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see page 61

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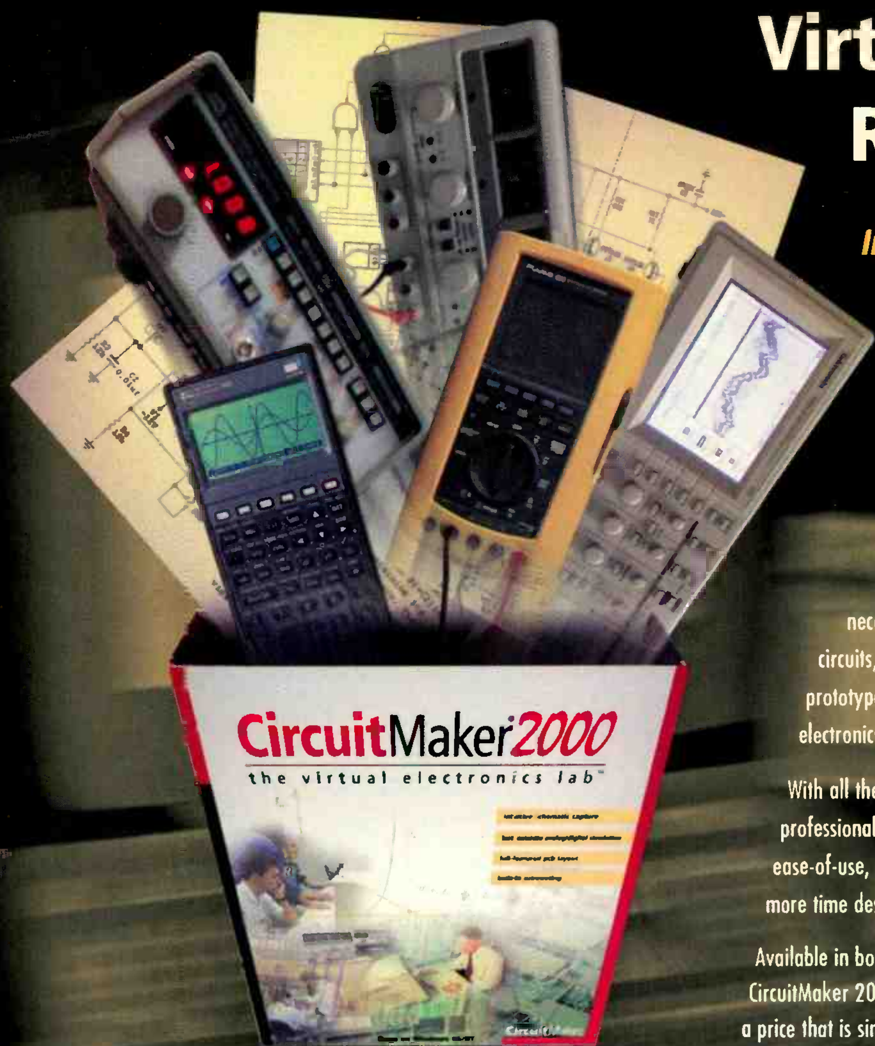

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Electronics Now

November 2000, Vol. 1, No. 11

Popular Electronics®

Poptronics®

THE MAGAZINE FOR THE HANDS-ON ELECTRONICS ACTIVIST!

FEATURES

25 ELECTROSURGERY

When we think of "electronics in the operating room," the usual impressions are of sophisticated monitoring devices that keep track of the patient's vital signs, alerting the doctors if any reading deviates from the "norm." Suprisingly, one of the most basic electronic/electrical inventions to assist the surgeon is an "electric scalpel" that cuts flesh by means of a high-voltage, high-frequency signal. What's more, this device has been used in hospitals for longer than you might think! Learn the "hows and whys" behind electrosurgical units in this fascinating peek behind the sterile curtain.—Albert Lozano-Nieto, Ph.D.

29 AF/RF SIGNAL CHASER

When the "weak link" breaks in a chain of audio or RF circuits, it can be difficult and frustrating to find the spot where traffic stops. Instead of chasing your tail, you can use this device to sniff out any audio or radio-frequency signal, giving you a great advantage in the "fox and hound" game that has plagued repair technicians through the years.—Netwon C. Braga.

38 TUBE AMPLIFIER BIAS CHECKER

The vacuum-tube-based amplifier has been a staple of musical instruments since the development of amplified instruments. The venerable tube has also enjoyed a resurgence in the home-stereo market over the past few years owing to its "warm-sounding" distortion characteristics when driven to its limits. One problem with tube rigs is setting the bias and balance of the output circuit. If that isn't set correctly, the amp will sound horrible and the output tubes will burn out faster. Here is a fast and—more importantly—safe way to read the bias current of any standard amplifier. Not only is it easy to get an accurate reading of the bias setting, the procedure doesn't expose you to dangerous high voltages.—Gary McClellan

DEPARTMENTS

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Airborne laser mapping, virtual medical system, molten-glass measurement system, high-speed fiber-optic laser, judicial video-conference system, and tracking the Los Alamos fire aftermath.

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A starry-eyed Ted Needleman examines some heavenly bodies with computer-controlled telescopes.

20 SURVEYING THE DIGITAL DOMAIN

The Web helps those who help themselves. Reid Goldsborough shows you how to help yourself to knowledge about the Internet in order to build a better Web site.

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Joe Black buys toys ... and then tries to get them fixed.

43 Q&A

Go on, ask away; Michael Covington has the answer to your most puzzling dilemmas.

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John Iovine muscles his way into the world of air muscles.

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Exploring the basics of robot "brains" with our resident electro-mechanical reanimator, Gordon McComb.

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Sam Goldwasser mops up last month's battle by tackling video recording and playback problems in VCRs.

61 BASIC CIRCUITRY

Spoil a would-be burglar's "party" with more of Charles Rakes' alarm circuits. Download the circuits from www.electronicsworkbench.com/poptronics *and play with a "virtual workbench."*

PRODUCT REVIEWS

7 GIZMO®

Digital camera, VHF/UHF antenna, CD recording deck, home-theater projector, multimedia monitor/receiver, DVD development system, portable media player, camcorder tote bag, Hi8 camcorder, surge protector.

AND MORE

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Editorial

mailto: popeditor@gernsback.com

The Dog Ate My E-Mail!

How many times have we used that excuse—or one equally lame—for not doing our homework when we were kids? Apparently, that "non-work" ethic has translated all too well into the 21st Century.

WizardMail Marketing released the results last summer of a year-long study on e-mail responses from on-line businesses. In four batches, 1000 messages were sent to various Fourtune-1000, e-commerce, and industry-specific companies in the U.S. and Canada asking about price and availability of whatever product or service they provide. The responses were rated with the following criteria:

- Did they reply?
- Did they answer the basic question?
- If not, did they suggest the correct contact?
- Could the response be considered "warm and fuzzy?"

Of the four batches (April, July, and December 1999, and April 2000), the first batch got the highest percentage of responses: 24.8%.

That's right: out of 1000 e-mails, 752 were ignored completely—and that was the *best* response rate! The numbers were equally dismal when looking at the actual responses; the "warm and fuzzy" category garnered a high of 34 (December 1999) to a low of only 9 (April 2000). After spending millions on advertising to attract potential customers to their Web sites, is it any wonder that the failure rate of Web-based businesses pushes 95%? When asked about the situation, company responses ranged from "The e-mail computer thingie has been broken for weeks" to "Do you know someone who's available that we can hire?"

If you've used the Internet for any amount of time, I'm sure that I'm not telling you something that you don't already know from personal experience. I recently sent messages to two companies concerning price and availability of some hobby-related products; only one responded. I've also fallen victim of the "not very warm and fuzzy" response in an area a bit more serious than simple e-commerce. A close friend once had a problem with her Internet connection—she couldn't log in; the system was reporting that her password was wrong. When I called the ISP (a small "mom-and-pop-"style provider), the technician happily reset the account to the password that I gave him. No checking records, no identity verification. I could have easily hijacked the account for whatever purposes I desired.

When she wrote the ISP owner detailing her concerns over how the situation was handled, a terse five-word response was delivered: "Our security is very tight."

That's not exactly the type of response that gives one a "warm and fuzzy" feeling.

Putting the shoe on the other foot, how well do I do in responding to readers' messages? I'll be the first to admit that I'm not at the 100% mark; however, I do make an effort to answer every question. I have lost a few messages when my machine crashed before responding ("the dog ate my e-mail"). I've had some with no valid address. Others were sent to other Gernsback mailboxes at random; it usually takes a few days until they get forwarded to me.

I know I'll never reach a perfect score; that's the "beauty" of being a fallible human. That doesn't mean that I'm not going to try my best within my limits—human or electronic. To that end, the only "boilerplate" text I put in my responses is my signature; every other character is personally typed with my own "fat" fingers.

Joseph Suda
Managing Editor

mailto: letters@gernsback.com

LP to CD "Armchair Critic" Exchange

I've been a subscriber since the late 1950s and have owned a consumer-electronics firm since the mid-1970s. I look forward to every issue. However, I was surprised by the relative amateurishness of Ted Needleman's "Plastic-to-Plastic" series in "Computer Bits," specifically on "Converting LPs to CDs" (**Poptronics**, March and April 2000).

As an authorized warranty depot for most major manufacturers, I work on a lot of CD players. The compact layout of many mini-systems makes the CD players difficult to work on, especially when the whole system has to be stripped to access a CD mechanism on the bottom of the unit. Several times in the last month alone we have voided a customer's warranty when we found their jammed mechanism was caused by a label on a CDR. Whether the adhesive was inadequate and couldn't cope with internal heat in the unit, or the label was improperly applied, or a roller caught a little extra adhesive and caused a jam—we couldn't care less.

The fault was NOT caused by a manufacturing defect in the unit, but by not reading the specific instructions, that application of self-adhesive labels is NOT recommended. Customers become quite irate when they are informed that there will be an hour or more labor charge to continue working on their equipment, and even more so when they refuse to pay and receive their unit back in many pieces. Removing the labels from the discs can still leave adhesive on them, causing them to jam in units with loading rollers.

Cover art on CDR jewel cases can be fun and entertaining, but labeling a disc which you can't see when it's in the player or the box seems silly in view of the problems and costs it might cause.

You may wish to alert your readers about this potential problem (and revenue creator).

FRED WEYERMAN
President, Hytek Electronics Inc.
Victoria, B.C., Canada

I'm not quite sure how to take your comments. I've been using CD-R burners since they first became available, and we have a half-dozen here, going through a whole lot of CD-Rs every month. I've had labels buckle in the past, but never to the extent that they've nuked a drive. I personally prefer to use the Primera Signature III CD-R printer I have on loan. But obviously, not everyone is fortunate enough to have the use of this type of printer.

I don't doubt that you've seen what you claim. At the same time, I've never experienced the type of damage that you describe, even when using slot-fed CD drives, such as Pioneer's.

I'm sorry you found the last several columns "amateurish." Other readers apparently haven't felt that way, since I've received more reader e-mail on these two columns than on any of the others.

In any case, I appreciate all feedback, even when it's not particularly positive, so feel free to raise the flag anytime you have something to say.
TED NEEDLEMAN

Please take my comments as constructive criticism, not as slag. I wasn't trying to be insulting in any way. Had I been writing for **Poptronics**, I probably would have focused on audio production more deeply than a whole month on disc labeling (or avoiding disc labeling). For instance, after I get a track on my hard drive, I open the .WAV file in *Sound Forge* and get rid of the fractions of seconds of blank groove noise at the beginning and end of the .WAV I recorded. Then I might do a new fade-out for the last second remaining to minimize noise as the audio approaches turntable noise floor, listening for ticks, pops, and (if from a tape) possible dropouts on one channel or the other.

As an experienced audio buff (and picky armchair critic, gee, sure is easy), I could also have mentioned the "de-hissing" feature of *EZ-CD Creator* for old cassette tapes. I might also have compared the differences between *Sound Forge*, *Cakewalk* and other digital editors so that the readers would avoid the perception that the author was plugging one particular product.

Not infrequently I find that some articles focusing solely on one product become little more than a plug for that product. When I read a magazine such as **Poptronics**, I look forward to broadening my knowledge in various ways of doing things in general.

As far as "nuking" drives is concerned, I've had only one problem myself with a burned disc from a friend, and that was in a tray mech. But our customers are having label problems more frequently, and we had a screamer last week.

My letter is not really an "alternate" view, just personal experience I wanted to share with readers such as myself. Most of what I learned about electronics I picked up from reading *Electronics World*, **Radio-Electronics**, **Electronics Now**, *Byte*, and of course **Popular Electronics**.

I did not really mean to say that the columns were amateurish; it's just that this subject could have been covered two years ago. Just my perspective, no offense intended. Keep up the good work.

Perhaps, once in a while, you could aim at a more in-depth subject for us long-time readers. How about an article about home automation, focusing on X-10 (*www.x-10.com*), BeAtHome (*www.beathome.com*), and others?

I greatly appreciate your extremely professional and considerate reply.
FRED WEYERMAN

Yeah? Sez Who?

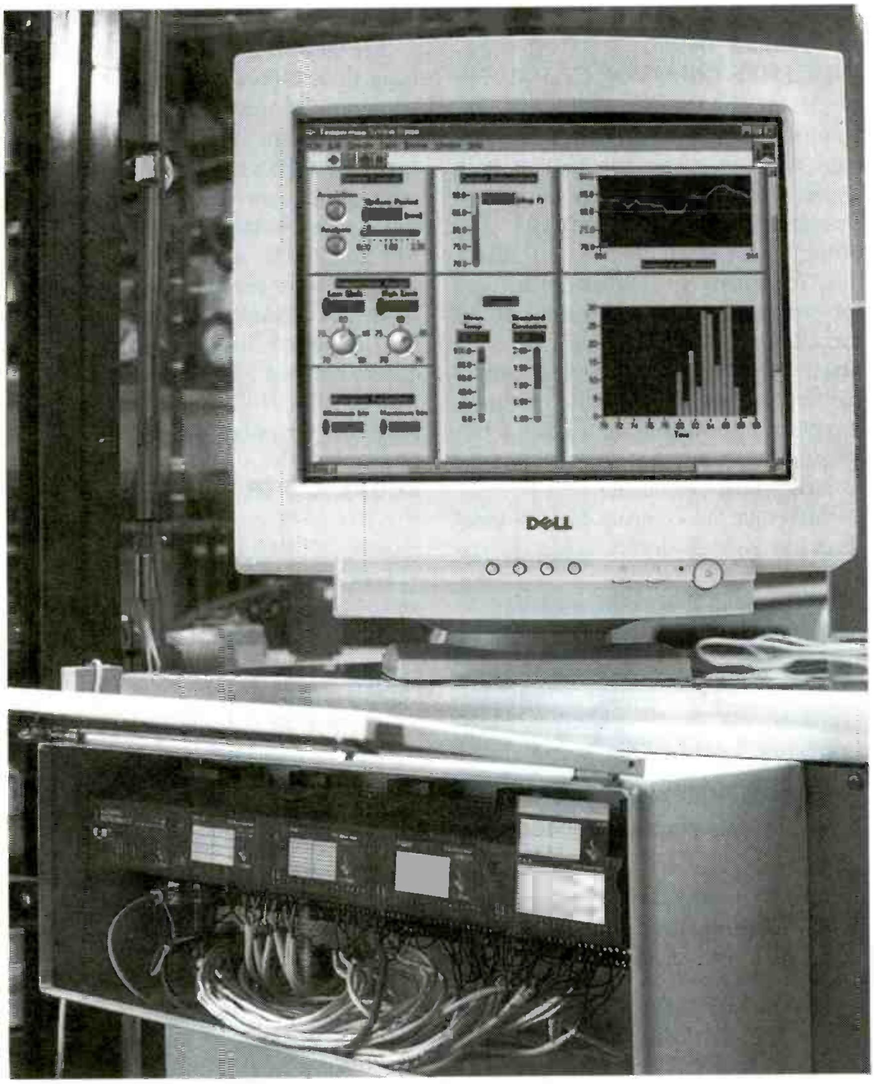
I have enjoyed many of your articles over the years, and have found most to be well written and factual. However, the qualifications of the author are not always clear, and many times the article would be more meaningful if we knew a little about the author. A short resumé of the author's background—either in a sidebar, or at the end of an article—would accomplish this. Nothing long or involved; just something like "a practicing electronics engineer," "a long-time hobbyist," or "a long-time CATV technician." I'm sure that you could be very creative there.
DON KISER
via e-mail

(Continued on page 60)

NEW GEAR

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Data-Acquisition Software



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LABVIEW 6I IS AN INTERNET-ready software data-acquisition package that enables users to send applications to colleagues with the LabView Player browser plug-in, publish data to the Web, and share data throughout an organization. For example, users can direct a remote computer to acquire data, instruct a powerful workstation to analyze the results, and then publish the data anywhere. Designers can easily share test results and measurement data with built-in Internet tools. With a single mouse click, scientific personnel can continuously publish or subscribe to live data without doing any programming and can also stream live data from any user-interface control to the Web or other apps.

LabView 6i users can also build measurement applications in fewer steps than in previous versions, using the concept of measurement intelligence. This concept covers the integration of measurement hardware, sensors, and software to automatically recognize and configure available measurement components for faster application development and increased productivity. Another feature of measurement intelligence is a comprehensive waveform data format that defines names, unit information, and frequency characteristics of measured signals. To further simplify measurement application development, the new version includes single-icon measurement functions that generate and manipulate waveforms, log waveforms to spreadsheet files, and process measured signals.

This sophisticated program offers a wide variety of measurement functions for data acquisition and instrument control, as well as new image-acquisition and motion-control libraries. New features include three-dimensional user-interface controls and new graphing functions, such as multi-axis charts and graphs, plus more Microsoft Windows-style controls.

Pricing for LabView 6i starts at $995 and upgrade pricing starts at $395.

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A PORTABLE, STAND-ALONE CABLE/harness tester that can be used for testing any type of wired assembly with up to 128 points, the *Model 205* detects opens, shorts, and miswires in less than 50 nanaoseconds. A universal, user-configurable connector card is designed to accept up to 28 of the most popular cable connectors. The card allows the user to easily mix/match connector types and plugs into the tester with two 96-pin

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DIN connectors. The connector on the B side accommodates 64 receiver inputs, and the connector on the A side accepts 64 driver outputs.

An easy-to-follow menu, displayed on the 2-line by 16-character LCD, simplifies testing and operation. All the test patterns are recorded on the receiving end and compared to stored data. Battery backup memory permits the storage of up to 50 non-standard cable/wiring configurations. Wiring messages are shown on the built-in LCD display and can be sent to an external printer.

Weighing only six pounds and measuring approximately 14 by 9 by 2 inches, the tester comes with a 12-volt/14-volt DC, 500 mA AC adapter; universal connector card; and probe. The Model 205 Universal Cable Tester sells for $895.

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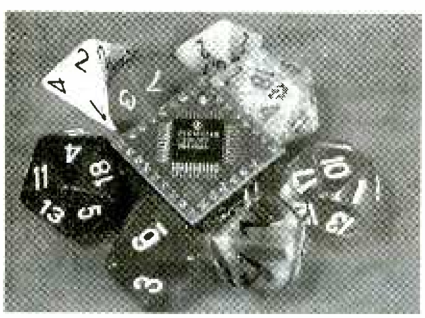
714-237-9220
www.bkprecision.com

Single-Board Computer

THE *MC2000-074* EMBEDDED CONTROLLER is based on a 20-MHz, 8-bit PIC processor, and it features the Vesta Single Tasking Basic (VSTB) language. VSTB is fast (12,000 lines per second on the MC2000-074) and supports executable files up to 32K, but requires less code than conventional PIC languages for most tasks. It supports integer, float, bit, byte, and array variables, and string constants, and also provides event handling and timer control.

The MC2000-074 is just under an inch square and uses the Dev-074 carrier board



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to provide its pin-compatible connectors for two serial ports, an LCD port, a keypad port, a TTL port, 9 pins for general I/O, and a connector for Vesta's SPI- and IIC-compatible VAST port.

The MC2000-074 Embedded Controller ships in two different memory configurations for $59–$69, or in development kits that include carrier board, language CD, debug cable, keypad, LCD, and battery for $179.

VESTA TECHNOLOGY INC.
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HF Amateur Radio

WHETHER USED FOR COMMUNICATIONS or just for listening, the *IC-718* compact HF Amateur Radio can give ham radio operators the best of both worlds. It provides coverage of the AM Broadcast, maritime, Amateur, and other HF services (0.03 to 30 MHz). The 101 memory channels can be used for programming your favorite stations for scanning or quick recall. The Band Stack Register makes hopping around the bands a simple one-button control, or you can go directly to a desired frequency by using the numeric keypad located on the front of the unit.

Although the compact IC-718 measures just 9½ by 3¼ by 9½ inches approx-

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imately, the front panel controls are easy to use. The front-facing speaker and the large LCD readout complete the front panel.

The IC-718 Amateur Radio has an MSRP of $899.

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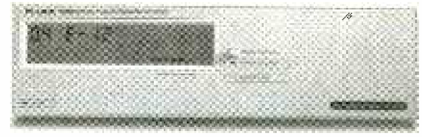
Frequency-Reference Unit

TWO GLOBAL-POSITIONING SYSTEM (GPS) disciplined frequency-reference units, the *910/910R* provide timing-reference signals with great stability over the long, medium, and short terms. Fundamental stability of the frequency references is achieved through the use of an oven-controlled crystal oscillator



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(OXCO) in the Fluke 910 and by a Rubidium oscillator in the Fluke 910R. These features offer intrinsic short-term frequency stability of 3×10^{-12} or 5×10^{-12}.

For long-term frequency-reference stability, these GPS-disciplined devices take advantage of the Cesium-based timing information transmitted by the twenty-four hour GPS satellites to calibrate their internal frequency reference. Previously, this approach lacked traceability. The 910 and 910R solve this problem by using a built-in high-accuracy timer counter to continuously measure the internally-generated frequency against the frequency received from the GPS satellites.

The 910/910R frequency-reference units have list prices of $4995 and $8995, respectively.

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THE *PROTECHPAK* LAPTOP CASE is portable, organized protection for your electronics. It features two separate zippered compartments, padded space for your laptop, and two inside panels. There are ten pockets to hold accessories and tools, three CD and Zip disk pockets, and a large inside document pocket.

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The ProTechPak's padded shoulder strap and attaché handles make it easy

(Continued on page 46)

GIZMO®

Give It a Twirl

The flagship product in a line of audio gear that Philips is dubbing "Twirl"—for *The Way I Record Life*—is the *CDR785* ($499), which houses a single CD-recording deck and a three-disc CD changer in a single unit. The integrated unit allows double-speed CD-to-CD dubbing and one-touch recording of CD compilations.

For personalized mixes, the COMPILE CD feature guides the user through the programming sequence required to select the desired disc and track order. It then begins the recording process, adds pauses between recordings, and allows for auto finalization when requested. The CDR785's analog- and digital-level-control ensures that tracks from various prerecorded CDs are recorded at a consistent volume level.

The carousel design of the unit lets you reload CDs while recording. Up to four discs can be shuffled or programmed using the carousel and the single CD deck. The CDR785 automatically switches between the carousel and the single deck, even though they are physically separate in the component.

A microphone input lets you record live sources directly to CD, without an external preamplifier. It also allows karaoke-style sing-alongs. The CDR785 provides CD TEXT capability, automatically recording encoded text on source CDs.

Philips Consumer Electronics Company, 64 Perimeter Center East, Atlanta, GA 30346-6401; 770-821-2400; *www.philips.com*.

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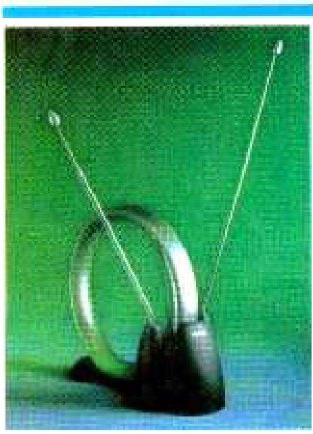

Super Snail

RCA's new take on the old "rabbit ears" antenna more closely resembles a snail than a bunny. The streamlined, high-tech *ANT1020* set-top antenna ($14.95) is uniquely designed to fit in with just about any décor. The snail's "shell" is a UHF loop, while its "antennae" are 39-inch retractable dipoles.

The VHF/UHF/FM antenna includes an integrated hook-up cable, screw-on "F" connectors, and a no-scuff pad to protect cabinet finishes. The ANT1020 is capable of receiving both analog and digital over-the-air TV signals.

Thomson Consumer Electronics, 10330 North Meridian St., Indianapolis, IN 46290; 317-587-3000; *www.rca-electronics.com*.

CIRCLE 51 ON FREE INFORMATION CARD

Palm-Sized Digital Imaging Solution

A dual-mode digital camera, Agfa's *ePhoto CL18 Digital Camera* ($129 MSRP) captures either still images or video footage, with a VGA resolution of 640 × 480 pixels. At approximately 4 by 2½ by 1½ inches, it is small enough to go most anywhere. A USB interface and a universal mini-video output plug allow for easy downloadable TV viewing, e-mailing, Web-page use, or screen displays.

Performing first and foremost like a portable point-and-shoot camera, it does not require a PC for shooting images. Bundled with the CL18 are 2MB of internal memory, and Corel's *Print Office 2000* and *Photo House 5*.

Agfa Corp., 200 Ballardvale St., Wilmington, MA 01877-1069; 888-281-2302; *www.agfaus.com/cdi*.

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Gizmo is published by Gernsback Publications, Inc., 275-G Marcus Blvd., Hauppauge, NY 11788. Senior Writers: Christopher Scott and Teri Scaduto.

GIZMO®

"Affordable" DLP-based Projector

If you've been waiting for prices to come down before adding a video projector to your home-theater setup, your patience has been rewarded. Runco "breaks the $10,000 barrier by a considerable margin" with its *Reflection VX-101* subcompact video projector, ticketed at $7495.

The unit features the latest version of Texas Instruments' Digital Light Processing (DLP) technology, which eliminates the need for convergence adjustments. The single-chip DLP imaging engine is said to create near high-definition images on screens measuring up to 300 inches (diagonal). The projector's light output of 800 ANSI lumens allows it to produce a sharp image even on larger screens and in rooms with a high level of ambient light.

The projector reproduces both anamorphic (widescreen images that fill the whole screen without the letterbox borders) and conventional widescreen programs. With its SVGA native resolution and 1024 × 768-pixel data compatibility, the VX-101 is completely DTV-ready. It offers S-Video and composite video and accepts RGB input as well. Setup is simplified by the projector's vertical position-shift feature and by its wide-ranging zoom lens that can be configured for floor or ceiling installations. The Reflection VX-10 is compatible with Runco's VX-Controller ($3000), an interlace-to-progressive scaler that combines 10-bit decoding with 3:2 pull-down to reduce motion artifacts. The controller also allows the projector to display video in 4:3 and letterbox aspect ratios.

Runco International, 2463 Tripaldi Way, Hayward, CA 94545; 510-293-9154; *www.runco.com*.

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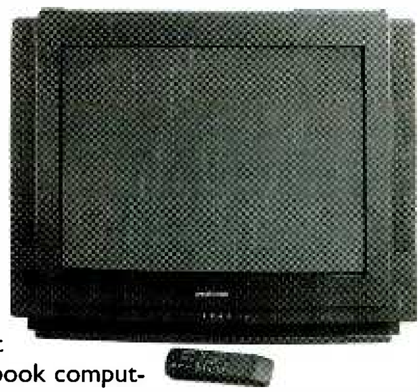
Multimedia Monitor/Receiver



Designed to serve as the visual centerpiece of a sophisticated home-theater entertainment/information system, Proton's *MM-2701VT* 27-inch DTV/PC/NTSC monitor/receiver ($1700) delivers both high-resolution video signal source images and flexible real-world interactive capability. It features a built-in 181-channel auto-programming NTSC tuner and offers a 60-MHz video bandwidth. The monitor displays standard 640 × 480 (VGA), 800 × 600 (SVGA), and 1024 × 768 resolutions.

The MM2701VT is fully compatible with all HDTV/SDTV formats and provides component video inputs for connection of a DVD player or DTV set-top box. Dual RGB inputs (one rear and one front) are provided for a PC or Internet device. The front-panel input allows for easy connection of PC games or a notebook computer. S-Video and A/V inputs are also conveniently located on the front panel. A full-featured remote control and on-screen programming makes it a snap to navigate through the MM-2701VT's functions and features, which include channel block and V-Chip, a clock timer, and three-way audio system.

The audio portion is composed of dual bi-amplified 5-watt-per-channel full-range speakers, two one-inch tweeters, and an 18-watt subwoofer powered by a dedicated amplifier. A four-setting audio-effects switch includes SPATIAL EXPANSION mode, which uses Spatializer audio processor circuitry to create a three-dimensional surround-sound listening experience.

Proton U.S.A., 13855 Struikman Road, Cerritos, CA 90703-1031; 562-404-2222; *www.proton-usa.com*.

CIRCLE 54 ON FREE INFORMATION CARD

DVD Cut Machine

Called a *DCM* by the manufacturer—VITEC Multimedia (a French company), this device allows the user to convert new and old video film to DVD format using a PC. The unit offers a complete suite of DVD creation tools. These tools allow for real-time encoding, authoring, and editing for the entire range of MPEG-1 and -2 content—including VideoCD- and DVD-compliant video.

The DCM also has the ability to preview videos on a PC or TV monitor while encoding. Among the included software are *MPEG Maker*, *Video Clip MPEG-2SE*, *DVD Maker*, and *MPEG Remix*, as well as the *Software DVD Video Player*. And it's priced just under $800.

VITEC Multimedia, Inc., 556 Weddell Dr., Suite 3, Sunnyvale, CA 94089; 408-752-8483; *www.vitecmm.com*.

CIRCLE 55 ON FREE INFORMATION CARD

Windows Media Player

The *Win-Jam Digital Music Player* ($129.99 MSRP) from I-JAM enables consumers to easily enjoy CD-quality music files that are half the size of equivalent MP3 files. It is said to be the first all-in-one digital music player for consumers. The software that comes with the player includes Microsoft's *Windows Media Player 7*.

Bundled with the unit are USB cable for interfacing with a PC, two multimedia card slots for both MMC Flash and ROM cards, one blank 16-MB MMC card for downloading music, and one pre-recorded 8-MB MMC card with music from an assortment of independent artists. The Win-Jam is 4 × 2.5 inches and runs up to eight hours on two AAA batteries.

I-JAM MultiMedia Corp., 1200 Remington Rd., Schaumberg, IL 60173; 888-FAN-IJAM; *www.ijamworld.com..*

CIRCLE 56 ON FREE INFORMATION CARD

A Place for Your Stuff

Most of the occasions that require a camcorder—vacations, weddings, parties, graduations—also call for a still camera. That's why Case Logic's *CBV-12* camcorder carrying case ($39.95 MSRP) includes a detachable point-and-shoot camera bag that can be firmly secured to the main bag. The case boasts stylish rounded corners, extra accessory pockets, new hardware treatments, and improved safety and security features.

The bag is designed to hold a compact 8-mm or digital camcorder. Removable padded dividers provide a custom fit for the camcorder and accessories. Additional slip and zippered pockets are available to hold film and batteries. The opening is reinforced for added security, and a gray interior lining makes it easier to see the bag's contents.

Case Logic, 6303 Dry Creek Parkway, Longmont, CO 80503; 800-925-8111; *www.caselogic.com.*

CIRCLE 57 ON FREE INFORMATION CARD

Low-Cost Hi8

Canon puts Hi8 videography within reach with its *ES8100V* camcorder, which carries a suggested retail price of $549 but doesn't skimp on features. The Hi8 camcorder offers a flip-out 2.5-inch color LCD screen, 22X optical and 500X digital-zoom capabilities, and an image-stabilization system. Its *f*1.6–3.8 lens has a 4–8mm focal length.

The ES8100V provides total point-and-shoot simplicity. Its fully automatic Easy Green mode exposure setting is suitable for most indoor and outdoor shooting situations. The FlexiZone Auto Focus/Auto Exposure mode lets you center the subject in a box transposed on the viewfinder to achieve perfect focus and exposure.

If you prefer to take control yourself, you can select one of four preprogrammed auto-exposure modes (sports, portrait, spotlight, and sand and snow). Then use the built-in digital effects to add mirror, mosaic, negative or other effects during recording; or else opt for 16:9 widescreen, art, or sepia effects during playback. Six digital faders can be added during recording; five can be preset; or your own original titles can be superimposed.

Canon U.S.A., Inc., One Canon Plaza, Lake Success, NY 11042; 800-828-4040; www.usa.canon.com.

CIRCLE 58 ON FREE INFORMATION CARD

Gear Protector

Insure your electronics against electrical surges and lightning strikes with the *SurgeProtector 8 Coax* ($34.95) from Panamax. The device features eight AC outlets separated widely enough to accommodate transformers. Four of the outlets are always "on" in order to provide constant power where needed. A master switch controls the other four outlets. In/out female "F" connectors protect your roof-top antenna or cable-based home-entertainment system. (For satellite protection, Panamax also offers the SurgeProtector 8 DBS.)

The coax surge protector features new Joule technology that is capable of handling an unlimited number of surges. The device either absorbs and reroutes the surge energy to ground or, in the event of a catastrophic surge, disconnects the power to the gear. Diagnostic safety lights indicate proper grounding and outlet wiring, and they signal that the protector is functioning correctly. A lifetime connected-equipment and product warranty ensures that Panamax will repair or replace any equipment that is damaged—even by lightning—for up to $50,000.

Panamax, 150 Mitchell Blvd., San Rafael, CA 94903; 800-472-5555; *www.panamax.com.*

CIRCLE 59 ON FREE INFORMATION CARD

CD ROM based resources for learning and designing

The internationally renowned series of CD ROMs from Matrix Multimedia has been designed to both improve your circuit design skills and to also provide you with sets of tools to actually help you design the circuits themselves.

matrix multimedia

Electronic Circuits and Components provides an introduction to the principles and application of the most common types of electronic components and how they are used to form complete circuits. Sections on the disc include: fundamental electronic theory, active components, passive components, analogue circuits and digital circuits.

The Parts Gallery has been designed to overcome the problem of component and symbol recognition. The CD will help students to recognize common electronic components and their corresponding symbols in circuit diagrams. Quizzes are included.

Digital Electronics details the principles and practice of digital electronics, including logic gates, combinational and sequential logic circuits, clocks, counters, shift registers, and displays. The CD ROM also provides an introduction to microprocessor based systems.

Analog Electronics is a complete learning resource for this most difficult subject. The CD ROM includes the usual wealth of virtual laboratories as well as an electronic circuit simulator with over 50 pre-designed analog circuits which gives you the ultimate learning tool. The CD provides comprehensive coverage of analog fundamentals, transistor circuit design, op-amps, filters, oscillators, and other analog systems.

Electronic Projects is just that: a series of ten projects for students to build with all support information. The CD is designed to provide a set of projects which will complement students' work on the other 3 CDs in the Electronics Education Series. Each project on the CD is supplied with schematic diagrams, circuit and PCB layout files, component lists and comprehensive circuit explanations.

PICtutor and C for PICmicro® microcontrollers both contain complete sets of tutorials for programming the PICmicro series of microcontrollers in assembly language and C respectively. Both CD ROMs contain programs that allow you to convert your code into hex and then download it (via printer port) into a PIC16F84. The accompanying development board provides an unrivaled platform for learning about PIC microcontrollers and for further development work.

Digital Works is a highly interactive scalable digital logic simulator designed to allow electronics and computer science students to build complex digital logic circuits incorporating circuit macros, 4000 and 74 series logic.

