Resonance Imagining) or high-frequency ultrasound—microscopic tissue terrain disruption, an indication of potential problems, can be detected early

FOR MORE INFORMATION

Sandia National Laboratory
PO Box 5800
Albuquerque, NM 87185
Web: www.sandia.gov

Applied Biotech Products, Inc.
230 Heymann Blvd., Suite A
Lafayette, LA 70503
Web: www.venoscope.com

Ichor Corporation
4750 Goer Drive
North Charleston, SC 29406
Web: www.ichorcorp.com

Massachusetts Institute of Technology
Room 5-111
77 Massachusetts Ave.
Cambridge, MA 02139-4307
Web: web.mit.edu

and treated promptly.

The first application of OCT is for use by ophthalmologists in detecting and monitoring eye diseases such as the early stages of glaucoma. There, high-resolution cross-sectional tomographs of the eye are made. To date, several thousand patients have already been examined using OCT. The next step is to fully develop the technology for imaging non-transparent tissue in *vivo*; that is, in living organisms. Besides replacing conventional biopsies for many applications, OCT could be used in cases where a surgical biopsy misses the diagnosis, such as in early detection of colon, esophagus, and cervical cancer.

Finally, OCT can be used to guide surgical and micro-surgical procedures such as nerve repair or prostate surgery. OCT could also be combined with other diagnosis techniques, for instance using OCT with spectroscopy to obtain both biochemical and structural information on tissue. Ω

VIDEO AMP

(continued from page 36)

o'clock and set the trimmer capacitor to half mesh of the plates. Another way to set up the amplifier is to patch it in and out of a signal feeding a monitor. Watching the monitor, make adjustments until you cannot see any change in the brightness or color intensity of the picture.

At this point, the Video Distribution Amplifier is ready to go. Simply connect any S-video source to J1 and up to four S-video inputs to J2–J5. Turn on the power, and you're ready to enjoy the benefits of S-video picture quality.

Until digital-television transmission and digital connections between our home-satellite receivers, videodisc players, video recorders, computers, and television displays becomes a reality, the S-video connection is the state-of-the-art method to connect those devices together. However, one can't help but wonder—had CBS Labs developed a color picture tube, might we have spent the last 50 years watching high-definition television? Ω

PULSE GENERATOR

(continued from page 44)

Another point to consider when driving heavy loads is the accuracy of the measurement system. The input signal for the display comes from the inverting driver output (TP1); certain conditions might introduce errors. All measurements in the "PERIOD" mode or any measurements made with the load driven with the non-inverting (positive-going) driver output will, however, be accurate. When driving a heavy load with the inverting (negative-going) output, a "PULSE WIDTH" measurement might be inaccurate or non-existent. That is due to the fact that the voltage swing from TP1 might not be enough to turn Q5 completely on or off with a heavy load pulling TP1 further away from the supply rails. The answer in that case, of course, is to make the measurement *before* applying the load!

Since the Portable Pulse Generator runs on a 5-volt supply, it can drive standard 5-volt TTL or CMOS logic directly. It is possible to also drive the newer 3-volt logic systems. In that case, simply use one of the balanced-impedance, terminated cable methods mentioned earlier. That will supply a 2½-volt (maximum) pulse to the load.

As mentioned previously, the author's "Duty Cycle monitor" can be used with this project. In fact, the duty-cycle monitor circuit can be installed and wired to the Portable Pulse Generator, sharing the same display meter and power supply. If that is done, the duty-cycle monitor's input protection circuit will not be needed.

As you can see, the Portable Pulse Generator is a versatile and accurate instrument. It is simple to use and easy to construct, making it a great addition to your bench. Ω

EXPERIMENTING WITH MAGENTIC SENSORS

This month, we put our flux-gate sensors to work and build a practical magnetometer and gradiometer.

JOSEPH J. CARR

In the June, 1998 issue of **Electronics now,** we introduced the FGM-x series of flux-gate magnetometer sensors from Speake & Co. Ltd. These relatively low-cost devices are made in the United Kingdom, but are distributed in the United States by Fat Quarters Software (24774 Shoshonee Drive, Murrieta, CA 92562; Tel: 909-698-7950; Fax: 909-698-7913: Web: www.dconn.com/fatquarterssoftware). For those not with us then, let's quickly review some of the important features of the FGM-3, which is used in the projects that are described in this article.

The FGM-3 is a three-terminal device (see Fig. 1A) that will measure magnetic fields over the range ± 0.5 oersted (± 50 mteslas). It can be used in a wide variety of magnetometer and gradiometer circuits. The three terminals on the FGM-3 are: RED: POWER (+5 VDC); BLK: GROUND (0V); and WHT: SIGNAL

The output signal is a train of TTL-compatible pulses with a period that ranges from 8 to 25 mS, or a frequency range of 40 to 125 kHz. The magnetic field strength is indicated by the frequency produced, and can be read on a variety of display devices including digital frequency counters, digital period counters, analog meters, and even computers. It is relatively easy to interface the FGM-3 device to microcontrollers—such as the Parallax BASIC-Stamp or Micromint PicStic devices—using a line of interface chips offered by Speake and Fat Quarters.

The sensitivity pattern of the FGM-3 device is shown in Fig. 1B. It is a figure-8 pattern with its maxima along the major axis of the FGM-3, and minima orthogonal to the major axis. At other angles, the sensitivity drops off as the cosine of the angle from the major axis.

Analog Interface to FGM-3. Figure 2 shows a method for providing an analog interface to the FGM-3 and its relatives. The output of the sensor is a 40- to 125-kHz frequency that is proportional to the applied magnetic field. As a result, we can use a frequency-to-voltage (F/V) converter such as the LM2917 to render the signal into a proportional DC voltage. That voltage, in turn, can be used to drive an analog or digital voltmeter or milliammeter. The LM2917 is used here because it is widely available at low cost from mail-order parts distributors.

The output circuit consists of a bridge made up of R1–R3 and the output of the LM2917. A resistive voltage divider (R2/R3) produces a potential of ½(V+) at one end of the 22,000-ohm sensitivity control (R4). If the voltage produced by the LM2917 is the same as the voltage at R4, then the differential voltage is zero and no current flows. But if the LM2917 voltage is not equal, then a difference exists and current flows in R4 and M1. That current is proportional to the applied magnetic field. Meter M1 and R4 can be replaced with a digital voltmeter, if desired.

The DC power supply uses two regulators, one for the FGM-3 and one for the LM2917. Even better results can be obtained if an intermediate voltage regulator, say a 78L09, is placed between the V+

source and the inputs of IC2 and IC3. That results in double-regulation, and produces better operation.

Digital "Heterodyning." A different interface method is shown in Fig. 3. It results in a more sensitive measurement over a small range of the sensor's total capability. In other words, that circuit makes it possible to measure small fluctuations in a relatively large magnetic field.

In that circuit, a D-type flip-flop is used to "mix" the frequency from the FGM-3 with a reference frequency (F_{REF}). The FGM-3 literature calls that process "digital heterodyning," although it is quick to point out that it is really more like the production of alias frequencies by undersampling than true heterodyning.

Two types of frequency sources can be used for F_{REF}. For relatively crude measurements, such as a passing-vehicle detector, the CMOS oscillator of Fig. 4A is suitable. This circuit is based on the 4049 hex inverter connected in an astable multivibrator configuration. The exact frequency can be adjusted using R2, a 10,000-ohm, 10-turn potentiometer.

Where a higher degree of stability is needed, for example when making Earth-field variation measurements or testing magnetic materials, a more stable frequency source is needed. In that case, use a circuit such as the one in Fig. 4B. That circuit uses a crystal-controlled oscillator feeding a binary divider network. Crystal oscillators can be built, or if you check the catalogs you will find that a large number of frequencies are available in TTL- and CMOS-compatible formats at low enough costs to make you wonder why you would want to build your own. I've seen them sold for about the price

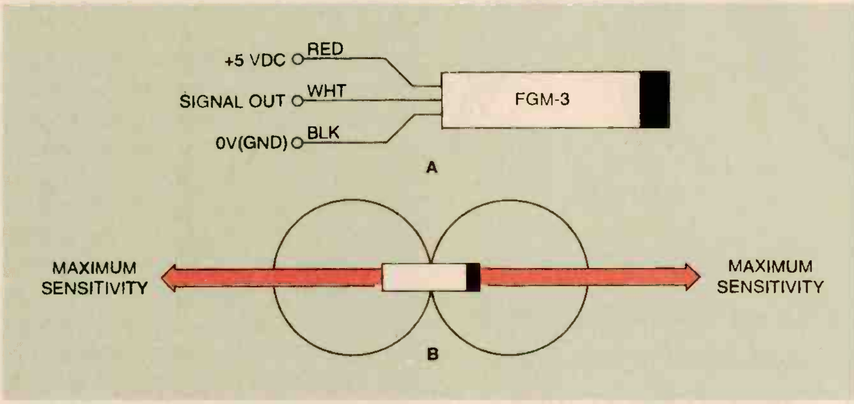


Fig. 1. The FGM-3 sensor is a three-terminal device that can be used to measure magnetic fields (A). Its sensitivity pattern is a figure-8(B).

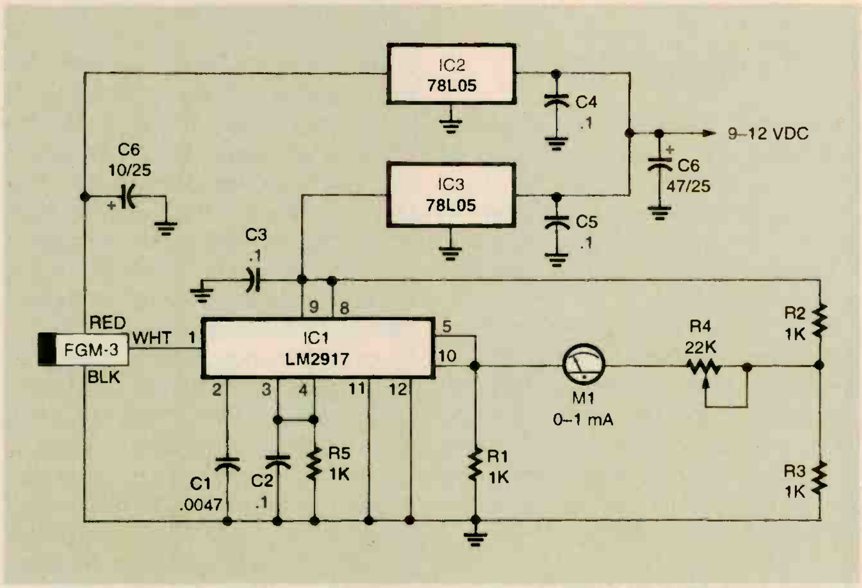


Fig. 2. This circuit can be used to provide an analog interface to the FGM-3. The heart of the circuit is an LM2917 F/V converter, which is inexpensive and easy to find.

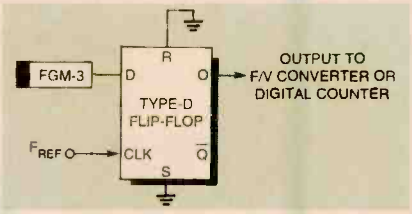


Fig. 3. To provide a more sensitive measuring capability, but over a smaller range, a type of "digital heterodyning" can be used.

of a crystal alone in many mail-order catalogs (Digi-Key, etc.).

The reference frequency is adjusted to a point about 500 Hz below the mean sensor frequency. That frequency is measured when the sensor is in the east-west direction. That arrangement will produce a frequency of 0 to 1,000 Hz over a magnetic field range of ±500 gamma.

A Magnetometer Project. Figure 5 shows the circuit for a simple magnetometer based on the FGM-3 flux-gate sensor. A PC board, the sensor, the ICs, and most other parts (but no power supply, enclosure, or switch S1) can be obtained from Fat Quarters Software (contact them directly or see their Web page for more information). That circuit takes the output frequency of the FGM-3, passes it through a special interface chip (IC1), and then to a digital-to-analog converter to produce a voltage output.

The heart of the circuit, other than the FGM-3 device, is the special interface chip, Speake's SCL006 device. It provides the circuitry needed to perform magnetometry, including Earth-field magnetometry. It integrates field fluctuations in one-second intervals, producing very sensitive output variations in response to small field variations. It is of keen interest to people doing radio-propagation studies, and those who need to monitor for solar flares. It also works as a laboratory magnetometer for various purposes. The SCL006A is housed in an 18-pin DIP IC package.

The D/A converter (IC2) is an Analog Devices type AD557. It replaces an older Ferranti device seen in the Speake literature because that older device is no longer available. Indeed, being a European device, it was a bit hard to find in unit quantities required by hobbyists on this side of the Atlantic. The kit from Fat Quarters Software contains all the components needed, plus a printed circuit board. The FGM-3 device is bought separately.

The circuit is designed so that it could be run from 9-volt batteries for use in the field. A sensitivity switch, S1, provides four positions, each with a different overall sensitivity range. The output signal is a DC voltage that can be monitored by a strip-chart or X-Y paper recorder, voltmeter, or fed into a computer using an A/D converter.

If you intend to use a computer to receive the data, then it might be worthwhile to eliminate the D/A converter and feed the digital lines (D0-D7) from the SCL006A directly to an eight-bit parallel port. Not all computers have that type of port, but there are plug-in boards available for PCs, as well as at least one product that makes an eight-bit I/O port out of the parallel printer port.