CADPACK includes software for schematic capture, circuit simulation, and PCB design and is capable of producing industrial quality schematics and circuit board layouts. CADPACK includes unique circuit design and animation/simulation that will help your students understand the basic operation of many circuits.

Analog Filters is a complete course in filter design and synthesis and contains expert systems to assist in designing active and passive filters.

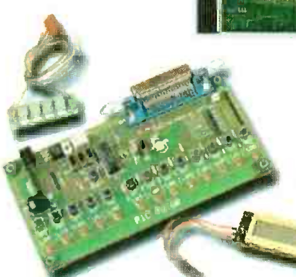


Photo shows PICmicro® development kit supplied with institution versions of C for PICmicros® and PICtutor

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C for PICmicros	$179	$350
Digital Works	$50	$99
CADPACK	$75	$159
Analog Filters	$75	$159
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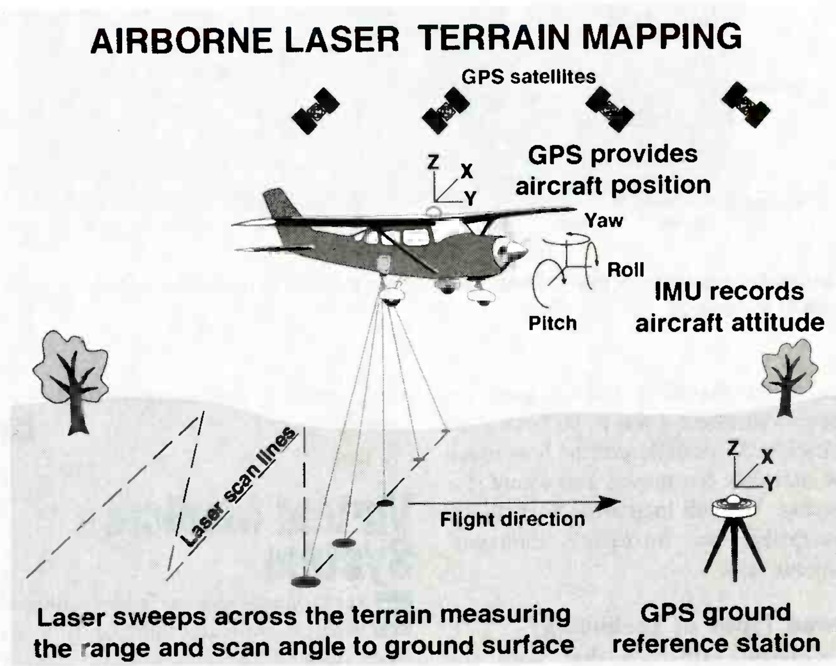
Prototype

Maps From the Sky

A sophisticated mapping process that combines laser scanning and satellite global positioning technology holds new hope for lessening storm damage in hurricane-prone areas, experts say.

In 1998, Honduras and other Central American nations experienced severe damage from Hurricane Mitch, which killed more than 11,000 people, destroying roads, bridges, and crops. As part of the Hurricane Mitch Reconstruction Program, the Bureau of Economic Geology, a research unit of the University of Texas (UT) at Austin, worked with the U.S. Geological Survey (USGS) and the U.S. Agency for International Development (USAID) to produce high-resolution maps of 15 areas in Honduras considered to be at high risk of flooding.

The UT Austin team includes Dr. James C. Gibeaut and Dr. Andrew Warne, both research associates, and Dr. Roberto Guitierrez and Rebecca Smyth, both research scientist associates.



Three types of technology were used in the mapping projects: satellite GPS technology, Light Detection and Ranging (LIDAR) technology, and a measuring device that records variations in the movement of the aircraft. The LIDAR equipment is attached to the bottom of a fixed-wing aircraft. During the flight, the laser sweeps back and forth—firing 25,000 times per second—over the area to be mapped, determining the distance to the ground. Instruments aboard the plane and instruments monitored by a survey team on the ground collect the satellite GPS data during the flight—essentially collecting a continuous data set of the topography.

Destruction from Hurricane Mitch

Flooding and landslides from Hurricane Mitch destroyed 89 major bridges and countless smaller ones and dumped so much sediment into rivers that stream channels and their flow characteristics have changed. Narrowed channels mean less space for water to flow through, and that means flooding problems even from smaller rainfalls, Gibeaut said. Bridges must be built differently because the channels are different.

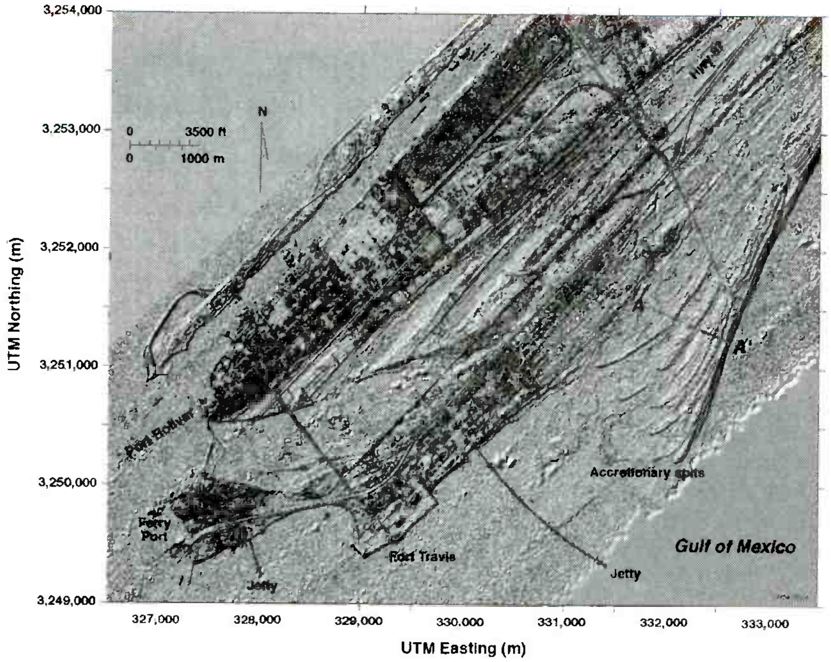
It would have taken months to survey river systems in Honduras using conventional ground survey methods, instead of the days it did take. The team worked in Honduras in early March, flying a total of 70 hours at relatively low levels—often 2500 feet—in mountainous territory. After each Honduran flight, a second team in Tegucigalpa, the capital city, merged the data collected by the aircraft with the data collected on the ground to make sure each area was adequately surveyed.

The maps being developed for both Honduran government agencies and municipal officials will be available by the time of publication. The maps can be used for computer modeling to help in bridge reconstruction as well as in determining where flood walls, levees, or better land-use planning might help lessen storm damage in vulnerable areas.

Aerial Mapping in Texas

Laser scanning was also used for the May aerial survey of beaches and dunes along the entire Texas Gulf Coast, by the bureau and UT Austin's Center for Space Research. The Gulf Coast survey is supported by NASA and the Texas Coastal Management Program through a grant from the National Oceanic and Atmospheric Administration (NOAA) as part of efforts to mitigate beach erosion problems. Analysis of the Texas findings will be completed by the end of the year.

"These maps will determine the posi-



This shaded relief map of Port Bolivar, Texas shows the type of map produced by the three types of technology.

tion of the shoreline and compare the position to where it was as far back as 50 years ago. We will determine how much the shoreline has moved and where it is moving. We will map areas particularly susceptible to hurricane damage," Gibeaut said.

Three Types of Technology

Gibeaut explained that both the Texas and Honduran mapping projects are based on three types of technology: satellite GPS technology, Light Detection and Ranging (LIDAR) technology, and a measuring device that records variations in the movement of the aircraft. The LIDAR equipment is attached to the bottom of a fixed-wing aircraft. During the flight, the laser sweeps back and forth over the area to be mapped, determining the distance to the ground. Instruments aboard the plane and instruments monitored by a survey team on the ground collect the satellite GPS data during the flight.

"The neat thing about this is we fire the laser 25,000 times per second. And that means we can get data points on the ground less than three feet apart. As we fly along, we are essentially collecting a continuous data set of the topography," Gibeaut explained. "This is technology originally developed by NASA that is more detailed and accurate than ever before." PT

Virtual Medical System

Every second counts when military medical staff are fighting time to treat injured personnel and increase their chance of survival. Being able to make on-the-spot diagnoses and choose a course of treatment can make the difference between life and death.

Under development at the DOE's Pacific Northwest National Laboratory (PNNL), a virtual medical system called Tactical Medical Coordination System (TacMedCS) expedites the process Navy medical corpsmen use to assess injuries, administer treatment, and transport patients. TacMedCS, a prototype system, relies on radio-frequency (RF) technology, electronics, and global positioning systems (GPS) to quickly store, record, and transmit information on an injured person's medical condition.


Navy medical staff could coordinate more efficient treatment, transport, and care of the wounded by using the virtual medical system, TacMedCS.

At the heart of TacMedCS is an RF tag that carries an electronic medical record of the person's condition, blood type, and allergies. Encapsulated in rubber, the tag is designed to be the same size as metal "dog tags."

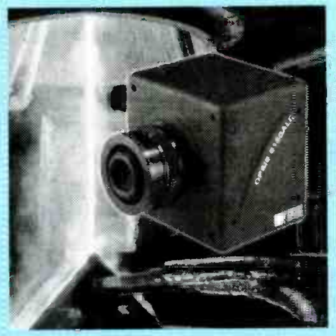
The project was a joint collaboration between PNNL engineers, the Naval Aerospace Medical Research Laboratory (NAMRL) of Pensacola, FL, and Navy corpsmen who provided expertise on the demands of their jobs and what they needed in order to do that job more efficiently. Based on that input, the developers designed the RF dog tag to be read from up to four feet away in less than one second, freeing up valuable time for injury treatment.

TacMedCS also improves upon the paper-tag (triage tag) system that medics use to record treatment information. The RF tag developed by PNNL researchers consists of a tiny silicon chip and antenna, which can store up to 110 characters of information. When they are using TacMedCS, the corpsmen will be carrying electronic interrogators that beam RF waves and "read" data recorded on the tag. The data is uploaded almost instantaneously into a program stored on a miniaturized hand-held computer.

Included software automatically formats the patient's information onto a screen, where the medic can simply point and click to indicate the patient's alertness, as well as the location and type of injury. Information on how the patient was treated can be programmed back into the RF dog tag. Using GPS, the corpsman can also send the location of the wounded individual to the tag and to command center personnel, who can coordinate and expedite transport of multiple patients according to wound severity.

PNNL engineers have tested the prototype TacMedCS to ensure the tag can be read through military clothing, including

➤ Watch That Hot Glass!



Shown here is an OPSIS 5150 camera juxtaposed against a background of a molten-glass stream.

A leading building materials company recently installed a smart camera-based caliper. Designed for precise, real-time measurement and control, it is being used to monitor a molten-glass application.

The fiber-spinning process used in creating molten glass requires that the glass stream pouring from the reservoir into the diffusing station remain at a constant width of 2 inches, ± 0.01 inch. To obtain the necessary measurements, the company installed an OPSIS 5150 ALC Vision Processing Camera System from Wintress Engineering (San Diego, CA.) The system is a turnkey linear-imaging solution that allows the user to measure the molten stream to extremely tight tolerances.

The OPSIS 5150 linescan system provides up to 7500 lines per second at full 5000-pixel resolution, built-in pipeline vision processing, and real-time digital and analog outputs. An extra benefit of the system is the fact that it can convert the pixelized width data into a proportional 0-10V signal every 250mS.

With ambient temperatures reaching 120°F, it was necessary to protect the camera. The OPSIS 5150 camera system and other hardware were installed in a NEMA 12 enclosure that is 65 inches away from the stream. Because of the camera standoff distance and the extremely close tolerance of the stream-width measurement, a 400mm f5.6 tele-macro lens with a Nikon mount was used for imaging the data. To begin with, the system measurement parameters were set up using a PC. Afterwards, the camera operated in a stand-alone mode, maintaining the correct stream width, without further direction. PT

chemical and biological suits, Kevlar and body armor vests, and field jackets.

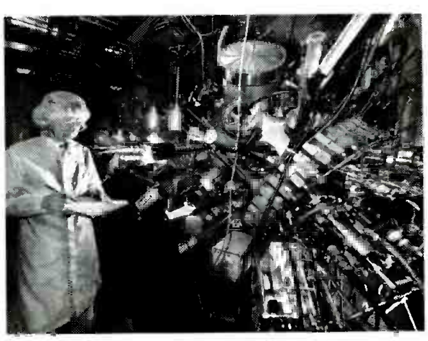
"The faster a corpsman can treat one patient, the sooner he can reach the next injured person. Our goal is to make their job as simple as possible," said Ron Gilbert, Pacific Northwest engineer. PT

High-Speed Fiber Optics

Working through a cooperative research and development agreement (CRADA) with Cielo Communications, Inc., researchers at the DOE's Sandia National Laboratory have introduced the first 1.3-micron electrically pumped vertical cavity surface-emitting laser (VCSEL) grown on gallium arsenide. Cheaper and easier to build than standard edge-emitting lasers used in current high-speed communications, the new 1.3-micron VCSEL is predominantly made from stacks of layers of semiconductor materials common in shorter wavelength lasers—aluminum gallium arsenide and gallium arsenide.

The Sandia team added a small amount of indium gallium arsenide nitride (InGaAsN), initially developed by Hitachi of Japan in the mid 1990s, to this structure. The InGaAsN causes the VCSEL's operating wavelength to fall into a range that makes it usable in high-speed Internet connections.

"This VCSEL will meet the needs of high-speed fiber optics connections of



Sandia researcher John Klem stands next to the molecular beam epitaxy system used to grow the crystal structure of the 1.3-micron communications vertical cavity surface-emitting laser (VCSEL). (Photo by Randy Montoya.)

the future," says Peter Esherick, manager of the Compound Semiconductor Materials and Processes Department at Sandia "We expect there to be great excitement over the device—fueled by the rapid expansion of Internet use and craving for faster Internet access."

The laser is the light source that transmits information down optical fibers. Two types of semiconductor lasers are used in high-speed data and telecommunications fiber optics—the edge emitter and the VCSEL. In the edge emitter, which has traditionally dominated the semiconductor laser market, photons are emitted out of one edge of the semiconductor wafer after rebounding off mirrors that have been literally cleaved out of the crystalline substrate.

In the VCSEL, laser photons bounce between mirrors grown into the structure and then emit vertically from the wafer surface. VCSELs, which are grown by the thousands on a single wafer, have significant advantages over edge-emitting lasers in the areas of lower costs, as well as lower power dissipation and higher reliability. This development promises to reduce the cost of high-speed fiber-optic connections.

VCSELs made of combinations of aluminum gallium arsenide and gallium arsenide have been used in the shorter wavelength window of 850 nanometers for local connections. However, because none existed that could work in the 1.3-micron window required for high-speed, long-distance communications, the optical networking industry turned to the more expensive and complicated edge-emitting lasers.

Sandia researchers successfully built an edge emitter using InGaAsN early this year, enabling them to analyze the material's properties and quality. The development of the first InGaAsN VCSEL is the next step.

"The key to making this work was to optimize the material quality of the InGaAsN and to make subtle changes to the rest of the structure," said John Klem, a Sandia researcher on the VCSEL project. "Once we had the high quality InGaAsN in hand, our extensive experience with shorter wavelength VCSELs allowed us to quickly produce the full 1.3-micron device."

Esherick added "What's exciting for us is that the 1.3-micron light can be transmitted through silicon—the silicon is transparent at that wavelength. The additional flexibility this offers for integrating photonic devices with silicon-based microsystems will have significant implications for national security systems." PT

Order in The Court

The U.S. District Court in Concord, New Hampshire recently installed a video-networking system. The use of video communications in the federal judicial system is expected to streamline everyday proceedings, while simultaneously safeguarding the privacy and safety of its participants.

In Courtroom 4 of the U.S. District Court in Concord, New Hampshire, the plasma screen of the video networking system from Video Network Communications (VNCI) is installed behind the judge's bench. The system has numerous applications, including conferences between local judges and out-of-town judicial staff, and remote prisoner hearings with the Magistrate Judge as well as remote witness testimony.

The Concord U.S. District Court wanted to expedite court business, while retaining the quality of personal interaction; and the staff felt that remote video communications would accomplish that. After thorough research, judicial officials chose Video Network Communications (VNCI)—the only company to offer full-motion, TV-quality video broadcast, personal communications, and video-on-demand capabilities. Furthermore, VNCI could do it over the court's existing telephone network. To date, VNCI's system has delivered efficiency, ease-of-use, and immediate results, according to court personnel.

Jim Starr, Clerk at the U.S. District Court explained. "The VNCI team worked diligently to get us up and running—on schedule and within budget."

Within a month of installation, the staff were holding remote prisoner hearings with their Magistrate Judge, employment interviews, and meetings between local judges and out-of-state colleagues. In addition, the system allowed them to hear the first remote witness testimony.

Stephen Lamarche, VNCI's Vice President of Sales and Marketing, said, "New Hampshire's U.S. District Court is setting the communications standard for government agencies striving to accelerate processes, cut costs, and reduce liability, while meeting the public demand for enhanced levels of service." PT

Fire Down Below

Inaugurating the scientific-data development stage of its three-year mission, the Multispectral Thermal Imager satellite, MTI, is providing pictures of the fire-ravaged Los Alamos area, among other U.S. sites. The Los Alamos National Laboratory's Data Processing and Analysis Center (DPAC) is receiving data from the satellite across 15 spectral bands (only three of which are visible to the human eye). DPAC is the main data and distribution center for data and data products for MTI. There researchers are processing the data into images. They are performing scientific analysis and will distribute the results to research partners in this project.

"The successful shift of MTI from checkout to scientific data processing is a credit to the whole, multi-lab team," said Don Cobb, the Laboratory's associate director for threat reduction. "They've taken a brilliant idea and brought it from concept through development, calibration and now to the research phase, using an advanced instrument payload that will improve our abilities in treaty monitoring, environmental research, and a range of areas of important study."

Among the images of special interest to Los Alamos researchers are those showing the fire-damaged areas around the Laboratory and townsite from the recent Cerro Grande fire. Images, to be shot on a continuing basis as the vegetation returns, will be shared with laboratory and multi-agency teams. These teams will be analyzing the burn area, the region's ground cover, as well as potential flood-mitigation efforts currently underway.

The excellent spatial resolution of the instrumentation and the specific spectral range offered by MTI is expected to be very useful in tracking regrowth of trees and ground cover in the wake of the fire. Across visible bands, the satellite can provide five-meter resolution, and in other wavelengths it is accurate to 20 meters. This compares with 10- to 30-meters resolution for other imaging satellite systems currently in use.

To gather its image data, MTI looks through a 36-centimeter aperture and uses a bank of three sensor chip assemblies, each carrying 15 arrays of cryogenically cooled detectors. The arrays provide MTI with nearly 17,000 tiny detectors, each no larger than the tip of a well-sharpened pencil.

The 510-pound instrument is designed to be self-correcting in its data gathering, adjusting for the effects of clouds, water vapor, and airborne particles present in each image of the ground. Such corrections ensure that data analysts have full information about the factors affecting images, exactly as they are captured.

The Multispectral Thermal Imager is a research and development project sponsored by the U. S. Department of Energy—a joint project of Los Alamos and Sandia National Laboratories and the Savannah River Technology Center. The three-year mission objectives of the project are to advance the cutting edge of multispectral and thermal imaging, image processing, and associated technologies.

MTI's design is based on detailed physics-based modeling and analysis performed at Los Alamos, and engineering by Sandia, as well as contributions from major industrial partners including Ball Aerospace, TRW, Santa Barbara Research Corporation, and Hughes Danbury Optical Systems. The satellite's instrument package was calibrated at Los Alamos, its system was integrated at Sandia, and it flew into orbit from Vandenberg Air Force Base aboard an Orbital Sciences Corporation Taurus rocket, funded by the US Air Force. PT

TED NEEDLEMAN

mailto: computerbits@gernsback.com

Computerized Star Gazing

As I imagine many of you might be, I've always been fascinated by astronomy. Numerous trips to the then named Hayden Planetarium in New York City always left me fired up to take a closer look on my own at celestial objects.

Several telescopes, which I purchased over the years and relegated to the basement, taught me that star-gazing isn't that easy—at least through most optics. Industry statistics seem to bear out the frustration of my past experiences. Telescopes are popular gifts, but few of these consumer models get used more than a few times before being abandoned.

That's largely because a telescope is not particularly easy to use. It seems like it should be—just point the scope towards what you want to see, focus it, and—presto, the rings of Saturn jump into view.

The reality of the experience is more humbling. In the evening sky, the dot of light that's Saturn doesn't look appreciably different to a beginner than most of the other points of light up there.

That's why, when I visited the Tasco/Celestron exhibit at a recent Toy Fair, I was excited to see that the company was offering new telescope models with computerized mounts. These mounts feature two-axis stepper-motor control over the scope, with a handheld controller that also has a small computer and a ROM database of over 18,000 objects. Once the controller is calibrated with the date, time, and latitude and longitude of the viewing site, it can slew the telescope tube to the part of the sky that contains the object you wish to view. This type of telescope is called a *GOTO* telescope, since the controller actually instructs the mount to "GOTO" a specific part of the sky.

Here's the NextStar 5 ready to go. All I need to do now is wait for the Sun to set.

When I learned that the controller also has an RS-232 port so that it can be used with compatible software on a PC or laptop, I was sold. Finally, I figured, here is a telescope I can actually use.

I arranged with Tasco for the use of a Celestron NextStar 5. The nice folks over there even provided me with a copy of Software Bisque's *The Sky* and an RS-232 cable—whose street price is $129—so I could use my Compaq Presario 1600 to control the whole shebang.

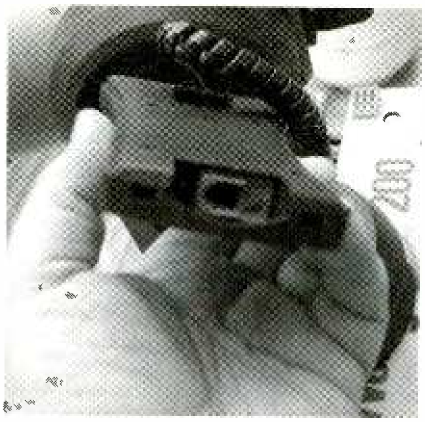
STARTING AT THE TOP

To be honest, I should warn you that the NextStar 5 is not a beginner's telescope. With a street price of about $1200, it's really targeted towards a somewhat experienced amateur astronomer, rather than a rank beginner like myself. The NextStar 5 isn't the only GOTO telescope on the market. Celestron's parent company, Tasco, has a $400 reflector telescope with GOTO technology, and both Meade Instruments and Bushnell also have modestly priced GOTO telescopes as well.

There are also much more expensive optical instruments with GOTO technology, though the NextStar 5 is a very sophisticated piece of optical equipment. Incorporating a five-inch mirror and folded optics in the Schmidt-Cassegrain design, the NextStar 5's tube uses two mirrors to reduce the tube length to only 11 inches.

The motor-driven base adds a bit of heft, though, bringing the weight up to a bit under 18 pounds. There's an optional tripod, though I used the NextStar 5 on a portable workbench, a system that I found both easy to move and stable once set up. After the telescope almost knocked my laptop off the bench as it slewed to a target, I started using a plastic chair for the PC.

The NextStar 5 also comes with a Plossel eyepiece. This design has a very large aperture, so you don't have to squint to see through it. A unique finderscope, which Celestron calls a Star Pointer, has minimal optics. Instead, like the latest generation of rifle scopes, it projects a red dot from an LED; you move the telescope to cover the target object. This is a lot easier than the typical telescope, which requires that you try to find a small object in a small sighting telescope so that you can then try to find it again in the main unit.



This small modular port on the handset controller connects the NextStar 5 to a laptop or other PC through a serial port.

NOT AS EASY AS IT LOOKS

Reading the NextStar 5's excellent instruction manual, I figured that I'd have the scope up and running in minutes. Theoretically, you can do that. Calibrating the scope and controller is a relatively simple process, with one large exception that I'll get to in a minute.

One thing to keep in mind is that it's a good idea to let the telescope sit outside for a while before using it, especially if you're moving the instrument from a warm to a cold environment, or vice versa. Not only do you not want to have moisture condensing inside the telescope, but thermal differentials can really screw up the precise focusing needed to bring faint objects into view.

The first step is to point the telescope towards the North and level the tube, using the controller handpiece. The NextStar 5 takes 8 AA-size alkaline batteries that last about four or five hours, or you can use the included AC power supply if you're near an outlet.

Once the tube is parallel to the ground, and pointed North, the handset will ask for the date, time, and the longitude and latitude of the viewing site. The manual has these figures for some major cities; the nearest to me was about 30 miles away. After you've entered these, the scope will slew to the first of three bright stars that it thinks you should be able to find. Next, you center the star in the Star Pointer, and then in the main scope. The process is then repeated.

If one of the objects isn't visible due to an obstruction or clouds, the controller suggests an alternate. If two of the three objects aren't visible, the calibration can't be completed. I had to move the scope around the backyard several times before I found a spot where there were no obstructions. A better idea would have been to find a large open field or parking lot to use for my observing.

Once it was scalibrated, I discovered that the telescope would indeed slew to an object selected using the hand controller. The hand controller has the expected locations of more than 18,000 objects; many of them are what are called "named objects." Some of these names, like the planets, are familiar. Most, however, while recognizable to a more experienced stargazer, were completely unfamiliar to me.

I quickly learned that none of the planets were visible that night; since whenever I selected one, the telescope pointed towards a different part of the ground.

When I selected some stars whose names I was familiar with, I quickly discovered a drawback to putting the NextStar 5 in the hands of a "newbie." As much as one star looks like another, it's even worse when the scope actually points towards a section of the sky. You center what you think is the target star in the Star Pointer, and then look through the NextStar 5's eyepiece.

What makes it difficult to know if you've zeroed in correctly is the sheer light-gathering capability of a superb optical instrument like the NextStar 5. What I took to be a relatively unoccupied area of the sky when using the Star Pointer looked quite different through the eyepiece of the telescope, with over 100 bright points of light—many of which were completely invisible to my naked eye. Any one of them could have been the star I was trying to view!

WORKS TOO WELL

My first viewing experience with the NextStar 5 served to point out that as sophisticated and "intelligent" as the telescope is, it can't make up for an appalling lack of knowledge on the part of its user (me) or the wildly unreal expectations that I had about the viewing experience.

To make things worse, I wasn't sure that the scope was even correctly calibrated, especially with longitude and latitude figures entered for a city 30 miles distant. It was time to bring the computer into the picture.

Next time around, I'll detail how adding a $130 piece of software helped level the field and allowed even a beginning astronomer like me to actually see the stars (and recognize what stars I was seeing.) The lessons learned are equally appropriate for an expensive telescope like the NextStar 5 or one of the more consumer-priced GOTO scopes now hitting the market. P

VENDOR INFORMATION

Celestron International
2835 Columbia St.
Torrance, CA 90503
310-328-9560
www.celestron.com
CIRCLE 100 ON FREE INFORMATION CARD

Software Bisque
912 Twelfth St.
Golden, CO 80401-1114
800-843-7599
www.bisque.com
CIRCLE 101 ON FREE INFORMATION CARD

REID GOLDSBOROUGH

mailto: digitaldomain@gernsback.com

Creating Substantive Web Sites and Learning About The Web

On the Web, content is king. This notion was recently reinforced by a study from the Poynter Institute and Stanford University showing that people who visit Web sites typically focus on the text first, looking at photos and other graphics afterward—unlike newspapers and magazines.

The appearance of your Web site is still important, helping to establish professionalism and credibility. But the information and other substantive material that you provide—the "content"—matters most.

"Content is the 'there' that's there," says Christopher Barr, president of the Internet Content Coalition and editor-at-large for the computer-news Web site *cnet.com*. "It's what people go to the Web for."

The content of the Web also makes markets, bringing buyers and sellers together.

If you need "bells and whistles" to fill out your Web site's content, iSyndicate *is the place to go.*

REDUCING "CYBER-BABBLE"

Whether you produce content in-house or you outsource, ensure that it reflects your individual or organizational goals and that it's targeted to your audience. It should also be accurate, complete, and entertaining or at least interesting; and it should be updated regularly. Check for spelling and grammatical errors, broken links, and other mistakes that can undermine your credibility.

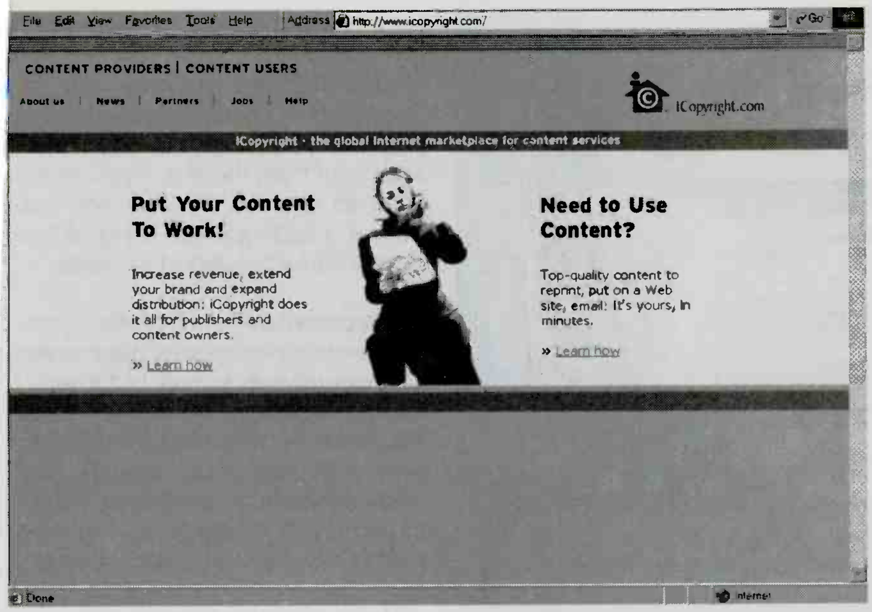
Make background information about yourself or your organization available from the home page, if appropriate. Discerning readers will look for this to help determine the authority and legitimacy of your content. If you include advertising, separate it from the informational content to avoid compromising your objectivity.

Include a "last updated" or similar message. If you're not finished with a page or section, don't link to it, apologizing with an "Under Construction" sign. It's far better to link to pages after you've completed them, preventing frustration when readers try to access unavailable content.

The biggest mistake people make in creating content is in not understanding what their audience wants, says Barr. Along with traditional surveys and focus groups, you can also use Web-response forms and tracking services such as HitBox, at *www.hitbox.com*, to help determine what's working and what's not.

BECOMING (OR FINDING) A WEB GURU

If you don't have the time or talent in-house to create content, you



Just because something is easy to grab from the Internet doesn't make it legal to use. iCopyright *is a clearinghouse for getting copyright permissions...and giving copyright permissions for your original content!*

have several options. First, to obtain original content, you can farm the job out to a freelance writer, independent-site developer, Web-design shop, technology-consulting firm, interactive agency, or conventional advertising or public-relations agency.

C-Net's Web Services, at *www. webdesignlist.com*, lists Web developers and their areas of expertise.

Another option is contracting with an online syndication service such as *iSyndicate*, at *www.isyndicate.com*. You can obtain written, graphical, audio, or video content there from more than 900 sources—some free, some carrying fees.

To beef up their content, some Webmasters make arrangements directly with content creators, including authors of columns such as this one.

For other sources to obtain content for your site, check out *1000 Free Webmaster Resources*, at *www.world zone.net/ss/antelope/con tent.html*.

In creating or obtaining content, don't neglect your neighborhood or region. The Web may be worldwide, but people live locally. In a recent survey by the online newsletter publisher *Streetmail*, 72% of Web users said they were more likely to use content created within their communities than any produced by a remote source.

WHO TOLD YOU TO TOUCH THAT?

Whatever you do, resist the temptation to swipe content you see elsewhere for your site, whether it's text, visual art, or music. "Get permission," says Richard Stim, author of the new book *Getting Permission: How to License And Clear Copyrighted Materials Online & Off*.

This is important, especially if you expect your site to become popular or make money. "It makes it more likely that people will complain, and those complaints can turn into lawsuits," says Stim, a lawyer who specializes in intellectual property.

For tips on getting permission and dealing with the licensing fees sometimes involved, check out Stim's "Getting Permission to Publish: Ten Tips for Webmasters" at *www. nolo. com/encyclopedia/articles/pct/ pub_permission.html*.

To make it easier for other sites to license your content, you can partner with an online copyright clearinghouse such as *iCopyright*, at *www.icopyright.com*.

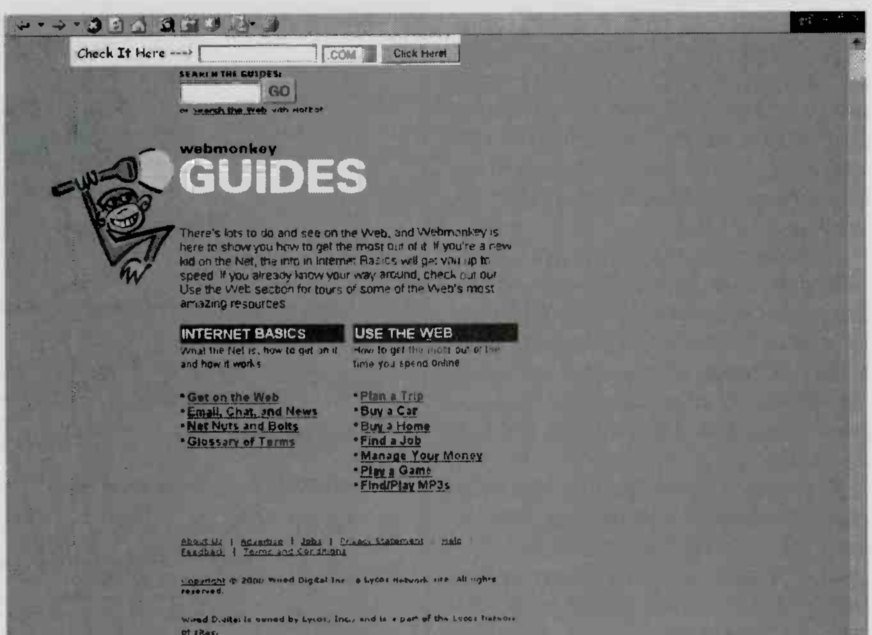
DRAW THEM A MAP

Regardless of how you obtain content in designing your site, help Web surfers find the information they want by including a search engine, site map, or index.

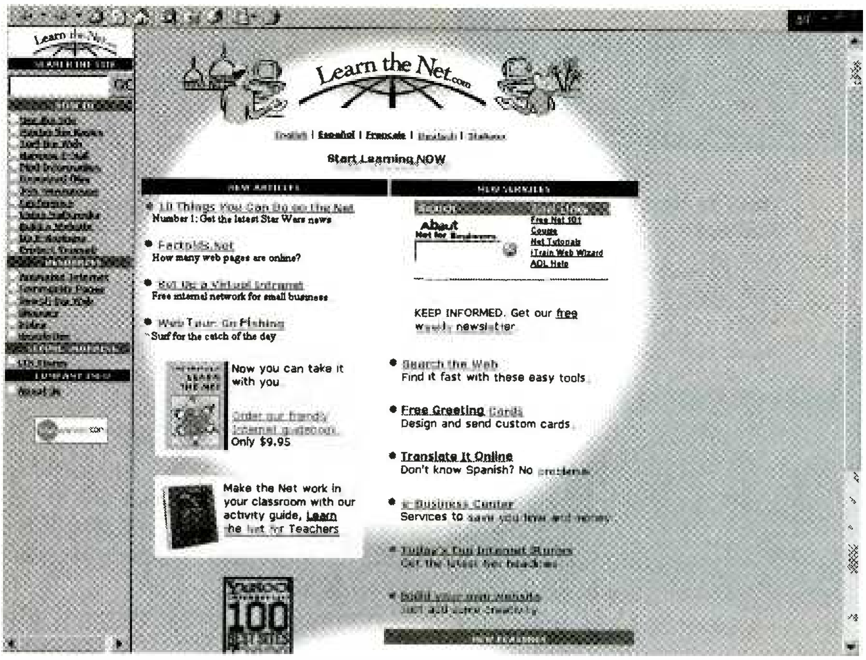
Atomz, at *www.atomz.com*, lets you add either a simple or sophisticated search engine to your site and sends you a periodic report of what visitors are searching for. It's free for sites with fewer than 500 pages.

Index Generator, at *www.mh.ic 24.net*, is a free program for automatically generating a site map or index.

Finally, periodically reevaluate the quality of your content. Make sure that the information is still current, accurate, and complete. Test links, both internal and external, to ensure that they're still working. Don't become obsolete.



Webmonkey *tells you how to perform different tasks with the Internet's help from finding a job to buying a house. Bananas are not included.*



With Learn The Net, *you can learn all about the 'Net. A weekly newsletter is even available for your pointing and clicking pleasure!*

USING THE 'NET TO LEARN ABOUT THE 'NET

We live in the "Age of Information," where knowledge explodes exponentially. You need information to gain knowledge, and knowledge to gain wisdom. In practical terms, as the noted economist Peter F. Drucker has written, knowledge more than technology is key in giving individuals and companies a competitive edge.

If you're like me, though, your head often spins from the thought of how much you don't know. That isn't necessarily a bad thing. As the English statesman Disraeli said 150 years ago, "To be conscious that you are ignorant is a great step to knowledge."

Information technology—particularly the Internet—can help you gain knowledge. But first you need to know how to use it. And even if you know the basics, you're likely missing out if you're not using the Internet to its full potential.

One of the things the Net has always done exceedingly well is help you learn about itself. The following is a roundup of some of the best Web sites today aimed at teaching you the ins and outs of Internet technology. Unless indicated otherwise, all are free.

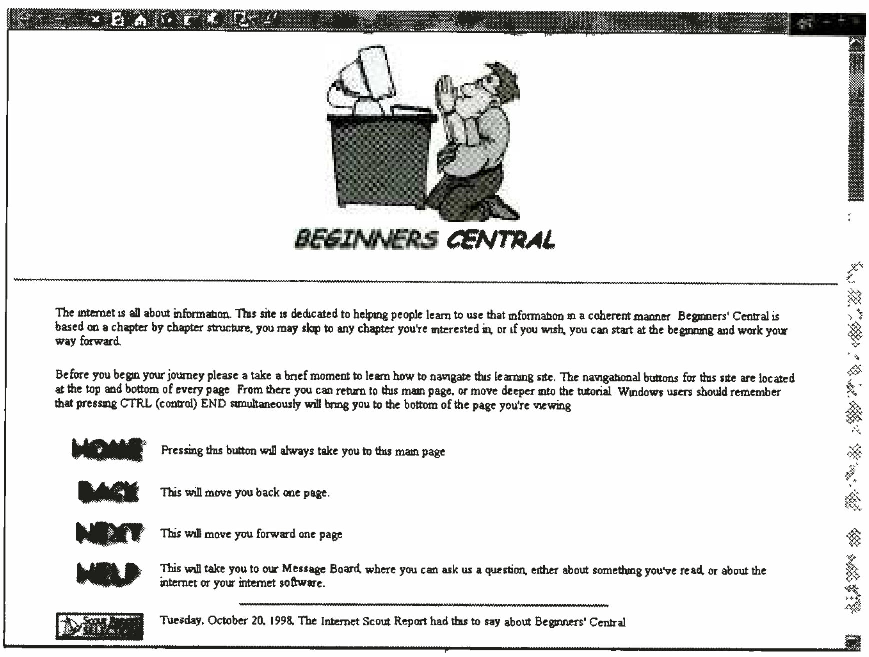
Help.com—C-Net's *Help.com*, at *www.help.com*, is a huge repository of well-organized tips and tutorials about not only the Internet, but also hardware, software, games, and consumer electronics. You can browse the categories or do a search. Business and consumer topics—beginning as well as advanced—are covered. *Help.com* is unequaled in terms of the quantity and quality of information provided.

The site also includes relevant discussion from Usenet newsgroups and lets you post your own questions right from the site. If you're not satisfied with the answers, you can peruse a topic-specific listing of free and paid tech-support services.

Webmonkey—At *hotwired.lycos.com/webmonkey/guides, Webmonkey* isn't extensive in scope, but it won't be overwhelming for beginners. It links technical terms to a glossary and walks you through specific procedures such as using the Internet to find a job, manage your money, plan a trip, and buy a car or home.

Learn About The Net—*This site* (*www.learnthenet.com/english*) includes a wealth of basic information about business topics such as e-commerce along with more general topics such as e-mail, Web surfing, and multimedia. The site provides versions of itself in Spanish, French, Italian, and Dutch as well as English.

Yahoo Tutorials—Yahoo's "How-To: A Tutorial for Web Surfers," at *howto.yahoo.com*, does a good job of covering the basics with easy-to-follow instructions. Unfortunately, when explaining a subject such as chat services,



If you've ever felt like the character depicted on the top of this Web page, then Beginners' Central *is the site for you.*

Yahoo How-To often lists Yahoo's own offerings first or even exclusively, which detracts from the site's objectivity and usefulness.

About-the-Web—At *www.about-the-web.com*, About-the-Web is more of a home-grown effort and truer to the Internet's heritage than other sites described here. It's not slickly designed, but it includes lots of information and links for newcomers as well as entrepreneurs and Webmasters. Be careful, though, about ads that are hidden within the instructional material, such as one for Turbo-Surfer near the beginning of the section on e-mail.

Beginners' Central—This site, at *www.northernwebs.com/bc*, is for "newbies" struggling with such matters as configuring a newsreader and FTP'ing files to a Web site. It's organized in chapters, and, though it's not comprehensive, the last chapter includes needed warnings about Internet myths and scams.

Darwin Magazine—The magazine's tutorial, at *www.darwinmag.com/learn*, is an all-business offering. Subjects covered, among others, are e-business, customer-relationship management, outsourcing, knowledge management, application-service providers, and change management. Along with tutorials covering the basics, you'll find in-depth articles, surveys, interactive discussions, a glossary, and links to other Web sites dealing with the subject matter at hand.

Wiredguide—Here, at *www.wiredguide.com*, is a portal providing links to tutorial resources located elsewhere on the Web rather than a cohesive aggregation of content. It is well organized and comprehensive, covering Internet topics primarily and general personal computer topics secondarily.

AllAboutYourOwnWebsite—This portal, at *www.allaboutyourownwebsite.com*, is also a portal to other tutorial sites. However, the focus here is strictly on building and maintaining a Web site, whether you're a business, nonprofit organization, or hobbyist. Topics covered include design; domain names; hosting, testing and analysis; and getting listed with search sites.

SmartPlanet—Ziff-Davis' *SmartPlanet*, at *smartplanet.zdnet.com/fp.asp?layout=computing_home&learning_zone_id=4*, provides paid instructor-led courses. One recent five-day course called "Exploring Electronic Commerce" costs $19.95 and required the purchase of a textbook, which also costs $19.95.

The above sites can help you learn, though keep in mind that knowledge has its limits. As Emerson said, "Ideas must work through the brains and arms of good and brave (people), or else they are no better than dreams." P

POINT AND CLICK

1000 Free Webmaster Resources
www.worldzone.net/ss/antelope/content.html

About-the-Web
www.about-the-web.com

All About Your Own Web Site
www.allaboutyourownwebsite.com

Atomz
www.atomz.com

Beginners' Central
www.northernwebs.com/bc

C-Net's Help.com
www.help.com

C-Net's Web Services
www.webdesignlist.com

Getting Permission to Publish: Ten Tips for Webmasters
www.nolo.com/encyclopedia/articles/pct/pub_permission.html

HitBox
www.hitbox.com

How-To: A Tutorial for Web Surfers
howto.yahoo.com

iCopyright
www.icopyright.com

Index Generator
www.mh.ic24.net

iSyndicate
www.isyndicate.com

Learn
www.darwinmag.com/learn

Learn the Net
www.learnthenet.com/englis

SmartPlanet
smartplanet.zdnet.com/fp.asp?layout=computing_home&learning_zone_id=

Webmonkey
hotwired.lycos.com/webmonkey/guides

Wiredguide
www.wiredguide.com

Electronics and medicine merge in the operating room.

ALBERT LOZANO-NIETO, Ph.D.

Electrosurgery, as it is known today, was developed as a result of accidents that occurred when spark-gap transmitters were used aboard ship in the early 1900s. Engineers and scientists realized that when these sparks accidentally contacted the human body, they caused cuts in the areas they touched. This is one more example of an important discovery that resulted from an unfortunate accident.

In 1925, William T. Bovie developed the first practical electrosurgery unit (ESU). It was successfully used for neurosurgery in 1926. Even today, some surgeons and nurses use the name "bovie" to refer to ESUs, as for some time these were the only commercially available units.

Electrosurgery applies a very high-current-density radio-frequency signal to the area of the human body that the surgeon wants to cut through. Figure 1 is a photograph of a solid-state ESU. The buttons on the right side select the different operating modes. The two knobs set the delivered power for each mode of operation. The connectors at the bottom are for the different types of electrodes.

The actual cutting instrument is shown in Fig. 2. An extremely high voltage—up to 4000 volts—is applied to the active electrode. This powerful voltage creates a very defined spark that will start the current flow from the electrode to the surface of the body. The large current flowing inside the cells that are close to the electrode delivering the current signal vaporize, breaking the biological tissues, resulting in the cutting effect. The current spreads quickly inside the body, and current density in nearby areas decrease to levels that have no effect.

The current exits the body through a large return (or *passive*) electrode. The total current through the active electrode is the same amount that flows through the return electrode. Because the return electrode is much larger than the active electrode, there are only low levels of current density at the exit point that are too slight to cause any harm. It is the current density (current divided by the area through which the current flows) that is the important parameter, since it is the high-density current at the active electrode that does the actual cutting. The low-density current at the return electrode has no effect.

High-frequency currents are used. Thus, the patient doesn't experience any of the typical results of electric shock, since the human body is insensitive to these currents.

Fig. 1. The front panel of an electrosurgical unit contains the controls that set the power level and mode of operation.

The major advantage of electrosurgery is that the heat of the process gives the surgeons the option of controlling and sealing bleeding vessels. Electrosurgery is mostly used for large and rapid excisions in vascular areas.

Types of Electrodes. We've already mentioned the two distinct types of electrodes used—active and passive. The active electrode delivers the current and is used to do the actual cutting. It has a very small area, around a few square millimeters. The one shown in Fig. 2 is a blade-type electrode about 1-mm thick and 10-mm wide. Two types of signals can be sent to the active electrode. One is used for cutting; the other for coagulation. The actual waveforms that are used are shown in Fig. 3. They are easily selected by depressing the proper pushbutton on the front panel of the instrument.

Another type of active electrode is shown in Fig. 4. In this particular model, the electrode tips are interchangeable depending upon the procedure selected by the surgeon. The one in the upper left is a *blade* electrode. The tip in the middle is a *needle* electrode. It has the smallest area and consequently has the strongest cutting power. The tip at the bottom right is a *ball* electrode. It has the largest area and is normally used for coagulation purposes. Note, too, how the electrode pencil (holder) has two buttons for selecting the desired waveform. These buttons are color-coded and positioned in the same way on all models and brands of

Fig. 2. The active electrode—looking much like a pencil—does the cutting.

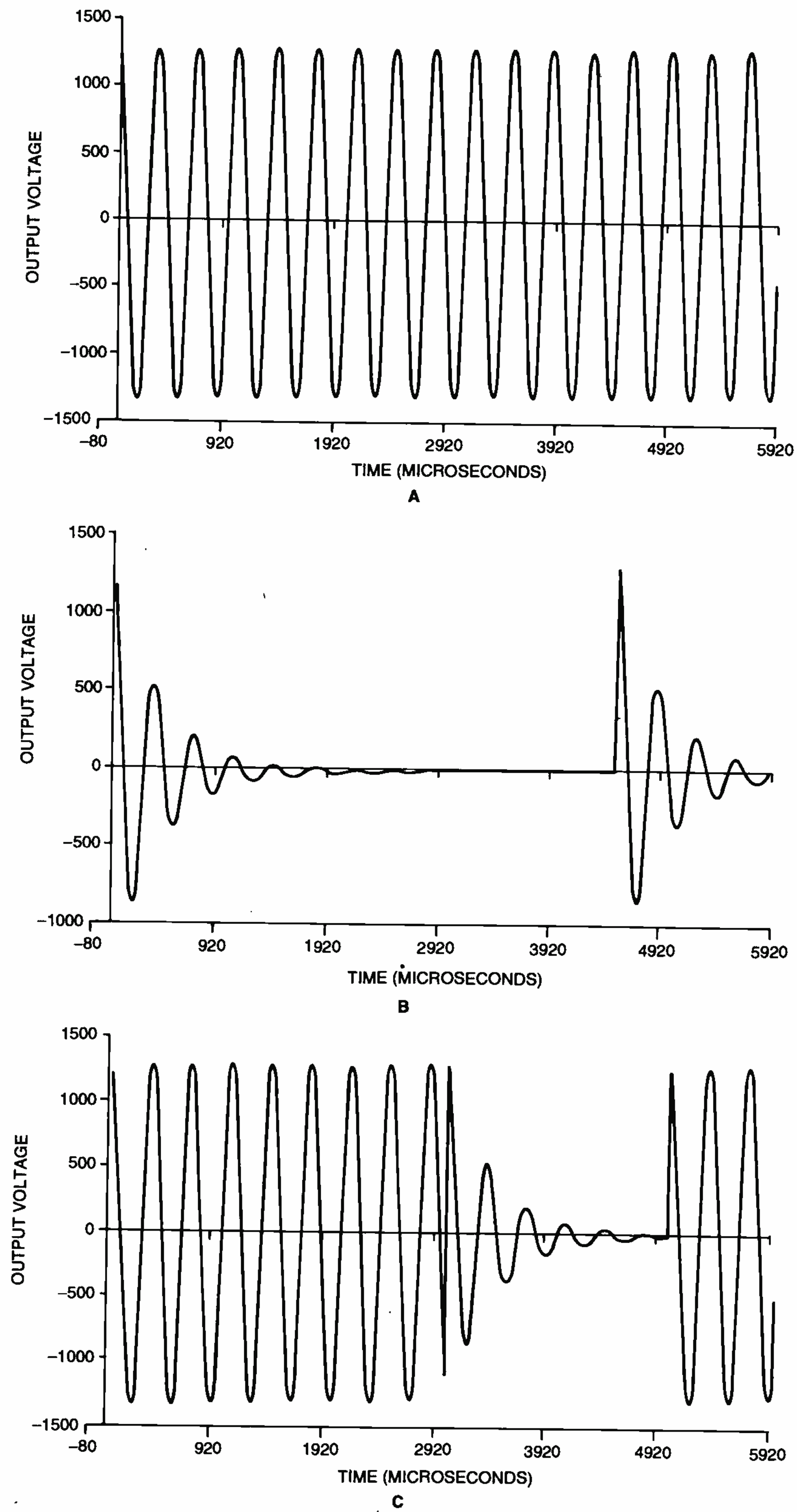


Fig. 3. An electrosurgical unit outputs different waveforms for the three modes of operation. The modes are cutting (A), blend (B), and coagulating (C).

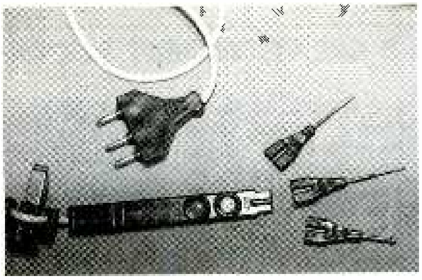


Fig. 4. This kind of active electrode has a reusable main part; different kinds of tips can be connected depending on the specific needs of the surgical procedure. The main difference between the tips is their surface area.

electrosurgery equipment to eliminate confusion and accidents.

In this article, I used a grapefruit to simulate human skin and to show the effects of electrosurgery. In Fig. 5 you can see our "patient" with the return (or passive) electrode attached. In a real-life surgical procedure on humans, the return electrode is much larger.

Modes of Operation. The electrosurgery unit has different modes that can be selected depending on what needs to be done. Let's take a closer look at what modes are available.

In the *cutting* mode, the signal applied to the active electrode is a constant-value sinusoidal signal with a frequency ranging from 300 kHz to 3 MHz, depending upon the model of the ESU. The one shown in this article applies a 700-kHz signal with a maximum voltage of 2600 volts peak-to-peak in its cutting mode. This setting produces maximum cutting power with the least coagulation. As the blade moves along, the tissue received the same treatment, resulting in a smooth cut with no jagged edges.

In the *coagulation* mode, the average power delivered to the tissue is reduced, as the duty cycle is much smaller. For the ESU shown in this article, the duty cycle is approximately 10%, with a maximum voltage of 4000 volts peak-to-peak. The goal here is to heat the tissues, causing deep dehydration and tissue cauterization without vaporizing the cells. The short duty cycle lets the heat propagate along the tissue to coagulate as it goes. The depth of the coagulation depends upon the duration of the time that the electrode contacts the tissue. Using this process results in ragged edges; and there may be some browning of the tissue, although bleeding will be greatly reduced.

Another way to achieve coagulation is to use a large-area electrode, such as the ball electrode. When this electrode touches the tissue, the current density from its larger surface area is not enough to vaporize the cells, but is high enough to coagulate the blood vessels.

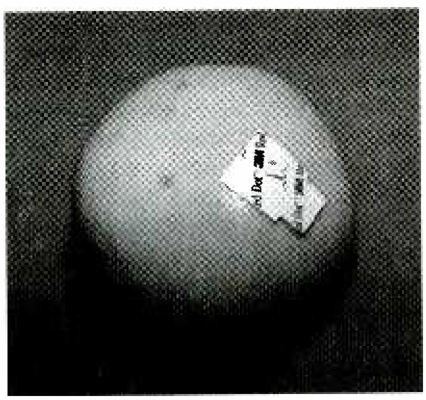


Fig. 5. Our "patient" for today, a grapefruit, shown with the passive (or return) electrode connected.

Finally, the *blend* mode is used to cut and seal bleeders simultaneously. Because it delivers a relatively low average power, it reduces cutting and increases the penetration of heat into the tissue to coagulate blood. Blend settings produce waveforms with a duty cycle between the 100% used in the cut and the 10% used in the coagulation modes, keeping the peak-to-peak voltage constant. Cutting happens during the time that the signal is on. During the rest of the time when there is no signal applied, the heat propagates into the tissue and creates a layer of coagulation along the incision that controls bleeding. The ESU described in this article has three blend modes, with duty cycles of 50%, 25%, and 20%.

Properly anesthetized, our "patient" is seen in the photograph (Fig. 6) being "operated" on with the blade electrode used in the blend mode. The narrowest side of the blade electrode is moved along the flesh to be cut. The blade being used determines the width of the cut. The photo in Fig. 7 was taken without flash so you could see the sparks coming from the active electrode as it cuts. There is also a barely visible plume of smoke as high-temperature substances are emitted into the air. In real applications, these need to be carefully controlled to ensure the safety of the surgeon, nurses, and patient alike.

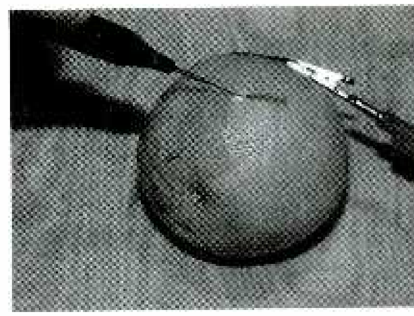


Fig. 6. With this type of electrode, we cut the patient as we move the device along—similar in style to what happens with a very sharp scalpel.

Typical Uses of Electrosurgery. In general surgery, the ESU is used for cutting tissue, clamp coagulation, and coagulation. As it seals gaps in tissues and lymph vessels, the process helps protect against toxins, malignant cells, and bacteria. It is a contact surgery, as opposed to laser surgery; but it is largely sterile, especially because of the high temperatures reached by the electrode tip. Electrodes are easily sterilized; or as is done with modern units, the electrode tips are discarded after a single use, eliminating the potential problem of cross contamination.

Electrosurgery is also used for desiccation. In these instances, the surgeon inserts the ESU needle electrode into a mass—a vascular tumor, for example. The current through the tumor heats its fluids above the boiling point (above 100° C). This vaporizes and dehydrates the lesion. Because proteins and lipids require a much higher temperature to decompose (around 500° C), the surgeon can use this technique to simply dehydrate tissue—not decompose it.

The main problem of electrosurgery is the possibility of inadvertent burns to patients in locations other than the sites where the surgeons intend to operate. These alternate-burn sites are often caused by a poor electrical contact between the patient and the return electrode. However, while they do hap-

Fig. 7. In this illustration, you can see the sparks drawn from the tip of the electrode. The extreme voltage at the tip is high enough to break the insulation of the air.

pen at times, these are very isolated incidents when the latest state-of-the-art equipment is used. To avoid such burns, modern ESUs constantly monitor the impedance of the return electrode. The unit sets off an alarm if a preset safety setting is exceeded and simultaneously shuts itself down.

Since the signals generated by an ESU are in the RF range, it is possible for them to interfere with other nearby equipment. Modern EKG diagnostic machines and pacemakers incorporate circuits and devices to protect them from ESU signals; but where older equipment is used, the patient might be at risk. A pre-op medical history should ask the kind of questions that will protect against such incidents.

Because the ESU procedure does produce sparks, both explosions and fires are a possibility. All operating room personnel must make sure that no flammable gasses or plastic tubing are used in the vicinity of the patient who is being treated.

Biomedical Techs at Work. When working with ESUs, the biomedical technicians are responsible for the areas of electrical safety and performance analysis. The first step is to make sure that the unit is safe to operate and that leakage currents are below the established maximum. This ensures that both the surgical staff and the patient are protected against electric shock. Next, they need to measure and evaluate the effective power delivered by the unit and compare that with the manufacturer's specifications. Many output levels are checked with an electrosurgery tester (a network of high-power resistors that simulate the typical resistance of the human body), measuring the power delivered to the tester. Using the tester, the technicians check all the different outputs and modes of operation of the ESU. Last (and the second-most important test) is the operational testing of the return electrode.

The technicians' tests also ensure that the ESU alarm is functioning properly and will detect any improper high resistance. Another test determines that the cut function does not switch in when the coagulation setting is selected. They must also make sure that if both the cut and coagulation buttons are pressed simultaneously (an accidental event), the ESU output goes into the less destructive coagulation mode. Other responsibilities include verifying its integrity by looking for frayed or damaged cords and leads.

Electrosurgery is one of the many ways electronics enters into the health-care system. It is a simple yet complicated procedure that works its wonders every day.

FOR MORE INFORMATION

The following URLs are for Web sites of manufacturers of ESUs and accessories where readers can learn more about the latest innovations in electrosurgery and state-of-the-art equipment. They are examples of manufacturers and distributors of this equipment, which are provided for informational purposes only. This list is certainly not exhaustive.

Doing a search for "electrosurgery" on any major search engine will yield scores of sites that deal with sales, service, and the background technology.

A & E Medical
www.aemedical.com

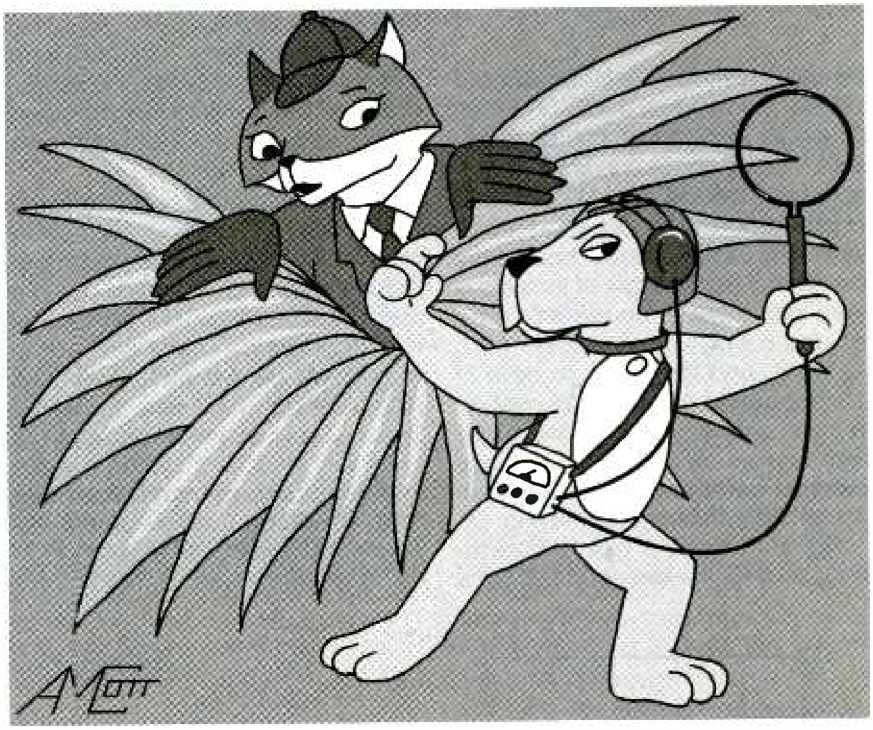
Medtrex Corporation
www.medtrex.com/esu/esu.html

Valley Labs
www.valleylab.com

Chase Down Signals With the AF/RF SIGNAL CHASER

Having difficulty troubleshooting a circuit where the signal goes in but doesn't come out? This simple tool will help you pinpoint the problem for both audio- and radio-frequency systems.

NEWTON C. BRAGA



Picture this: You have a radio or amplifier on the bench that has no output. Obviously, trying to find the "break in the chain" where the signal stops on its trip from input to output can be frustrating and time-consuming without the right test equipment.

The best way to find the bad component is to start checking in those parts of the circuit where you know the trouble is. So how exactly do you do that? By injecting a known signal into the circuit and tracing its path, you can quickly and easily find the point where it disappears.

You can use an oscilloscope and a signal generator, but what if you don't have ready access to those items? That's where the *AF/RF Signal Chaser* presented here comes to the rescue. With care and proper construction techniques, this low-cost project can fit on a piece of perfboard small enough to fit in a shirt pocket. Powered by a 9-volt battery, it can be used "in the field" as well as on the bench. If a piece of equipment can be easily diagnosed and fixed where it stands, you won't have to drag it back to your bench.

The AF/RF Signal Chaser is useful for finding problems in AM and FM radios, CD players, common amplifiers, multimedia audio systems, and televisions. However, electronics hobbyists and technicians aren't the only ones who can make use of this project; there are many more non-obvious applications for the AF/RF Chaser. For example, the amateur scientist or the high school or college student looking for a different type of science project can use this circuit as a light-to-sound converter or a sound- and RF-"sniffer" to perform some interesting experiments involving physics, chemistry, and natural sciences—to name a few. By connecting a coil to the input, you can pick up audio and RF signals inductively from transformers or low-power transmitters. To use the AF/RF Signal Chaser as a light-to-sound converter, connect a photocell to its input instead of the coil mentioned above. Now you can listen to lightbulbs, the sun, stars, or any other modulated light source, whether visible or not.

How It Works. Any signal detector like the AF/RF Signal Chaser needs the ability to work with weak, low-level signals; some form of amplification is required. To that end, we'll

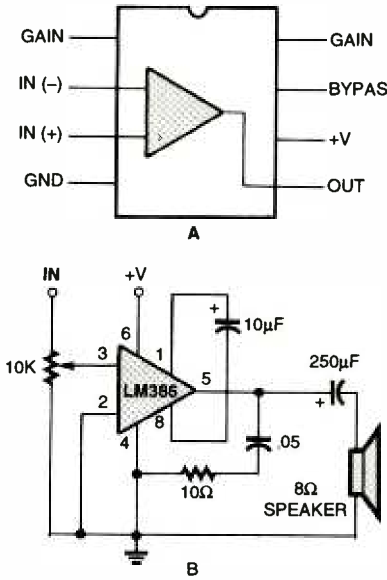


Fig. 1. The LM386 is a simple yet versatile audio amplifier in an 8-pin package (A). Its basic circuit is very simple, requiring few external parts to drive an 8-ohm speaker (B).

be using National Semiconductor's LM386 low-voltage audio amplifier. Originally designed for small radios with headphones or small loudspeakers, the LM386 is a complete audio amplifier in an 8-pin dual-inline package. Features that we will be taking advantage of include a very low quiescent current (4 mA), a wide supply-voltage range (4 to 12 volts), and the ability to drive 8-ohm speakers at up to 325 mW on a 6-volt supply. What's more, those features are designed so that few external components are needed. The LM386's pinout is shown in Fig. 1A.

Figure 1B shows a typical application circuit for the use of an LM386 as

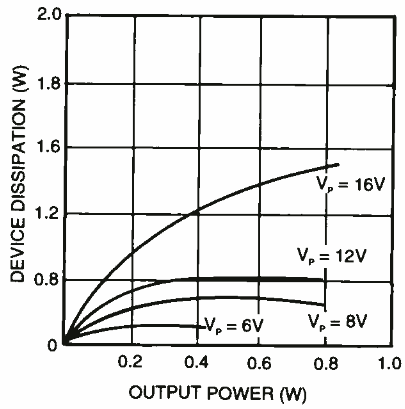


Fig. 3. The output power of an LM386 is a function of its supply voltage. The curves shown here are for an 8-ohm load.

an audio amplifier. Note that connecting a capacitor to pins 1 and 8 sets the output gain. With a 10-µF capacitor, the voltage gain is 200. You can see the effect of the gain capacitor in the response chart of Fig. 2.

If you need more "oomph" from the LM386, simply boost the supply voltage. The relationship between output power and supply voltage can be seen in Fig. 3.

Another feature in signal-tracing that is very important to performance is the input impedance. Unfortunately, the LM386 has an input resistance of only 50,000 ohms. Any high-impedance circuit that we try to test will be loaded down and stop working; it will see the AF/RF Signal Chaser as a short circuit. What we need to do is increase the circuit's input impedance to the point that it will be undetectable by whatever circuit we're testing. To do that, we'll use a field-effect transistor as an input buffer. Those devices can have very high input impedances; the one we'll be using is rated at about 10 megohms. That amount of loading (or lack thereof) should be good for the majority of circuits that we'll be testing.

Circuit Description. The schematic diagram for the AF/RF Signal Chaser is shown in Fig. 4. The signal from J1 is amplified by Q1 with R1 and R2 providing a bias for the FET. The amplified signal is capacitively coupled to R4 (volume control) and D1.

The purpose of D1 is to act as a demodulator for RF signals. If you're working with audio signals, find D1 has no effect on the signal. On the other hand, when working with RF signals, the diode acts like an old- style crystal-set demodulator. The inclusion of D1 gives the AF/RF Signal Chaser its versatility. Both frequency-modulated (FM) and phase-modulated (PM) signals can be detected; D1 acts as a slope detector. However, the audio will be poor in fidelity.

The remainder of the circuit is a standard LM386 amplifier with a gain of 200 and an 8-ohm output. Any suitable speaker or earphone can be connected to J2.

Note that S1 and R4 are coupled so that the AF/RF Signal Chaser's volume control also turns it on and off like a battery-powered radio. The power supply is a set of four AA batteries in an appropriate holder.

Construction. In spite of its sensitivity, the AF/RF Signal Chaser can be built on a piece of perfboard using

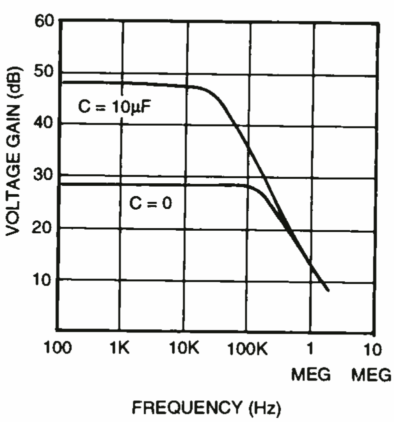


Fig. 2. By varying the capacitor value across pins 1 and 8, you can set the LM386's gain as high as 200.

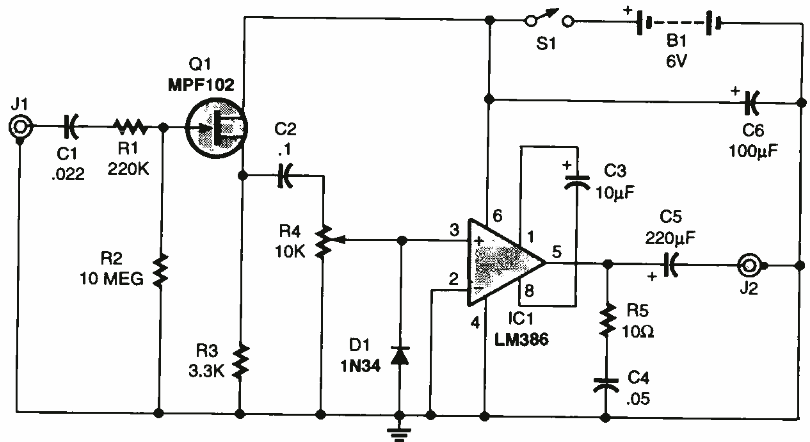


Fig. 4. The AF/RF Signal Chaser uses a field-effect transistor to increase the input impedance of the LM386. Because of its sensitivity, use shielding on any cable connected to J1.

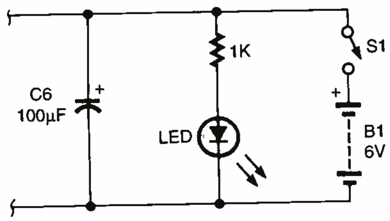


Fig. 5. Adding a "power-on" LED indicator is simple and straightforward.

standard construction techniques—the method used in the author's prototype. If you'd like to use a PC board, you'll have to design one yourself.

With the exception of J1, J2, B1, and the R4/S1 combination, all components mount on the perfboard. If you like, you can use a small piece of universal printed-circuit board that matches modular breadboard sockets with predrilled connection points.

Keep the connections as short as possible. When you are finished wiring the board, check your work against Fig. 4 for any wiring mistakes or wrong components. Use solid bus wire for any short jumpers that you might need; use insulated wires for the longer runs. Stranded 22-gauge wire connects the external components, such as the jacks, battery, and volume control, to the board.

It is advisable to use a plastic or other non-metallic box to house the project. Many small plastic boxes can be found at electronics stores like RadioShack or many mail-order firms; choose one that can hold all of the components.

Drill appropriate holes for the board, jacks, volume control, and battery case. Be careful when drilling holes in plastic boxes—too much pressure can crack the plastic. In addition, plastic has a tendency to "kick up" during drilling; be sure to hold it firmly. An alternate method for making holes in a plastic box is with the sharp point of a hot soldering iron. Melt the tip through the plastic and make circular motions to enlarge the hole to the needed size. Be careful not to apply too much heat. This method should only be done in a well-ventilated area—outdoors if possible. The fumes that the melting plastic might give off can be harmful. Don't forget to clean the soldering iron's point after the "drilling" operation.