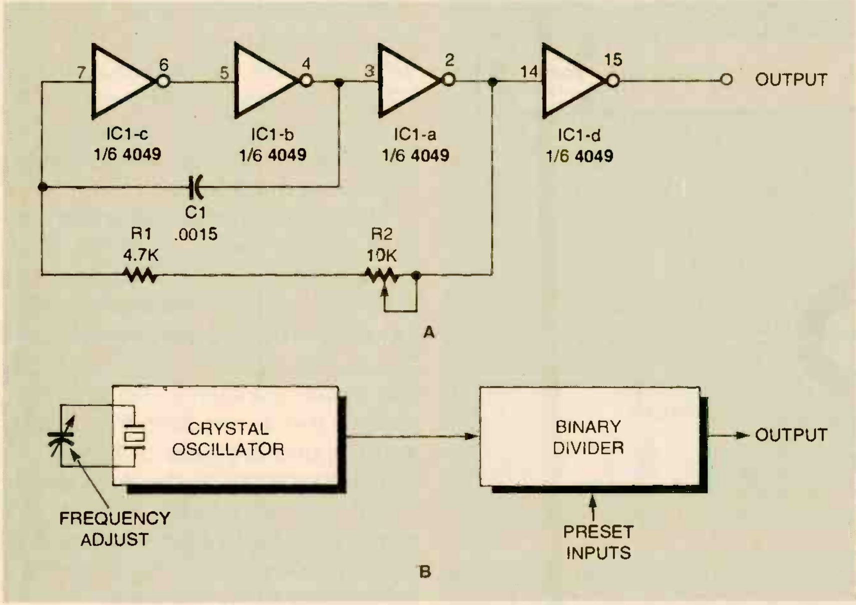


Fig. 4. For relatively crude measurements, a CMOS oscillator like the one in A can be used to generate the reference frequency. In more demanding applications, a crystal oscillator and binary divider can be used (B).

Gradiometers. One of the problems with magnetometers is that small fluctuations occur in otherwise very large magnetic fields, and those fluctuations can sometimes be important. A further problem with single-sensor systems is that they are very sensitive to orientation. Even a small amount of rotation can cause unacceptably large, but spurious, output changes. The changes are real, but are not the fluctuations that you are seeking.

A gradiometer is a magnetic instrument that uses two identical sensors that are aligned with each other so as to produce a zero output in the presence of a uniform magnetic field. If one of the sensors comes into contact with some sort of small magnetic anomaly, then it will upset the balance between sensors, producing an output. The gradiometer gets its name from the fact that it measures the gradient of the magnetic field over a small distance (typically 1 to 5 feet).

These instruments can be used for finding very small magnetic anomalies. For example, the metallic firing pin of plastic land mines buried a few inches below the sur-

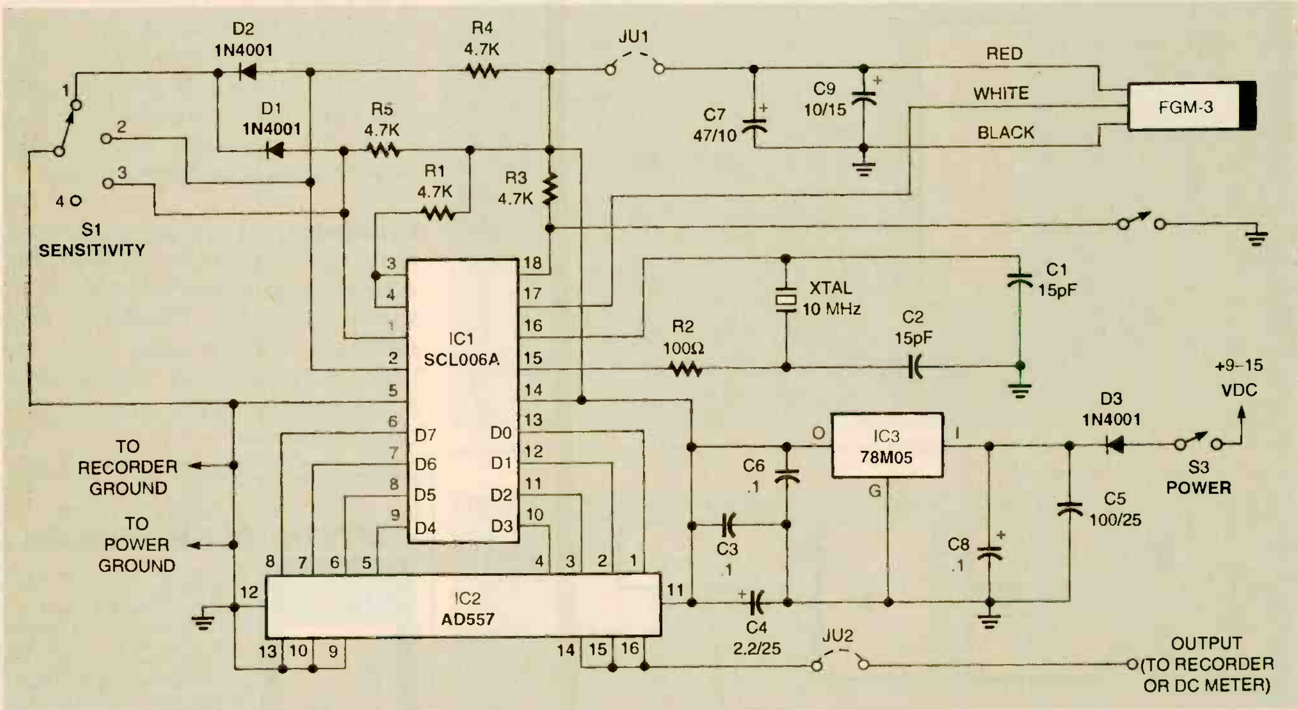


Fig. 5. Here's the circuit for a practical magnetometer. Most of the components needed and a PC board can be obtained from the source mentioned in the article.

face, or a shipwreck buried deep in the ocean silt. Archeologists use gradiometers to find artifacts and identify sites. Also, people who explore Civil War battlefields, western mining camps, and other sites often use gradiometers to facilitate their work.

Figure 6 shows the construction details for a simple gradiometer based on the FGM-3 device. It is built using a length of PVC pipe. One sensor is permanently mounted at one end of the pipe, using any sort of appropriate non-magnetic packing material. In one experiment, I used standard 0.5-inch adhesive-backed window-sealing tape, which is used in colder areas of the country to keep the howling winds out of the house in wintertime. It worked nicely to hold the permanent sensor in place.

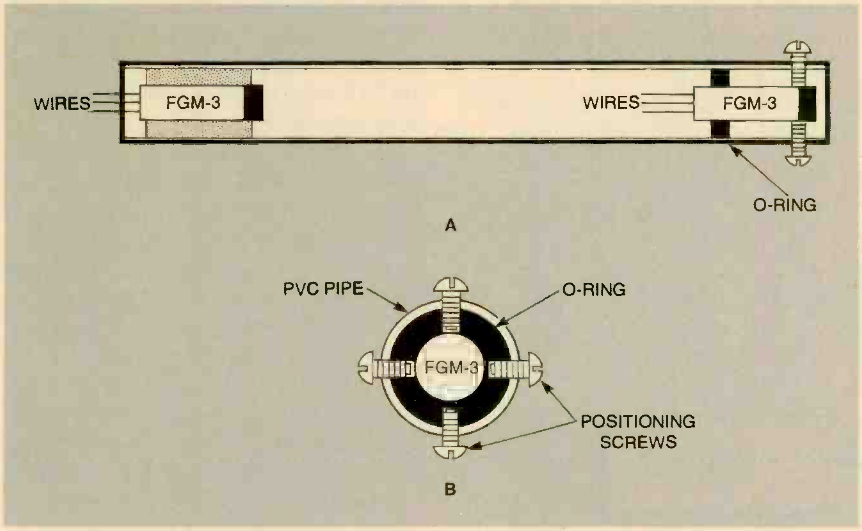


Fig. 6. This two-sensor rig forms the heart of a practical gradiometer. It is easy to build and provides excellent results.

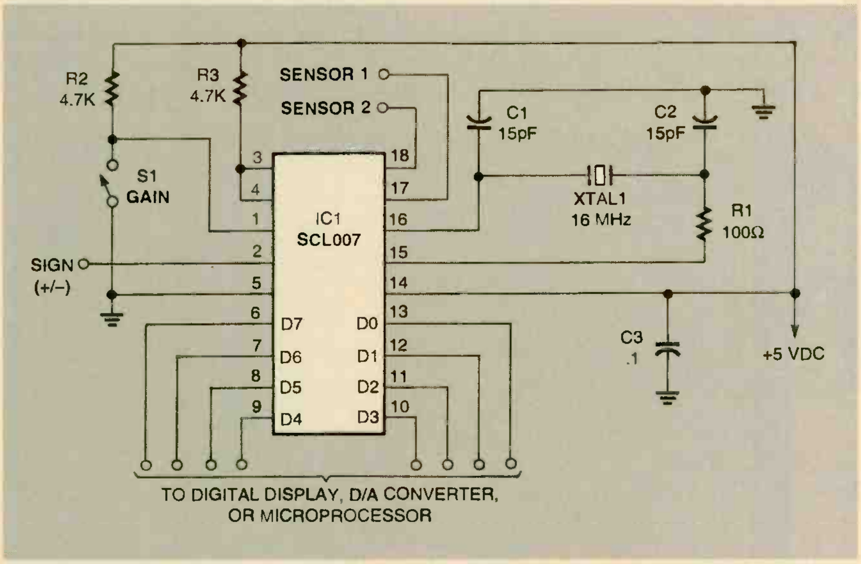


Fig. 7. Here's a circuit that converts the output of the gradiometer's sensors into a digital signal that is proportional to the field gradient.

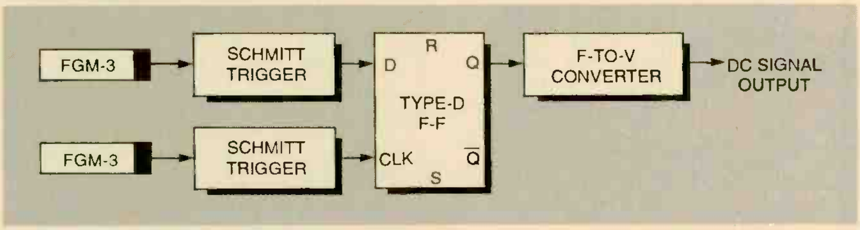


Fig. 8. Using the digital heterodyning concept discussed earlier, it is easy to build a low-cost but very sensitive gradiometer.

The other sensor is mounted in the opposite end of the tube using an O-ring that fits snugly into the tube. Four positioning screws made of non-magnetic materials are used to align the sensor. The position of the sensor is adjusted experimentally. The idea is to position the sensor such that the gradiometer can be rotated freely in space without causing an output variation.

The gradiometer sensor is usually held vertically such that the end with the wires coming out of the FGM-3 devices is pointed downwards. That alignment allows you to find buried magnetic objects even if they are quite small.

A practical gradiometer can be built using a special interface chip by Speake, the SCL007 device. It is an 18-pin device that accepts the inputs from the two sensors, and produces an eight-bit digital output. The circuit is shown in Fig. 7. It can receive the signals from the sensors in Fig. 6, and produce a digital output proportional to the field gradient. If you want a DC output, the same sort of D/A converter used in the magnetometer of Fig. 5 can also be used for the gradiometer.

Figure 8 shows a method of using digital heterodyning to make a very sensitive gradiometer at low cost. The outputs of the two FGM-3 sensors are fed to the D input and clock (CLK) input of a D-type flip-flop. The output of the flip-flop is fed to an F/V converter such as the LM2917 device discussed earlier.

Conclusion. As we've seen, magnetic sensor projects are relatively easy to build when the FGM-3 sensor is used. The device is well behaved, and will serve nicely for both hobbyist and professional instruments, as well as for classroom demonstrations. Ω

BY DON LANCASTER

Understanding Crest Factors, Temperature-Sensing Circuits, and More

IN SEVERAL PREVIOUS COLUMNS, WE HAVE SEEN HOW EXCRUCIATINGLY HARD IT IS TO ACCURATELY MEASURE AC POWER, ESPECIALLY IF PHASE SHIFTS, REACTIVE ENERGY, NONLINEARITIES, STRANGE WAVEFORMS, SPARKING, STRONG HARMONICS, OR low duty cycles are in any way involved. More often than not, a casual or improper power measurement tends to end up wildly low, leading to dead wrong conclusions concerning real efficiency. Sometimes such wrong measurements are what's behind those "overunity" pseudoscience fantasies seen on the web.

This month, we'll look at yet another power-measurement "gotcha."

Crest Factors

Figure 1 shows us a property of any repeating waveform that's known as its Crest Factor. We have already seen that the peak value of a waveform is its maximum height, the average value is like any other average, and that effective or rms value is the equivalent DC heating power. Because power involves either the square of current or voltage or else the product of these two, rms values are always equal or greater than average. Except for a pure DC current, rms is always greater than average. Sometimes it is even ridiculously greater.