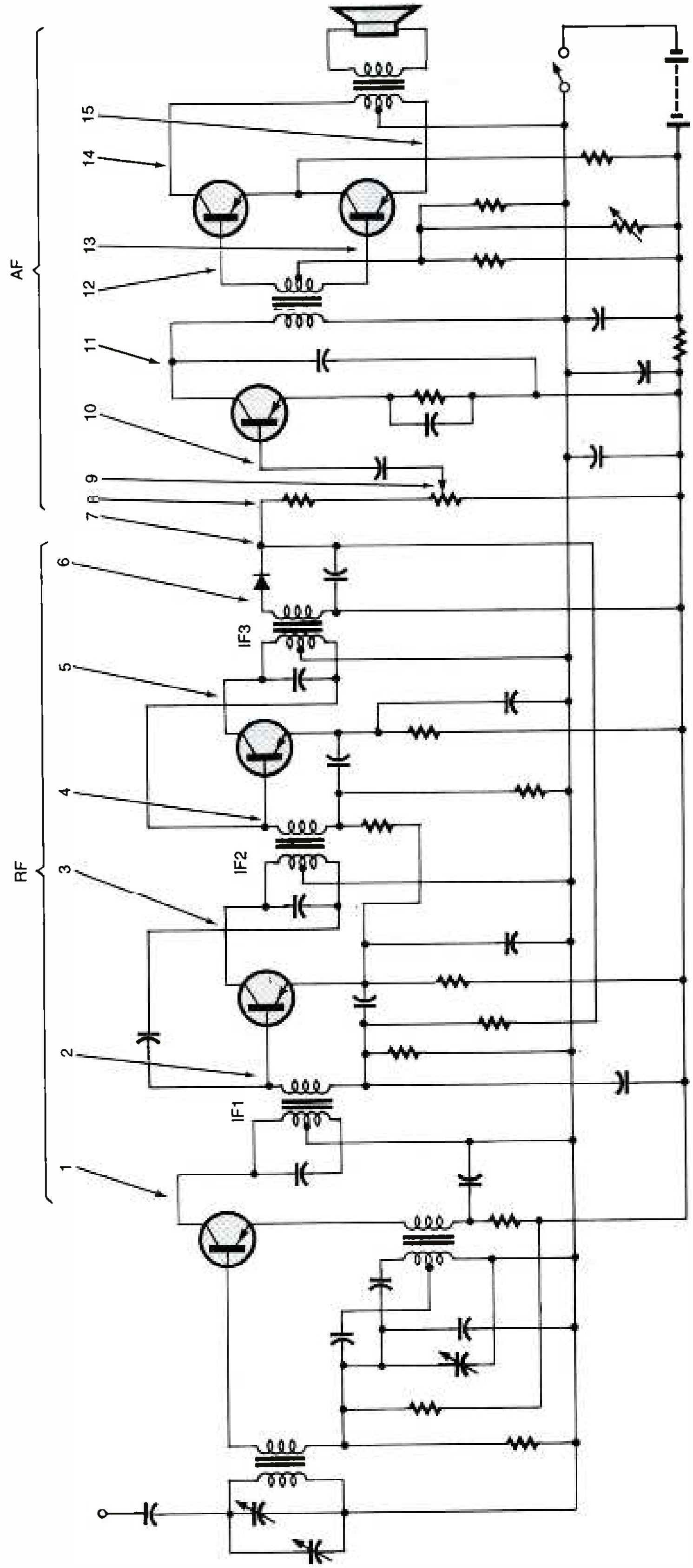
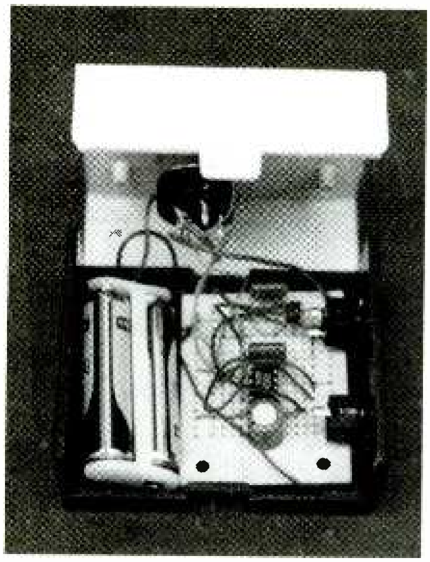


Fig. 6. Here's a typical portable-transistor radio with numbered test points showing where to use the AF/RF Signal Chaser.



The AF/ RF Signal Chaser can be built on a piece of perfboard. It fits neatly into a small plastic case.

Mount the PC board with two or three machine screws, nuts, and washers. You may use coupling nuts to act as spacers to hold the board away from the case.

You can put additional input connections in parallel with J1. One suggestion is a pair of wires with an alligator clip on the ground wire and a meter probe on the other. You can also build that as an "accessory" terminated with a ¼-inch phone plug. That way, you can plug in the probe attachment when needed instead of having it dangle from the unit all the time.

While we suggest a ⅛-inch jack for J2, you should choose an appropriate jack to match the type of plug on your speaker wire or earphone. If you are using stereo headphones, J2 should be a stereo jack. Although the obvious choice would be to wire the two stereo channels in parallel, it's better to wire them in series. That way, the headphone impedance is higher and reduces current drain on the battery.

An option that you might want to consider is an LED "power-on" indicator. Simply wire a 1000-ohm resistor and an LED across C6; the details are shown in Fig. 5.

If you're satisfied with your work, snap a set of four fresh AA batteries into the holder and close up the case; the AF/RF Signal Chaser is ready for use.

Using the AF/RF Signal Chaser. No adjustments are needed. Plug an appropriate probe (such as the two-wire arrangement we mentioned before) into J1 and a set of headphones into J2. Clip the ground wire to circuit ground near the point of the circuit that you're testing (a radio, for example), turn R4 to a comfortable listening level, and probe away!

To learn how to use the AF/RF Signal Chaser, you should look at the schematic diagram (Fig. 6); it shows some test points in a common portable transistor radio. Simply start at the front end and work your way through the circuit to the output.

The high input impedance of the AF/RF Signal Chaser means high sensitivity, which allows some unusual applications, including the suggestions at the beginning of this article.

PARTS LIST FOR THE AF/RF SIGNAL CHASER

SEMICONDUCTORS

IC1—LM386 low-voltage audio power amplifier, integrated circuit
Q1—MPF102 N-channel junction field-effect-transistor
D1—1N34 germanium signal diode

RESISTORS

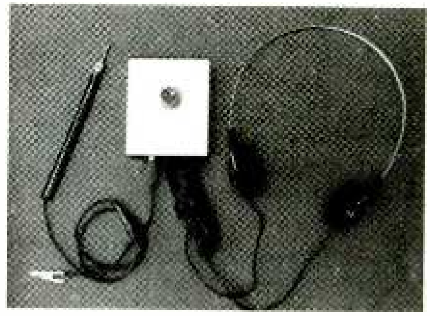
(All resistors are ¼-watt, 10% units unless otherwise noted.)
R1—220,000-ohm
R2—10,000,000-ohm
R3—3300-ohm
R4—10,000-ohm panel-mount potentiometer with integral single-pole, double-throw switch
R5—10-ohm

CAPACITORS

C1—0.022-µF, ceramic-disc
C2—0.1-µF, ceramic disc
C3—10-µF, 6-WVDC, electrolytic
C4—0.05-µF, ceramic-disc
C5—220-µF, 6-WVDC, electrolytic
C6—100-µF, 6-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

B1—6-volt battery (4 AA cells)
J1—⅛-inch phone jack
J2—⅛-inch phone jack
S1—Single-pole, double-throw switch (part of R4)
8- to 64-ohm earphones, battery holder, case, alligator clip, probe, wire, hardware, etc.



With grounding probe and headphones attached, the AF/RF Signal Chaser is ready to chase signals no matter what their source.

Here are more with a few details on how to do them:

- Connect a coil to J1 for an inductive pickup. You can listen to the audio transformers in audio amplifiers or to the IF transformers in AM/FM receivers. The coil is either an audio transformer's primary winding without the core or a telephone pick-up coil. You can also use the circuit to get the signal from a telephone.
- Connect a photocell or phototransistor to the input and you can listen to light bulbs, fluorescent lamps, TV screens, computers screens, etc. That simple exercise can grow into an involved program of scientific experiments in converting light to sound.
- Connect a 200- to 600-ohm ceramic or crystal microphone to J1. The result: a sensitive electronic stethoscope. You will be able to hear the sounds of leaking plumbing or animate sounds—including the chomping of termites!
- Use a piezo-ceramic disc protected against water to hear the sounds of marine life (see the "Marine Life Acoustic Sensor" article in the October 1997 issue of **Electronics Now**).
- Place a microphone connected to J1 in the center (focus) of a parabolic reflector. You can hear birds and other wildlife from a distance without disturbing them.

Once you start experimenting with the AF/RF Signal Chaser, you'll never look at it again as "just another piece of test equipment!" **P**

JOE BLACK

mailto: netwatch@gernsback.com

"Where Does He Get Those Wonderful Toys...Fixed?"

We are going to try something different this time. Consumer electronics play a major role in our lives. So first, we are going to look at *getplugged.com*—one of many great places to purchase consumer-electronics gear on the Internet. From there, we will visit *NESDA.com*, *ISCET.org*, and *Repair Now.com*—great resources for keeping those expensive electronics products working well.

When you are looking for consumer-electronics devices, there are two major criteria:

1. Am I getting a good price?
2. Is there someplace close I can go if I have a problem or need advice?

The sites we will discuss will answer these questions.

GETPLUGGED.COM

Although still young even by Internet time—September 1999 is its birth date—*getplugged.com* can do wonderful things! This is a full-service Web site designed so you can walk through the entire process of learning, building, and buying enjoyably, at home, without intimidation.

After you log on, the site asks you a series of questions to determine your objectives—including ones about the environment it will be used in, your budget, and ultimate goals. Moreover, the site tells you at the beginning why the questions are being asked; you're also offered the option of keeping that information totally confidential.

Available 24 hours a day, 7 days a week, the interactive site provides the expertise of industry experts to answer any question. Upon request, they will recommend equipment to meet specific needs and budgets. You can set up a personal, confidential notebook to store technical information. If you leave the site and return later, the site lets you pick up where you left off.

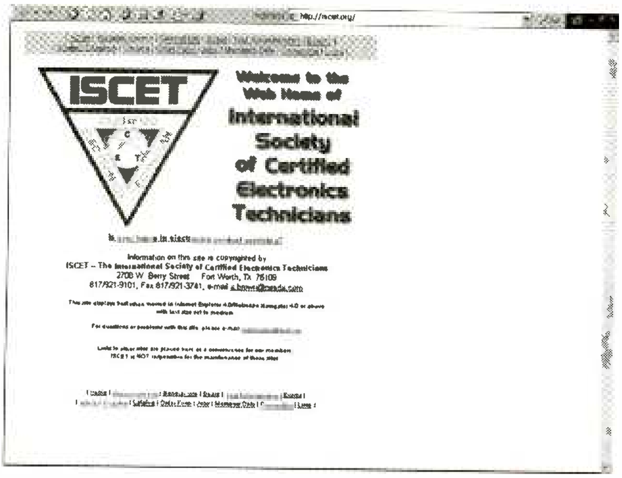
Perhaps the most important part of this operation is that after you have selected your "perfect" system, you can link to an affiliated retailer in your area. After selecting a retailer, you can visit them for a product demonstration and have that dealer deliver and/or custom install the selected system. As of this moment, 73 specialty dealer locations exist on the site.

Recognizing the needs of the Spanish-speaking population, *getplugged.com* has an English-to-Spanish translator built in. It allows users to switch to either language from anywhere in the site. So far, there have been 2,300,000 individual visitors to this site. Might I suggest that you take a look and become number 2,300,001?

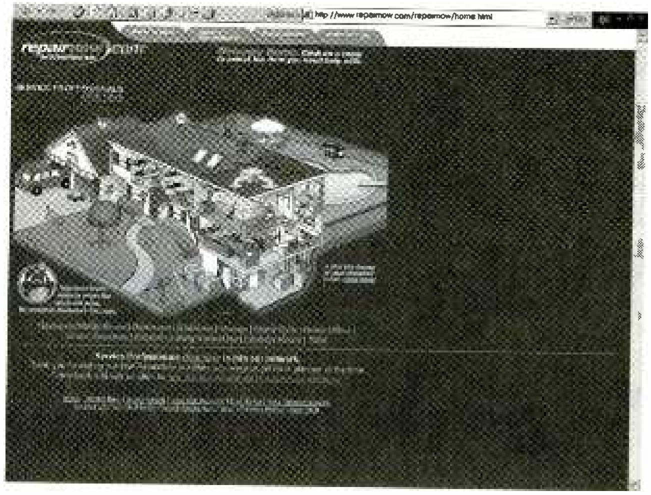
One closing note before moving

At getplugged.com, *you can find out everything you want to know about consumer-electronics equipment.*

The National Electronics Service Dealers Association will help you find a qualified repair technician.

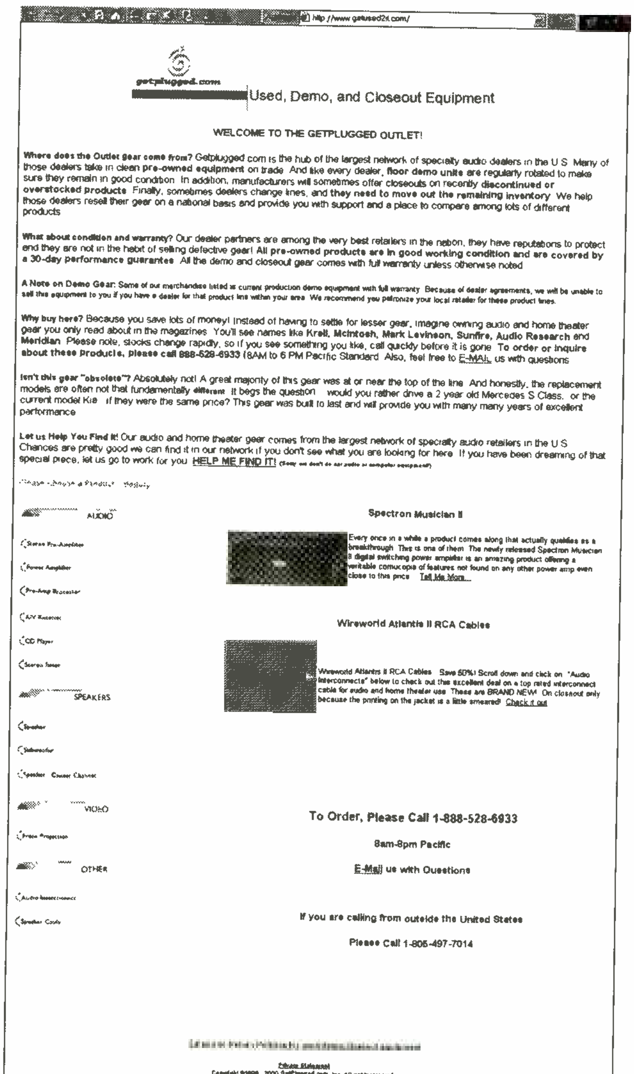


If you want someone who knows what they're doing when they open up your equipment for repair, be sure that they are certified by the International Society of Certified Electronics Technicians.



RepairNow has a clickable map to identify what type of equipment you need repaired.

on. There is also an "Outlet Store" where you can look over a selection of used equipment, at great prices.



You can also find used equipment through getplugged.com.

NESDA.COM

NESDA stands for *National Electronics Service Dealers Association.* Their members have probably already repaired at least one of your consumer-electronics devices. If not, you should consider one of their members when you next have an electronics device that needs repair. When you explore their Web site, you will find information about the member "Code of Ethics" and a simple way—just plug in your zip code—to find a member Service Center near you that repairs the product you need to have fixed. They handle everything electronic—from clock radios to home theater to computers—and much, much more.

ISCET.ORG

ISCET is the abbreviation for *International Society of Certified Electronics Technicians.* Our editor-in-chief, Larry Steckler EHF/CET, is currently the chairman of that organization. When you visit their Web site, you will find out why it is important to have certified-electronics technicians work on your equipment—they have proven that they know what they are doing—and learn how to locate them. Make a visit and discover what a trained and certified technician can do for you.

HOT SITES

GetPlugged
www.getplugged.com

Get Plugged Outlet Store
www.getused2it.com/

ISCET
iscet.org

NESDA
www.nesda.com

RepairNow
www.repairnow.com/repairnow/home.html

REPAIRNOW.COM

This site has great potential. It can help you find a place that can repair your consumer-electronics gear. The graphics are great, but the site runs a bit on the slow side, and the list of available service centers is not as extensive as it might be. However, it sure is worth visiting before you make a blind call out of the Yellow Pages.

They rate their local service

(Continued on page 42)

TEST EQUIPMENT FOR AUDIO TECHNICIANS: TUBE AMPLIFIER BIAS CHECKER

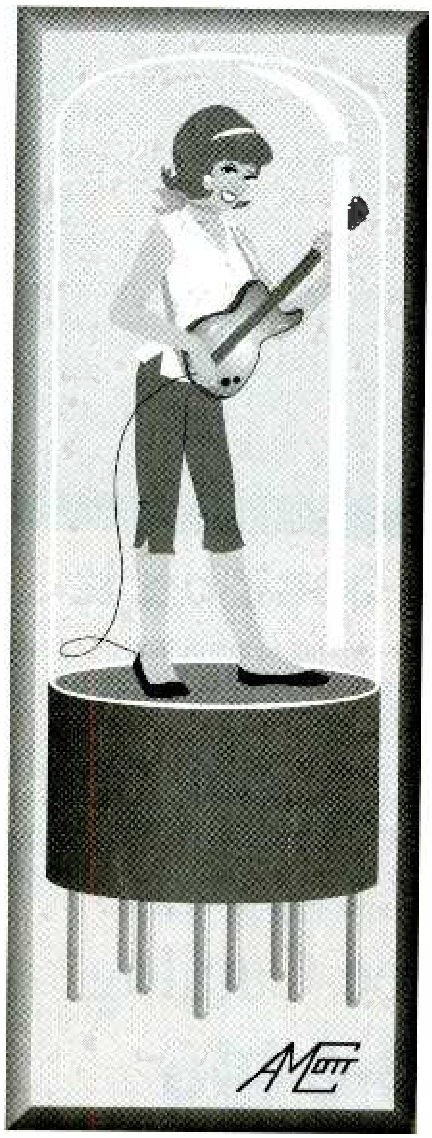
With the resurgence of tube-based amplifiers, you will want to know if your rig is running at peak performance. This simple tester makes final adjustments a snap!

GARY MCCLELLAN

Aside from replacing tubes, the next most common task in servicing tube-type musical-instrument amplifiers is adjusting the output-tube bias. As you probably know, the purpose of the bias adjustment is to set the no-signal current of the output tubes to a factory-specified value. Correct adjustment assures optimum sound quality and long tube life. Since vacuum tubes are very "individual" when it comes to performance characteristics, the bias adjustments must be made whenever the output tubes are replaced. It should be checked whenever the amplifier doesn't "sound right."

Unfortunately, the bias-adjustment methods advocated by some manufacturers can be time-consuming and dangerous. For example, one popular method requires disassembly of the amplifier and clipping a voltmeter across the output transformer's primary winding. You then turn the amplifier on and adjust its bias potentiometer for a specified current value. That procedure exposes you to a measurement error due to transformer resistance, the possibility of a severe shock because the DMM is 500 to 700 volts above ground, and the probability of equipment damage if a test probe slips.

The *Tube Amplifier Bias Checker* presented here neatly solves all of those problems and makes bias adjustments a snap. You simply install a socket adapter under each output tube and adjust the no-signal current for the correct value. That's it. There is no need to disassemble the amplifier, expose yourself to dangerous high voltages, or risk damage to your voltmeter. The Tube Amplifier Bias Checker is also great



for servicing tube-type hi-fi amplifiers and professional sound equipment. Why not build one today?

How it Works. As you can see from the schematic diagram shown in Fig. 1, the Tube Amplifier Bias Checker is a special-purpose DC-current meter. The unit is based upon two custom-made octal-socket adapters and a cabinet containing a digital-current meter.

The octal socket adapters are made out of old tube bases (PL1 and PL2) and tube sockets (SO1 and SO2). With the exception of pin 8, all other pins are wired straight through from the tube socket to the tube base. Diodes D1 and D2 prevent high voltages from appearing on plug PL3 if it becomes disconnected while the amplifier is operating. Should a short appear in a tube, the diodes also protect current-shunt resistors R1 and R2 from damage. The beauty of that configuration is that it may be used with any tube that has its cathode connection on pin 8. That arrangement includes all of the popular tubes used in musical-instrument amplifiers, such as the 6CA7/EL-34, 6K6, 6L6/KT-66, 6V6, 5881, 6550/KT-88, 7027, and 8417.

Inside the cabinet, the current inputs from the tube socket adapters appear on connector J1. From there, they go to resistors R1 and R2, which serve as current shunts. For optimum performance, those resistors will be matched using a simple process that we'll describe later. The voltage drop across each resistor goes to switch S1, which connects digital-panel meter DISP1 across resistor R1, (Tube 1's cathode current), resistor R2 (Tube 2's cathode current), or both resistors (Balance). The "Balance" position makes it easy to set both tubes to the same current simply by adjusting the amplifier's bias potentiometers until the meter reads zero.

The digital-panel meter is an

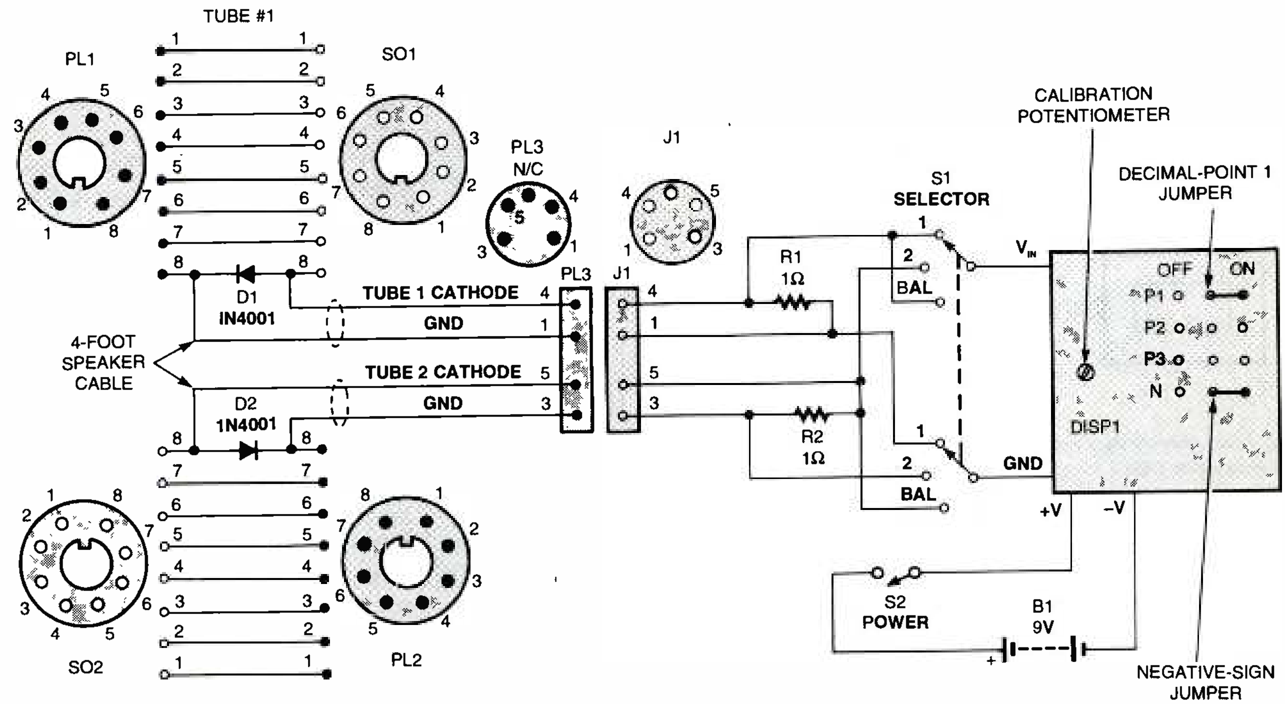


Fig. 1. The Tube Amplifier Bias Checker is a simple adapter that reads cathode current in an output tube while it is in-circuit. A digital-panel meter displays the current reading.

inexpensive unit that features a liquid-crystal display, 3½-digit capability, and 9-volt-battery operation. The unit reads 0-200 mV DC with better than 0.5% accuracy. Power is provided by B1, a standard 9-volt alkaline battery. Current drain is under 1 mA, so the battery should last 300 hours or more.

Gathering the Parts. The octal-tube bases and tube sockets may be purchased by mail from Antique Electronic Supply, from local distributors, or scrounged from a junkbox. When you shop for bases, look for the older tube types that have 0.85-inch-high bodies. The specified Amphenol tube sockets are available in Bakelite, mica, or ceramic versions. Any type that you can get will work fine, but avoid used sockets because they can cause intermittent operation.

Good junkbox sources of tube bases are burned-out 6SN7 or 6SL7 tubes. To obtain a base, place a tube in a paper bag and crush the glass in a vise. Carefully remove the tube from the bag and cut off the elements with a pair of heavy-duty wire cutters. Break out the remaining glass inside the base with a screwdriver and pour it into the bag. Do this carefully so you don't get cut by the glass. Finally, desolder the wires from the pins, remove the solder with a desoldering tool, and scrape out the cement inside the tube base.

A good 24-gauge, two-conductor speaker cable will do for the tube-socket adapters. Try to get the type with a white identifying stripe printed over one conductor.

The cabinet used in the prototype pictured here is a CR-531 "Crown Royal" unit manufactured by LMB. That particular model measures 1¼ × 3 × 5½ inches. It is available from any LMB distributor such as Mouser Electronics. Feel free to use any other cabinet that you like. The only important consideration is that it be large enough to hold DISP1, J1, and the controls.

Switch S1 deserves special attention. Although only three positions are used, a six-position switch is specified. That switch is readily available and is easier for most people to wire. You may substitute any three- or five-position switch with at least two poles. In either case, be sure to get a non-shorting type.

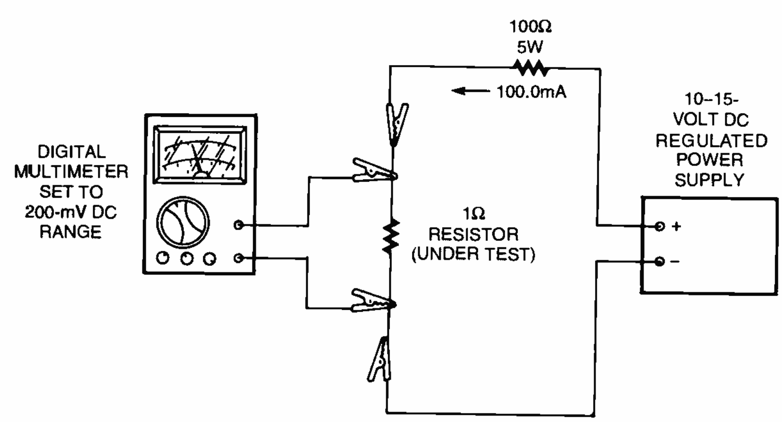


Fig. 2. For best performance, a matched set of resistors as close to one ohm as possible is needed. This simple circuit lets you test a number of devices to find the best units.

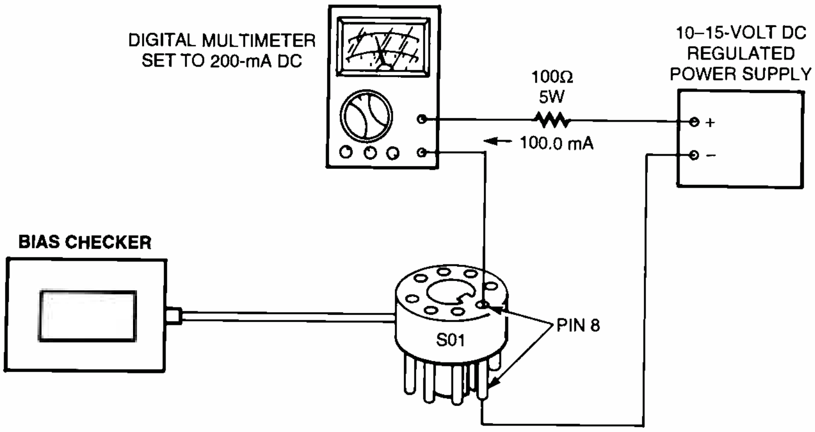
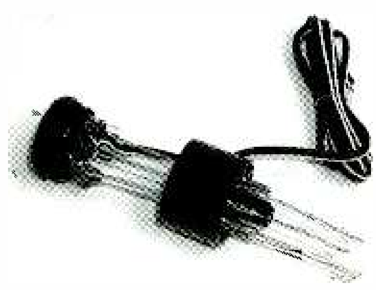


Fig. 3. To calibrate the Tube Amplifier Bias Checker, apply a current across the adapters and adjust the reading on DISP1 to match the reading on the digital multimeter.

When shopping for resistors R1 and R2, be sure to get at least ten pieces; this will make it easier to select a matched pair later.

The remaining components may also be scrounged from a junkbox or purchased from distributors. For example, the digital-panel meter is readily available by mail from All Electronics and other advertisers in this magazine. Keep in mind, though, that All Electronics is a surplus dealer; future availability is not guaranteed. Any digital-panel meter that fits the basic specs will do.

Tube-Socket Adapters. Once you have all of the parts, start construction with the tube socket adapters. Be sure to read the following procedure several times before starting and look at the photographs, which show the construction of the socket adapter. By doing so, you will reduce the possibility of a mistake, which can cause problems later!



A vacuum-tube base and a tube socket form the tube-adapter socket. Bus wires make the connections within the adapter.

Turn a tube socket over so that the pins face you. Identify pin 8; it's the first pin to the right of the keyway. Bend it over by 45° and cut ⅛ inch off the end of the pin.

Cut seven pieces of 24-gauge bus wire. Each piece should be four to five inches long. Bend a small loop in one end of each wire, hook the loop to each socket pin *except* pin 8, crimp the loop closed on each pin, and solder the connections. Cut a length of ¼-inch-diameter shrink tubing into seven ⅜-inch pieces. Slip those pieces over the socket pins, which have the wires and shrink them.

Cut a four-foot length of the speaker cable and strip one end. Wrap the wire identified with a stripe around the cathode lead of D1. Push the wire against the diode body and solder. To avoid possible insulation damage, this wire should be soldered as quickly as possible. Wrap the unmarked wire around the other lead, push it against the diode's body, and solder it.

Place D1's anode lead through the hole in pin 8; the diode should lie between pins 4 and 5. Push D1 until it is as close to pin 8 as possible. Bend the anode lead over pin 8 and solder it. Bend the other lead back over the diode so it is above pin 8. Slip a ½-inch piece of ⅛-inch diameter heat-shrink tubing over the cathode lead so that one end touches D1's body. Shrink the tube.

Bend the cathode lead so that it points straight up, like the seven bus wires. Finish by routing the speaker wire between pins 1 and 2 of the socket.

With the keyway pointing toward you, mark a hole location between pins 1 and 8 on the side of a tube base. The hole should be ¼-inch up from the bottom. Drill a pilot hole with a 1/16-inch drill and enlarge it with other drills until the speaker wire can pass through it.

Push the speaker wire through that hole from the inside. Position the tube socket over the tube base and carefully thread the wires through the tube-base pins. Start with the pin 1 wire and make sure that it goes through pin 1 on the base (pin 1 is immediately to the left of the keyway when viewing the base from the bottom). Repeat with the other wires. Tug gently on each wire with a pair of pliers until the socket is flush with the base. You may need to pull the socket out about an inch to adjust the diode lead until it slides into pin 8. When all eight wires protrude through the base pins, pull them tight and bend them over to hold the socket in place. Solder each pin and clip off the excess wire.

Repeat the procedure for the second tube-socket adapter.

After the socket adapters are assembled, connect the speaker wires to PL1 as shown in Fig. 1. Label the socket adapters with a "1" or "2," as appropriate. An engraving tool or marked paper labels can be used. Put the socket adapter set aside.

Cabinet. Refer to the photographs for the component layout. To duplicate the layout, start by placing four or five strips of masking tape over the top of the cabinet.

The completed socket-adapter cable is ready to plug into the Tube Amplifier Bias Checker. A four-foot wire keeps you safely away from any high voltage within the amplifier.

The internal layout of the Tube Amplifier Bias Checker is simple and clean. The most complex wiring is with S1 and the resistors. Note how R1 and R2 are mounted directly to S2.

Measure the inside of the digital-panel meter's bezel and transfer those dimensions to the cabinet. Be sure to locate the top of the cutout ⅜ inch from the edge of the cabinet. That will provide a convenient holder for B1 later. Continue drawing a line ¾ inch from the right edge of the cabinet. Mark hole locations for S1 and S2. Mark a location on the left side for J1. Drill all of the holes and file them to size as needed. Remove the masking tape and clean the cabinet with soap and water.

At this point, you may label the cabinet. On the prototype, press-on letters from Russell Industries were used with excellent results. Equivalent letter sets are available from electronics distributors, office-supply stores, and graphics-supply houses. Spray the cabinet with several light coats of clear lacquer spray paint and allow it to dry.

Start the unit assembly by installing the "bolt-on" components (switches, connectors, etc.). When installing DISP1, tighten the mounting nuts just enough to hold the unit firmly in place. Do not tighten them further, or the bezel will break. After S1 is installed, temporarily install the knob on the shaft and turn the knob fully counterclockwise. Loosen the knob, point it to the "Tube 1" position, and retighten.

Matching Resistors. At this point, we need to select a matched set of resistors for R1 and R2. Matched resistors will allow you to almost perfectly balance the output tubes. If you aren't interested in that level of precision, you can use two resistors selected at random. Keep in mind, though, that two randomly selected resistors can produce measurement errors of 5% to 10%, which are barely acceptable for most equipment.

If you prefer the balanced route, refer to Fig. 2 for a simple circuit that permits comparison of resistor values. To build it, obtain a 12-volt regulated power supply; a 100-ohm, 5-watt wirewound resistor and a digital multimeter (DMM). Connect the circuit with clip leads and note the voltage value on the DMM. Repeat the test with all the resistors. Select two resistors with the closest voltage readings for R1 and R2.

Final Assembly. With the resistors selected, we can finish assembly of the Tube Amplifier Bias Checker. Use short lengths of hookup wire for the connections between J1, S1, S2, and DISP1. Pieces of leftover resistor lead "program" DISP1 for its decimal point and negative sign. Resistors R1 and R2 mount on back of S1. Battery B1 is wedged between DISP1 and the edge of the front panel.

PARTS LIST FOR THE TUBE AMPLIFIER BIAS CHECKER

B1—9-volt alkaline battery
D1, D2—1N4001 silicon-rectifier diode
DISP1—200-mV digital-panel meter (All Electronics PM-128 or equivalent)
J1—5-pin DIN socket, panel-mount
PL1, PL2—Octal tube base (Antique Electronic Supply P-SP8-476 or equivalent—see text)
PL3—5-pin DIN plug
R1, R2—1.0-ohm, 1-watt, 5% metal-oxide-film resistor (see text)
S1—6-position, 2-pole, non-shorting rotary switch
S2—Single-pole, single-throw toggle switch
SO1, SO2—Octal tube socket, Amphenol type 78S8 (Antique Electronic Supply P-ST8-311, P-ST8-318, or equivalent)
Battery connector, cabinet (Mouser Electronics 537-CR-531 or equivalent), knob for S1, 24-gauge solid bus wire, Insulated hookup wire, 24-gauge two-conductor speaker wire, shrink tubing, hardware, etc.

Note: Some of the hard-to-find vacuum-tube components are available by mail from Antique Electronic Supply, 6221 S. Maple Ave., Tempe, AZ 85283; 602-820-5411.

The completed Tube Amplifier Bias Checker is a welcome addition to any audio technician's toolbox.

Strips of ¾-inch-wide foam tape placed in the cabinet hold it in place. When you are done, check your work for errors and correct any that are found.

Checkout and Calibration. It would be wise to evaluate the Bias Checker with a tube tester before it is calibrated. To do that, plug the Tube 1 socket adapter (PL1/SO1) into the tester and plug a 6L6 or other known-good tube into the adapter. The tube must test good for shorts, and the emission/mutual conductance reading must be good. Turn the Tube Amplifier Bias Checker on. Note the reading on DISP1 when the tester's emission/ mutual conductance button is pushed. It must be a positive value. Repeat the same process for the Tube 2 socket adapter.

If you see any short indications, or if the tube doesn't test good, repair the appropriate socket adapter. Should you get a negative reading, reverse the wires for that socket adapter inside PL3.

To calibrate the unit, use the test circuit shown in Fig. 3. Note that you can reuse the components from the resistor-matching circuit of Fig. 2. Connect the Tube 1 socket adapter as shown and set the DMM to the 200-mA range. Note the current reading on the DMM, which should be approximately 100 mA. Set S1 to the "Tube 1" position and turn the unit on. Adjust DISP1's calibration potentiometer for exactly the same reading.

Disconnect the test circuit and close up the cabinet. The Tube Amplifier Bias Checker is ready for use.

Operation. To use the Tube Amplifier Bias Checker, turn off the amplifier that you want to calibrate and remove one output tube. Also, be sure to disconnect any signal sources. Insert the Tube 1 socket adapter into the amplifier and plug the tube into the adapter. Remove the other output tube and install the Tube 2 socket adapter in the same manner. Turn the amplifier and Bias Checker on, and allow a five-minute warm-up. Rotate S1 to the "Tube 1" position and read the cathode current. If necessary, adjust the amplifier's Tube 1 bias potentiometer to the manufacturer's recommended value. Typical values for 6V6 tubes are 20–30 mA, 6L6 tubes are 40–50 mA, EL-34 tubes are 45–55 mA, and 6550 tubes are 50–65 mA.

Turn S1 to the "Tube 2" position and read the cathode current. Adjust the Tube 2 bias potentiometer, if available, to the manufacturer's recommended value.

Should the amplifier have a balance potentiometer, set S1 to the "Balance" position and adjust it for zero or minimum current reading on DISP1. Recheck the current readings for Tube 1 and Tube 2, and touch up the bias potentiometers as required for the correct values. Turn off the amplifier, remove the socket adapters, and replace the output tubes into the amplifier. It goes without saying—but I'm saying it—that you shouldn't mix the output tubes.

Musical-instrument amplifiers typically have only one bias potentiometer; balance is accomplished by hand-selecting replacement tubes. That is done until the currents are within 5% of each other. Of course, using a matched pair of output tubes can eliminate the process.

Purists will note that the Tube Amplifier Bias Checker reads cathode current while manufacturers specify a plate current value. If you set the bias reading to the manufacturer's value, the amplifier's plate current will be incorrect. That hasn't caused any amplifier damage in over two years of using the Tube Amplifier Bias Checker. However, if you set the bias reading for the specified plate current plus 5 mA, your settings will be much closer to the manufacturer's recommendations.

Caution—Use an insulated potholder to remove hot tubes. Do not remove tubes while the amplifier is in operation.

Please be aware that the unit does not have a "low battery" warning indicator. As a result, the unit will display incorrect readings when the battery becomes weak. Play it safe and test the battery periodically. Replace it when the voltage drops below 7.5 volts or once a year, whichever comes first. **P**

NET WATCH

(continued from page 34)

agencies. For example, when I entered a Las Vegas zip code I got a listing of three local service agencies (listed in order of their rating). Unfortunately, the rating section said, "not yet rated."

NOW DO YOUR PART

I'm only one person, so do me a favor—visit each of the sites I have mentioned in this column and send your comments on your visit to me; the e-mail address is at the top of this column. I need to know if these sites worked for you, if you had any problems, and if you have any recommendations to make them more useful. See you again, soon. **P**

Line and Speaker Levels

Q *I have questions about line and speaker levels. First of all, what are they? Second, how do I convert between the two? I built the "Little Earthquake" subwoofer from the October 1995 issue of* **Electronics Now**, *and I want to connect it to the subwoofer output of my stereo.—J. I., Saukville, WI*

A You're in luck because the Little Earthquake takes either speaker-level or line-level signals. It has a volume control that you can adjust to get the right level. Simply connecting it should work.

Speaker-level and line-level signals are nearly the same voltage, but a speaker-level signal can deliver a great deal more current (amperage) and hence a lot more power. It's like the 1.5 volts that you get from a tiny watch battery versus the 1.5 volts from a D cell. The voltage is the same, but the D cell will light a 1-amp flashlight bulb while the watch battery won't. Even though the voltage is right, it can't deliver enough current. You can find tiny "grain-of-wheat" light bulbs that the watch battery will light, but they're not very bright.

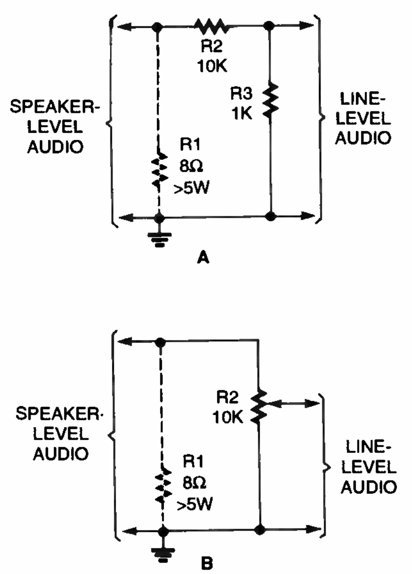


Fig. 1. Here are some ways to convert speaker-level to line-level audio. Resistor R1 is needed only if the amplifier will not operate safely without a speaker and there is no speaker connect-

In the same way, a line-level output won't drive a speaker, though it might drive headphones; and it will certainly drive the input stage of another amplifier, which is one of its main design features.

I said that the voltages were about the same. Let me clarify that. All audio signals span a wide variety of voltages as the sounds range from soft to loud. Line-level audio typically runs from 0.1 to 1 volt rms. Speaker-level voltages depend on the kind of speaker and the amount of power. A small radio delivers 0.1 watt into an 8-ohm speaker; that's 0.9 volt. A large stereo amplifier might deliver 10 watts into a 4-ohm speaker; that's 6 volts—somewhat higher than normal line level, though not drastically so.

The bottom line? You can often feed speaker-level audio directly into a line-level input. It's like connecting a tiny grain-of-wheat light bulb to a 1.5-volt D cell. As long as it's getting the specified voltage, the fact that the battery could deliver more amps won't matter.

There are two situations where this should not be done. First, powerful audio amplifiers sometimes deliver a stronger signal than some line-level input can handle. In that case, you can reduce the level with one of the circuits in Fig. 1. Build one for each stereo channel.

Second, older amplifiers with audio-output transformers might suffer damage if turned up too loud with no speaker connected. In that case, you can put an 8-ohm, 5- to 20-watt, non-inductive wirewound resistor (RadioShack 271-120 or equivalent) in place of the missing speaker to supply the amplifier with the load it requires. This is shown as R1 in Fig. 1.

Automatic Button-Pusher

Q *I need an IC or small circuit that will close one pair of contacts for 1 second, open them and wait 2 seconds, then do the same thing again for a total of five pairs of contacts in sequence. The purpose is to electronically "press" the buttons on a remote control. Any help would be appreciated.—F. C., Baldwin Park, CA*

A If the time delays are critical, this is a job for a programmed microcontroller; but if you can accept slightly different timing, the circuit in Fig. 2 should be sufficient. When power is turned on, it "presses" each button for about 1.5 seconds and then waits 1.5 seconds before pressing the next one. After the fifth button, the action stops.

Although a 9-volt battery is shown in the schematic, the circuit will actually operate on any voltage from about five to 12 volts.

In the circuit, the TLC555 (or 7555 or LMC555) is an oscillator whose speed is controlled by R1, R2, and C2; any of which can be changed to speed up the oscillator or slow it down. The 4017 (CD4017, MC14017) counts the pulses from the oscillator. Each of its "Q" outputs goes high for 1.5 seconds, one at a time, in sequence. Five of those outputs feed optocouplers to "press" the buttons. The last one, Q9, is fed back to the clock-enable input so that when Q9 goes high, the 4017 stops counting and the cycle doesn't repeat. Components C3 and R3 supply a brief reset pulse when power is applied so that the 4017 always starts in a known state.

The 4N25 optocouplers contain an internal LED and light-actuated switching transistors. This makes it possible to close a pair of contacts without making any direct electrical connection to them. You could use relays, but optocouplers are cheaper and require less power. If you don't know which sides of the push-buttons are positive and negative, use a voltmeter to find out.

Suitable optocoupler types include 4N25, 4N26, 4N27, 4N28, ECG3040, ECG3041, or ECG3042.

If you choose to use a microcontroller, write a program that outputs the binary patterns 00000001, 00000000, 00000010, 00000000, 00000100, 00000000, 00001000, and 00000000—each for the right length of time—and run the port outputs to optocouplers exactly as in Fig. 2. To learn more about microcontroller programming, see articles in the September 1998 and September and October 1999 issues of **Electronics Now**, available from our Reprint Bookstore.

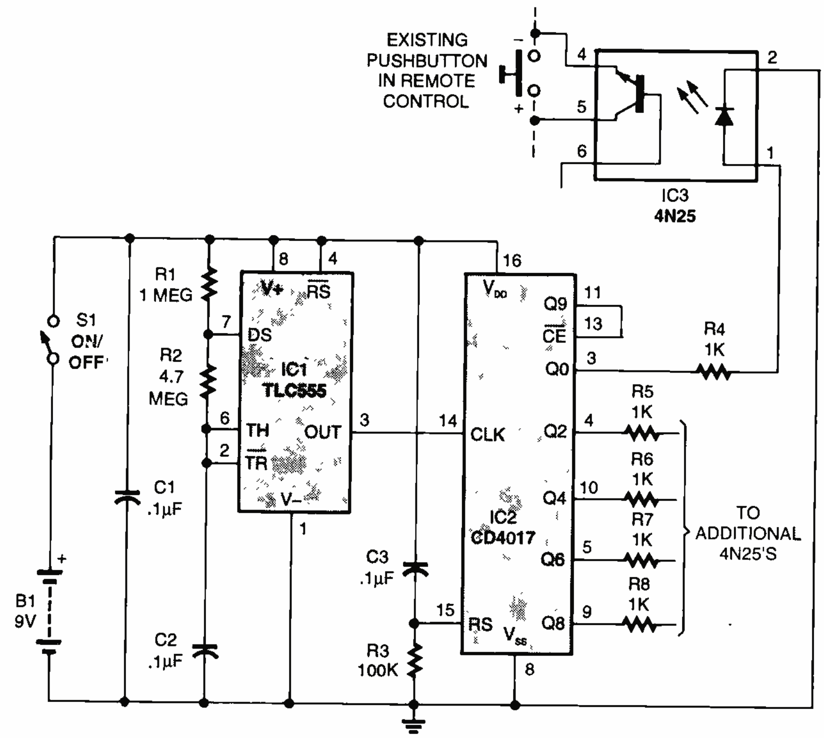


Fig. 2. This circuit "presses" five buttons sequentially on a universal remote control.

Can't Print From *QuickBasic*

Q *I'm trying to print an old QuickBasic program, but my printer won't print it. Windows98 says to increase the printer's timeout, but that doesn't help.—P. W., no location given.*

A I assume that you're having no trouble printing from Windows applications. *QuickBasic* is a DOS application, and it's trying to print to DOS printer port LPT1. To tell Windows what printer to use for LPT1, go to "My Computer," "Printers;" right-click on your favorite printer; choose "Properties," "Details;" and select "Capture Printer Port." Tell it to capture LPT1 and reconnect every time you log on. Then any DOS-based output will go to that printer.

A Matter of Magnetism

Q *I have been trying to find a way to trigger a "doggy-door" latch with a magnet on my dog's collar while preventing my cat or other neighborhood pets from using it. All of the inexpensive magnetic-proximity devices require intimate contact between the magnet and the detector. I am looking for a system that will work when the magnet and sensor are separated by two or three inches.—C. L. M., Gilbert, AZ*

A It's not impossible, but you're up against one of the laws of physics. The strength of a magnetic field falls off very sharply with distance, so from a magnet's point of view, two inches is a lot farther than half an inch.

You might try using a compass with a beam of light blocked by its needle as a detector, with a photocell to sense when the needle moves.

Wanted: Alarm Clock Chips

Q *Can you tell me which IC companies are still making digital alarm-clock chips? I need chips to drive both seven-segment LED displays and displays with BCD output.—B. B., Wayne, NJ*

A None, as far as we know; clock manufacturers now program their own microcontrollers to get exactly the features they want. You can still get some old-style clock chips through the replacement-semiconductor trade. Check *www.ecgproducts.com* or contact your local ECG distributor, which is Wayne Electronics, 637 State Rt. 23, Pompton Plains, NJ 07444; 973-839-5888. ECG not only markets the chips, but also has good data sheets and data books (much more than just the cross-reference book that the distributors give out).

I don't know if a BCD-output alarm clock chip was ever made; most, if not all, alarm-clock chips were designed for special displays with "A.M." and "P.M." indicators, LEDs to indicate alarm status, and the like.

To learn how to make a clock out of a PIC microcontroller, see application notes AN529 and AN590 from Microchip, Inc., 2355 W. Chandler Blvd., Chandler, AZ 85224-6199. You can view these application notes on the Web and download code from *www.microchip.com.*

Toshiba Service Manual

Q *I am looking for a service manual for a Toshiba T1950CT laptop computer. Where might I find one?—L. H., Apple Valley, MN*

A Try Toshiba America Information Systems, Inc., Computer Systems Division, 9740 Irvine Blvd., Irvine, CA 92618-1697. You can also get Toshiba parts, and perhaps manuals, from the following sources:

Advanced Computer Services, Inc.
2262 S. Arlington Rd.
Akron, OH 44319
330-785-5200
www.acsparts.com

CPAC Computers
22901 La Palma Ave.
Yorba Linda, CA 92887
714-692-5044
www.cpacinc.com

New Dimension Service Solutions
110 Sutter St., Ste. 404
San Francisco, CA 94104
415-733-1040
www.NDSsolutions.com

Call Waiting Switch Found

Q *Regarding F. G.'s letter in the May issue, I have been using a "call-waiting switch" as described at* www.cpscom.com/uprod/cws.htm. *It detects an incoming call, disconnects me from the Internet, and flashes some LEDs to alert me. The support people at CPS are very helpful and would probably work with someone in a foreign country to assure proper operation.—Larry Morgan, Walla Walla, WA*

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at *www.gemsback.com* for information and files relating to **Poptronics** and our former 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 *www.hitex.com/chipdir/*, or try addresses such as *www.ti.com* and *www.motorola.com* (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online: www.questlink.com features IC data sheets and gives you the ability to buy many of the ICs in small quantities using a credit card. You can also get detailed IC information from *www.icmaster.com*, which is now free of charge although it formerly required a subscription. Extensive information about how to repair consumer electronic devices and computers can be found at *www.repair faq.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, 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 over 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, Popular Electronics** (post 1995 only) and **Poptronics** are available from our Claggk, Inc., Reprint Department, P.O Box 12162, Hauppauge, NY 11788; Tel: 631-592-6721.

Poptronics and many other magazines are indexed in the *Reader's Guide to Periodical Literature,* available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214; (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; (*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.

A Thanks for the tip. CPS's address is Computer Peripheral Systems, Inc.. 5125 South Royal Atlanta Dr., Tucker, GA 30084; 770-908-1107. The list price of the call-waiting switch is $99.00.

LM3909 is Not Dead Yet!

Q *Further to your July 2000 column, the LM3909 LED flasher IC is still available as the NTE876 from all major distributors (see also* www.nteinc.com*).—Brenden McNeil, Elsmere, DE*

A Thanks! The widely available ECG876 will also work.

Battery-Life Record?

Q *A few years ago, I helped a sixth grader build an LED flasher using an LM3909. It was a good learning tool for him, and the circuit did something visible. Last week at his high school graduation, he showed me that the circuit was still flashing on the original D cell.—E. M., Midland, MI*

A Impressive! I wonder how long a big 1.5-volt "Ignitor" cell would last. With the discrete-component substitute for the LM3909 that was published in the June column, I got an LED to flash for tens weeks with a single N cell (smaller than an AA cell). I suppose that it will be a while before we know if anyone got an LED to flash for six years using discrete components.

Not Quite Impossible...

Q *In your August column, you said that a video projector couldn't be made out of an ordinary TV. You are correct about the lack of brightness, but it can be done and I have done it. I used a 13-inch remote-control TV and swapped the vertical and horizontal yoke wires to invert the picture (necessary because the projected images are upside down). Next, I got an old 3 × 7-foot Radio-Shack projection TV screen for about $100. A surplus copier lens (about 3 inches in diameter) that is mounted in a plastic toilet-bowl flange (so I can focus) mounts on a box with the TV inside. It works well in a totally dark room if you are directly behind the TV.—D. C., no location given.*

A Yes, it's doubtless a satisfying optical experiment, but not the kind of thing you'd invite your friends over to watch the Super Bowl on...or would you? In any case, thanks for the data point.

Writing To Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to:

(1) include plenty of background information (we'll shorten your letter for publication);

(2) give your full name and address on your letter (not just the envelope);

(3) type your letter if possible, or write very neatly; and

(4) if you are asking about a circuit, include a complete diagram.

Questions can be sent to Q&A, **Poptronics** Magazine, 275-G Marcus Blvd., Hauppauge, NY 11788, or e-mailed to *q&a@gernsback.com*, but please do not expect an immediate reply in these pages (because of our backlog) and please don't send graphics files larger than 100K. Due to the volume of mail, we regret that we cannot give personal replies.

NEW GEAR

(continued from page 6)

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The improved exhaust cap increases internal static pressure and also prevents dirt from being sucked into the handpiece. The new system comes with an in-line air-pressure gauge to provide easy set up. With the system's use of stencils and a video, carving is as simple as tracing lines. There are accessories available that allow users to perform more sophisticated operations.

The Turbo Carver system sells for $214, and the handpiece alone sells for $122.

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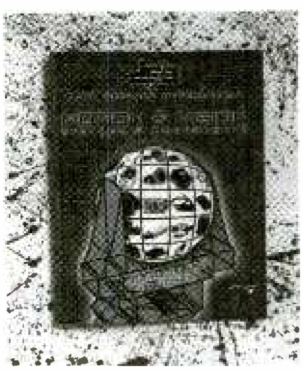
This catalog describes the company's various motion and vision system components and identifies the numerous options for each. For example, many types of motors are available, including rotary AC/DC brush/brushless servo, stepper, induction and vector, as well as linear motor options.

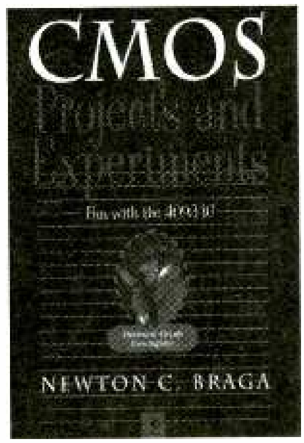


Software, framegrabbers, cables, cameras, lenses, lighting, and fixtures for complete vision systems are also included. In addition to component descriptions, the catalog contains sections on system design and engineering services and training.

CMOS Projects and Experiments

by Newton C. Braga
Newnes, Butterworth-Heineman
225 Wildwood Ave.
Woburn, MA 01801
800-366-2665 or 781-904-2500
www.newnespress.com
$29.95

Information on audio and RF devices, lamps, LEDs, timers, alarms, and inverters is provided in this guide to building over 100 unusual and useful projects. Among the devices are touch- and light-



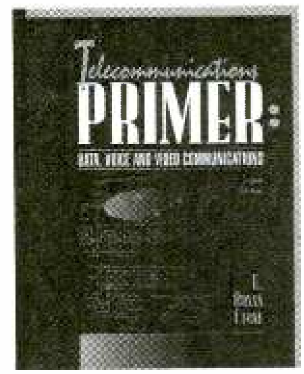
controlled oscillators, a Morse Code tone generator, a CW transmitter, a neon-lamp flasher, an auto turn-off relay, a touch-controlled motor, a freezer alarm, a nerve stimulator, and an experimental high-voltage generator.

This book, written by Newton Braga—a regular contributor to **Poptronics**—offers hobbyists and students a satisfying, practical way to understand the hot topics in electronics today. Readers can learn how to master the capabilities of the 4093 IC, which is the basis for all these projects, and how to use CMOS ICs in their six primary applications.

Telecommunications Primer: Data, Voice, and Video Communications, 2nd Edition

by E. Bryan Carne
Prentice Hall
One Lake Street
Upper Saddle River, NJ 07458
800-382-3419
www.phptr.com
$65

Fully updated and expanded by more than 40%, this edition discusses all the latest advances in the field of telecommunications. Special sections have been added to cover the growth of Internet, intranet, and extranet applications; scalability and network management in distributed systems; and advances in digital and cellular systems in North America, Europe, and Asia. Other special sections cover intercontinental fiber optic networks with wavelength-division multiplexing, Asynchronous Transfer Mode, and developments in switching and routing protocols.

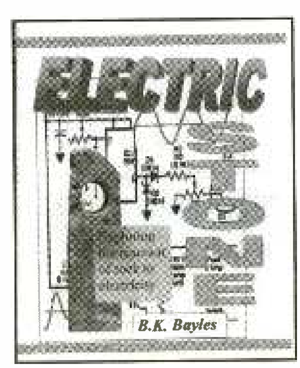


A wealth of information is presented in terms that can be understood by readers from many different disciplines. Numerous illustrations, cross-references, and a complete glossary and reading guide make this book indispensable for knowledge workers in the 21st century.

Electric Stone: Exploring the Reaction of Rock to Electricity

by B. K. Bayles
Johnson Smith Company
4514 19th St. Court East
P.O. Box 25600
Bradenton, FL 34206-5600
800-588-1142
www.johnson-smith.com
$8.98

In this one-of-a-kind booklet, the author describes the building of a stone house and the idea that stone—when properly prepared—carries electric charge. Readers



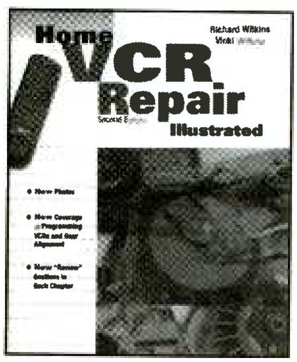
get historical and scientific background for the experiments that are accompanied by charts, graphs, and schematics, as well as photos.

All the equipment that readers need to conduct their own experiments is simple and easy to find—an induction coil, ground rods and wires, and an electric-fence charger. Hobbyists with some electrical experience can follow the step-by-step instructions to hook up two stones as a diode, conduct other experiments, and come to their own conclusions.

Home VCR Repair Illustrated, 2nd Edition

by Richard Wilkins and Vicki Wilkins
McGraw-Hill
2 Penn Plaza
New York, NY 10021
800-2MCGRAW
www.books.mcgraw-hill.com
$29.95

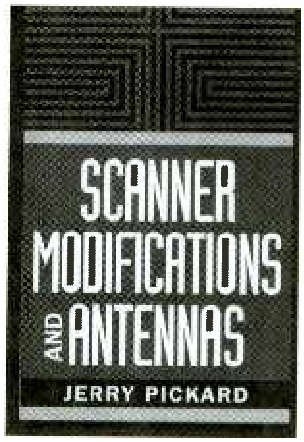
Written for the do-it-yourselfer, this completely revised guide book is designed to prove that it's still possible to save money any time a VCR needs work. Without the need for costly shop equipment, readers are shown in a step-by-step manner how to diagnose and fix VCRs at home.



The book is loaded with easy-to-follow instructions and over 500 photos and illustrations. Everything is covered from the everyday tools needed to how to fix a VCR that's been dropped. Subjects include repairing a tape-eating VCR, cleaning video heads, and making fast forward and rewind work properly.

Scanner Modifications And Antennas

by Jerry Pickard
Paladin Press
P.O. Box 1307
Boulder, CO 80306
800-466-6868 or 303-443-7250
www.paladin-press.com
$20

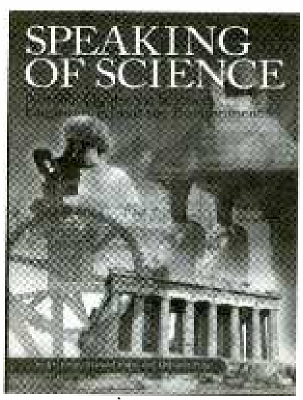


For those who want to get the most out of their scanner, this book shows you how to increase the speed of your scanner, build an easy amplifier, and design an antenna—even if you've always hated math. In addition, there's information on ways to track a channel's usage and improve the sound on a PRO-43, plus information on circuits and antennas.

Readers are also shown how to create dedicated search banks and how to handle and work safely on sensitive components, as well as how to eliminate shock hazards. Instructions are simple and straightforward and can be followed by anyone who can use a soldering iron.

Speaking Of Science

by Jon Fripp, Michael Fripp, and Deborah Fripp
LLH Technology Publishing
3578 Old Rail Road
Eagle Rock, VA 24085
800-247-6553 or 540-567-2000
www.LLH-Publishing.com
$14.95



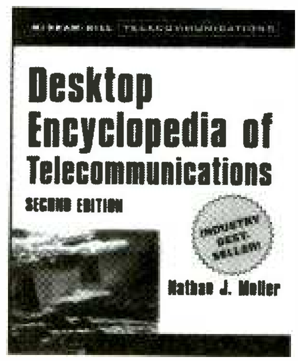
An entertaining read, this collection of pithy quotes is meant for those involved in science, engineering, or any technological field. It offers quotations all the way from Aristotle to Al Gore, from Einstein to Homer Simpson, and from Richard Feynman to Bugs Bunny.

Anyone who wants an appropriate scientific quote for a speech or paper will find this resource easy to use, since it's organized into major scientific categories and subcategories. Many of the quotes are hilarious, and all are insightful. Each quote is carefully referenced, and information about the speaker is also provided.

Desktop Encyclopedia of Telecommunications, 2nd Edition

by Nathan J. Muller
McGraw-Hill
2 Penn Plaza
New York, NY 10121
800-2MCGRAW
www.books.mcgraw-hill.com
$49.95

The new edition of this (weighty) desktop encyclopedia contains detailed, illustrated articles on telecom topics—not merely two- to three-sentence definitions. Telecom technologies, terms, and architectures are explained in everyday English, arranged alphabetically, and accompanied by over 150 clear diagrams.



There are 250 readable, up-to-date articles on topics ranging from access changes and multimedia networking to voice-data convergence and the World Wide Web. Fifty new entries on subjects such as bandwidth management systems, local multipoint distribution services, and voice-over IP have been added. In addition, the encyclopedia includes details on local-area networks (LANs); wide-area networks (WANs); regulations; standards; and coverage of voice, data, and video.

(Continued on page 56)

mailto: amazingscience@gernsback.com

JOHN IOVINE

Artificial Pneumatic Muscles

An air muscle is a simple pneumatic device developed in the 1950s by J.L. McKibben. Like biological muscles, air muscles contract when activated. An interesting fact about air muscles is that they provide a reasonable working copy of biological muscles—so much so that researchers can use a human skeleton with air muscles attached to the skeleton at primary biological muscle locations to study *biomechanics* (the design of biological systems from an engineering point of view) and low-level neural properties of biological muscles. See the sidebar for further Internet-based resources.

In published papers, air muscles are also referred to as:

- McKibben Air Muscles
- McKibben Pneumatic Artificial Muscle
- Rubbertuator

I simply call them air muscles.

Applications

Air muscles have applications in robotics, biomechanics, artificial-limb replacement, and industry. The principal reasons experimenters and hobbyists will have for liking air muscles are their ease of use (as compared to standard pneumatic cylinders) and simple construction. Air muscles are soft, lightweight, and compliant; have a high power to weight ratio (400:1); can be twisted axially and used on unaligned mounting; and provide a contracting force around bends.

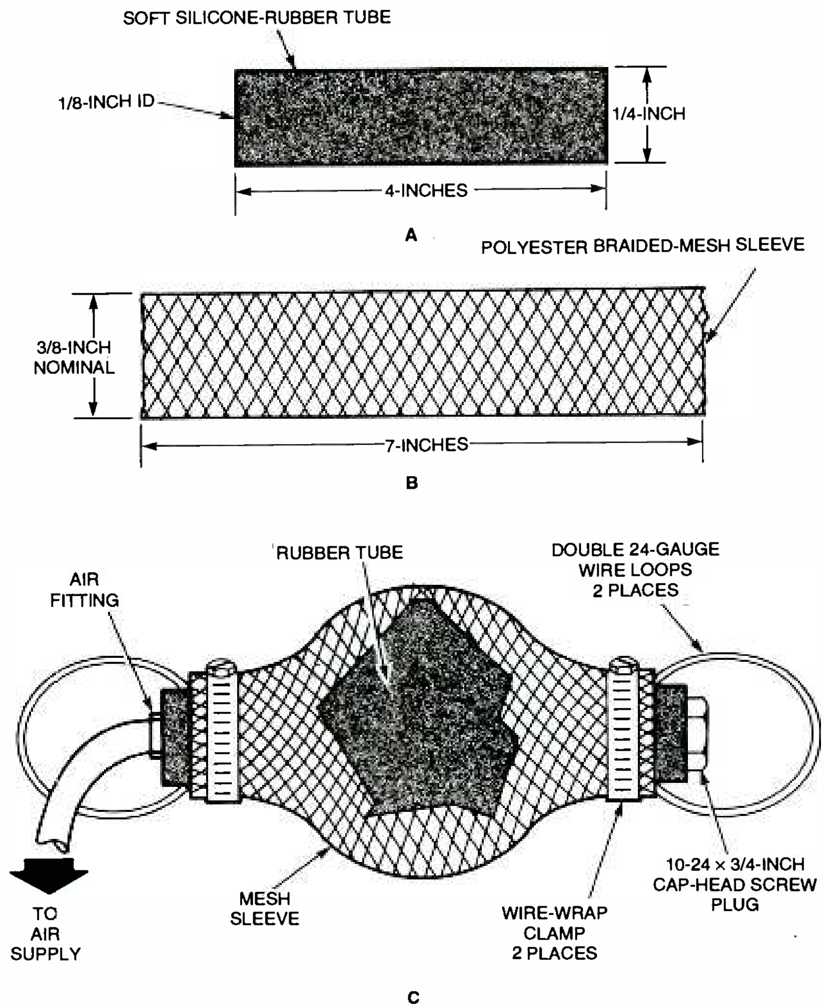


Fig. 1. An air muscle consists of a soft rubber tube (A) encased by a braided-mesh sleeve (B). One end of the tube is plugged; the other end receives air pressure (C). The ends of the muscle have wire loops that act like "tendons" to pull on whatever device to which the muscle is attached

How Air Muscles Work

There are two primary components to the air muscle: an inner tube of soft, stretchable rubber and a braided polyester-mesh sleeve. The basic arrangement is shown in Fig. 1. The rubber tube—also called an *internal bladder*—is positioned inside the braided-mesh sleeve.

To complete the air-muscle, we need an air fitting on one end (don't forget to seal the other end of the tube!) and two mechanical anchors (loops) on each end of the air muscle. The loops allow us to attach the air muscle to devices. The clamps in Fig. 1 are made from 24-gauge wire tightly wrapped and twisted around the ends of the air muscle. You could also use "ty-wraps," which are used to bundle wires into cables, or hose clamps from the hardware or auto-supply store.

When the internal bladder is pressurized, it expands and pushes against the inside of the braided-mesh sleeve, forcing the diameter of the braided mesh to expand. The physical characteristics of the mesh sleeve make it contract in proportion to the degree its diameter is forced to increase. This produces the contracting force of the air muscle. The sleeve is like a Chineese "finger-puzzle" toy. The only way to get your fingers out

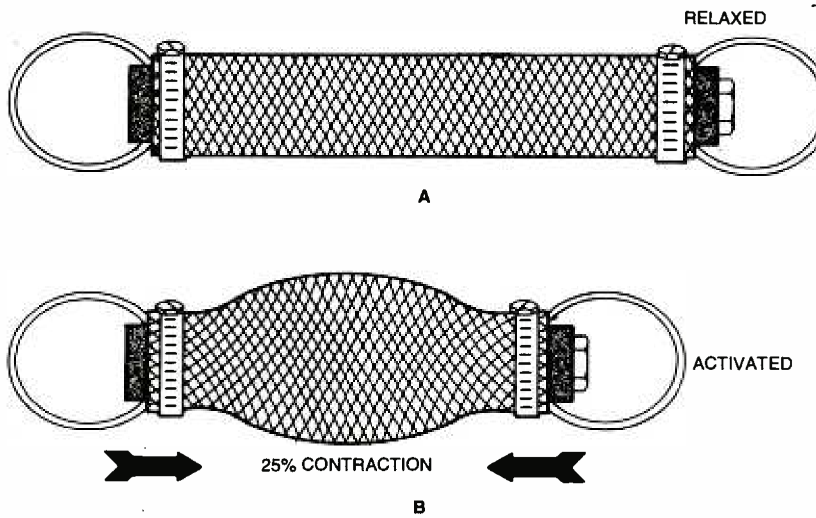


Fig. 2. When the muscle is pressurized (B), it can contract up to about 75% of its relaxed length (A).

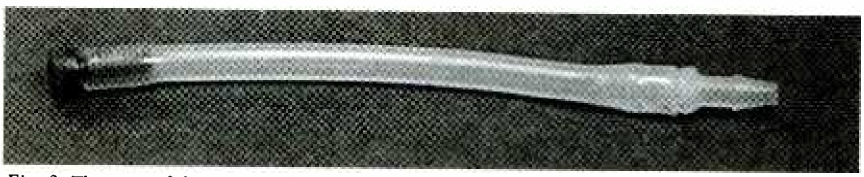


Fig. 3. The core of the air muscle is flexible rubber tubing. One end is plugged with a screw; the other receives an air fitting.

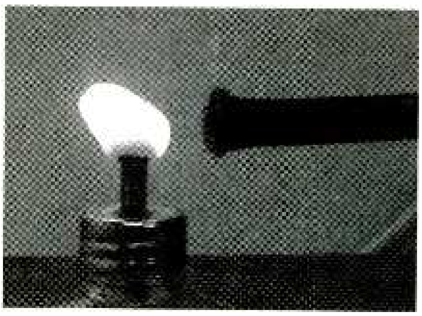


Fig. 4. After you cut the braided-mesh sleeve, singe the ends with a candle to melt the strands together; the sleeve won't unravel.

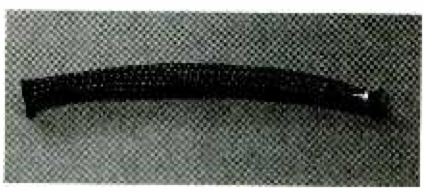


Fig. 5. Slip the sleeve over the tube and use several wraps of galvanized wire to secure the end with the screw "plug."

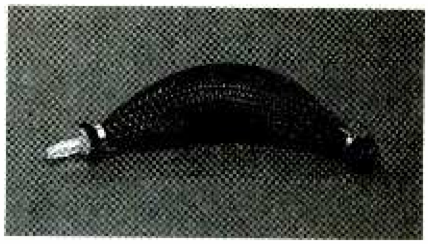


Fig. 6. Secure the other end of the sleeve with more wire. You'll need to "balloon" the sleeve a bit to reach the end of the tube.