The crest factor of any current or voltage waveform can be defined as the ratio of peak to rms. For instance, a DC voltage has a peak value of 1.0, an average value of 1.0, a rms value of 1.0, and thus a crest factor of 1.0. One cycle of a pure sinewave might offer a peak value of 1.00, an average value of 0.634, a rms value of 0.707, and a crest factor of 1.00/0.707 = 1.414.

A low brightness setting on a half-wave lamp dimmer may give you a peak value of 1.28, a rms value of 0.32, an average value of 0.11, and a crest factor of 4.0. Values for the narrow impulse current waveform of a capacitance-input diode rectifier will end up waveform dependent, but you can have a peak value of 1.414, an average value of 0.04, and a rms value of 0.22, and a crest factor of 6.42.

There are two key points here: First, the ratio of rms to average current will change wildly from waveform to waveform! That is always highly duty-cycle dependent. Thus, most average-responding meters lie like a rug when fed anything but whole cycles of pure AC sinewaves.

A figure of "1.11" rms-to-average seems to be widely bandied about. In reality, that figure is not a constant; its value can (and will) be anything from one to a million. In fact, nearly all real-world waveforms will have rms to average readings far above unity, leading you to wildly wrong underreporting on cheap meters.

The second point is that every wattmeter design has its specific maximum allowable crest factor. Crest factors above that critical value will usually read low, and possibly severely so. Most ordinary wattmeters are totally unsuited to accurately measure lower duty-cycle waveforms with high crest factors. Always check on your crest factor limit to be sure.

Why is there a crest-factor limit? Because the product of any two big numbers will end up as a very big number, meaning that a tremendous dynamic range is required for large crest factors. Analog multipliers and rms chips often lack that extended range. High crest factors also imply higher frequencies and higher-order harmonic waveform components as well. A workable scheme to handle high crest factors is to use a digital floating-point multiplier that can follow hundreds or more samples for each half cycle.

More details on accurate power measurement are in MUSE112.PDF, MUSE113.PDF, and MUSE123.PDF on my www.tinaja.com Web site.

Temperature Sensors

At long last, we're starting to get temperature chips that are cheap, accurate, linear, and really easy to use. We're also starting to see LCD digital thermometers selling for as little as $5 each from such sources as the Innovative Solutions folks. So, I thought it might be a good time for a temperature-measurement resources sidebar. But first, let us do a brief review:

Temperature is simply a measure of hotness or coolness of an object. More exactly, it is a measure of the atomic

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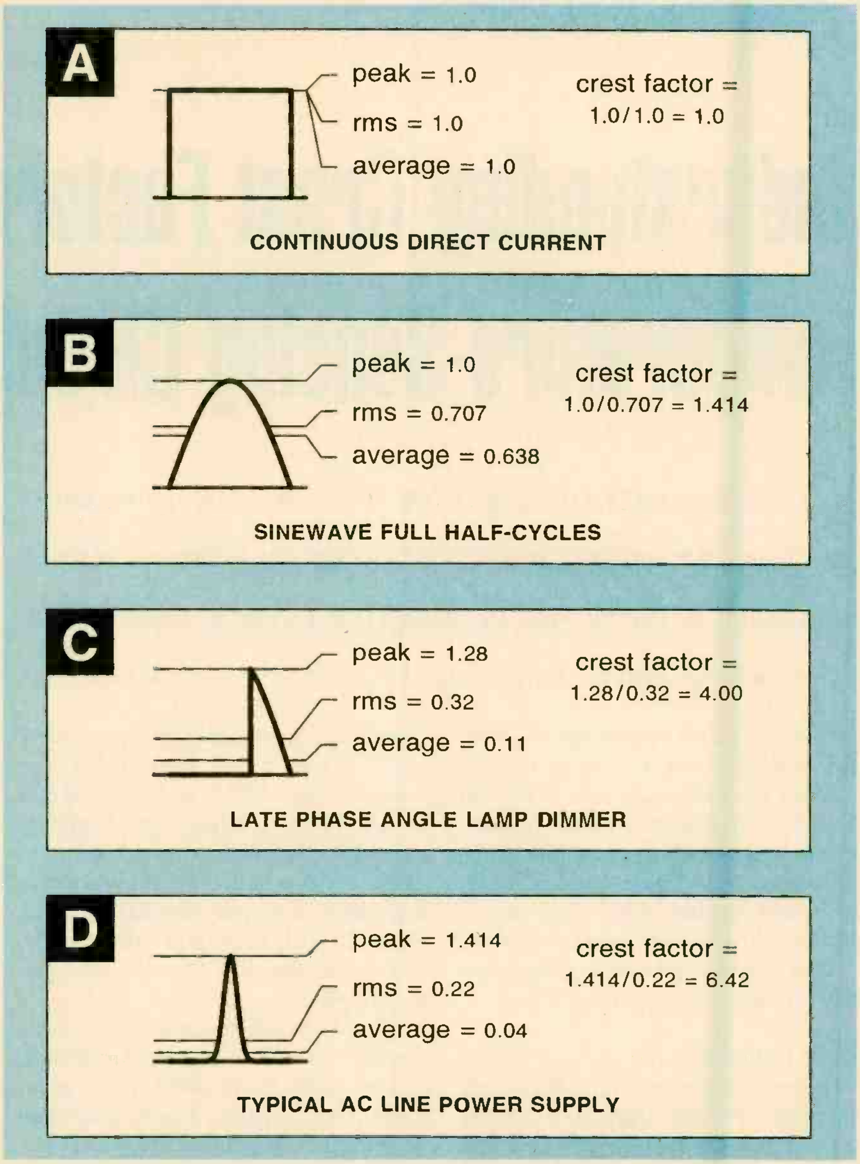

FIG. 1—THE CREST FACTOR of any repetitive waveform is the ratio of its peak to rms values. Typical wattmeters will read uselessly low when their maximum allowable crest factor is exceeded.

activity and motion. That temperature point with zero activity is called absolute zero. As substances are heated, they typically move through solid, liquid, and gas phases as their atomic or molecular activity increases.

There are four popular temperature measurement scales. Each scale is broken down into lots of small and convenient degree units. The four scales, and how key temperatures are measured in each, are illustrated in Fig. 2.

The metric Celsius or "Centigrade" scale is set to zero at water freezing and to one hundred at water boiling. Absolute zero is at -273 degrees C. To do away with all the negative numbers for low temperatures or for such things as heat-engine-efficiency calculations, which demand absolute values, the Kelvin scale is used. In it, absolute zero is zero, water freezing is 273 degrees, while water boiling is 373 degrees.

The Fahrenheit scale starts with zero being the coldest thing they knew how to make (a salt slurry) in a lab at the time it was established, sets water freezing to 32 degrees, and water boiling at 212 degrees. Fahrenheit degrees are 5/9ths smaller than Centigrade degrees. Absolute zero is near -460 degrees F.

The absolute scale corresponding to Fahrenheit is known as the Rankine scale, with absolute zero being zero degrees and water freezing being set to 460 + 32 = 492 degrees R.

Here are some other terms: The accuracy of a temperature-measuring

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device is how close its value will match the actual temperature. The resolution is the smallest temperature change that can be registered. The linearity is a plot of how the accuracy varies over a wide temperature range. The range is your spread between the maximum and minimum measurable temperatures.

The time constant is how long it takes to measure your temperature change to reasonable accuracy. The typical time constants of conduction devices are minutes in air, seconds in still liquids, and fractional seconds in moving liquids.

Some of the older ways to measure temperature include:

Simple Expansion: Most substances expand when heated. That effect can be greatly magnified when you place mercury or alcohol into some tiny capillary tube to create a traditional thermometer. One quality thermometer supplier is Brooklyn Thermometer. Abbeon Cal is a second. A variation on this theme is to measure the pressure of gas in a fixed and closed container.

Thermocouples: A thermocouple is made up from two dissimilar metals (sometimes copper and constantan) that have been welded together. The junction can generate a measurable voltage that's proportional to the temperature. For the device to be useful, you have to either provide a second junction in an ice bath or whatever, or else build an ice-point reference voltage to work against.

Typical thermocouples are rather expensive and klutzy, but do remain industry standards. They provide an exceptionally diverse measurement range. Omega Engineering has lots of information on thermocouples.

Platinum Resistance Temperature Detector (RTD): The resistance values of most materials are temperature dependent. When you have a positive temperature coefficient, resistance increases with temperature, and vice versa. Platinum wire is quite stable and suitable as a linear temperature sensor. Unfortunately, the resistance change with temperature is rather low, and fancy signal conditioning is needed.

Thermistors: Metal-oxide ceramics can be made up that have very strong negative temperature coefficients. Unfortunately, those are also highly nonlinear, leading to correction and conditioning hassles. Yellow Springs Instruments is one older supplier for corrected and repeatable temperature-measuring thermistors. Thermistors with highly positive coefficients also make superb circuit protectors and self-resetting breakers. Raychem is one of the major sources.

Optical Pyrometers: Take a wire and heat it with an adjustable current. As the current increases, the wire will go through red, orange, and finally to its white stages. By matching the wire color to the background color, your background temperature might be measured. This is useful for remote measurement of rather hot objects, such as steel billets in a rolling mill.

Emissivity: When objects are heated, they will generate electromagnetic radiation in the infrared region. Often that radiation will follow a characteristic broadband black-body radiator curve. Numerous infrared energy-sensing devices exist. These are used for everything from night-vision and intrusion detectors to fire-service "hot-spot" detectors. One source for low-cost sensors is Amp Piezo. A useful trade journal is *Advanced Imaging*.

Quartz Crystals: Quartz crystals can be specially cut so they have a linear temperature response. By placing one crystal in a fixed oven and comparing its frequency against one in a space being measured, extreme temperature-measuring accuracy—to a thousandth of a degree or finer—can result. Hewlett Packard is one source of suitable instruments. Needless to say, there are plenty of "gotchas" when measuring ultra small temperature differentials.

Plain Old Diodes: A silicon diode has a temperature coefficient of ten millivolts per degree C or so, and thus makes a low-cost and simple temperature detector. Note that calibration and conditioning will be required because the temperature change tracks on top of a device-dependent 0.6-volt offset. The RadioShack 277-0123 is a typical diode-sensed LCD temperature panel meter.

Differential Currents: Junctions in bipolar transistors are diodes. By measuring a pair of junctions in a fixed ratio of currents, a linear temperature output can result. By adjusting the exact current ratio, the degrees-per-millivolt of output can easily be adjusted. The classic chips here are the National LM34 (Fahrenheit) and LM35 (Centigrade), but the general concept is also the basis of most of today's new sensor semiconductors.

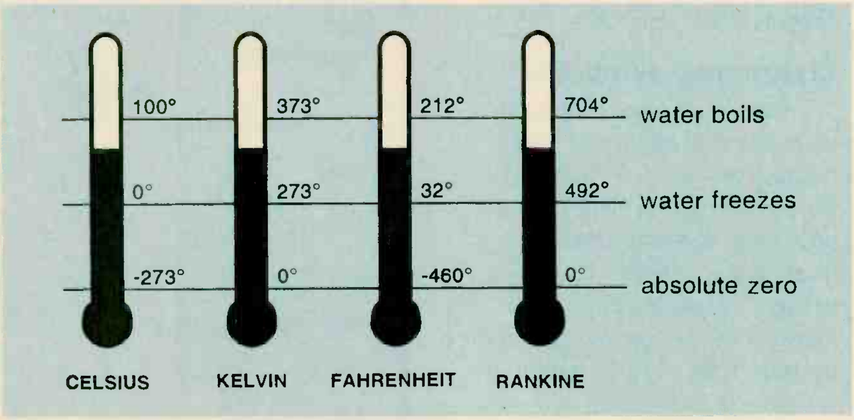

FIG. 2—THE FOUR TEMPERATURE SCALES in common use.

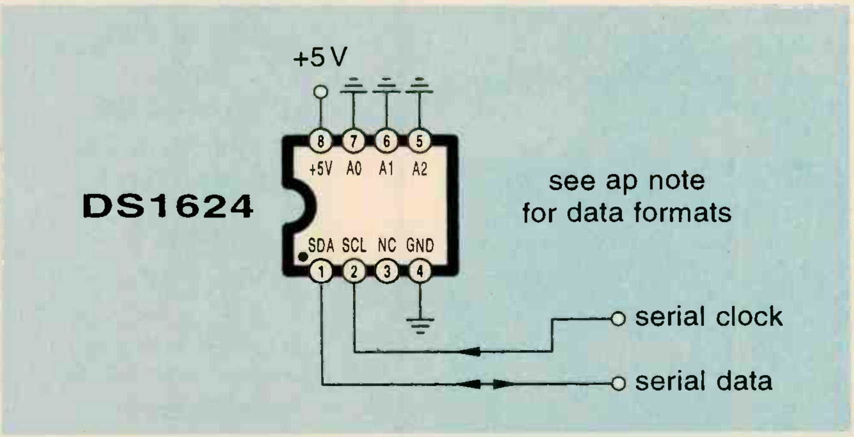

FIG. 3—THE DALLAS DS1624 is a new self-sensing digital thermometer chip that offers 0.03-degree resolution and 13-bit data.