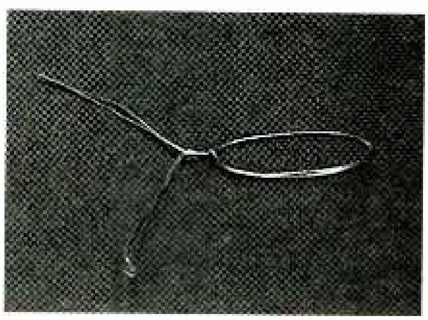


Fig. 7. The wire-loop "tendon" is a doubled length of wire twisted into a one-inch loop.

of the tube is to push them together, expanding the diameter of the tube. If you've ever worked with the braided shield on a coaxial audio cable, you can appreciate how the braided mesh behaves.

To operate properly, it is important that the air muscle be in a stretched or loaded position when it's inactive or in a resting state. If not, there will be little—if any—contraction when the muscle is activated. To see this, roll up your sleeve and watch the bicep muscle as you bend your arm at the elbow.

Air-muscle operation is shown in Fig. 2. Typically, the air muscle can contract by about 25% of its length.

ON THE WEB

Anthroform Arm Project
http://brl.ee.washington.edu/brl/project/aarm/

Construction of McKibben Artificial Muscles
http://rcs.ee.washington.edu/brl/devices/mckibben/acon.html

Cricket Micro-robot
http://biorobots.cwru.edu/projects/c_mrobot/c_mrobot.htm

Pneumatic Robot Home Page
http://www.ks.uiuc.edu/Research/Neural/robot.html

Powered Prosthetics Project
http://brl.ee.washington.edu/brl/project/powerp/

Air Pressure

Air muscles require a source of compressed gas—usually air. The air muscle that we will build operates at about 50 PSI. Any convenient source of air pressure in that range will work well. For example, a small bicycle pump with an air pressure gauge can activate most small experiments; here is where an assistant ("Who wants to be 'Igor' for a day?") comes in handy—unless you are feeling particularly physically fit. An inexpensive automobile-tire air pump that operates on 12 volts DC can reduce the manual effort at the expense of the pump's noise.

Other sources include a small air tank that can be filled at the local gas station air pump. If you use an air tank, make sure that it is equipped with an adjustable air-pressure regulator. That will prevent pressurizing the air muscle with too much air.

If you don't have an air tank, a spare automobile tire—mounted on a rim and able to hold air—makes a good substitute. Keep in mind that most tires carry 35-PSI ratings. That rating is a "cold" rating to allow pressure buildup as the tire heats up while being driven; the "hot" pressure can be quite a bit higher. Nevertheless, exercise caution when trying to inflate an old spare tire to higher pressures.

Making An Air Muscle

Air muscles are available commercially in a variety of sizes from the sources given in the sidebar. That list is

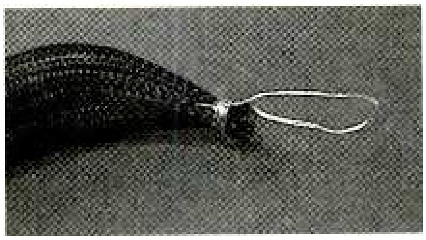


Fig. 8. Wrap the ends of the wire loop around each end of the air muscle.

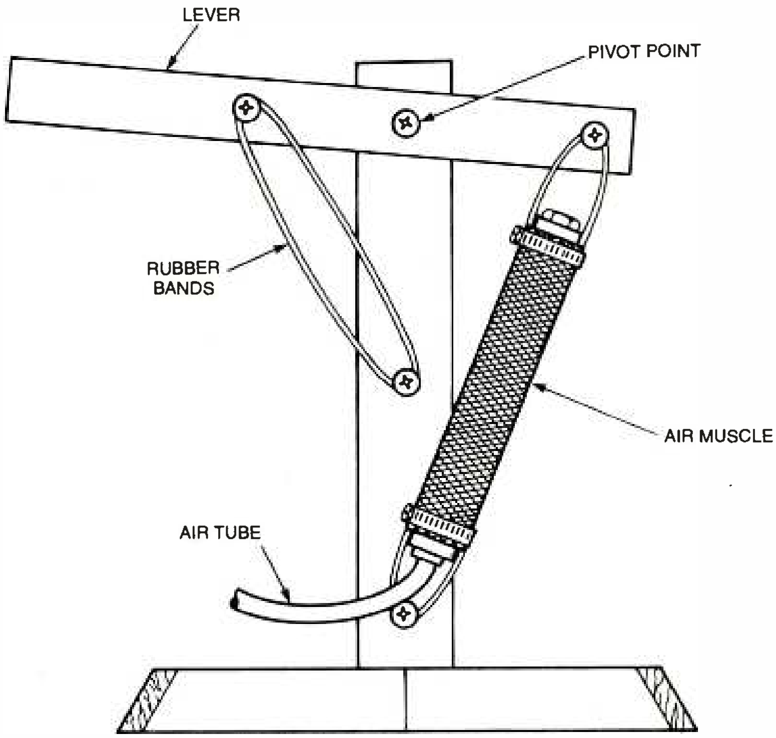


Fig. 9. A good demonstrator and "test bed" for an air muscle is a simple lever. One or more rubber bands provide a load for the muscle to work against.

just a small sampling and may not be exhaustive in its scope.

You can build your own if you are willing to expend the time and effort to "scrounge" the needed parts. The inner tube is made from soft silicone tubing that has a ¼-inch outside diameter and an ⅛-inch inside diameter. Go to a local pet shop that sells aquarium supplies and purchase a small quantity of clear PVC tubing the same size as the silicone tubing. You won't have any trouble telling the difference between the two; the PVC type is less flexible and tougher. While you're there, pick up a few aquarium air valves and couplings.

Many electronics distributors sell the polyester braided-mesh sleeve. The braided sleeve is used as a flexible conduit for electrical wiring. Purchase a small quantity—six feet or so—of ⅜-inch-diameter sleeve.

Finish the materials purchase with a few ⅜-inch-long 10-24 screws and a small quantity of 24-gauge galvanized wire at a local hardware store.

Cut a four-inch length of silicon tubing. Insert the 10-24 screw in one end of the tube. Insert an aquarium air coupling in the other end of the tube. The assembly should look something like the one shown in Fig 3.

Cut a seven-inch length of ⅜-inch braided-mesh sleeve. To prevent the ends of the sleeve from fraying and coming apart, singe the ends with a match or candle flame (Fig. 4). The idea is to just singe the ends of the polyester sleeve; it's easy to go too far and melt too much of the sleeve. In that case, cut another piece and start over.

Insert the rubber tube inside the braided sleeve. Align one end of the sleeve with the bottom of the head on the 10-24 screw in the rubber tube. Wrap a piece of 24-gauge wire three or four times around the end, capturing the sleeve, tubing, and threaded portion of the 10-24 screw. Twist the ends of the wire together. Use a pair of pliers to make this as tight as possible. After cutting any excess wire, the muscle assembly should look like Fig. 5.

To finish the other side, push down the sleeve until it is aligned with the rubber tube on the air coupling. Wrap another piece of 24-gauge wire around this end, tighten the wire with pliers, and cut off any excess wire (Fig. 6). At this point, you may want to pressurize the air muscle to insure that the two fittings do not leak. Since the air muscle is not loaded, only use a pressure of 20 PSI. If any air leaks, try tightening the 24-gauge wire.

Cut two 14-inch lengths of wire for the mechanical loops. Fold each wire in half to double it. Form a one-inch-diameter loop at the middle of the doubled wire and twist the wire at the bottom of the loop. (See Fig. 7.) Next, wire-wrap one loop to one end of the air muscle as shown in Fig. 8. Do the same to the other side with the second loop. Pull on the loops to insure that they are secure.

SOURCE INFORMATION

Commercial Air Muscles

Images Company
39 Seneca Loop
Staten Island, NY 10314
718-698-8305
www.imagesco.co

Shadow Robot Group
251 Liverpool Road
London UK N1 1LX
44 (0) 20 7700 2487
www.shadow.org.uk/index.html

Soft Silicon Tubing
Part No. 75-300-016

Barnant Company
Dept. 77-3397
Chicago, IL 60678-3397
847-381-7050

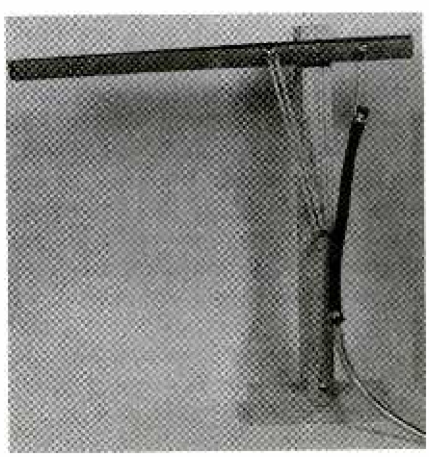


Fig. 10. Here is my completed lever system. Note how the muscle stretches out when relaxed.

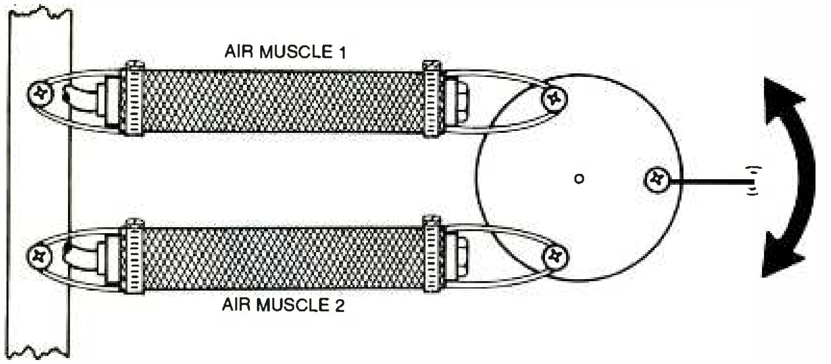


Fig. 11. You can replace the rubber bands with a second air muscle. Activating one muscle at a time moves the lever back and forth—just like real muscles in your body.

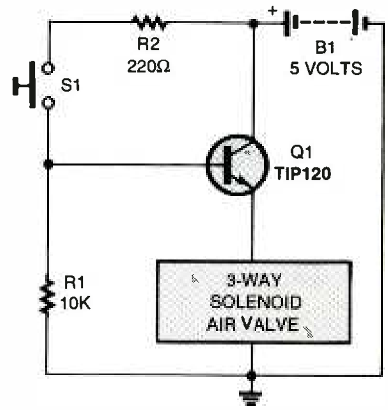


Fig. 14. This simple circuit lets you control the Mead valve with a pushbutton.

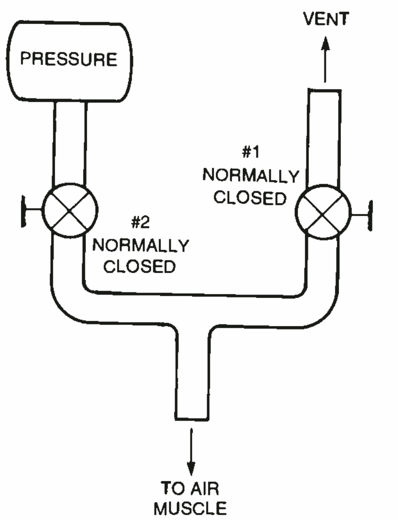


Fig. 12. To control the muscle, a three-way valve arrangement can be formed from two individual valves. Opening and closing valve 2 contracts the muscle; opening valve 1 lets it relax by venting the pressure.

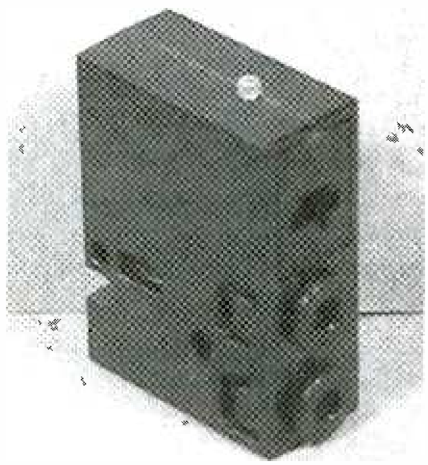


Fig. 13. This three-way valve from Mead can be controlled by a five-volt signal.

PARTS LIST FOR THE MANUAL ELECTRIC-CONTROL CIRCUIT (FIG. 14)

Q1—TIP120 silicon transistor, NPN
R1—10,000-ohm, ¼-watt, 5% resistor
R2—220-ohm, ¼-watt, 5% resistor
Normally-open pushbutton switch,
5-volt DC power supply, 5-volt DC
Isonic three-way solenoid air valve (Mead)

Testing The Air Muscle

The first test to perform is a simple static test. Wear eye protection when pressurizing the air muscle. Attach one end of the air muscle to a stationary object, using the loop. At the other end, hang about five to six pounds of material to the air muscle using the other loop. That weight will load the air muscle, causing it to stretch. Pressurize the air muscle with about 50 PSI. The air muscle should contract and easily lift the weight. While it's pressurized, listen for any air leaks. Repair any air leak by tightening the 24-gauge wire.

A lever is a simple mechanical device. A drawing of a lever is shown in Fig. 9 and the completed unit in Fig. 10. Activating the air muscle causes the lever to rise. Note that several rubber bands load the air muscle. You can replace the rubber bands with a second air muscle; they will provide a counter force or load for each other (Fig. 11).

Controlling The Air Muscle

Typically, three-way air valves are used to control an air muscle. The "schematic" of the tubing is shown in Fig. 12. To activate the air muscle, valve 2 is opened. Pressure flowing through the open valve contracts the air muscle. Once activated, valve 2 may be closed without impacting on the state of the air muscle—the pressure trapped in the line will keep the muscle contracted. To relax the air muscle, vent the air pressure by opening valve 1.

LISTING 1

```
5 rem Solenoid Air Valve Controller
10 rem find printer port address
15 def seg = 0
20 a = (peek(1032) + 256 * peek(1033))
25 Rem next line activates the air muscle
30 out a,1
35 Rem next line is a time loop for delay
40 for t = 1 to 1000: next t
45 Rem next line deactivates the air
   muscle
50 out a,0
```

A three-way air valve may be constructed using two one-way air valves. The small plastic aquarium valves purchased at a local pet shop have work quite well. However, they are not rated for work at 50 PSI—a good reason to wear eye protection in case they pop apart from the air pressure!

Electronic Control System

Using manual valves is fine for testing air muscles. To build a robot or industrial device, we must provide a way for electronic control. Fortunately, this is not difficult—there are a number of solenoid air valves available. I prefer the Isonic valves from Mead Fluid Dynamics. These are three-way air valves that are activated using 5 volts. An Isonic valve is shown in Fig. 13.

The three-way Isonic valves automatically vent the air muscle when they are deactivated. To see how this particular valve works, look back to Fig. 12. In

(Continued on page 65)

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GORDON MCCOMB

Microcontrollers as Robot Brains

Robot "brains" are what differentiate our machines from simple automated devices. Without a brain of some type, a robot is really nothing more than just a motorized toy, repeating the same actions over and over again, oblivious to anything around it. The brains of a robot process outside influences, like sonar sensors or bumper switches; then based on the programming or wiring, these controls determine the proper course of action.

All that's really needed to make a functional robot is a simple assortment of electronic components—a few transistors, resistors, and capacitors. However, with the ever-increasing capabilities of robots, their need for more sophisticated brains increases as well. A computer of one type or another is the most common brain found on a robot, though not all robot brains are computerized. A robot-control computer is seldom like the PC on your desk, though robots can certainly be operated by most any personal computer. Rather than plop a PC or Macintosh into your robot, you can simply use a microcontroller—a computer in a single chip—to control all or nearly all of the robot's functions.

In previous columns, I've discussed two new microcontrollers that are ideally suited for robotics—the BasicX and the OOPic. In this column, I'll cover the general features common to microcontrollers, explore their differences, and explain the features that are useful for amateur robots.

Brains from Microcontrollers

An almost endless variety of computers can be used as a robot's brain. The three most common are:

- *Microcontrollers*—These are programmed either in assembly language or a high-level language such as Basic or C. The LEGO Mindstorms RCX is a good example of a robot run from a microcontroller.

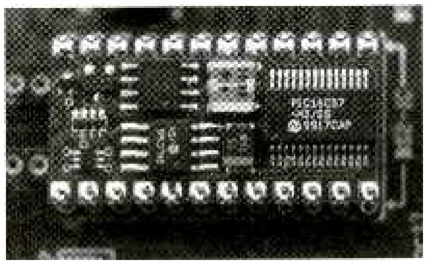


Fig. 1. The Basic Stamp is perhaps the most popular microcontroller used in amateur robotics.

- *Single-board computers*—These are also programmed either in assembly language or a high-level language, but they generally offer more processing power than a microcontroller does.
- *Personal computers*—Examples include an IBM PC-compatible or an Apple Macintosh, or even an older model such as the venerable Commodore 64.

Of those three types of brains, microcontrollers are fast becoming a favorite method for endowing a robot with "smarts." Microcontrollers are inexpensive, have simple power requirements (usually just +5 volts), and most can be programmed using software on your PC. Once programmed, the microcontroller is disconnected from the PC and operates on its own. Microcontrollers are available in 4-, 8-, 16-, and 32-bit versions (plus a few others, used for special purposes). While PCs have long since "graduated" to 16-bit and higher architectures, most applications for microcontrollers do not require more than 8 bits; hence, the 8-bit controller is still very popular.

Microcontrollers are, in effect, programmable integrated circuits (ICs) in which you define how the "innards" of the chip are connected and how the various connections interact with one another. Following the cues of your program, the microcontroller accepts input, analyzes it in one way or another, and outputs some value. This is fundamentally the same as any computer, except that a microcontroller is primarily designed to operate things (motors, relays, lamps, etc.) rather than interact with people through a keyboard and display monitor.

The traditional way to program a microcontroller is with assembly language, using your PC as a host-development system. Assembly language appears somewhat arcane to newcomers. However, because microcontrollers use a limited set of instructions, it is not overly difficult to master with adequate study. The exact format and contents of an assembly-language microcontroller program vary between manufacturers. The popular PIC microcontrollers from Microchip follow one language convention. Microcontrollers from Intel, Atmel, Motorola, NEC, Texas Instruments, Philips, Hitachi, Holtek, and other companies may follow a different convention. While the basic functionality of microcontrollers from those companies is similar, understanding how to use each one involves a learning curve. As a result, microcontroller developers tend to fixate on one brand and even one model, since learning a new language syntax can entail a lot of extra work.

ON THE WEB

Basic Stamp
www.parallaxinc.com/

BasicX
www.basicx.com/

OOPic
www.oopic.com/

Motorola 68HC1x-based microcontroller boards
www.technologicalarts.com/
www.steroidmicros.com/

Other microcontrollers
www.star.net/people/~mvs/
www.melabs.com/

Assembly language is a common method for programming microcontrollers, but it is by no means the only method. Numerous compilers are available that convert the syntax of a higher-level language—such as Basic, C, or Pascal—into a language the controller can use. In one approach, the compiler transforms your Basic, C, or other program into the machine code required by the microcontroller. Once compiled, the program is downloaded from the PC to the controller.

Popular microcontrollers commonly used in robot control include those listed in Table 1.

TABLE 1

Part Name	Manufacturer
68HC05	Motorola
68HC11	Motorola, Toshiba
8051	Intel and various*
80186,80188, 80386 EX	Intel
AVR	Atmel
H8/3292**	Hitachi
PIC16F84***	Microchip
Z8	Zilog

Notes:

* The 8051 has become an industry-standard microcontroller design and is available from a number of companies, which include (as of this writing) Intel, Atmel, Philips, Dallas Semiconductor, and several others. As such, the functionality and capabilities of 8051 systems can vary.

** The "H8" is the microcontroller used in the popular LEGO Mindstorms RCX robot.

*** The PIC16F84 is just one of several dozen microcontrollers in the PICMicro line of microcontrollers from Microchip. The PIC controllers vary by internal architecture (e.g., 8- or 16-bit), number of inputs, and special I/O features such as built-in analog-to-digital converters.

An *embedded-language* programmable microcontroller contains a high-level language interpreter that is permanently stored on the chip. For lack of a better term, we'll refer to these as "embedded-language programmable." With this system, the compiler on your computer converts your program into an intermediate "tokenized" language. The interpreter in the microcontroller finishes the job of translating the tokens to the low-level machine code needed by the chip.

Among the most popular embedded-language programmable microcontrollers for hobby robots is the Basic Stamp

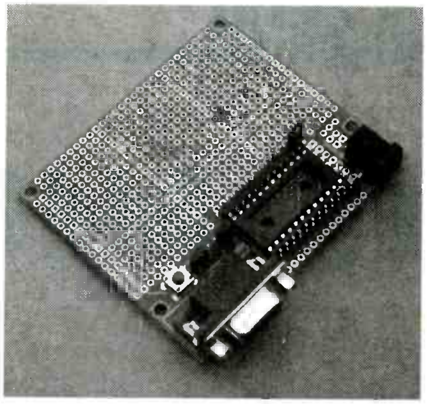


Fig. 2. Carrier boards are offered for many commercially made microcontrollers. This carrier board is designed for the BasicX microcontroller from NetMedia.

shown in Fig. 1. Over the past few years, several competitors to the Basic Stamp have appeared, including the OOPic from Savage Industries and the BasicX from NetMedia. These use Basic or a Basic-like syntax to save you from having to program the microcontroller in assembler.

Standard and semi-standard variants of the Basic programming language permeate microcontrollers. For example, a number of microcontrollers use Basic-52 (as found on the Micromint 80C52, for example), a fast and efficient version of Basic that fits in about 8K of memory space. Basic-52 provides additional command statements to support direct interfacing with the hardware of the chip. This includes interfacing with the chip's real-time clock, hardware interrupts, assembly-language routines (when speed is required), and more.

Another popular flavor of Basic, currently available for the 8051 and Atmel AVR microcontrollers, is BASCOM, from MCS Electronics, based in Holland. BASCOM is a development environment in which you write code in Basic; and then compile the result in machine-readable code, which gets transmitted to the microcontroller. Users of BASCOM enjoy the easier Basic development language, while still being able to take advantage of all the hardware of the microcontroller including timers and interrupts.

Inner Resources

An essential benefit of microcontrollers is that they combine a microprocessor component with various inputs/outputs (I/O) that are typically needed to interface with the real world. For example, the 8051 controller sports these features, many of which are fairly standard among microcontrollers:

- Central processing unit (CPU)
- Hardware interrupts
- Built-in timer or counter
- Programmable full-duplex serial port
- 32 I/O lines (four 8-bit ports)
- RAM and ROM/EPROM in some models

SERIAL-COMMUNICATIONS METHODS

I^2C (inter-integrated circuit)—This is a two-wire serial-network protocol used by Philips to allow ICs to communicate with one another. With I^2C you can install two or more microcontrollers in a robot and have them communicate with one another. One I^2C-equipped microcontroller may be the "master," while the others are used for special tasks, such as interrogating sensors or operating the motors.

Microwire—This is a serial synchronous communications protocol used in National Semiconductor products and popular for use with the PICMicro line of microcontrollers from Microchip Technologies. Most Microwire-compatible components are used for interfacing with microcontroller- or microprocessor-support electronics, such as memory and analog-to-digital converters.

SCI (serial communications interface)—This is an enhanced version of the UART, which is detailed below.

SPI (serial peripheral interface)—This is a standard used by Motorola and others to communicate between devices. Like Microwire, SPI is most often used to interface with microcontroller or microprocessor support electronics, especially outboard EEPROM memory.

Synchronous serial port—In this technology, data is transmitted one bit at a time, using two wires. One wire contains the transmitted data, and the other wire contains a clock signal. The clock serves as a timing reference for the transmitted data. Note that this is different from asynchronous serial communication, discussed next, which does not use a separate clock signal.

UART (universal asynchronous receiver transmitter)—This is used for serial communications between devices, such as your PC and the robot's microcontroller. Asynchronous means that there is no separate synchronizing system for the data. Instead, the data itself is embedded with special bits (called start and stop bits) to ensure proper flow. The USART (Universal Synchronous/Asynchronous Receiver Transmitter) can be used in either asynchronous or synchronous mode, thus making possible faster throughput of data.

As I said before, different manufacturers produce different microcontroller designs. Some microcontrollers have more than or less than 32 I/O lines; and not all have hardware interrupt inputs. Some will have special-purpose I/Os (see the section "Of Inputs and Outputs" later in this column) for such things as voltage comparison or analog-to-digital conversion. Just as there is no one car that's perfect for everyone, the design of each microcontroller makes it more suitable for one application than for another.

One potential downside to microcontrollers is that they have somewhat limited memory space for programs. The typical low-cost microcontroller may have only a few thousand bytes of program storage. While this may seem terribly confining, in reality, most microcontrollers do only a single job. That one job might not require more than a few dozen lines of program code. If a human-readable display is used, it's typically limited to a small 2-line by 16-character LCD, not entire screens of color graphics and text.

By using external addressing, advanced microcontrollers can handle more storage—8K or 32K are not uncommon, and a few can support well over a megabyte. Compared to what you find on your personal computer, this might still not be a lot of space. Fortunately, most robot-control programs don't take up nearly as much room as the average Windows application! However, keep the program storage limitations in mind when you're considering which brain to get for your robot.

Some microcontrollers—and computers for that matter—stuff programs and data into one lump area and have a single data bus for fetching both program instructions and data. That style is called the *Princeton* (or more commonly, *Von Neumann*) architecture. That is the architecture common to the IBM PC-compatible and many desktop computers, but it is not as commonly found in microcontrollers. Rather, most microcontrollers use the *Harvard* architecture, where programs are stored in one place and data in another. Two busses are used: one for program instructions and one for data.

The difference is not trivial. A microprocessor using the Harvard architecture can run faster because it can keep track of its current program location while handling all of the data needs. When using the Von Neumann architecture, the processor must constantly switch between going to a data location and a program location on the same bus.

Because of the clear delineation in program and data space in the Harvard architecture, such microcontrollers have two separate memory areas: ROM (read-only memory) for program space and RAM (random-access memory) for holding data used while the program runs. For that reason, you will often see two data storage specifications for microcontrollers. The data-storage space is typically quite small—perhaps 256 bytes or less. The program storage space can be 1K and over, depending on the controller. As mentioned earlier, some microcontrollers also support external addressing, which allows you to expand the amount of memory available to the controller.

DATA-CONVERSION METHODS

ADC—Short for analog-to-digital conversion, which transforms analog (linear) voltage to binary (digital). ADCs can be outboard, contained in a single integrated circuit (IC), or included as part of a microcontroller. Multiple inputs on an ADC chip allow a single IC to be used with several inputs (4-, 8-, and 16-input ADCs are common).

DAC—Digital-to-analog conversion. The opposite of ADC, it transforms binary (digital) signals to analog (linear) voltage levels. DACs are not as commonly used in robots; rather, they are mostly found on such devices as compact-disc players.

PULSE- AND FREQUENCY-MANAGEMENT METHODS

Input capture—This uses a timer to measure the frequency of an incoming digital signal. With that information, for example, a robot could differentiate between inputs, such as two different locator beacons in a room. Input capture is similar in concept to a tunable radio.

PMW—Pulse-width modulation is a digital output that has a squarewave with a varying duty cycle (that is, the "on" time for the waveform is longer or shorter than the "off" time). PMW is often used with a simple resistor and capacitor to approximate digital-to-analog conversion, to create sound output, and to control the speed of a DC motor.

Pulse accumulator—This is an automatic counter that counts the number of pulses received on an input over a period of time. The pulse accumulator is part of the architecture of the microprocessor or microcontroller and can be programmed autonomously. That is, the accumulator can be collecting data even when the rest of the microprocessor or microcontroller is busy running some other program.

SPECIAL MICROCONTROLLER FUNCTIONS

Analog/mixed-signal (A/MS)—These inputs (and often outputs) handle analog or digital signals under software guidance. Many microcontrollers are designed to handle both analog and digital signals on the same chip and even mix and match analog/digital on the same pins of the device.

Comparator—Think of a comparator as a one-bit ADC. This input can compare a voltage level against a reference. The value of the input is then lower (0) or higher (1) than the reference. Comparators are most often used as simple analog-to-digital converters where HIGH and LOW are represented by something other than the normal voltage levels (which can vary, depending on the kind of logic circuit used). For example, a comparator may trigger HIGH at 2.7 volts. Normally, a digital circuit will treat any voltage over about 0.5 or 1 volt as HIGH; anything else is considered LOW.

External reset—This input resets the microcontroller so it clears any data in RAM and restarts its program (the program stored in EEPROM or elsewhere is not erased).

Hardware interrupts—Interrupts are special inputs that provide the means to get the attention of a microprocessor or microcontroller. When the interrupt is triggered, the microprocessor can temporarily suspend normal program execution and run a special subprogram.

Input pull-up—Pull-up resistors (5-10K are typical values) are required for many kinds of inputs from control electronics. If the source of the input is not actively generating a signal, the input could "float" and therefore confuse the robot's brain. The pull-up resistors, which can be built into a microcontroller and activated via software, prevent this floating from occurring.

Switch debouncer—The purpose of this function is to clean up signal transitions when a mechanical switch (push button, mercury, magnetic reed, etc.) opens or closes. Without a debouncer, the control electronics may see numerous signal transitions and could interpret each one as a separate switch state. With the debouncer, the control electronics sees just a single transition.

Teach Your Microcontrollers Well

Since you can program the microcontrollers (and sometimes reprogram them many times over), the ROM is often designed to be erasable using any of several techniques. One of the oldest ROM-erasing techniques still used today is to expose the microchip to ultraviolet (UV) light. The microcontroller has a clear plastic, glass, or quartz "window" that exposes the semiconductor die within. To erase the chip, expose it to UV light of a certain frequency and intensity for a certain length of time; each chip's requirements are detailed in its data sheet. You can use a special UV light designed for the job. Sunlight will also work over several hours to a few days. In fact, you can use fluorescent lighting in the office—if you have about three years to spare! Once the old contents of the ROM are erased, it is ready to accept a new program. Those controllers are said to use EPROM, or erasable programmable read-only memory.

A more convenient method uses electrically erasable ROM (called EEPROM), or even static RAM memory with a built-in 5- to 10-year battery. With EEPROM, electrical signals erase the old content of the ROM so new bits can be written to it. EEPROM tends to be slow, and there is a limit to the number of times the ROM can be erased (albeit in the 100,000+ range). Both battery-backed static RAM as well as the latest Flash memory is faster than EEPROM. The current erase/reuse life on flash memory is about a thousand times; battery-backed static RAM can be erased an indefinite number of times.

A key benefit of microcontrollers with EEPROM or Flash memory is that they can be programmed and reprogrammed "in the field" (or "in circuit"). This has enormous potential for use in a programmable robot. With in-field programming, there is no need to remove the microcontroller chip from its circuit in your robot to reprogram it. Instead, you merely connect a cable from your PC and download the new program. Of course, this requires that the microcontroller have an on-board connector for connection to your PC. Most ready-made controllers for robotics (the Basic Stamp, the BasicX-24, etc.) come with, or have options for purchasing, a "carrier board" (see Figure 2) that has the proper cable connections.

Not all microcontrollers are meant to be reprogrammed. In fact, the reprogrammable controllers (with EEPROM or Flash memory) are among the most expensive of the lot. Less costly alternatives are made to be programmed only once and are intended for permanent installations. These one-time programmable (OTP) microcontrollers are popular in consumer goods and automotive applications. In quantity, an 8-bit OTP microcontroller might cost just a dollar, or even less.

For hobby-robotics applications, the OTP is useful for dedicated processes, such as controlling servos or triggering and detecting a sonar ping from an ultrasonic distance-measurement system. You'll find that several of the ready-made hobby-robotic solutions on the market today have, at their heart, an OTP microcontroller. The microcontroller takes the place of more complex circuitry that uses individual ICs.

An OTP microcontroller requires a special "burner" programming module that accepts the download from your PC. The burner is not complicated for the low- and medium-end microcontrollers that are programmed via a serial connection. A number of mail-order and electronics firms sell inexpensive programmers (under $30) for use with both one-time and in-field programmable microcontrollers.

Of Inputs and Outputs

The architecture of robots requires inputs (for such things as mode setting or sensors) as well as outputs (for things like motor control or speech). The design of the typical microcontroller provides for several types of inputs and outputs, making it easier to interface real-world devices to the robot.

The basic input and output of a microcontroller is a two-state binary voltage level (off and on), usually 0 and 5 volts. For example, to place an output on a microcontroller on HIGH, you must bring the voltage on that output to +5 volts, under software control. In addition to standard LOW/HIGH inputs and outputs, there are several other forms of I/O found on single-board computers and microcontrollers. Lists of the more common types are found in the sidebars. Those groups include serial communication, data conversion, and pulse and frequency management.

Many microcontrollers provide for special functions. Again, a list of the more common ones is found in a sidebar.

In future columns, I'll cover more microcontroller specifics, including interfacing and programming. Though microcontrollers might seem a bit frightening to the uninitiated, you'll be instantly hooked once you try your hand at one. You'll wonder how you ever built a robot without a microcontroller. **P**

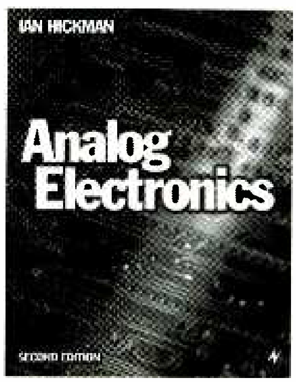
NEW LITERATURE

(continued from page 48)

Analog Electronics, 2nd Edition

by Ian Hickman
Newnes, Butterworth-Heineman
225 Wildwood Ave.
Woburn, MA 01801
800-366-2665 or 781-904-2500
www.newnespress.com
$37.95

Geared for electronics designers, the second edition offers practical design ideas with concise design implementations. Many of the circuits are taken from the author's magazine articles.



Subjects covered include passive components and circuits, active components, audio frequency signals and reproduction, radio frequency circuits, signal sources and power supplies. Analog theory and design principles and practical circuit ideas are all presented in this readable book. **P**

mailto: serviceclinic@gernsback.com

SAM GOLDWASSER

Video Record and Playback Problems

This month, we "mop up" the remaining foes from last month's battle as we tackle video-related problems. These are the types of faults that either affect the ability to record or play, or else result in video noise or other signal degradation.

Some General Suggestions

Let's start with an obvious playback problem. The VCR works in all respects when tuning broadcast or cable channels, but playing a tape results in no picture, a very snowy picture, or just a blue screen. In that case, there might be problems with the video heads, lower cylinder, head preamps, or other video electronics. Testing most of those is beyond the scope of this article and will require a service manual and test equipment. However, you can do a decent job of determining if the video heads are likely to be at fault.

When snow or serious video noise suddenly occurs while playing a rental, old, or damaged tape, it sometimes means that the video heads have picked up some oxide and are no longer making good contact with the tape. Letting the VCR play a newer tape for a few minutes might clear this if it is minor. However, video-head cleaning (using a cleaning tape or the manual procedure described in a previous "Service Clinic" or at *www.repairfaq.org*) will probably be needed.

CAUTION—NEVER attempt to clean the video heads without using one of the recommended techniques—you can easily destroy the heart of your VCR! Also, never attempt to play or record on a spliced or seriously damaged tape. Doing that can also result in destruction of the video heads.

What if you've recorded something and your recorded tape has problems when known-good tapes play back fine? In that case, you obviously need to look at the parts that are unique to recording. I've collected a few general problems and their causes in the sidebar.

Let's continue looking at some of the more "interesting" problems.

"Snow" In The Picture

Snow occurs at one or more speeds. Did the problem happen suddenly or did it develop over time? If suddenly, what were you watching at the time? A (literally) dirty rental movie?

If the ailing VCR has four or more heads, SP and EP modes might use a different set of heads; if so, only certain heads might be dirty or bad. If the machine tracks perfectly in EP, then the alignment is probably fine; EP is more critical in terms of alignment since the EP track is ⅓ the width of the SP track.