TEMPERATURE-SENSOR RESOURCES

Abbeon-Cal
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Santa Barbara, CA 93101
(805) 966-0810

Advanced Imaging
445 Broadhollow Rd., #21
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Amp Kynar Piezo
PO Box 799
Valley Forge, PA 19482
(610) 650-1500

Analog Devices
PO Box 9106
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Brooklyn Thermometer
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Electronics Test
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New York, NY 10119
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Palo Alto, CA 94303
(415) 857-1501

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Maxim
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The New Temperature Chips

There's bunches of new, low-cost temperature-measuring ICs that are accurate, have high resolution, and need little or no calibration. While Dallas Semiconductor seems to be leading the pack, an industry wide sampling might include:

Analog Devices TMP03: We looked at this chip back in August, 1997 (MUSE114.PDF). The output is a rectangular wave whose duty cycle should be temperature dependent and whose frequency can range from 20 to 50 hertz. It offers half-degree accuracy over a wide range. The linear temperature output is easy to read digitally. A simple resistor and capacitor can be used to get an equivalent analog output as well. No calibration is required. This chip would seem particularly well suited for wireless remote applications.

Dallas DS1624: This device (see Fig. 3) measures its own internal temperature to 13-bit resolution and a 0.03-degree accuracy. It outputs serial digital temperature information as well as providing for nonvolatile storage of precise calibration values. The operating range is -55°C to +125°C. One variation on this device is Dallas' DS1820 "temperature in a can" chip; it draws power and communicates over a single wire. It also offers thermostat-limit values. See their applications note (#105) for more information. Note that the address inputs can input binary values, letting you connect up to eight sensors on a single data and clock line pair.

Maxim MAX1617: A precise digital thermometer that reports its own temperature as well as that of any remote diode or pn-junction sensor. Its intended to keep tabs on Pentium and other fancier CPU-device internal temperatures, but also could be used in all the obvious indoor/outdoor applications. The device uses standard microcontroller serial communications. Free samples are available.

National LM75: This widely used chip gives you nine-bit resolution to give half-a-degree C temperature measurement from -55°C to +125°C. It uses serial digital communications. Both temperature measurements and thermostat settings are provided for. Nominal accuracy is two degrees. Dallas has just released their low cost DS-75 version of this part, which provides up to twelve-bit, 0.06-degree resolution.

Telcon TC1024: This one, shown in Fig. 4, is an older temperature-to-voltage converter IC, working over a −40°C to +125°C range. 2.0-degree accuracy and 0.8-degree linearity is offered. Output voltage is ten millivolts-per-degree C. Single-supply voltage can range from 2.2 to 12 volts. The operating current is typically 40 microamperes active and 5 microamps in shutdown mode. There is a 0.5-volt offset in the output. A companion TC1073 device offers zero offset, but requires use of a negative supply. Negative temperatures output a negative voltage.

Other temperature-sensing chips, especially all the newest and latest devices, can be found at www.questlink.com. Your best two trade journals here are *Sensors* and *Measurement & Control*; several others are listed in the nearby sidebar.

Radiotron Designer's Handbook

What is the greatest electronics book of all time? A recent candidate would be *The Art of Electronics*. But it is no contest that the *Radiotron Designer's Handbook* has to be the all-time clear-cut winner. This fat book from long ago and far away has way more than you could possibly ever want to know about vacuum-tube electronics.

There's been a lively trade on the web to scrounge collectible copies, some of which sell for outrageous prices; try www.dejanews.com to search for current activity. But the big news is that the entire *Radiotron Designer's Handbook* is newly available on CD ROM from Audio Amateur Publications at $65.

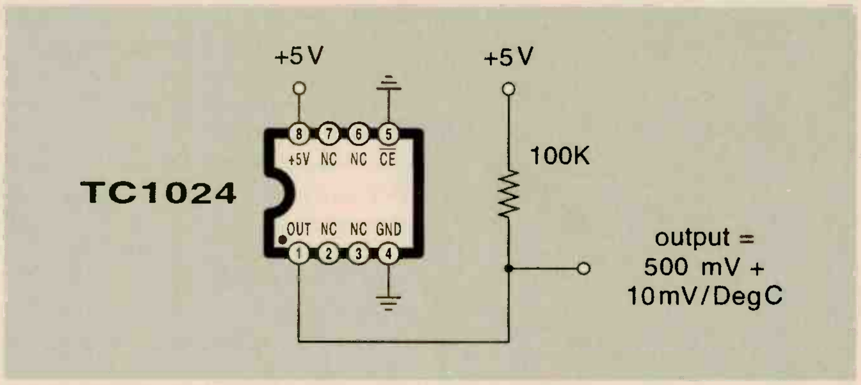


FIG. 4—THE TELCOM TC1024 is an analog-output temperature sensor.

NAMES AND NUMBERS

Adobe Acrobat System
1585 Charleston Rd.
Mountain View, CA 94039
(800) 833-6687

Analog Devices
PO Box 9106
Norwood, MA 02062
(617) 329-4700

Audio Amateur
Box 576
Peterborough, NH 03458
(603) 924-9464

Battery Power Products
10555 E Dartmouth #330
Aurora, CO 80014
(303) 745-5711

Bell Jar
35 Windsor Dr.
Amherst, NH 03031
(603) 429-0948

Burr-Brown
6730 S Tucson Blvd.
Tucson, AZ 85706
(520) 746-1111

Gennum
PO Box 489, Station A
Burlington, ONT L7R 3Y3
Canada
(800) 263-9353

Libby Owens Ford
PO Box 799
Toledo, OH 43697
(419) 247-4724

Lindsay Publications
PO Box 538
Bradley, IL 60915
(815) 935-5353

NC Shop Owner
1100 Superior Ave.
Cleveland, OH 44114
(216) 696-7000

RF Monolithics
4441 Sigma Rd.
Dallas, TX 75244
(972) 448-3700

Science/AAAS
1333 H St. NW
Washington, DC 20005
(202) 326-6400

Society of American Scientists
1549 El Prado
San Diego, CA 92101
(800) 873-8767

Solutions Software
1795 Turtle Hill Rd
Enterprise, FL 32725
(407) 321-7912

New Tech Lit

From R.F. Monolithics, there's a new data book on their SAW filters and low power RF transmitters and receivers. From Gennum comes a data book on unusual video integrated circuits for both digital and analog uses. Analog Devices has a stunning new ADV601LC wavelet compression chip for real-time digital video. The cost is $15 in quantity.

A review on thermoluminescence is found in the February 17, 1998 issue of *Science*; see pages 1322 and 1323. Sonoluminescence is the blue light emitted from tiny bubbles formed by cavitation. For largely yet unknown reasons, the bubbles can approach temperatures of 50,000 degrees and incredible pressures; yet they are easily played with on a kitchen table.

New trade journals for this month include *Battery Power Products and Technology* and *NC Shop Owner*. The latter is on numerically-controlled machine tools, laser cutters, rapid prototyping, and such.

Lindsay Press now has a new/old *Manual of Vacuum Practice* book that they've just added to their already stocked "Do It Yourself Vacuum" and "Introduction to Vacuum Technology" titles. Two other useful resources for amateur vacuum technology include Steve Hanson's Bell Jar and Shawn Carlson's unique Society of Amateur Scientists group.

Other new book titles include the "gotta have" *Troubleshooting Analog Circuits* from Bob Pease and Mark Swank's *Designing & Implementing Microsoft Index Server*. Adobe now has a free PDF plug-in for this search engine, meaning that you can now do simultaneous full text searches with both Acrobat and HTML. More on PDF and Acrobat can be found at http://www.tinaja.com/acrob01.html. Access to these and other great technical books can be found at http://www.tinaja.com/amlink01.html

The complete set of all 50 federal CFR regulations is now available on two CD ROM disks for $63 through Solutions Software. Included are the complete FCC part 47 rules.

Free samples this month include the DCP01 isolated DC power supply from Burr-Brown, and an AD158X precision

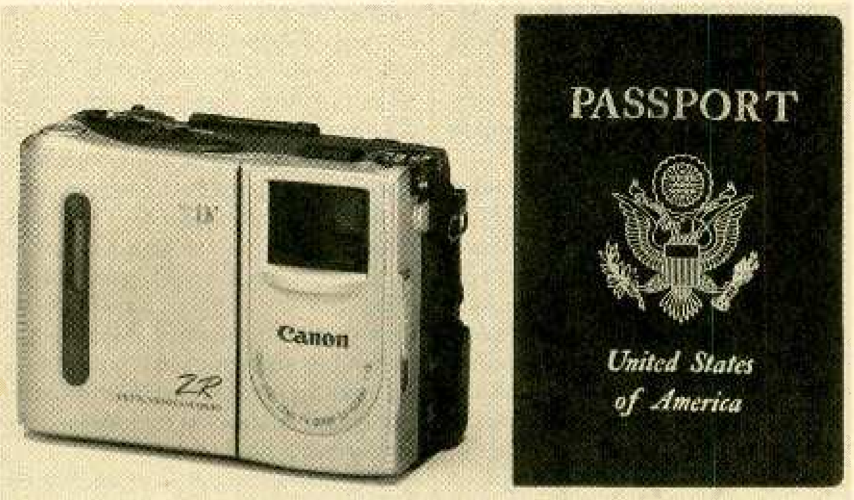
(Continued on page 62)

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Digital Camcorder

AT FIRST GLANCE, IT IS EASY TO mistake the recently introduced, ultra-compact ZR Digital Video (DV) camcorder for one of today's popular "point-and-shoot"-style film cameras. Well, that's really not a problem as the easy-to-use ZR can act both as a camcorder and a still camera. The camcorder's horizontal design, simple operation, and compact size make it convenient for both business and personal travelers. Measuring $4^{11}/_{16} \times 3^{3}/_{8} \times 2^{3}/_{16}$ and weighing a little over a pound, the Canon ZR fits easily into waist pack, glove compartment, or briefcase.



CIRCLE 20 ON FREE INFORMATION CARD

Recording to standard 30- or 60-minute mini-DV cassettes, the camcorder uses a $^{1}/_{4}$-inch interlace-scan CCD image sensor to product digital video. The digital format produces recorded images at least 25 percent better than the highest-quality analog model. For users who want to transmit DV image data directly to a computer, the ZR comes equipped with an IEEE 1394 DV terminal.

The compact camcorder has two recording modes: movie mode for full-motion video (SP and LP tape speeds) and photo mode for digital still shots. In photo mode, a single image is recorded to tape along with approximately six seconds of audio; that allows the user to record a voice-annotation to accompany the photo recording.

Other features include an optical zoom lens (3.9mm *f*/1.8), 44× digital zoom, image stabilization, programmed auto-exposure, plus a built-in lens cover and standby switch. The 2.5-inch, 180,000-pixel LCD screen adjusts to low angle, high angle, and mirror angle for self-recording. The screen combined with a built-in speaker (located in the camera body just behind the screen) enables the user to play back recorded images with audio immediately. A finder unit attaches to the screen, converting the LCD into an eyecup-type viewfinder.

The unit sports an integrated composite-video and stereo-audio output terminal so it can be connected directly to a TV or VCR. In addition, an included compact docking unit offers separate composite video, S-video, and stereo audio terminals for easy playback. The docking unit also includes a LANC terminal for camera operation or editing purposes and a microphone input.

The easy-to-use menu system offers digital effects; 12-bit and 16-bit digital stereo sound; manual controls for focus, exposure, and white balance; shutter speeds from $^{1}/_{60}$ to $^{1}/_{8000}$ second; a self-timer; and time, data, and camera data codes. In addition there is a world clock and an integrated AV output terminal.

The ZR Digital Video Camcorder retails for $1999 and comes with a remote control, charge coupler, compact power adapter/dual battery charger, finder unit, lithium-ion battery pack, docking unit, stereo video cables, S-video cable, shoulder strap, and a mini-DV cassette.

CANON U.S.A, INC.
One Canon Plaza
Lake Success, NY 11042
Tel: 800-828-4040
Web: www.canondv.com

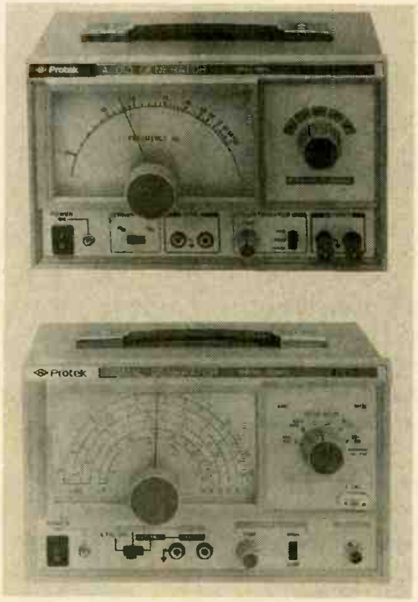
Audio and RF Generators

PROVIDING HIGHLY RELIABLE, cost-effective measurements, a group of solid-state, multi-purpose RF and audio generators is now available. These instruments are meant for the service bench, as well as for design and educational uses.

The Model 813 RF Generator features a 100-kHz to 150-MHz frequency range, expandable to 450 MHz on harmonics. It provides amplitude modulation, a 1-kHz internally generated audio tone, and external modulation capability to 20 kHz. The unit has a crystal-controlled oscillator input, ranging from 1 to 15 MHz for generating precise frequencies. A two-position attenuator plus a fine control for output voltage variations is included. Output audio level is .2V with a frequency accuracy of ±5%. Maximum no-load voltage is 250 mV.

The companion Model 850 Audio Generator is designed for a wide variety of audio applications. Features include low harmonic distortion of <5%, a 10-Hz to 1-MHz frequency range, a 15-volt peak-peak output, and a large readable dial for accurate settings.

List prices are $177 for the Model 813 and $183 for the Model 850.



CIRCLE 21 ON FREE INFORMATION CARD

HC PROTEK
154 Veterans Drive
Northvale, NJ 07647
Tel: 201-767-7242
Fax: 201-767-7343
Web: www.techexpo.com/WWW/hcprotek

Earphone/Microphone

THE MFJ-292 (I, K, Y) FEATHERweight Earphone/Microphone is so private and quiet that it won't bother anyone. Made of high-impact plastic, the Featherweight has an ear-plug earphone that fits comfortably in the ear. The dynamic earphone is 8 ohms and handles 250 mW.

If you whisper closely, the sensitive microphone lets you carry on a quiet discrete QSO that only you can hear. The non-directional electret condenser microphone has −64-dB sensitivity and 1.1k impedance. The tiny thumb-size microphone comes with a push-to-talk switch built right into the cord. It's barely noticeable, and so lightweight (just 30 grams) you won't even feel it. A small lapel/pocket clip secures it to your clothing. It comes with a 4-foot-long durable cord with heavy insulation at the crucial bend points.

CIRCLE 22 ON FREE INFORMATION CARD

The MFJ-292's high-quality dynamic earphone and electret microphone gives your handheld unit crystal-clear audio. It sells for $19.95.

MFJ ENTERPRISES, INC.
300 Industrial Park Road
Starkville, MS 39759
Tel: 800-647-1800 or 601-323-5869
Fax: 601-323-6551

Computer Tester

Professional Hardware Diagnostic Plus (P.H.D. Plus) is a 16-bit test card for component-level testing of AT 386 through Pentium II systems. This test card provides users with a comprehensive range of circuit diagnostics for system RAM, ROM, DMA controllers, page registers, 8042 keyboard controllers, interrupt controllers, timers, CMOS clock, and many other support chips.

Its design incorporates on-board flash firmware, memory, and video to allow the testing of seemingly "dead" motherboards. The use of flash technology allows the card to be quickly upgraded. Capable of running complete diagnostics even if memory, keyboard, and video adapter are absent or dead, the card's firmware will run automatically upon initialization.

On power-up, P.H.D. Plus initializes the system and runs a complete system-bus test, checking the bus functions, speed, and performance. It continues by injecting its diagnostics (embedded on the on-board ROMs) and displaying all information on the system monitor. In case of video failure, P.H.D. Plus has an on-board video connector to re-route test results directly to your VGA monitor. As each test is conducted, users see the results in simple-to-understand terms on the screen.

Combining both comprehensive motherboard and peripheral testing, the card provides a complete range of diagnostic capabilities and eliminates the need for multiple products. Its retail price is $849.

CIRCLE 23 ON FREE INFORMATION CARD

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1765 Scott Blvd., Suite 101
Santa Clara, CA 95050
Tel: 800-722-3789 or 408-261-7090
Fax: 408-261-7077
E-mail: pcdiag@ultra-x.com
Web: www.uxd.com

TECH MUSINGS

continued from page 60

voltage reference you can get from Analog Devices.

From Libby Owens Ford comes details about their conductive TEC-Glass products. These are fairly transparent conductive-glass sheets intended for such practical applications as supermarket non-fogging beer-cooler doors.

Tutorials and links to hydrogen resources can be newly located at http://www.tinaja.com/h2gas01.html. Other new site additions include lots of fresh content on wavelets, wind energy, Santa Claus machines, and home automation, plus my new fast-navigation site map and master directory at http://www.tinaja.com/map01.html.

For the fundamentals of starting up your own technical venture, get a copy of my *Incredible Secret Money Machine II*. Details per my nearby Synergetics ad. Or download my full interactive online catalog found at http://www.tinaja.com/synlib01.html.

My new InfoPack "cash and carry" consulting service is now going great guns. You can get instant answers to most any reasonable tech question or resource problem. Full details are at www.tinaja.com/info01.html

As usual, most of the mentioned items should appear in our Names & Numbers or the Temperature-Sensor Resources sidebars. Be certain to check there before you call our US technical helpline. Let's hear from you. EN

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FM Wireless TY-35 Microphone

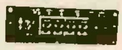
Clearance Sale

This is a low power real FM transmitter. Transmit frequency within 88-108 MHz. Transmit range about 200 ft. It has high sensitivity sound pickup by a capacitance microphone. May be used strictly for series purposes such as remote wireless monitering.

Kit $ ~~12.50~~ 6.99

4½ Digital LED Panel Meter

Clearance Sale SM-48



Kit $ ~~39.00~~ 20.00

This precision digital meter is a stand-alone voltmeter-ammeter or can interface with a computer! 4½ digit 0.55" LED display. Temperature compensated to 100 PPM/°C. Operating temperature range is 0°C to +70°C. Outputs include BCD date, Busy and strobe. Panel reading can be latched on hold.

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Microphone Mixer Mono Amp.	▲	20.79
Superior Electronic Roulette	▲	21.50
Digital Clock with Melody Alarm	▲	25.00
Stereo Pre-Amp with Mic Amp.	▲	10.78
Mini Stereo Multi-Input Amp.	▲	30.50
130-in-one Electronic Lab	▲	29.99

SEE OUR CATALOG FOR MORE KITS !

Stereo Loudspeaker Protector

TY-25 ▲

Kit: $ 16.75

Super fast acting relay protects speakers against destructive DC voltages. Can connect directly to a power amplifier or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

Regulated DC Power Supply

TR-503 ▲▲

Kit: $ 18.75

It is short circuit proof & has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer.

Fluorescent Light Driver

TY-2 ▲ (1 lb.)

Kit:$ ~~14.75~~ 9.99

This unit drives 6-40 watts fluorescent light for portable and emergency use. Works from a 7.2 - 16 VDC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights.

120-250W Mosfet Power Mono Amplifier AF-2 (6 lbs.) ▲▲

Kit: $ ~~89.80~~ 76.33 Asmb.$ 114.80

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 8,200uf 100V Model 020. Suggested Metal Cabinet LG-1925.

500-in-one Electronic Lab Kit

KA-904 $129.99

Contains its own computer with a simple explanation of the basic(Assembler) language required for operation. Compile programs to discover how computers operate while gaining an understanding of hardware & software. With easy-to-follow manual which explains by comprehensive diagrams. Requires 4 "AA" batteries.

300W High Power Mono Amplifier TA-3600 (5 lbs.) ▲▲▲

75.65
Kit:$ ~~89.00~~
Asmb.$ 115.00

Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 8,200uf 100V Model 020 Capacitor. Suggested Metal Cabinet LG-1925.

150MHz 8 Digit Frequency Counter

SM-100 (2 lbs.)

Sale

Kit:$ ~~79.00~~ 68.00
Asmb.$ 99.00

It is used for adjustment, test & repair of any kind of high frequency circuit products. It can give up to 8 digit of resolution for a wide frequency range 10Hz - 150 MHz. The last input frequency can HOLD on the display for future reference & comparison. The circuit structure is compact & reliable for the most updated A/D LSI circuitry. The input impedance is 1M ohm. ▲▲▲

120W + 120W Pre & Main Stereo Amplifier TA-800MK2 (4 lbs.) ▲▲

Kit: $ ~~67.92~~ 61.13 Asmb.$ 86.95

Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

80W + 80W Pure DC Stereo Main Power Amplifier TA-802 (4 lbs.) ▲▲

42.45
Kit: $ ~~49.94~~
Asmb.$ 69.94

Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

60 + 60W Stereo Power Amp. ▲▲

SM-302 (11 lbs.)

Kit:$ ~~85.00~~ 76.50

It provides 3 input jack pairs. One pair accept a high impedance micro-phone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20Hz-20KHz. THD:<0.1%. Input Sensitivity :Mic /Guitar 10mV, Hi 380mV, Lo 640mV.Ready to plug in when assembled.

30W + 30W Pre & Main Stereo Amplifier TA-323A (1 lb.) ▲

29.25
Kit: $ ~~32.50~~ Asmb.$ 50.50

Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

Metal Cabinets Aluminum Front Panel

LG-1273	3x12x7"	(4 lbs.)	$ 26.50
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LG-1925	5x19x11½"	(10 lbs.)	42.00
LG-1983	2¼x19x8"	(7 lbs.)	35.25
LG-1927	7x19x11½"	(15 lbs.)	52.50

Transformers (5-12 lbs.) **Toroidal Transformers

# 001	28V/30V x2	6A	$ 30.00
# 002	36V x2	3A	25.00
# 003	40V x2	6A	32.00
# 008**	28V/30V x2	6A	42.00
# 009**	48/53V x2	8A	68.00
# 012**	33/40/42V x2	6A	52.00

300-in-one Electronic Lab Kit ▲▲

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- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

$895.00

40MHz DUAL-TRACE

Model 1541C

- 1mV/division sensitivity
- Video sync separators
- Z-axis input
- Single Sweep
- V mode displays two signals unrelated in frequency
- Component tester

$695

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- 1mV/div sensitivity
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- Z-axis input
- Single sweep

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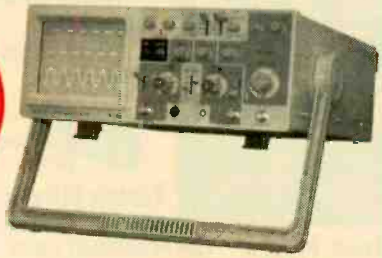

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B&K Precision Multimeters

Model 391	$143	Model 388A	$99
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Model 389	$109	Model 2860A	$79
Model 5390	$295	Model 5370	$219
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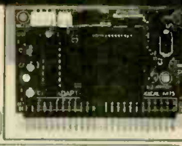

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The built-in controller allows you to do text and graphics.

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16x1 .... $7.00	20x2 .... $10.00	32x2 .... $8.00
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16x2 .... $7.00	20x4 (lg. char.) $10.00	40x2 .... 2 for $20.00
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16x4 .... $15.00	32x4 .... $10.00	4x2 .... $5.00

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$25.00	480x128	Hitachi	$10.00
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480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$25.00**

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEMOO. 15.5" long MFG: NEC **$89.00**

Laser Power Supply (for HeNe tube) $79.00

LASER SCANNER ASSEMBLY $19.00

Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator $20.00

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**

Index guided. Threshold current 40 ma typical.

3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $15.00
Mitsubishi Electric part number ML701BIR-E21A, General specs are:
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

POLYGON MOTOR UNIT & DRIVER $69.00

Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

POS & BAR CODE

MAGNETIC CARD READER $25.00

Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300)....................$25.00

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SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts

73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A

60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

CHARGE COUPLED DEVICES

"The Spy In The Sky" $29.00 — **MATRIX TYPE**

Thomson 576X550 pixel CCD
400-1,100nm resolution and responsivity. **$500.00 Original cost device**

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) **$29.00**
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

LINEAR TYPE

4096 element CCD $15.00
1024 element CCD $10.00
2048 element CCD $10.00 • 1728 element CCD $10.00

MISCELLANEOUS

ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00

IBM 370 option XT and AT emulation boards $25.00

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.

5 inch Amber $25.00 • 7 inch Amber $25.00
9 inch Amber or Green $25.00

5" COLOR MONITOR $39.00 — 2 for $69.00

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible • 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq. • Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

9" COLOR SVGA MONITOR $249.00
Fully Enclosed – Tilt and swivel type.

HACKER CORNER

EMBEDDED 486 COMPUTER $99.00

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

Encased Spread Spectrum RF Modem $199.00

The ProxLink Radio Module is a small communication device which replaces cables between RS-232 devices with wireless RF (Radio Frequency) technology. Attaching a pair of ProxLinks to any two devices with three wire asynchronous RS-232 ports allows wireless data transmittal at rates up to 19.2 Kbaud (full duplex) over a range of 500 - 800 feet. Modules use 900 MZ spread spectrum radio for communication which does not require an FCC site license. A variety of configuration information (radio channel, baud rate, serial port configuration, etc.) can be programmed into module's non-volatile memory by host PC to provide compatibility and avoid overlapping systems. Configuration changes are supported by menu driven, on-board software. Commonly used Terminal Emulation software and transfer protocols can be used for configuring modules and transferring data between computers. ProxLinks require only 6-9 VDC (350 mA), RS-232 (9 pin sub - D) interface, and small (~ 4") whip antenna for operation. Unit size is 4.0" x 6.5" x 0.75". Installation schematics and application details available.

US made Micronics 486 VLB ALL in ONE $39.00 or 2 for $69.00

motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic dock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

COLOR CCD CAMERA $149.00

• 12 VDC • 1/3-inch, CCD area image sensor • 514 (horizontal) x 491 (vertical) • 2:1 interlaced • 15.734 kHz (horizontal), 59.94 Hz (vertical) • 330 horizontal and 350 vertical lines • 10 lx • 1V, NTSC signal format • Lens: 1/3-inch, fixed focus (F:2.8 f:5.6) • Dimensions: (W) 67 (2.63) x (H) 34 (1.45) x (D) 112.6 (4.43)

SONY Miniature Color LCD Display (LCX005BKB) $29.00

• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

CELL SITE TRANSCEIVER $49.00 2 for $89.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H

Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**

Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**

This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

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SINGLE OUTPUT *Analog Displays*

PS-303 $159.00, 30V/3A.
PS-305 $219.95, 30V/5A.
PS-1610S $289.00, 16V/10A.
PS-2243 $139.00, 12V/24V select, 3A.
PS-2245 $159.00, 12V/24V select, 5A.
8107 $399.95, 30V/10A.
8110 $289.95, 60V/3A.
8112 $399.95, 60V/5A.