Have the video heads been cleaned using the proper procedure (not just a cleaning tape)?

New video heads might fix this, though it can be caused by other problems such as the read electronics being weak.

You should also check the backtension adjustment. If it is too loose, the head-to-tape contact will be compromised. Try increasing it momentarily by pushing the backtension lever slightly to the left while the tape is playing. The usual way to adjust backtension without a backtension meter and service manual is to look at the image just before vertical retrace at the bottom of the screen; this is normally not visible unless you can reduce the TV's vertical size or play with the vertical hold to get the vertical blanking bar to appear. Sadly, most modern TVs don't have any such controls!

This part of the signal is the *head-switching* point. When the backtension is properly set, the image above and the bit of image below this break will be approximately aligned.

If increasing the backtension helps, it means that either the heads are marginal or the backtension was low. However, low backtension will usually show up as a "waving" or "flagging" effect at the top of the picture.

Intermittent Snow Showers

Some time after cleaning the video head, you get snow in the picture. What this means is that you are watching your favorite movie and in the middle of the most exciting scene, your picture turns to snow or a blue screen. You performed what you thought was a thorough cleaning, and then it happened again.

Well, if it is indeed your most-watched tape, *that* might be the cause—especially if it happens during the same scene—or it might be a problem with the VCR. I've collected some causes and solutions in the sidebar.

If you rent movies or have a collection of older well-used tapes, the most likely cause is what I just said: your tapes are bad.

There Are Lines In The Picture

If there are horizontal lines (one or more) at fixed locations on the screen during playback, they could be the result of electronic problems or marginal video heads. However, the possibility that should be explored first is that of tape damage.

If a prerecorded tape that plays properly on another VCR shows the effect on the suspect VCR and then plays poorly on the other VCR, it is being damaged by something in the suspect VCR's tape path. Open the door of the cassette by releasing the catch on the side. Look carefully at the surface of the tape—it should be mirror smooth all across its length. If you see any evidence of hair-fine (or larger) scratches running the length of the tape, that is what's causing the line. It is likely the result of a bit of debris or a rough edge on one of the guideposts in the VCR. The effect on the picture is the inverse of the crease location vertically: lines near the top of the tape affect the bottom of the picture and vice-versa.

Get a brand new tape or a known-good tape that you can afford to mess up and test it on another VCR at the tape speed that is worst, if this matters. Assuming that playback is fine, play it on the suspect VCR for a couple of minutes. Pull the plug (DON'T hit STOP) so the transport remains in the fully loaded position.Carefully examine the surface of the tape all along the tape path—disturbing its position as little as possible—to identify the location where the damage begins. It might just be a bit of something stuck to a guide post. Has the VCR been cleaned in the last ten years?

Note that this sort of damage to the tape does not represent a risk to your VCR's video heads, so you can continue to use the tape if desired.

A Jumpy Picture

During Playback—You have a VCR with known good heads that produces jumpy (vertically) video during playback that cannot be stabilized with the tracking control. Perhaps you have attempted to adjust the mechanical tracking and some other stuff as well.

The first question to ask is did you replace the heads? Could you have gotten them rotated 180° from the correct position? I don't know what the implications would be on your model VCR, but there is a definite right and wrong way for the heads to be placed. Misplacement would certainly show up with the tracking being way out of line when you attempt to play a tape recorded on the problem VCR on another machine.

Some other questions to ask yourself include:

- Exactly what adjustments did you touch?
- Have you verified that the roller guides are fully engaged against the stops?
- Have you checked backtension?
- Did you touch the roller guide height?

In general, you're probably looking at a mechanical problem—most likely an adjustment or fault related to the tape-path alignment. However, it could also be due to electronic problems with the video or servo circuitry. The vertical sync could be corrupted or the head-switching point not be set correctly.

The head-switching point is 6.5 lines before vertical sync. If this ends up moving into the vertical sync for some reason, the result is unstable video. The supply-side roller-guide height adjustment is also critical and would be the first thing to check whenever mechanical-alignment problems are suspected.

However, don't overlook the obvious: Your TV might be marginal or misadjusted, or you are trying to play a bad tape.

During PAUSE/CUE/REV—Note that on a two-head VCR, it is not possible to display a noise-free picture on a tape recorded at the SP or LP speeds. Therefore, for rental or pre-recorded tapes, the jumpy picture you are seeing might be normal. A two-head machine should execute those special effects perfectly fine with EP (SLP) recorded tapes, however.

VCRs with four or more heads will usually have a "V-Lock" adjustment—either a knob on the front or rear panel or else "conveniently" accessible from under the VCR. Sometimes, a special tool is needed to adjust this control.

Where tracking is adjusted with a set of +/- buttons, these may also be used in the PAUSE mode. There may be separate adjustments for SP and EP speeds as well. In any case, those settings are made while viewing a tape in PAUSE mode that was recorded at the appropriate speed.

For the LP speed—which many manufacturers are phasing out, at least for RECORD—those special effects usually do not work well if at all. That is due to the nature of the sync signal alignment on tapes recorded at the LP speed, which requires complex circuitry for proper handling at anything other than normal LP play speed. For those who are interested in the technical "fiddly bits" behind that, the sync tips between adjacent tracks align on the tape in SP and EP recorded tapes but are off by .5 line with LP-recorded tapes. That misalignment results in the tearing seen in search modes with LP-recorded tapes. Since the tape speed is of little true value—it is a compromise—the added

RECORDING PROBLEMS

Attempts to record are ignored by the VCR or cause the cassette to be ejected—This might mean that the record-protect tab on the cassette is broken off or the record-tab sense switch is dirty or bad.

Recording (either manual or timer) stops at random times; possibly with a flashing display and/or ejected cassette—This could be the result of a dirty or defective record-sense switch or misalignment preventing proper engagement with it. Some VCRs check for the record tab constantly while others just check when the REC button is pressed or if the timer initiates recording. It could also be a defective reel or tape-end sensor halting the recording though that would likely affect playback as well.

Playback results in video snow; whatever was on the tape, if anything, is gone—The old recording is being erased (if there was one), but either nothing or a weak signal is being written by the video heads. This could be due to a variety of electronic faults as well as marginal or bad video heads.

Playback results in a picture, but it has a wiggling rainbow pattern running through it—This is normal at the start of a recording made on top of an old recording if your VCR does not have a flying erase head. However, it should wipe down the screen in a few seconds and disappear. If it does not go away, then the full-width-erase head is not working.

Playback results in a flickering picture alternating between good video and snow at the frame rate (about 30 Hz for NTSC)—This could mean that one of the two heads used for recording is dirty or defective.

Playback results in proper video but the audio either comes from previously recorded material or there is no audio—The audio-dub switch (if any) might be in the wrong position or the audio circuitry might be defective.

Playback results in a picture that is cycling in brightness or flashing—This likely means that you are attempting to record (copy) a Macrovision or some other copy-protected tape, or your cable or satellite company is transmitting copy-protected video. More information on this subject is available at *www.repairfaq.org/~filipg/LINK/F_Macro Vision.html*. Some of the new digital DBS satellite receivers output a Macrovision copy-protected TV signal so you can't tape the movies from them.

Newer VCRs will generally not record successfully. Some older VCRs will record without problems. The 8-mm VCRs may record the entire signal and therefore be able to playback successfully. However, attempting to copy 8-mm tape onto a VHS tape will result in the same problem.

expense of such circuitry has not been found to be justified except on professional machines.

Problems With Video Search

At times, the video blanks out or doesn't work on recordings made at certain speeds. This may be a "'feature" of your VCR. On some older models, the designers or their marketing departments (in their infinite wisdom) decided that no picture or no search capability at all was preferable to a picture with serious noise bars or one that didn't sync properly. This was usually before the days of four-head VCRs, which directly addressed at least some of those issues.

Most two-head VCRs will work fairly well on EP recordings but show noise bars over about 50% of the picture with SP recordings. With tapes made at LP speed, tearing will occur in addition to noise bars if they sync at all. Few VCRs deal properly with LP search as substantial additional circuitry is required.

In my opinion, any picture is better than a blank screen or no search capability.

Noisy Or Jumpy Recordings

The VCR plays pre-recorded tapes, but its own recordings are noisy or jumpy. First, make sure that the tapes are in good condition. They may have been damaged (edge crinkles) before you serviced the VCR. This is now causing the erratic behavior, and there is nothing wrong with the VCR.

Before considering drastic action, record on a brand-new tape—from end-to-end if the initial results seem promising. You might have a non-problem.

Try recording on your VCR and playing back on another one. If that works, then bad tapes are the most likely explanation. If this does not work, there could be electronic problems.

Rainbow Patterns In Recorded Tapes

Unless your VCR has a flying erase head—located along with the normal video heads on the rotating drum—you will see a faint rainbow pattern near the start when recording over a previously used tape. The reason is that there is a separation of a few inches in the tape path between the video heads and the full-width erase head. When you start recording at an arbitrary point, it takes several seconds (actual time depends on recording speed) for a totally erased tape to make it to the video heads. You are seeing an interference pattern between the old and new video signals. The pattern will slowly wipe from top to bottom as the diagonal tracks of the new video signal intersect more and more of the erased tape.

This effect will not occur (except possibly at the very beginning of the tape) as long as you record from start to finish without backing up the tape at any time.

If the rainbow pattern is present whenever recording over previously recorded tapes and does not go away, then the full-width erase head is not working. That could be due to an electronic failure or simply a bad connection to the head. Alternatively, a mechanical problem—such as a broken or popped spring or gummed-up lubrication—might prevent a pivoting full-width erase head from contacting the tape properly.

"Barber Poling" (Bands Of Rainbow Or Color)

Although as we already mentioned, some rainbow patterns are normal for the first few seconds on previously recorded tapes, alternating bands of rainbow or color indicate a fault sometimes referred to as "barber poling."

This is likely an electrical fault in the chroma-playback circuitry buried deep in the bowels of your VCR. The chroma reference is not locking or is locking erratically with the chroma signal. Unless you can find some bad connections or other obvious problem, this will be difficult to troubleshoot without schematics. Don't be tempted to twiddle any internal controls even if they appear to deal with color—you will just mess things up for whoever finally repairs your VCR!

SHOVELING SNOW OUT OF YOUR VCR

Old, well-worn, or dirty (the physical kind) tapes can result in oxide being deposited on the video heads even during normal play. After cleaning the video heads using the proper manual technique, play only newer tapes for a while and see if the problem returns.

Was your video-head cleaning really done properly? One pass with a wet cleaning tape (assuming that you believe in such things) is usually enough, but not always. Doing the head cleaning manually is best.

If your VCR has an automatic head cleaner...remove it! The little foam wheel can just as easily put dirt back onto the video heads as remove it—especially after *it* collects a fair amount of debris.

Your video heads might be worn. Video heads that clog up on their own indicates that replacement might be needed.

The backtension might be too high. That can sometimes be remedied by a proper cleaning of the reel and felt band.

"Flag Waving"

You have just loaded a videotape sent to you from your long-lost cousin, and you notice that the top of the picture is wiggling back and forth. If this wasn't the original complaint, make sure the flag-waving problem exists with the TV that will actually be used with the VCR; it might just be your test TV or monitor that is unhappy or the particular combination of TV and VCR.

This could be due to differences between the VCR's video-field timing on which the recording was made and the one used for playback. Backtension and/or video-head chip alignment on the drum can create those differences. While you can fiddle with the backtension, you can't do anything about the chip alignment.

Some TVs are more tolerant of these variations than others. In addition, there is a special channel or setting on some TVs to be used for VCR viewing. In that case, there is more tolerance of this "timebase error."

It's also possible that the backtension on either VCR is misadjusted or incorrect due to wear.

Next Month

Now that we have the video portion of a VCR polished and shiny, we'll start tackling the audio portion of the system next month. Until next time, feel free to check on my Web site at *www.repairfaq.org*. I welcome e-mail comments and questions sent to the address at the top of the column. **P**

(continued from page 4)

[An interesting suggestion—one that would require cooperation from the authors. On the subject of "creative" author resumés, one of my personal favorites for understatement appeared in the first edition of the book Incredible Secret Money Machine. *It read: "About the author: Don Lancaster writes books."—Editor.]*

Need For An Index Reader

For years, I have been asking the publisher of **Radio-Electronics**, **Electronics Now**, and now **Poptronics**, for a file (an ASCII text file is fine), which is a comprehensive index on articles that have appeared in those magazines over the years. Many of your readers, myself included, keep those magazines for reference. Sure enough, from time to time, I have to look up an article I remember reading about years ago, but have no idea the exact year.

It is not always convenient to get on the Internet in order to look up an article at your site, if you have an index there. I am perfectly willing to pay for the comprehensive index (download, disk, or CD-ROM).
JOHN AUGUSTINE
via e-mail

[We do have an on-line searchable index; it currently goes back to 1994 or so. What if a few readers got together and created one that anyone could use? After all, that's how Linux got started.—Editor.]

Articles Wanted

I have been a subscriber to **Radio-Electronics**, **Electronics Now**, and now **Poptronics** for several years during which many articles on electronics have been presented. Yet none of them—that I remember—have been about automobile, satellite-receiver, and infrared transmitter/receiver electronics.

Can they be presented (in detail) in future articles? Thank you for considering this query.
IRA CREW
Zapata, TX

Why Doesn't "Free" Include the Silver Plate?

At first glance, Fred Eady's article "Internet Appliance Development Board" in the June 2000 issue of **Poptronics** looked like it might be an exciting article. I was also interested in the prospect of the "free" software.

After reading the article and visiting emWare's Web site, excitement soon turned to dismay. Clearly, the software mentioned in the article is not free. All of the software has only a limited trial period of use and is extremely restricted in the manner in which it may be used. The licensing terms are horrifying and completely unacceptable.

As a result, the article turns out to be highly misleading and totally useless. I am even wondering if this was simply an attempt by emWare to get some free advertising. It seems like many articles are nothing more than advertising masquerading as an article. In general, I expect articles to include PCB layouts so I can fabricate my own boards and all software (including source code) to be available without significant restrictions.
GREG YORK
Kalamazoo, MI

Let me begin by apologizing. It is obvious from the tone of your letter that the Internet Appliance Development Board does not meet your needs. As an author for **Poptronics**, I always attempt to offer articles and kits that are useful to the **Poptronics** readership. I am very sorry that I failed you.

To add insult to injury, it also seems that I misled you. At the time of publication for the Internet Appliance Development Board, emWare was offering their free *EMIT* code as a download. Due to high demand, the emWare folks decided to distribute the trial software on CD. In either case, the emWare *EMIT* software is free for noncommercial use. Once you obtain the *EMIT* code via CD, the emWare documentation on the CD explains how to get a persistent (and still free) license for the noncommercial version of EMIT.

A companion package, *Visual Café*, is also free for downloading on a trial basis from the emWare site. Again, as a **Poptronics** author, I respect your integrity and offer only the truth and technical fact in my articles. On page 44, column 3, paragraph 4, I point out that *Visual Café* is not really "free." I also go on to inform the reader how to obtain a legal copy of *Visual Café* if that fits their needs.

I am a "student" of emWare's *EMIT* technology. During the production of the Internet Appliance Development Board article, I worked closely with the emWare engineering staff. I feel that this type of relationship with a product that I present to the **Poptronics** readers is a benefit as I have in-depth knowledge of the subject matter.

The Internet Appliance Development Board article and project was my idea—an attempt to present some very relevant technical information to the **Poptronics** readers. I was not asked by emWare to do this article and I was not paid by emWare to publish the text. I too subscribe and read **Poptronics** every month. Like you, I also expect to find top-notch article material that is not tainted by outside commercial influences. Therefore, I practice what I preach when I submit an article to the Editorial staff.

If you visit the E D Technical Publications Web site at *www.edtp.com*, you will quickly see that I am in the business of writing technical articles and selling the resulting kits to those interested. I have been in this business since 1984 and enjoy it immensely. Despite the business end, I also offer everything necessary for anyone with the ability to construct any of my kits without having to purchase anything from EDTP. I have never

(Continued on page 65)

KEEP IN TOUCH

We appreciate letters from our readers. Comments, suggestions, questions, bouquets, or brickbats ... we want to hear from you and find out what you like and what you dislike. If there are projects you want to see or articles you want to submit—we want to know about them.

You can write via snail mail to:

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And don't forget to visit our Web site: *www.gernsback.com*.

mailto: basiccircuitry@gernsback.com

CHARLES D. RAKES

More Alarm Circuits

We're back! Are you ready to continue with our burglar alarm circuitry? Just last month, we looked over a number of simple but effective burglar-alarm-sensor circuits. As promised, we're going to continue with more building-block alarm circuits in this visit. The purpose behind any good alarm system is to confuse the would-be-burglar to the point where he/she considers the risk of breaking in to be too great and moves on or forgets the idea entirely.

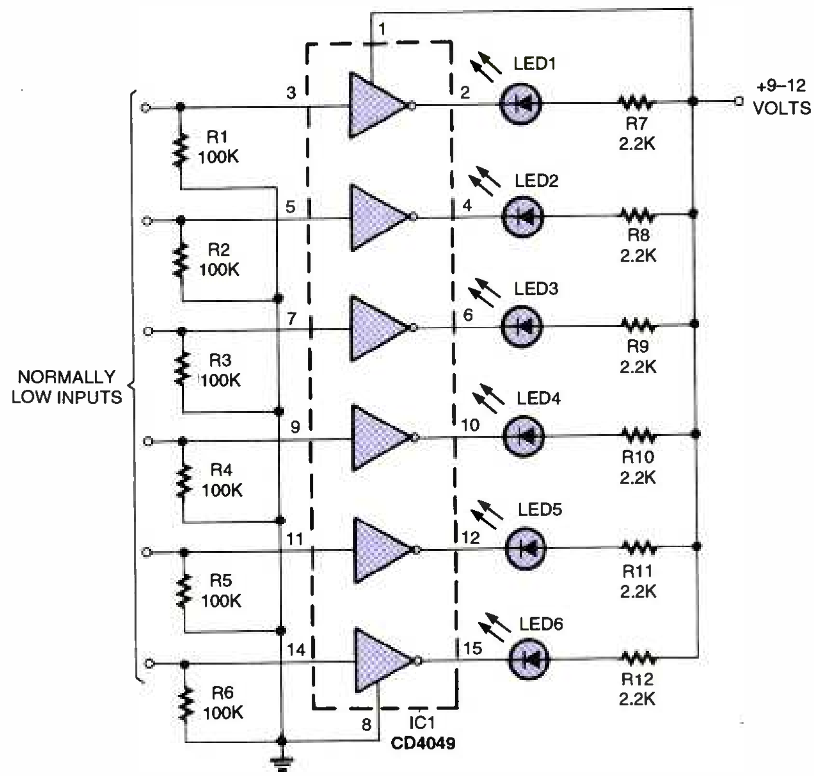

Fig. 1. By connecting the inputs of this circuit to individual alarm sensors, you can monitor which sensor was tripped.

Where's the Fire?

Adding more sensors to the alarm system makes keeping track of each sensor's status more difficult. If one of the sensors activates the alarm while you are on site, you need to know which sensor has been activated. This very well could be life-saving information. The circuit in Fig. 1 will monitor up to six normally low output sensors and indicate the sensor's status with an LED.

Selecting a CMOS inverting buffer for the monitoring circuit was an easy choice; the versatility is great and the cost is low. Each inverter drives an LED independently, which is what we want to do in our monitoring circuit.

The inverting buffer's output is always the opposite of its input: input low, output high, and vice versa. The buffer's input impedance is very high and will not affect or load the circuit being monitored. As long as the buffer's input is at or near ground level, the output will be high and no LED will be on. When the input goes high, the buffer's output goes low, creating a ground path for the LED. That lets the LED light, indicating that the sensor's normal condition has been breached, thus alerting you to the problem.

When There "Isn't No" Fire

It's a simple task to modify the Fig. 1 monitoring circuit to handle sensors with a normally high input. Here's how it's done. Any two inverting buffers can be connected in series (see Fig. 2) to cause the LED to turn on when the sensor's output goes from a high to a low. When two inverters are connected in series, the output of the last inverter will be the same as the input of the first inverter. When the input of IC1-a goes low, the output of IC1-b goes down, lighting LED1. The 100K resistor (R2) is only necessary when the monitor is not connected to a sensor.

Never leave any CMOS input open; always tie any unused inputs to either ground or battery positive. Believe me, you do not want the slow-developing mischievous behavior that an open input on a CMOS gate can bring you. I've seen circuits operate flawlessly for hours and then begin to do goofy things just because I didn't take the time to tie a single unused gate to something.

PARTS LIST FOR THE HIGH-INPUT MONITOR (FIG. 1)

SEMICONDUCTORS

IC1—CD4049 CMOS hex inverting buffer, integrated circuit
LED1–LED6—Light-emitting diode, any color

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1–R6—100,000-ohm
R7–R12—2200-ohm

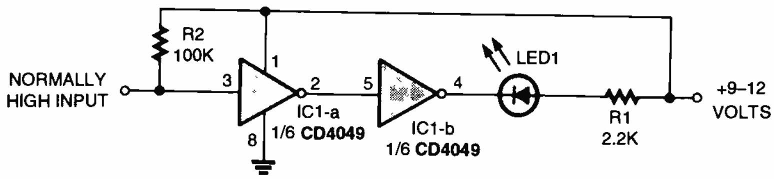

Fig. 2. One way to monitor a normally high signal is to double-buffer the input with a pair of inverters. That way, the polarity of the signal is preserved.

PARTS LIST FOR THE LOW-INPUT MONITOR (FIG. 2)

SEMICONDUCTORS

IC1—CD4049 CMOS hex inverting buffer, integrated circuit

LED1—Light-emitting diode, any color

RESISTORS

(All resistors are ¼-watt, 5% units.)

R1—2200-ohm

R2—100,000-ohm

Correcting "Bad English" in Electronic Circuits

Our next monitoring circuit, see Fig. 3, is set up to keep tabs on a normally high output sensor. A CMOS 4050 hex non-inverting buffer is connected in a circuit very similar to Fig. 2. The output of a non-inverting buffer remains the same as its input—high input, high output, and vice versa. When the sensor's output goes from high to low, the buffer does the same and turns on the LED. Any time an LED is on, a sensor has detected a breach in security.

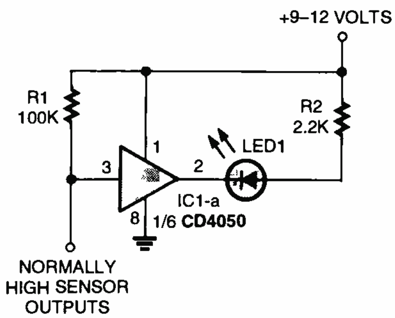

Fig. 3. If you feel that using two inverting gates to buffer a signal is wasteful, use a non-inverting buffer instead.

PARTS LIST FOR THE NON-INVERTING MONITOR (FIG. 3)

SEMICONDUCTORS

IC1—CD4050 CMOS hex non-inverting buffer, integrated circuit

LED1—Light-emitting diode, any color

RESISTORS

(All resistors are ¼-watt, 5% units.)

R1—100,000-ohm

R2—2200-ohm

No Matter How You Wire It, It's Still Electronics

Take a look at the two circuit arrangements in Figs. 4A and 4B; you will see another way to connect the buffers to reverse their output function.

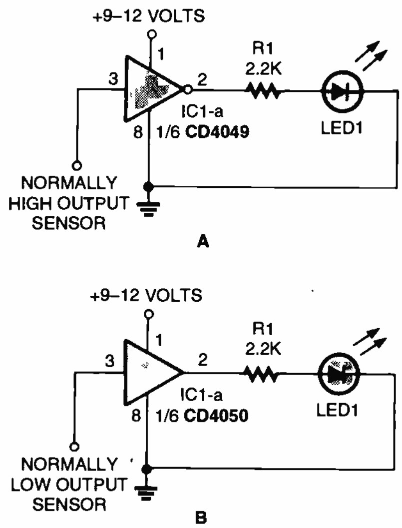

Fig. 4. Light-emitting diodes can be "sourced" with current from an active-high output. Simply choose whether you need an inverting (A) or non-inverting (B) control.

PARTS LIST FOR THE CURRENT-SOURCING MONITORS (FIGS. 4A AND 4B)

SEMICONDUCTORS

IC1— CD4049 CMOS hex inverting buffer (Fig. 4A) or CD4050 CMOS hex non-inverting buffer (Fig. 4B), integrated circuit

LED1—Light-emitting diode, any color

RESISTORS

R1—2200-ohm, ¼-watt, 5% tolerance

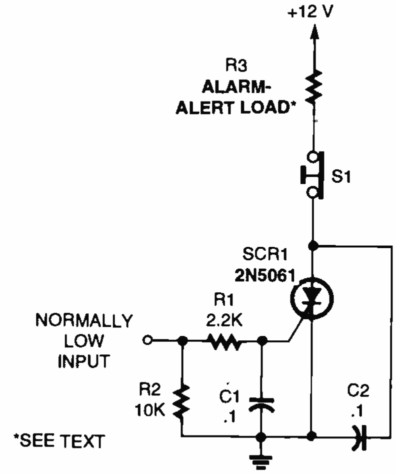

Fig. 5. An alarm circuit is a perfect application for an SCR. Once triggered, the device continues to conduct until current in interrupted by pressing S1.

PARTS LIST FOR THE BASIC ALARM CONTROLLER (FIG. 5)

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)

R1—2200-ohm

R2—10,000-ohm

R3—Alarm load (see text)

ADDITIONAL PARTS AND MATERIALS

SCR1—2N5061 silicon-controlled rectifier

C1, C2—0.1-µF, ceramic-disc capacitor

S1—Single-pole, single-throw, normally closed momentary-contact switch

The 4049 in Fig. 4A will now operate with a normally *high* output sensor and the 4050 in Fig. 4B will operate with a normally *low* output sensor. The only real change is in the output circuit and how the LED is connected. In both circuits, the buffer sources a positive output to light the LED; where previously the buffer switched the cathode of the LED to circuit ground.

In electronics, there are many ways to accomplish the same functional outcome; and that is just one of the reasons that working with electronic circuitry is so much fun.

A Burglar's Basic "Party Spoiler"

Our first alarm-control circuit is shown in Fig. 5. A single silicon-controlled rectifier (SCR) is the heart of the

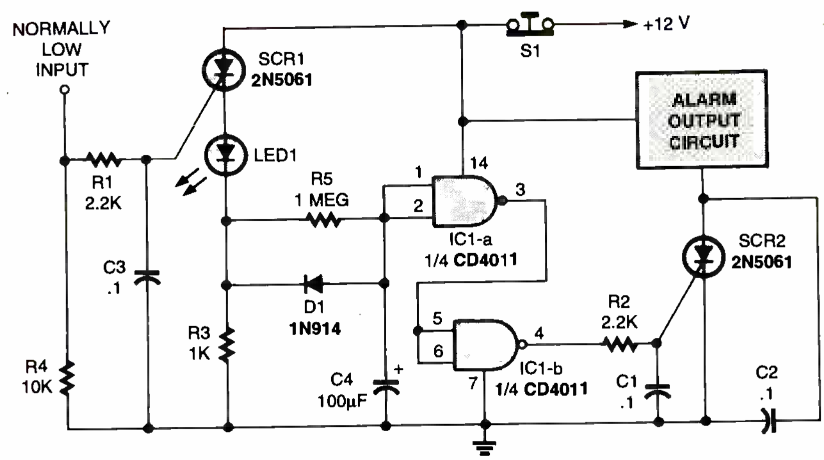

Fig. 6. A useful addition to a basic alarm circuit is an entry delay so you have time to deactivate the system "before the party starts!"

PARTS LIST FOR THE ALARM CONTROLLER WITH ENTRY DELAY (FIG. 6)

SEMICONDUCTORS

IC1—CD4011 CMOS quad two-input NAND gate, integrated circuit
SCR1, SCR2—2N5061 silicon-controlled rectifier
LED1—Light-emitting diode, any color
D1—1N914 silicon signal diode

RESISTORS

(All resistors are ½-watt, 5% units.)
R1, R2—2200-ohm
R3—1000-ohm
R4—10,000-ohm
R5—1-megohm

CAPACITORS

C1–C3—0.1-µF, ceramic-disc
C4—22- to 100-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1—Single-pole, single-throw, normally closed momentary-contact switch

control circuit. The control circuit is designed to operate with a normally low output sensor.

As long as the voltage at the circuit's input remains near ground level, the SCR will remain off and no current will flow through the alarm's output-alert circuitry (R3). Bypass capacitor C1 keeps noise spikes from triggering the SCR, and C2 keeps the SCR from turning on when power is first applied.

Switch S1 is normally closed; pressing it interrupts the SCR's current flow, resetting the alarm circuit after it has been triggered. The maximum current that the SCR can supply to the alert circuitry is 0.8 amps. However, a higher current SCR can increase the circuit's maximum-current capability. The alarm-alert device (represented by R3) can be anything from a store-bought siren to any home-built high-level noisemaker—as long as it attracts attention.

"Wait For Me!"

Our next alarm system, see Fig. 6, adds an entry timer to the basic circuit in Fig. 5. A high input signal turns SCR1 on, supplying approximately ten volts to the junction of R3 and R5. The current through R5 charges timing capacitor C4 toward the ten-volt source. When the voltage rises to about eight volts, IC1-a switches from a high to a low output. Gate IC1-b then switches its low output to a high, turning SCR2 and the alarm-output circuit on. Both SCRs remain on until S1 is momentarily pressed, interrupting the circuit's current flow and resetting the alarm circuit.

Diode D1's purpose is to rapidly discharge timing capacitor C4 when S1 is activated so that each timing cycle will be alike. The timer's RC component values (C4 and R5) can be varied to offer entry delays from a few seconds to over a minute. A one-megohm resistor and a good quality 22-µF electrolytic capacitor will give a delay of about 10 to 20 seconds; one-megohm and 100-µF will delay over a minute. Since the actual value of most electrolytic capacitors can vary greatly from their marked value, plan on doing a little experimenting with these components to obtain the desired entry time.

The LED in SCR1's cathode circuit is an indicator that lights when the timing cycle starts. The sensor that supplied the circuit its positive-input signal must return to its normally low output before the circuit will remain in the reset or ready state. If the sensor does not return to its low state, the circuit will cycle on again after being reset and sound the alarm.

The More, The Merrier

Just about any number of normally low output sensors may be connected to the alarm circuit. The easiest method of connecting a large number of sensors to the alarm circuit is shown in Fig. 7. It takes just one diode for each sensor to isolate the sensors from each other and to combine all the outputs into one input signal.

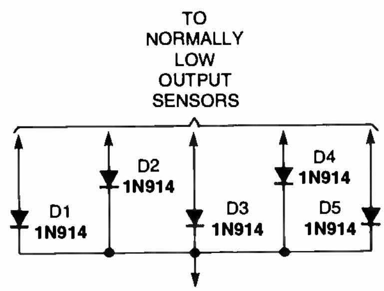

Fig. 7. If your system has multiple sensors, a simple diode matrix will combine the individual signals into one master signal.

PARTS LIST FOR THE MULTIPLE-SENSOR-INPUT CIRCUIT (FIG. 7)

D1–D5—1N914 silicon diode

The Final Holdout

Our next entry—Fig. 8—is a latching circuit that can activate and hold a circuit condition until the reset switch is turned on or the power is removed. The circuit can be used as a "panic" alarm or as a latching output activated by a momentary switch closure or some other pulse-type input. Three inverting buffers of a 4049 hex inverter IC are used in the latching circuit. A high input at pin 3 produces a low at pin 2, a high at pin 4, and a low at output pin 6. A low input takes pin 3 to ground; all other outputs change state producing a high output at pin 6. The output at pin 6 will remain high until the circuit is reset.

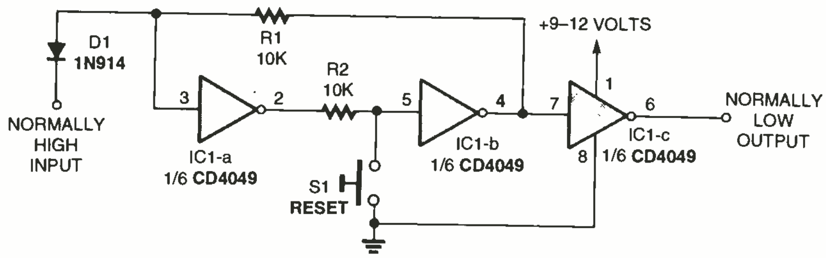

Fig. 8. This circuit will latch any momentary trigger—perfect for the burglars who think they know how to deactivate your alarm system.

PARTS LIST FOR THE TRIGGER-LATCHING CIRCUIT (FIG. 8)

SEMICONDUCTORS

IC1—CD4049 CMOS hex inverting buffer, integrated circuit

D1—1N914 silicon signal diode

ADDITIONAL PARTS AND MATERIALS

R1, R2—10,000-ohm, ¼-watt, 5% tolerance resistor

S1—Single-pole, single-throw, normally open momentary-contact switch

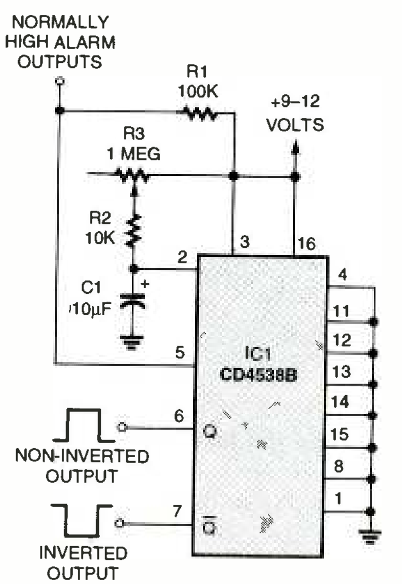

Fig. 9. Here is another variation on a time-delay circuit. The CD4538B contains two monostable multivibrators. The circuit is wired so that when the first one times out, the second one is tripped.

This circuit can be connected to the input of either alarm circuit (Figs. 5 and 6), through one of the Fig. 7 coupling diodes, or directly to the alarm input if no other sensors are connected.

"Last Call"

Our last two entries for this visit use a versatile CMOS 4538B dual precision-monostable multivibrator IC in a positive- or negative-input-trigger timer circuit. The first 4538B-timer circuit, shown in Fig. 9, is activated with a negative-going input trigger. The RC timing components are C1, R2, and R3. Resistor values up to ten megohms and capacitors up to 100 µF may be used in the timing circuit. The values shown in Fig. 9 will allow a maximum output pulse of about ten seconds. Timing periods up to several minutes are possible. Experiment with different values and choose the value that works best for you.

At rest, the output of pin 6 is low and pin 7 is high. When the circuit is triggered, the outputs will reverse for the timing cycle.

The positive-trigger-timing circuit using the 4538B is shown in Fig. 10. It operates with the same timing-component values used in the previous circuit. The outputs are the same as in the previous circuit; only the input requirement is reversed.

PARTS LIST FOR THE NEGATIVE-INPUT-TRIGGER ALARM (FIG. 9)

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)

R1—100,000-ohm

R2—10,000-ohm

R3—1-megohm potentiometer

ADDITIONAL PARTS AND MATERIALS

IC1—CD4538B CMOS d al precision-monostable multivibrator, integrated circuit

C1—10-µF, 25-WVDC, electrolytic capacitor

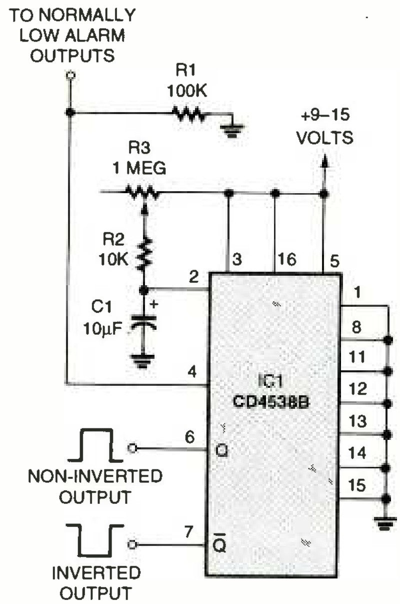

Fig. 10. By simply rewiring the connections, the exact same parts used in the circuit in Fig. 9 can work with the opposite polarity trigger signal.

PARTS LIST FOR THE POSITIVE-INPUT-TRIGGER ALARM (FIG. 10)

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)

R1—100,000-ohm

R2—10,000-ohm

R3—1-megohm potentiometer

ADDITIONAL PARTS AND MATERIALS

IC1—CD4538B CMOS dual precision-monostable multivibrator, integrated circuit

C1—10-µF, 25-WVDC, electrolytic capacitor.

These two timing circuits may be used to inhibit a sensor's output signal to allow entry without an alarm condition, or in any application where a timed delay is required.

All of the alarm circuits we've just looked at are not limited to alarm use only, but can be useful in many other circuit applications. In fact, most complicated circuits are made up of many basic and simple circuits, so few circuits are limited to a single application.

The sand is almost gone for our visit this time around. Meet me back here next month, and we'll tie all of the alarm circuitry together into a complete system with a loud alert sounder that can be built for "chicken feed." ■

AMAZING SCIENCE

(continued from page 52)

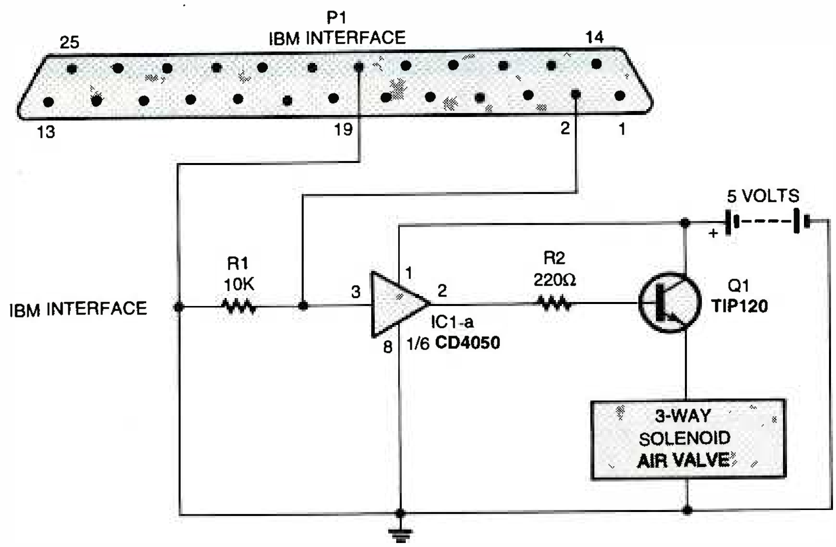

Fig. 15. A computer can also control the Mead valve. Although the circuit as shown is for a PC's parallel port, you can also use any type of five-volt logic—including Basic Stamps and OOPics. For more information on this subject, see Gordon McComb's "Robotics Workshop" columns in this magazine.

PARTS LIST FOR THE COMPUTER-CONTROL CIRCUIT (FIG. 15)

IC1—CD4050 non-inverting hex buffer, integrated circuit
Q1—TIP120 silicon transistor, NPN
R1—10,000-ohm, ¼-watt, 5% resistor
R2—220-ohm, ¼-watt, 5% resistor
P1—DB25 male connector
5-volt DC power supply, 5-volt DC
Isonic three-way solenoid-air valve (Mead)

the Isonic valve, the valve labeled "1" is normally open and valve 2 is normally closed. When activated, each valve changes state: valve 1 closes and valve 2 opens.

Figure 14 is a simple circuit for controlling an Isonic valve manually. The schematic in Fig. 15 takes that concept a step further. The Isonic valve is connected to the parallel port of an IBM PC for computer control of the air muscle. To operate the computer-control circuit requires a program; I've provided a simple Basic program to do that in Listing 1.

Going Further

Using pressurized air is an inconvenience, but one that can be overcome. For instance, at Case Western Reserve University, a team of faculty and students are building a "cricket" micro-robot that utilizes air muscles for walking and jumping. The micro-robot will walk and jump just like its biological counterpart. What makes this project so interesting is that the micro-robot is no larger than 5 cm (2 inches) in any dimension. To power the air muscles, the team made a micro-pump that supplies 35 PSI for the muscles.

As in all science, no problem is so insurmountable that it cannot be solved by applying a bit of ingenuity. **P**

LETTERS

(continued from page 60)

"charged" for personal telephone support or to answer questions via e-mail, and I never will. I also offer driver software for any of the EDTP kits that you will find on the EDTP Web site as a free download.

There are others like you that did not see the Internet Appliance Development Board as a useful item in the Internet sense. So, those readers (and kit builders) found that the Internet Appliance Development Board is a great (and cheap) PIC16F877 flash programmer.

I feel that your time is valuable, and you took some of that valuable time to let me know how to serve you better. Your comments have served as a tool to enable me to be a better author and thus make **Poptronics** a better publication. Thanks for reading and writing.

FRED EADY

[In response to Mr. York's comment concerning the availability of source code, that's left up to the author. As long as the object code is available, the project can be built. In short, if you want the source code to make your own modifications on most microcontroller-based projects, you're probably smart enough to create your own version.

*Carl Laron covered our policy on the source code/object code question in his **Electronics Now** editorial of June, 1998.—Editor.]*

Shedding Light on Lamps

I just got around to reading the April 2000 article by Gary McClellan. While the use of I1 might be considered an unusual design feature in terms of **Poptronics** articles, it is not so in electronics in general. Most circuits in use today were designed years ago and are updated as new devices became available.

When the Wien-bridge was designed, we only had tubes to work with. Those circuits were temperature sensitive. To correct for this, you could use a thermistor or a varistor (positive-temperature coefficient), or a lamp as the degenerative- (negative-) feedback device. Since thermistors and varistors were more expensive at that time, the common choice was to use a lamp. A No. 47 dial lamp was for the most part the lamp of choice for tube circuits. With the advent of transistors (germanium was the first type used), temperature was still a problem. Now that we use op-amps, the modern ones are fairly stable, but these have some temperature drift.

The use of the lamp solves three problems at the same time. As the author stated, it compensates for component-temperature drift, but also maintains an almost constant and undistorted signal at the output. Other devices used have been FETs and back-to-back LEDs. This is a useful circuit since 1 kHz is a good frequency for testing audio equipment.

WILLIAM J. NEWELL, JR.
Chief Petty Officer
USN (Ret.)
Toledo, OH

Haves & Needs

I am looking for a copy of the circuit diagram for a megohmmeter Model L-1CA manufactured by Beckman Instruments, Inc., Cedar Grove, NJ. Additionally, I am also researching the "Electromotograph" reciever-loudspeaker inventions of Thomas Edison, ca. 1875. Any help would be appreciated.

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Colorado Springs, CO 80909

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Newington, CT 06111

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Berwyn, IL 60402

Tri State Elex
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Mt. Prospect, IL 60056

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King of the Road Elec.
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Kokomo, IN 46902

Maryland

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Massachusetts

Electronic Hook-Up
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"You-Do-It" Electronics
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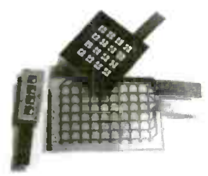

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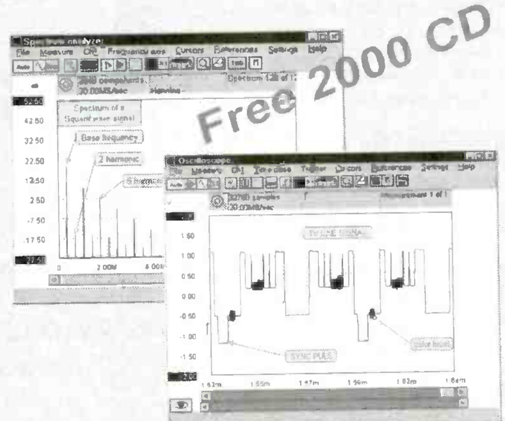

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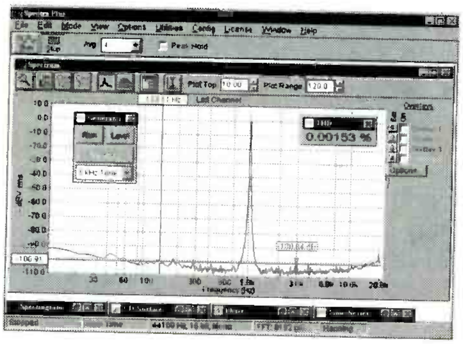

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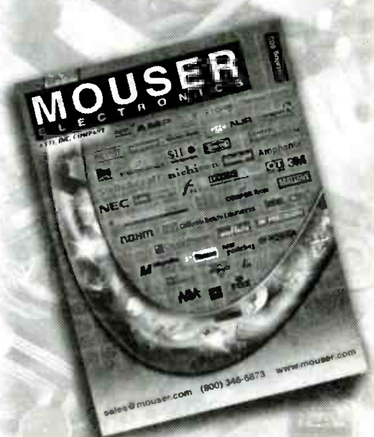

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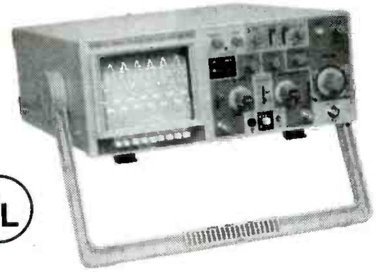

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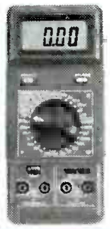

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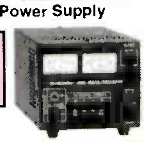

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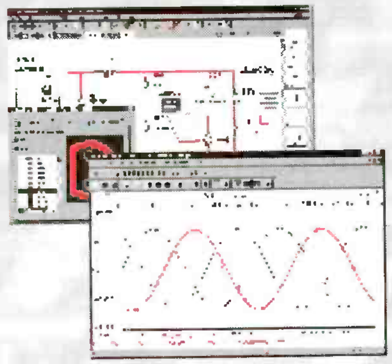

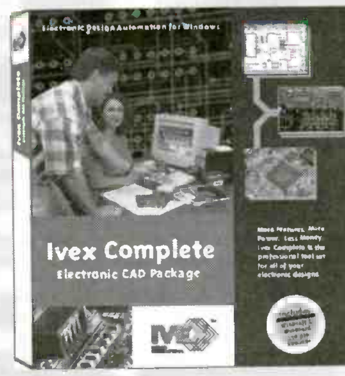

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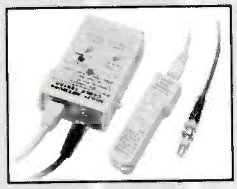

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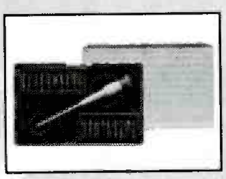

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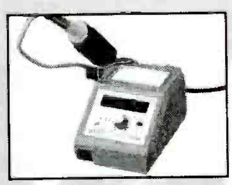

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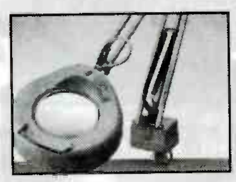

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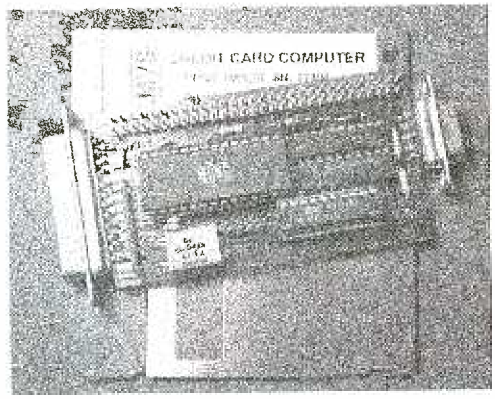

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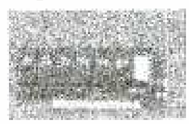

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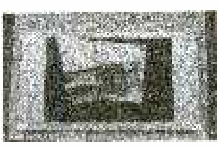

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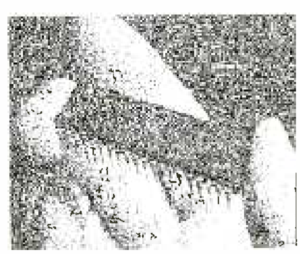

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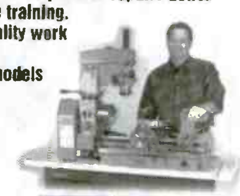

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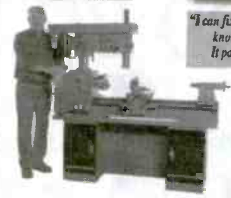

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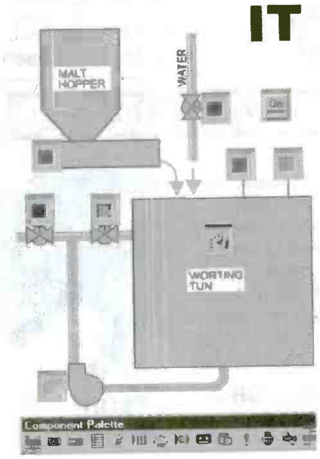

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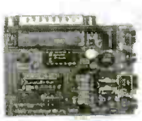

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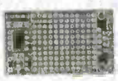

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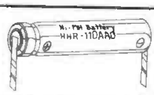

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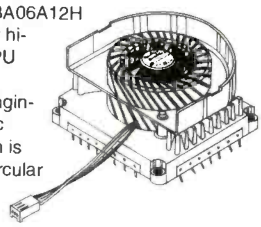

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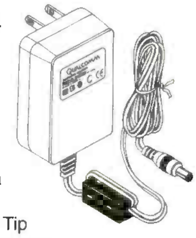

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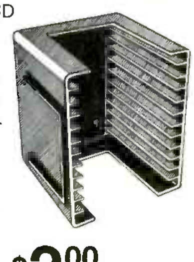

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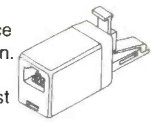

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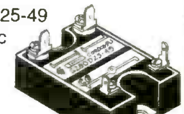

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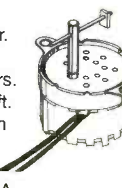

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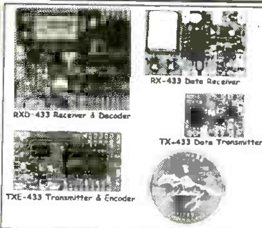
RSG-1000B RF Signal Generator $1995.00

Wireless RF Data Link Modules



RF link boards are perfect for any wireless control application; alarms, data transmission, electronic monitoring...you name it. Very stable SAW resonator transmitter, crystal controlled receiver - no frequency drift! Range up to 600 feet, license free 433 MHz band. Encoder/decoder units have 12 bit Holtek HT-12 series chips allowing multiple units all individually addressable, see web site for full details. Super small size - that's a quarter in the picture! Run on 3-12 VDC. Fully wired and tested, ready to go and easy to use!

RX-433 Data Receiver............ $16.95 TX-433 Data Transmitter............. $14.95
RXD-433 Receiver/Decoder..... $21.95 TXE-433 Transmitter/Encoder..... $19.95

Super Pro FM Stereo Transmitter

Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped if accompanied by a signed statement that the unit will be exported.*

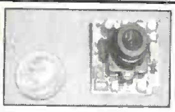
FM-100, Pro FM Stereo Transmitter Kit $249.95
FM-100WT, Fully Wired High Power FM-100.............. $399.95

World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies - that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Their very light weight and size make them ideal for balloon and rocket launches, R/C models, robots - you name it! Units run on 9 volts and hook-up to most any CCD camera or standard video source. In fact, all of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air! One customer even put one on his dog!

C-2000, Basic Video Transmitter.............. $89.95 C-2001, High Power Video Transmitter...$179.95

CCD Video Cameras



Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80°) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

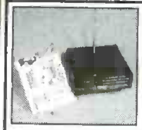
CCDWA-2, B&W CCD Camera, wide-angle lens $69.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens.. $69.95
CCDCC-1, Color CCD Camera, wide-angle lens $129.95
IR-1, IR Illuminator Kit for B&W cameras $24.95
IB-1, Interface Board Kit $14.95

AM Radio Transmitter

Operates in standard AM broadcast band. Pro version, AM-25, is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 is tunable, runs FCC maximum 100 mW, range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set that dresses up the unit. Great sound, easy to build - you can be on the air in an evening!

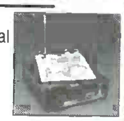
AM-25, Professional AM Transmitter Kit..... $129.95
AM-1, Entry level AM Radio Transmitter Kit... $29.95
CAM, Matching Case Set for AM-1.......... $14.95

FM Stereo Radio Transmitters



No drift, microprocessor synthesized! Great audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes snazzy case, whip antenna, 120 VAC power adapter - easy one evening assembly.

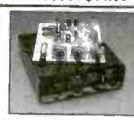
FM-25, Synthesized Stereo Transmitter Kit $129.95



Lower cost alternative to our high performance transmitters. Great value, easily tunable, fun to build. Manual goes into great detail about antennas, range and FCC rules. Handy for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or 5 to 15 VDC. Add matching case and whip antenna set for nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit................. $34.95
CFM, Matching Case and Antenna Set $14.95
FMAC, 12 Volt DC Wall Plug Adapter...................... $9.95

Mini Radio Receivers



Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast receiver which has subcarrier output for hook-up to our SCA adapter. The SCA-1 will tune in commercial-free music and other 'hidden' special services when connected to FM receiver. Add our snazzy matching case and knob set for that smart finished look!

AR-1, Airband 108-136 MHz Kit................ $29.95
HFRC-1, WWV 10 MHz (crystal controlled) Kit..... $34.95
FR-1, FM Broadcast Band 88-108 MHz Kit........ $24.95
SR-1, Shortwave 4-11 MHz Band Kit $29.95
SCA-1 SCA Subcarrier Adapter kit for FM radio.... $27.95
FR-6, 6 Meter FM Ham Band Kit $34.95
FR-10, 10 Meter FM Ham Band Kit......... $34.95
FR-146, 2 Meter FM Ham Band Kit......... $34.95
FR-220, 220 MHz FM Ham Band Kit......... $34.95
Matching Case Set (specify for which kit) $14.95

RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a freq range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set. Outdoor unit attaches right at the antenna for best signal - receiving or transmitting, weatherproof, too!

LPA-1, Power Booster Amplifier Kit $39.95
CLPA, Matching Case Set for LPA-1 Kit $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95
FMBA-1, Outdoor Mast Mount Version of LPA-1 .... $59.95

PIC-Pro Pic Chip Programmer

Easy to use programmer for the PIC16C84, 16F84, 16F83 microcontrollers by Microchip. All software - editor, assembler, run and program - as well as free updates available on Ramsey download site! This is the popular unit designed by Michael Covington and featured in Electronics Now, September 1998. Connects to your parallel port and includes the great looking matching case, knob set and AC power supply. Start programming those really neat microcontrollers now...order your PICPRO today!

PIC-1, PICPRO PIC Chip Programmer Kit $59.95

FM Station Antennas

For maximum performance, a good antenna is needed. Choose our very popular dipole kit or the Comet, a factory made 5/8 wave colinear model with 3.4 dB gain. Both work great with any FM receiver or transmitter.

TM-100, FM Antenna Kit $39.95
FMA-200, Vertical Antenna $114.95

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4 Jack Plug-ins: Safety design with different capacities for different functions.
Diode, Continuity Check Push-Button: For toggling between diode check and continuity check.
Low Battery Indicator: Advises you when it's time to change battery.
Extra Long 44" Test Leads: Helps get to hard to reach places
Screw-On Alligator Clips: Convert one or both probe tips to alligator clips.
Fuse-Protected Circuitry
Built-In Stand: Makes one hand operation easier.
Shock Absorbing Rubber Carrying Case: with convenient probe storage clips and hanging tab. Helps protect the DMM from damage if accidentally dropped.

Measures:
DC Volts: up to 1000V
AC Volts: up to 750V
AMPS: up to 20 Amps (AC & DC)
Resistance: up to 30M ohm
Continuity Check: with audible signal (signal sounds if resistance is less than 20 ohms. Display reads actual resistance).
Frequency: (1KHz to 300KHz) displays both digital and bar graph reading
Transistor hfe Test: Display shows approximate hfe value based on test condition of 10uA base current and Vce of approx. 3V.
Temperature Test: Measures from 0° to 1832° F (probe supplied!)
Diode Test: Tests if diodes are shorted or open
Input Impedance: 10Mohm (Vdc/Vac): over 100Mohm on 300 mVdc range

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#CSI9903

Specifications
Accuracy

Vdc:	±1.0% reading +5 ditis
Vac:	±1.5% reading +8 digits
Adc:	±1.2% reading +5 digits
Aac:	±1.5% reading +5 digits
Resistance:	±1.5% reading +5 digits
Frequency:	±3.0% reading +5 digits
Temperature:	±1.0% reading +6 digits

Requires two AAA batteries sold separately.

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For IDE/Ultra DMA Hard Drives

We Sold Over 14,000 In 1998!

This product can be used with any 3-1/2 IDE hard drive up to 1" high. It includes an electronic keylock for safe removal and insertion. Made of ABS 707 fireproof plastic. Use this product to protect sensitive hard drive data, take your hard drive between work and home or even set up different users with their own hard drives that they physically insert every time they use a PC. Other models available from C.S.I. Include RH10 series and RH20 series, which are interchangeable within the same interface design (IDE or SCSI). ***Other Models are Available.*** *See www.web-tronics.com under "hard drive and accessories" for more details and pictures.*

ONLY $14.95 any qty.

#RH-10C-IDE

Removable Hard Drive Rack with Auto Door And Cooling Fan
- Auto door on the outer frame
- ABS material of outer frame. High efficiency cooling fan
- Worldwide patent pulling function handle
- CE Approved
- Coating iron bottom cover
- For IDE interface
- For 1" high 3.5" HDD
- Not compatible with our RH10 & RH20 series. Compatible with our RH17-IDE model.

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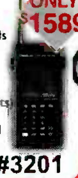
#MR-27

Details at www.web-tronics.com

2GHz RF Field Strength Analyzer
- Frequency Range: 100KHz to 2,060MHz
- Narrow Band FM (NFM), Wide Band FM (WFM), AM and Single Side Band (SSB) Modulated Signals May Be Measured
- PLL Tuning System for Precise Frequency Measurement and Tuning
- LED Backlight LCD (192x192 dots)
- Built-In Frequency Counter
- Hand-Held and Battery Operated
- All Functions are Menu Selected
- RS232C for PC Interface and Printer



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Detailed Specs on the Web

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VMCW-H12A 32mmx32mmx19mm, Color CCD with pinhole lens, pre-wired cabling, 12V DC Power Input $139.00 / $129.00 5 or more
VMPS-718A 25mmx25mmx30mm, B/W CCD with standard lens, pre-wired cabling, 12V DC Power Input $59.00 / $49.00 5 or more
VMPS-250A 25mmx25mmx15mm, B/W CCD with pinhole lens, pre-wired cabling, 12V DC Power Input $59.00 / $49.00 5 or more
VCC-3232 32mmx32mmx30mm, CMOS COLOR, std lens, see web for specs $79.00 / $72.00 5 or more

CCD B&W Board Cameras
- ***ASIC CCD Area Image Sensor***
- ***Extremely Low Power Consumption***
- ***0.5 Lux Min Illumination***
- ***Built-In Electronic Auto Iris for Auto Light Compensation***

Detailed Specs on the Web

LOWER PRICES

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VM1035A 42mmx42mmx25mm, Standard lens, 12V with back light compensation $49.00 any qty.
VMCB21 44mmx38.5mmx28mm, with 6 infra-red LEDs, 12V $49.00 any qty.
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- *Built-In Electronic Auto Iris for Auto Light Compensation*
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Detailed Specs on the Web

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VMBLT1020W B&W Weatherproof, 21mm(D)x58.5mm(L) $79.00 any qty.
VMBLTJC19BW COLOR! Weatherproof, 17mm(D)x88mm(L) $139.00 any qty.

COLOR CCD Mini Board Cameras
- *Low Power Consumption*
- *1 Lux Illumination*
- *Internal Synchronization*
- *12Volts*
- *400 TV Lines*
- *Built-In Electronic Auto Iris for Auto Light Compensation*

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VM3010PA 33mmx33mmx18mm, Pinhole lens $99.00 any qty.
VM3011-A 45mmx40mmx24mm, Standard lens, single board $89.00 any qty.
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See more detailed specifications at www.web-tronics.com in the CCD camera setcion.

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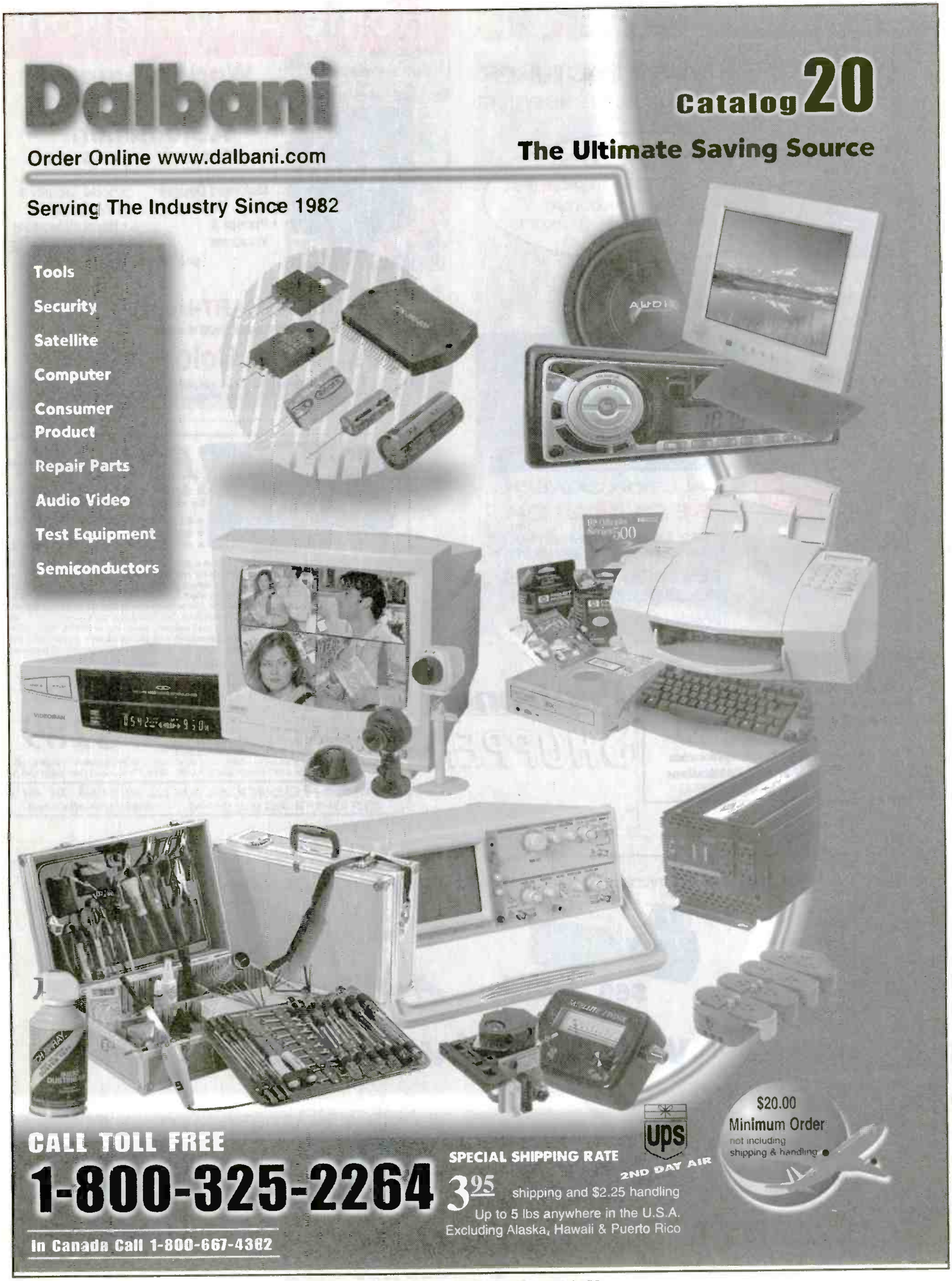

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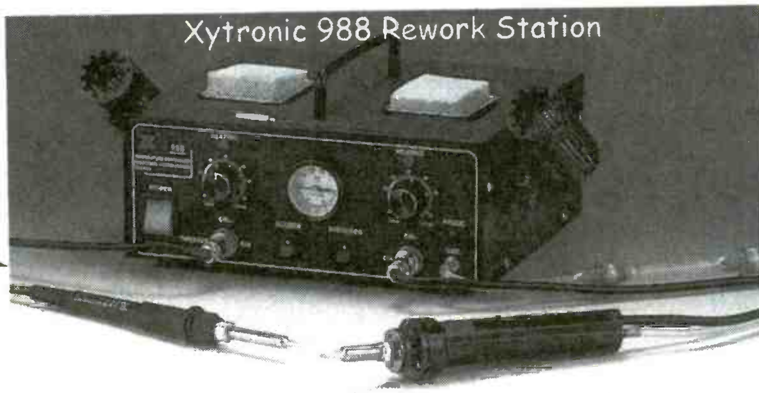

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Letter from a Very Satisfied Customer

When I first unpacked the solder station I was impressed with it's weight and feel. I fired it up and within a few seconds it was preheated and ready to go. I began to solder and loved the feel of the solder pencil. The heat is very adjustable and can be set to suit your needs. I have enjoyed soldering this last week. It's nice to not have the iron get so hot in your hand while soldering. Then it was finally time to desolder. The pump sounds smooth and has good power. At first I had a hard time working with it because of the pump staying on the extra few seconds, but after desoldering a few parts I got used to it. I just had to retrain my technique. Now when I use it I like that I can begin desoldering right away without unclogging it first. After I am done I use the cleaning stick and put it in the rest. So far it's always ready to go the next time I need it. I would attribute that to the pause mode. I have gone long periods of time between uses. I just push the button and within seconds it reheats to selected temperature and I am ready to go. After one week of use I am very impressed. It's a very good unit at a very good price! Thank You,
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PC Diagnostic Tool Set

- AMI Diagnostic Software
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Network Installation Tool Set

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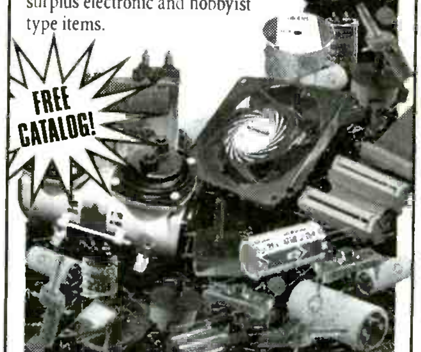

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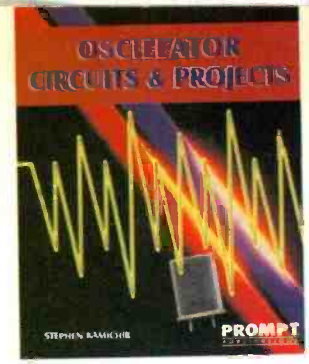

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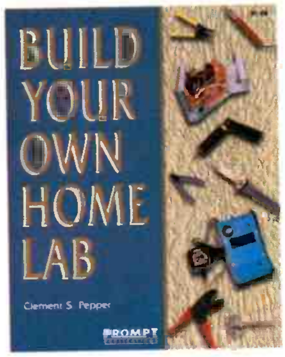

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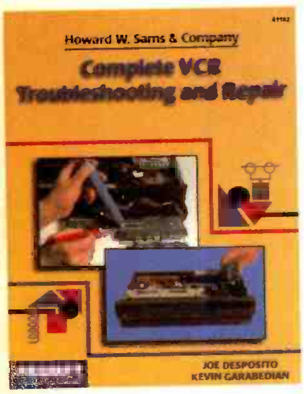

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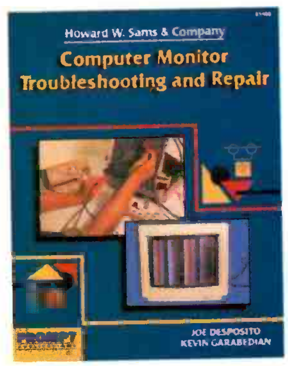

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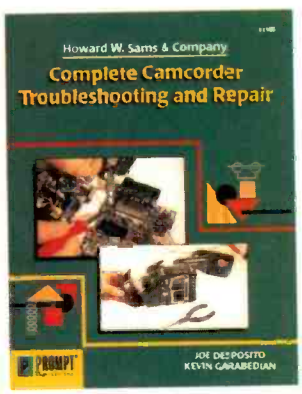

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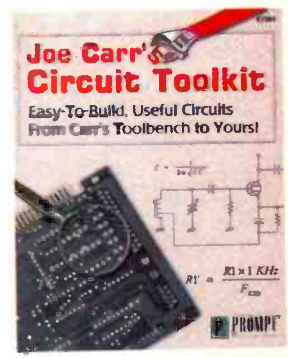

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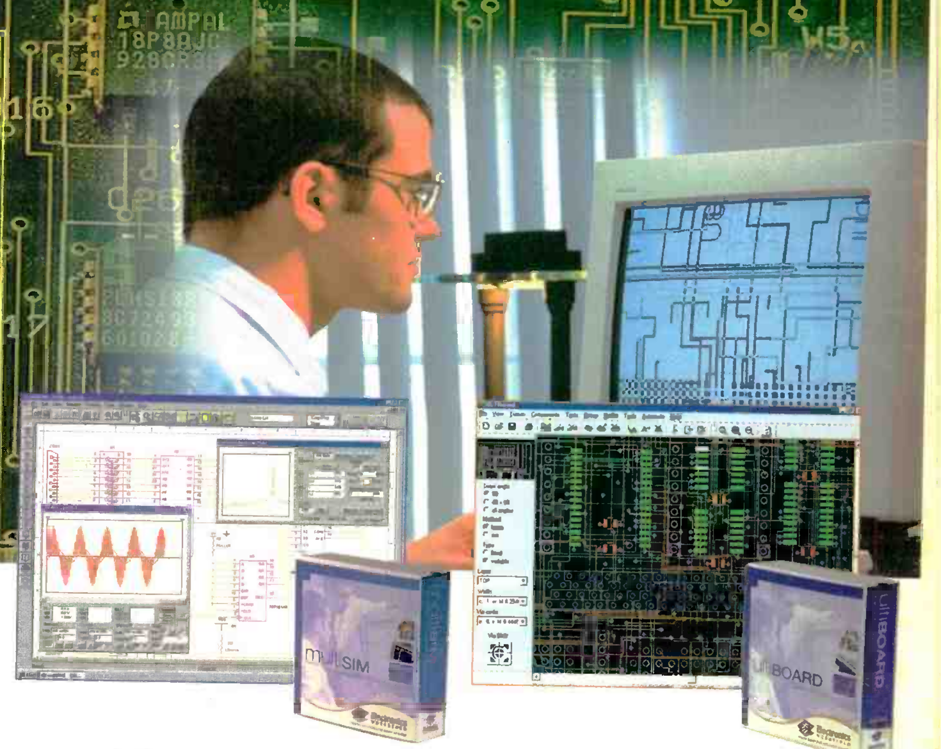

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