Digital Voltmeter & Analog Ammeter
8200(8201) $179.95($239.95), 30V/3A(5A)
Digital Displays **8210/8300 $199.95**, 30V/3A.
8211/8301 $259.95, 30V/5A.

DUAL OUTPUTS
Independent/Tracking
Analog Displays

8108 $549.95, 60V/3A.
8109 $699.95, 60V/5A.
PS-303D $314.95, 30V/3A. **PS-305D $399.95**, 30V/5A.

TRIPLE OUTPUTS, **a fixed 5V/3A output, Independ/Tracking**
Digital Displays **8202(8203) $499.95($549.95)**, dual 30V/3A(5A).
Analog Displays **8102(8103) $399.95($489.95)**, dual 30V/3A(5A), with *Parallel* (30V/6A) and *Series* (60V/3A) Mode operation.

NTSC/PAL TV COLOR BAR GEN.

CPG-1366A $159.95, VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedance: 75 Ohm;
Video Output: BNC, $1V_{p-p}$.
CPG-1367A $159.95, VHF PAL.

SWR/RF/mW POWER METER

310 $89.95, 1.8-150MHz; *RF Power*: 0-4W/20W/200W 3 ranges; *SWR Measurement*: 1.0~∞, 4W minimum. Accuracy: 5%-10%; *Insert Loss*: .3dB *Input/Output Imp.*: 50Ω; SO-239 plug
320 $89.95, 130-520MHz. Spec. 310.
330 $119.95, 1.8-520MHz. Spec. see 310.

SWR-3P $26.95 1.7-150MHz;
RF Power: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.
mW RF Power Meter 340 $219.00, 1.8-500MHz; *RF Power*: 20mW/200mW/2W 3 ranges; *Imped.*: 50Ω; *Accuracy*: ±10% full scale; SWR <1.15; N-type connector; BNC type output.

FM STEREO MODULATOR

AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%; *L-R Separation*: >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Separation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz.

TOOLKITS - ELECTRONIC/PC

9Z45 $29.99 U.S. Patented, 45-pcs. Contents: IC inserter/extractor with securers & bows, 3-prong part retriever, #0 phillips screwdriver, 1/8" flat srewdriver, self-hold tweezers, metal tweezers, extra parts tube, soldering iron, solder, crimping tool, long-nose plier, cutting plier, zipper vinyl case. Bits include: *Phillips*: #0/#1/#2/#3; *Flat*: 1/8"/3/16"/1/4"/9/32"; PZ1/PZ2; T8/T9/T10/T15/T20/T25/T27/T30/T40/T45; *Hex*: 5/64"/3/32"/1/8"/5/32"/3/16"; *Sockets*: 3/16" (5mm)/7/32" (5.5mm)/1/4" (6mm)/9/32" (7mm)/5/16" (8mm).
8G23 $34.99 23-pcs *Contents*: IC inserter/extractor with securer & bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/ 1/8" slotted screwdriver, #0/#1 phillips, reversible T10/T15 bits, re-versible #2 phillips/¼" slotted bits, tweezer, long-nose plier, cutter, 6" adj. wrench, soldering iron, solder, crimping tool, zipper case, manual
Different packages available, call/write/e-mail/fax for detail.

STEREO/ALIGNMENT/SWEEMAR SCOPE

STEREO SCOPE OS-7505B $369.00, 0-10MHz/20mV.
ALIGNMENT SCOPE OS-7001A $369.00, 0-200KHz/1mV.

SWEEMAR **SM-6225B/C $1999.95**
Freq Range: (AM)490KHz, (FM)10-11.4MHz; *Accuracy*: ± 0.1%; *Marker*: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

RF SIGNAL GENERATOR

SG-4160B $124.95, 100KHz-150MHz up to 450MHz on 3rd harmonics in 6 ranges; AM modulation; *Accucy*: ±5%. *RF Output*: 100mVrms to 35 MHz; *Modulation*: Int. 1KHz (AM) ≈30%; Ext. 50Hz-20KHz, at least $1V_{rms}$ input. *Audio Output*: 1KHz, $2V_{rms}$ minimum.
SG-4162AD (with Freq. Counter) $229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz; *Max. Input*: ≤3V effective *Gate Time*: .1, 1sec. *Input Sensitivity: 35mV, 10Hz-200MHz*. *Input Impedance*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs.

AM/FM STD SIGNAL GEN.

SG-4110A $1799.00, *Freq*: 0.1~110MHz; *Display*: 6-digit LED; Resolution: 100Hz (0.1~34.999MHz); 1KHz (35MHz~110MHz). *Accuracy*: <±(5x10⁵ ±1 count); *Output*: -19dBu~99dBu, 1dB steps. *Impedance*: 50Ω VSWR 1.2; 100 preset frequency & store functions

AUDIO GENERATOR

AG-2601A $124.95, 10Hz~1MHz in 5 ranges; *Output*: sinewave $0\sim8V_{rms}$, square $10V_{p-p}$. *Output Imped*: 600 Ohm. *Distortion*: <0.05% 500Hz~50KHz; <0.5% 50KHz~500KHz.
AG-2603AD $229.95, with 6-digit, Int/Ext. Freq Counter, 10Hz~150MHz, *Output Control*: 0/-20/-40dB & Fine adjuster. Spec. see AG-2601A

FUNCTION GENERATOR

FG-2100A $169.95, 0.2Hz-2MHz in 7 ranges; sne, square, triangle, pulse & Ramp; *Output*: $5mV_{p-p}$-$20V_{p-p}$, 1% distortion. *VCF*: 0-10V/freq. to 1000:1.
FG-2102AD $229.95 see FG-2100A; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
FG-2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG. *Freq. Counter*: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz.
FG-513 $769.95, 13 MHz, Microprocessor embedded dgital sweep; Sine, Square, Triangle, Pulse, Ramp, TTL & DC; ±(.01%+1dgt). *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits. x1/x20 attenuatn

AC MILLIVOLT METER

MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedance 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement.

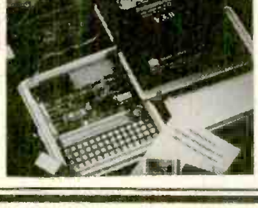
OSCILLOSCOPES

OS-7305B $249.00 DC~7MHz, 3" CRT; *Horz*: .25V/div, 10Hz~100KHz in 4 ranges; *Vert*: 10mV/div, Int. & Ext. Sync.; *Input*: 1MΩ/35pF.
OS-7010A $299.95 10MHz, 5"CRT, *Horz*: .2V/div; *Vert*: 10mV~10V /div.
OS-622G $389.95 20MHz, 2 CH/X-Y Alt trigger, trigger lock, hold OFF, TV syn., 8x10 div., 1mV/div., *Horz*: .2μs~.5s/div; *Vert*: 1mV~5V/div.
OS-653G $699.95 50MHz, 2 CH/delay sweep, Alt trigger, TV syn.
OS-6101G $1499.95 100MHz, 4ch/8 traces, delay sweep, cursor readout. *2 years warranty for OS-622G, OS-653G, & OS-6101G.*

UHF ATTENUATORS

RT-8815U (50Ω) $299.00 / RT-8817U (75Ω) $299.00, 950MHz, 81dB, 0.5W max.; *Steps*: 1/2/3/5/10/20/20/20, 8 switches.
085E-2 (50Ω) $399.00 / 087E-2 (75Ω) $399.00, 950MHz, 81dB, 0.5W max.; *Steps*: 10dB+7.1dBx10, Electronic adjustment knob.

MICROPROCESSOR TRAINER



BGC-8088 $699.00, learn computer theory. Excellent for school & individual who want to learn about ROM, RAM, I/O ports, programming, & run a 8088 Microprocessor. An easy to understand step-by-step manual guides you to achieve your goal. 56-key keyboard, LCD display, RS-232, UART...

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands; 6 plug-in coils, 2 transistor, and 1 diode.
Modulation: ≈ 2KHz Sinewave.
Crystal Oscillator: 1-15MHz.
Wave absorption meter. 9VDC battery.

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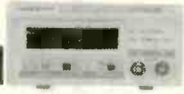


FC-5250C $119.95 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10-200MHz. *GateTime*: .1, 1sec. *Max. Input*: $10V_{p-p}$ *Input Sensitivity*: 35mV/10Hz-200MHz *Input Imped.*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs; 9V adapter **($6)**

FC-5260A $129.95
10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95
10Hz-1.2GHz; 8-digit LEDs.
FC-5600B $229.95
10Hz-600MHz; 10-digit LEDs.
FC-5700 $299.95 10Hz~1.3GHz; 10-digit LEDs. Period measure.

SIGNAL TRACER/INJECTOR

($ Reduction!) SE-6100 ~~$134.95~~ **$89.95**
TRACER: Gain 60dB maximum.
Attenuation: 0/20/40/60dB
Input Imped: 100KΩ; *Meter*: Vu 100μA
Output Imped.: 600Ω; *Speaker*: 8 Ω.
INJECTOR: ≈1KHz Squarewave;
Output Level: Variable 0 ~ $4.5V_{p-p}$; 9V battery or adapter **($6.00)**

LCR METERS

MIC-4070D $179.95, *Induct.*: 0.1μ~200H, *Capacit.*: 0.1p~20mF, *Resist.*: 1mΩ~20MΩ, 2Ω range, Dissipation factor measurement, Zero adjust; Surface mount device (SMD) test probe: **LT-06 $21.95**

DIGITAL MULTIMETER

DMM-120 $24.95, 3½ digit, 600VDC, 2ADC 500VAC, 2MΩ, hFE/diode/continuity test, 1.2%
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/600VAC, 10ADC/AC, 2GΩ, 20μF, hFE/diode test, continuity beeper, 0.8% accuracy
DMM-124+Cap.+Temp.+Freq. $69.95, 3½ dig, 600VDC/500VAC, -58~752° F, 2GΩ, 20mF, 200KHz, 3φ phase/diode/continuity test, 1.2%.
DMM-125 $54.95, Autorange/Bargraph, 32MΩ, 600VDC/AC, 10ADC/AC, diode/continuity test.
MIC-35 $59.95, Autorange, 3½ LCD, 20MΩ, 1000VDC/750VAC, 20ADC/AC, data hold, diode/continuity test, free holster, 0.5% accuracy
MIC-39 $129.95, Autorange/Bargraph, True RMS, 3¾ LCD, 40μF, 40MΩ, 1000VDC/750VAC, 20ADC/AC, 600KHz freq. cntr, data hold, sleep mode, memory, read functions, holster, 0.3% accuracy.

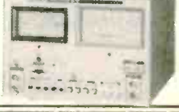
AUTO. CAPACITANCE METER

CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic.
Resolution: 0.1pF lowest, 0.1% full scale.
Accuracy:
0.5% of full scale ±1 digit to 99.9μF,
1% of full scale ±1 digit to 99.9μF.
Display: 3 digit LED.
Unit: pF, nF, μF, mF, Overrange indicators.

AUTO DISTORTION METER

DM-3104A $799.95
DISTORTION MEASURE
Range: 0.01% to 30%, 0.1/0.3/1/3/10/30% 6 ranges.
Freq: 400Hz±10%, 1KHz±10%(HPF).
Input: 3mV-100V; Ratio measure 20dB.
Auto. Freq. Switching Ranges:
Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
LEVEL MEASURE *Range*: 0 to 100V in .03/.1/.3/1/3/10/30/100V
Freq Response: ±0.5dB/20~50kHz; ±1dB/20~100kHz.
DM-3204 $1,599.00 dual channels; Spec see DM-3104A.

WOW-FLUTTER METER



WF-3103A $699.95 *Freq. Range*: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN.
Measuremt: .03/.1/.3/1/3% full scale.
Accuracy: ±5% of full scall.
WF-3105A $799.95, digital display;
Function: LIN/WOW/Flutter/WTD.
Freq Counter: 10Hz-9.99MHz.
Indication: CCIR/DIN/JIS.

CIRCLE 314 ON FREE INFORMATION CARD


SC-7000Z
DESOLDERING TOOL

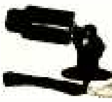
Color Weather Proof Bullet Camera

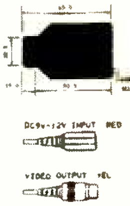
1/3" CCD with removeable rotation capable mounting bracket

new!

Specifications

Image Sensor:	Interline transfer CCD 1/3" format
Effective Pixel:	512(H)x492(V) pixels/NTSC 512(H)x582(V) pixels/PAL
Scanning System:	2 : 1 interlaced
Sync System:	Internal sync
Sync Pulse:	15.734KHz +1%(H)/15.625KHz +1%(H) 59.94Hz +1%(V)/ 50Hz +1%(V) Sub-Carrier 3.57 MHz +30ppm
Resolution:	400 TV lines (H)
S/N Ratio:	More than 46dB (typ)
Gamma Characteristics:	0.45
Min. Illumination:	1 LUX (F1.2 10 IRE)
Video Out:	Composite video signal : 1.0Vp-p
White Balance:	Auto white balance
Electronic Shutter:	1/60 - 1/100,000 SEC(N) 1/50 - 1/100,000 SEC (P)
Power Supply:	DC 12V + 10%
Power Consumption:	240mA (typ)
Lens:	4mm (78 or 92 degree) F : 2.0
Ambient Operating Temp:	-5 deg. C +40 Deg. C
Ambient Storage Temp:	-10 Deg. C+50 Deg. C RH 95% MAX
Dimension:	2 1/8" (L) x 1 1/4" (D)
Weight:	3 oz.





CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-5407S	Color Water Tight Bullet Camera	$299.00	$269.00

(water tight for outdoor use, not suitable for sustained underwater use)

CCD Bullet Cameras

new!

Available with standard or pinhole lens. Virtually indestructible bullet shaped casing. This sleek B&W camera can be mounted on walls or ceilings along narrow corridors or virtually any location for virtually any surveillance application. 0.5 lux minimum illumination with 380 lines of resolution. Even includes a built-in electronic iris for automatic light compensation.

Features

- Extremely low power consumption
- No blooming, no burning
- 0.5 LUX minimum illumination
- CCD area image sensor for long camera life
- Ultra small size allows for simple application and installation
- Built-in electronic auto iris for automatic light compensation
- Ultra compact camera

Specifications

Image Pick-Up Device:	1/3" CCD area sensor
No. of Pixels:	EIA = 512(H) x 492(V)
Pixel Pitch:	EIA = 9.6uM(H) x 7.5uM
Scanning System.	EIA=525 lines, 60 field/sec
Sync System:	Internal sync
H. Resolution:	430 TU line
V. Resolution:	400 TU line
Usable Illumination:	0.5 Lux F1.6
S/N Ratio:	More than 48dB
Gamma Characteristic:	0.45
Video Output:	1.0 - 1.1 up-p 75 Ohm
Electronic Shutter Time:	EIA=1/60 - 1/50,000 sec
Lens F No. Focal Length:	STD : 1.6 Open / 4.3mm(78 deg) Pinhole: 4.3 fixed/ 2.8mm(91.4 deg)
Power Consumption:	DC 9V (8-10V), 110mA
Operational Temp.:	-10 deg - +50 deg C RH95% max
Storage Temp:	-20 deg - +60 deg C RH95% max
Dimensions:	STD : 22mm(W) x 22mm(H) x 38mm(D) Pinhole: 22mm(W) x 22mm(H) x 30mm(D)
Weight:	35g max

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDB-07S	Standard Lens Version	$144.00	$129.00
WDB-07P	Pinhole Lens Version	144.00	129.00
WDP-07S/water	Standard Lens Weather Proof	169.00	152.00
WDP-07P/water	Pinhole Lens, Weather Proof	169.00	152.00

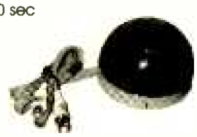
CCD Dome Camera with Audio

B&W DOME camera with integrated microphone. Ideal security system application. 12 VDC operation.

new!

Specifications

Image Device:	1/3" Interline transfer CCD
Picture Elements:	EIA=542(H)x492(V)
Scanning System:	2:1 Interlace
Synchronization System:	Internal
Horizontal Resolution:	380 TV Lines
Sensitivity:	Under 0.3 LUX
Electronic Iris (linear):	EIA = 1/60~1/100,000 sec
Video Output:	1.0vp-p, 75 ohm
S/N Ratio:	More than 50dB
Power Supply:	12V DC (±20%)
Gamma:	r=1
Power Consumption:	110 mA max
Operating Temp.:	-10°C ~ +50° C
Operating Humidity:	RH 95% Max
Weight:	100g
Applied Lens:	3.6mm -92°, 4.3mm -78°
AI/EE/Flicker Less/Mirror Image:	Jump soldering selection
Audio Pick-up Sensitivity:	-60dB (0dB=1V/ubar)
Audio Frequency Range:	20 Hz ~ 20 kHz
Audio S/N Ratio:	More than 40dB
Audio Output Level:	1Vp-p/600 ohm
Dimensions:	87 x 55.5mm



CAT NO	DESCRIPTION	PRICE EACH 1	5
WDDB-6500	B&W Dome Camera	$144.00	$129.00

1/3" CCD Board Cameras

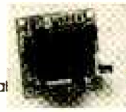
Available with **PINHOLE LENS with AUDIO; STANDARD LENS with AUDIO; and STANDARD LENS with INFRA-RED and AUDIO.** These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras

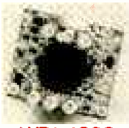
Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

WDP-2000



WDS-2005



WDI-4000

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED with Audio	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

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- *Auto-Temp 136ESD & Auto-Temp 137ESD*
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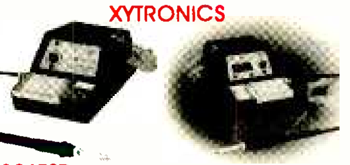
- *ESD safe featuring ceramic heating element and state of the art P.T.C. sensor to ensure accurate temperature performance*

Standard Tip

Features

Fine Tune Temperature from 150° C (300° F) through 450° C (850° F) without unnecessary tip or heating element changes.
Precision "Tip Temperature" accuracy is mastered to within ±3° C (6° F) using state of the art circuit technology and a built-in P.T.C. sensor located at the top of each ceramic heater shaft for fail safe accuracy.
Fast Heat Up & Recovery. A long life Japanese made ceramic heating element facilitates fast heat up, fast recovery and exacting temperature control with minimal overshoot. Heat-up time to working temperature is attained in about 45 seconds.**Spike Free Circuit.** "Zero voltage" switching and fully grounded design meets military application standards for protection of electrosensitive devices against line transience and voltage spikes. Tip leakage is less than 0.4 mv or 0.5 ohm resistance.**External Calibration Port.** A calibration port is located on the face of the unit thus temperature adjustments are quick and convenient.
Lightweight Soldering Iron. Ergonomic mini handle that stays "cool". Handle assembly cord is made from silicone rubber that won't be damaged when coming into contact with high temperature irons.
Isolated Power Unit. The power unit is isolated from the AC line by a high quality transformer and only 24 Vac voltage is used to drive the heating element.
ESD Safe. Exceeds all soldering equipment military specifications regarding electro static sensitive devices for critical applications.
Lock-Out Feature: Constructed with a lock-out feature to allow supervisors only to set and lock specific soldering temperatures. Accomplished via a special sized allen head screw located on the front panel.**Superior High Insulation** ceramic heater provides insulation rated over 100Mohms at 750° F. **Optional SMD Tip Series** for re-work applications. **Range of Interchangeable Tips Available** for maximum system flexibility.

XYTRONICS



136ESD 137ESD w/ Digital R/O

SEE www.cir.com FOR OUR SELECTION OF REPLACEMENT TIPS, REPLACEMENT IRONS AND SMD TIPS.

CAT NO	DESCRIPTION	PRICE EACH 1	5
136ESD	Electronic Temp Controlled ESD Safe Soldering Station	$99.00	$88.00
137ESD	Electronic Temp Controlled ESD Safe Soldering Station w/ Digital Readout	129.00	114.00

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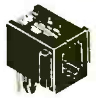
Filtered Modular Jack



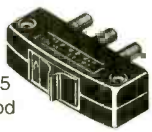
Corcom # RJ11B-4L-B "Signal Sentry™" 4 pin, RJ-11 modular jack with built-in ferrite block for inductive filtering. Fits the same space as non-shielded jacks. 0.52" x 0.8" x 0.59" high. UL, CSA listed. Large quantity available. Call for pricing.

$1.25 each

CAT # MT-4F

10 for $10.00 • 100 for $85.00
1000 for $650.00

Special Purchase Video AB Switch



Jebsee # SW78S
Compact, shielded two position co-ax slide switch. Standard F connectors for 75 ohm input and outputs. Good quality assembly with solid switching action.

CAT# ABS-2

$1.75 each

10 for $15.00
100 for $100.00

SPECIAL LOW PRICING Automotive Multi-Voltage Adaptor

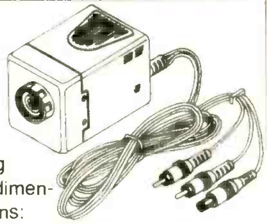
Sanbor M-24
Regulated DC converter plugs into car cigarette lighter and provides power for portable audio and communications devices and many battery operated devices that operate on 500 ma or less. Voltage selector switch for 1.5, 3, 4.5, 6, 7.5 and 9 volts. Polarity switch. Six varieties of output plug including, 2.1, 2.5 and 1.3 mm co-ax power plugs, 2.5 and 3.5 mm phone plugs and 9 volt battery snap.

CAT #APC-522

$2.00 each

10 for $15.00

INCREDIBLY LOW PRICE! Black & White Camera With Audio

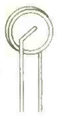


EZ View™ CCD security camera with built-in electret microphone. Our lowest price ever on a new, enclosed, working camera. Overall dimensions including lens: 3.25" x 1.77" x 1.81". Includes 13' power, audio and video cable and adjustable mounting stand. 78 deg. wide angle lens. Auto iris adjusts to low or bright light levels. Operates on 12 Vdc, 150 ma. Includes power supply and hook-up instructions.

CAT # VC-300

$97.00 each

Resettable Circuit Protector 0.65 - 1.3 Amps



Raychem "Polyswitch" # RXE-065S-1
Unlike traditional fuses, they automatically reset when fault condition is cleared. Can be paralleled for higher ratings. Current: 0.65 Amps. Trip Current: 1.3 Amps. Max Voltage: 60 Volts. 0.33" diameter. UL, CSA listed.

CAT # RXE-065

3 for $1.00

10 for $20.00
500 for $85.00
1K for $150.00

Miniature Electret Mike

Panasonic # WM-62A
0.24" diameter x 0.14" high. 1.5" leads terminated with female two pin socket connector (0.05" spacing). Operates on 2-10 Vdc.

CAT # MIKE-39

$1.00 each

10 for $9.00
100 for $75.00
1K for $450.00

RED Ultrabright LED

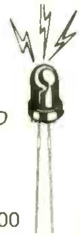
PAINFULLY BRIGHT RED LED
2500 to 4000 mcd @ 20 ma. These T 1 3/4 (5 mm diameter) red LEDs are significantly brighter than conventional LEDs. At close range, they are painful to look at. They are great for attention getting displays that can be seen from a distance. Water clear in off-state.

CAT # LED-42

2 for $1.20

10 for $5.00
100 for $45.00
1000 for $400.00

High Brightness FLASHER LEDs



T 1 3/4 (5mm) high brightness RED LEDs with built-in flasher unit.
3-5 Vdc operation

CAT # LED-4 2 for 90¢
100 for $40.00 - 1000 for $300.00

3 Volt Lithium Coin Cell

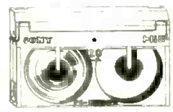
Panasonic # BR2330-1GU
3 volt, 255 mAh coin cell. Lithium batteries have a very long shelf life and are great for memory back-up protection. 0.9" diameter x 0.12" thick. 0.7" between positive and negative pc leads.

CAT #LBAT-16

2 for $1.50

20 for $12.00
100 for $45.00
1K for $300.00

"HI-8" Video Cassette



SONY Hi-8 Top quality, metal particle 120 minute video cassettes. *Used for a short time, then bulk-erased.* Each cassette has its own plastic storage box.

CAT # VCU-8

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100 for $250.00

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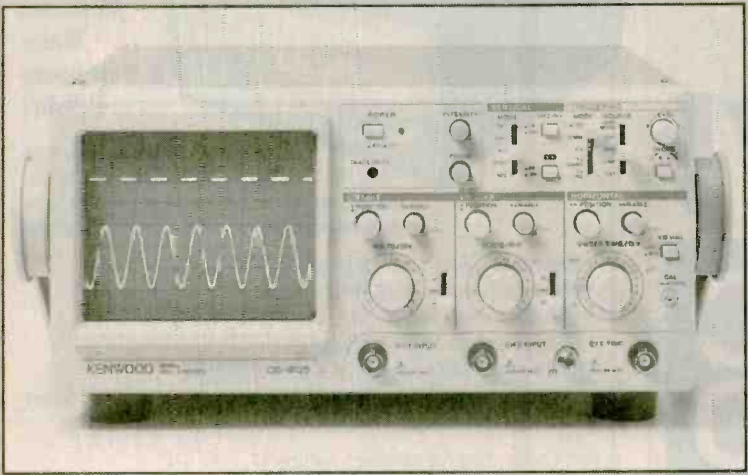
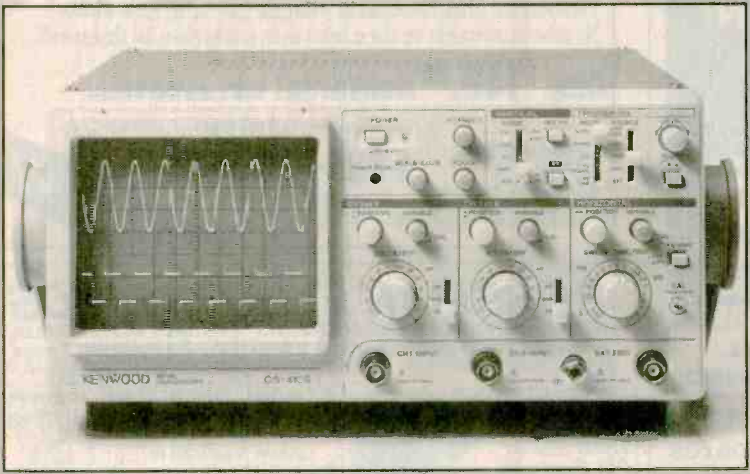


2-Channel, 20-MHz

CS-4125

Regular $595

Sale $389



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CS-4135

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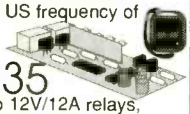
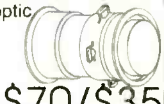
Self contained, tunable, powered by a single LR44/G13 1.5V battery, 15g, 1.3" X 0.9" X 0.4". $30

TWO CHANNEL UHF REMOTE CONTROL On US frequency of 318MHz, transmitter is assembled, receiver is a kit, includes two 12V/12A relays, 1Tx + 1Rx kit:$35, additional Tx: $12 $35



TIME LAPSE RECORDING INTERFACE KIT, Has relay outputs to switch VCR or connect via a remote control:$25 An alarm system output can be used to trigger record / stop. Unit automatically times out without movement. **PIR modules for:$10**

NIGHT VISION TUBE + SUPPLY
Used 25mm fiber optic tube plus an EHT power supply kit to suit. With no blemishes or with small side blemish. $70/$35



UHF DATA TRANSMISSION
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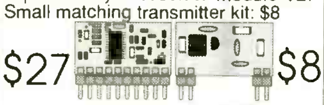

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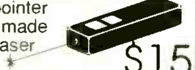

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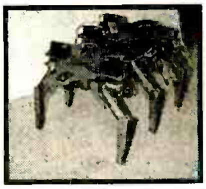

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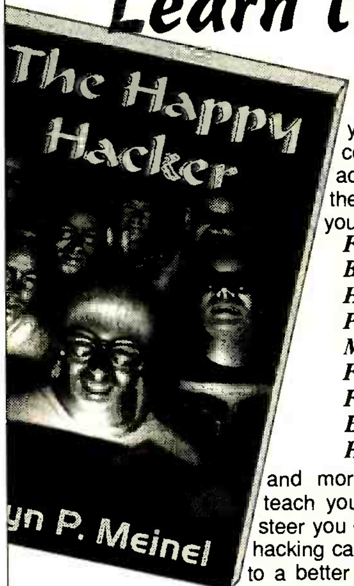

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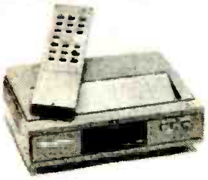

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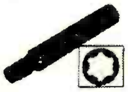

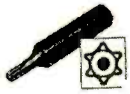

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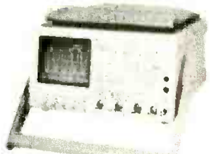

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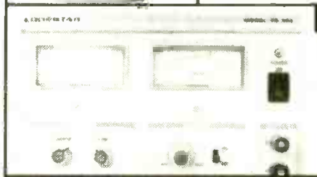

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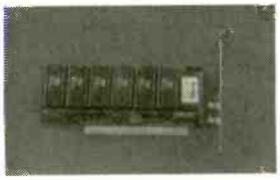

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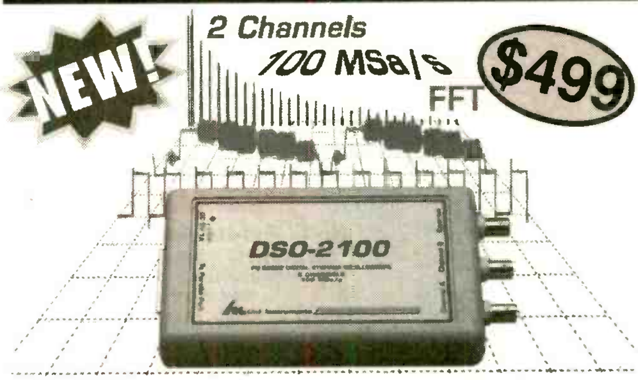

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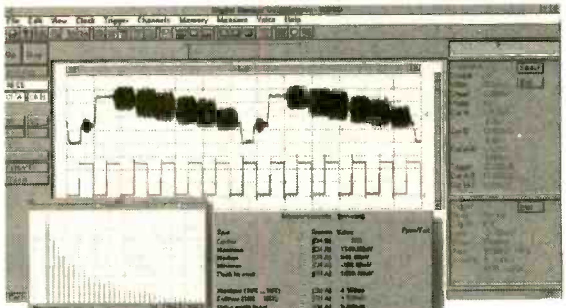

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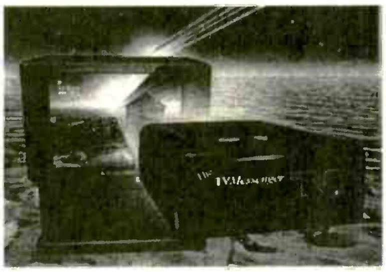

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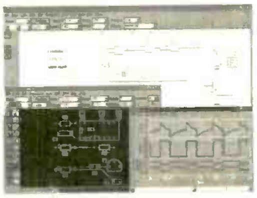

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USE ELECTRONICS NOW CLASSIFIEDS

READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Boldface (not available as all caps)**, add .40 per word additional. **Entire ad in boldface**, add 20%. **Tint screen behind entire ad**, add 25%. **Tint screen plus all boldface ad**, add 45%. **Expanded type ad**, add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics
130 -- Audio-Video Lasers
160 -- Business Opportunities
190 -- Cable TV
210 -- CB-Scanners
240 -- Components
270 -- Computer Equipment Wanted
300 -- Computer Hardware
330 -- Computer Software
360 -- Education
390 -- FAX
420 -- Ham Gear For Sale
450 -- Ham Gear Wanted
480 -- Miscellaneous Electronics For Sale
510 -- Miscellaneous Electronics Wanted
540 -- Music & Accessories
570 -- Plans-Kits-Schematics
600 -- Publications
630 -- Repairs-Services
660 -- Satellite Equipment
690 -- Security
710 -- Telephone
720 -- Test Equipment
730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #__________ **Special Category $30.00 Additional** ____________________

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00
17 - $42.50	18 - $45.00	19 - $47.50	20 - $50.00
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00
25 - $62.50	26 - $65.00	27 - $67.50	28 - $70.00

29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
37 - $92.50	38 - $95.00	39 - $97.50	40 - $100.00

Total words ________ $2.50 per word = $_______

Bold Face ________ $0.40 per word = $_______

Special Heading ________ $30.00 = $_______

Other ________ = $_______

Total classified ad payment $________ **enclosed**

TOTAL COST OF AD $ ________

[ ] Check [ ] Mastercard [ ] Visa [ ] Discover

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Name ______________________________ Phone ______________________________

Address ______________________________ City State Zip ______________________________

ELECTRONIC SHOPPER

CLASSIFIED

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$400 Weekly Assembling electronic circuit boards/products from home for free information send SASE: **Home Assembly-EN,** Box 216, New Britain, CT 06050-0216.

ASSEMBLE PRODUCTS at **HOME.** Informative truthful report. $4.00; **DCP Enterprises,** 15 Mayflower, Alisoviejo, CA 92656.

CABLE TV

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Cable TV Descramblers. One Piece Units. Pioneer, 6310's Scientific Atlanta 8580's DPV 7's and others. Lowest Prices. Money back guarantee. **PRECISION ELECTRONICS,** Houston, TX 1-888-691-4610.

CABLE TV major brands including Zenith St. 1600 $199.00, new Zenith add-on $99.00, Jerrold model CFT 2014 $249.00. One year exchange guarantee, accepted Visa, M/C, Am-Ex, Discover. Call **1-800-822-8530.**

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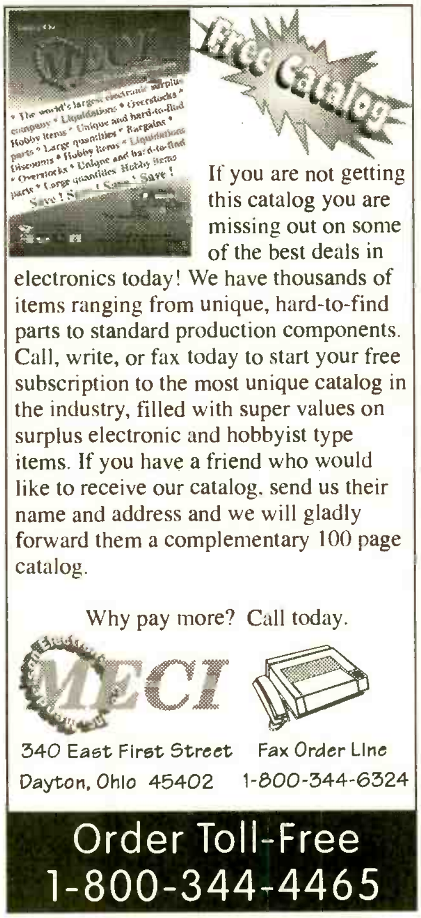

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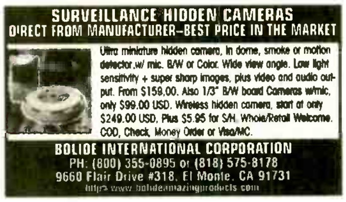

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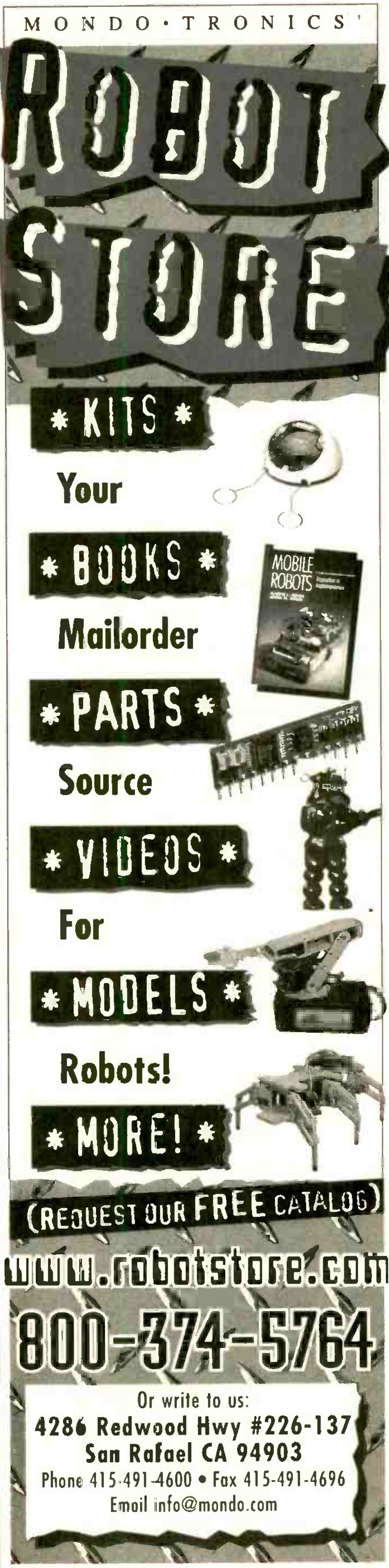

ADVERTISING INDEX

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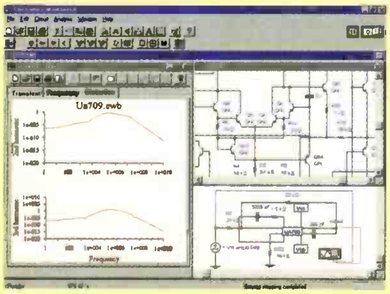

$299 Version 5

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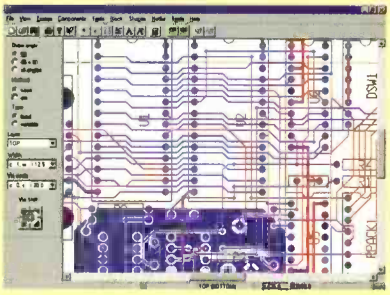

$299 Version 5

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FULLY INTERACTIVE SIMULATION	YES
PRO SCHEMATIC EDITOR	YES
HIERARCHICAL CIRCUITS	YES
VIRTUAL INSTRUMENTS	YES
ON-SCREEN GRAPHS	YES
ANALOG AND DIGITAL MODELS	OVER 4,000
FREE TECHNICAL SUPPORT	YES
DC OPERATING POINT	YES
AC FREQUENCY	YES
TRANSIENT	YES
FOURIER	YES
NOISE	YES
DISTORTION	YES

POWER-PACKED FEATURES

AUTOROUTING	YES
REROUTE WHILE MOVE	YES
LAYERS	32 ROUTING LAYERS
BOARD SIZE	50" X 50"
LIBRARY SHAPES	OVER 3,500
BLIND AND BURIED VIAS	YES
EXTENSIVE OUTPUT	YES
SELECTIVE NET HIGHLIGHTING	YES
USER DEFINED PADS	YES
REAL TIME DESIGN RULE CHECK	YES
DENSITY HISTOGRAMS	YES
FREE TECHNICAL SUPPORT	YES

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Join over 85,000 customers and find out why more circuit designers buy Electronics Workbench than any other circuit design tool.

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