FIND HUGO’S HEAD AND WIN!
www.poptronics.com
APRIL 2002

INTRODUCING THE ALP
A gadget for audio sampling/looping and remote keying

Home Appliance Watt Meter/ Watt-Hour Meter
Keep track of energy expenditure appliance by appliance

The Visie-Talkie
A classic from the Gernsback Archives

Also Inside:
• Quantum Dots
• Magnetic Circuits
• All About Op-Amps
• Dissecting Laser Pointers
• Graphics Rendering Workstations
High Tech Video System with Audio

Only $119.00!!
only $109.99 ea. in qty 4

Complete Package! Includes Two B/W Cameras with I.R. (night vision) & microphones.
One 5.5" B/W Monitor with Built in Switcher. Two pre-wired 60 ft hook-up cables.
Everything you need to be up & running in minutes with a high tech video system!!

System Features:
- 2 wide angle B/W cameras w.I.R. & Sound
- 5.5" B/W video monitor w/built in switcher.
- Two 60 ft. pre-wired cables.
- View one or both cameras. Switching Time variable from 2 to 20 seconds.
- Video easily hooks into a VCR.

Complete details at our web site!

www.web-tronics.com

Circuit Specialists Inc.

www.web-tronics.com

www.web-tronics.com

Removable H.D. Racks

For IDE/Ultra OMA Hard Drives

WinDrive Over 10,000!

This product can be used with any IDE hard drive up to 1.1GB. It includes an electronic keypad for safe removal and insertion. Made of ABS 7075 treaded plate. 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.J. include HDD & HDD series, which are interchangeable with the same model design or SCSI. Other Models Available. See www.web-tronics.com under "Hard Drive and accessories." For more details and pictures.

www.web-tronics.com

www.web-tronics.com

www.web-tronics.com

MinCi DCs (B/W & Color)

Sensational New Design for Small Observation Cameras. Smaller and Better!

Electronic Auto Iris for Auto Light Compensation

Ultra Mini Design

Black & White Versions Only 25mm x 25mm

Color Versions Only 32mm x 32mm

Available in Standard Lens or Pinhole Lens

All include Pre-Wired Cable Harness for Video & Power

12V Regulated Power Supply Required (120mA typical power consumption)

0.1 LUX Rating (B/W), 1 LUX (color)

CCD Area Image Sensor for Long Camera Life

Back Light Compensation Circuit

Built-In Electronic Auto Iris Lens

VMCW-H11A 33mmx32mmx25mm, Color Ccd with standard lens, pre-wired cables (12V DC Power 113.90/129.95 or more)

VMCW-H12A 33mmx32mmx19mm, Color Ccd with pinhole lens, pre-wired cables, 12V DC Power Input (159.90/179.95 or more)

VMPS-718A 25mmx25mmx30mm, B/W CCD with standard lens, pre-wired cable, 12V DC Power Input (59.90/69.95 or more)

VMPS-250A 25mmx25mmx15mm, B/W CCD with pinhole lens, pre-wired cable, 12V DC Power Input (79.90/99.95 or more)

VCC-2332 12mmx12mmx15mm, CMOS COLOR, std lens, see web for specs (79.95/179.95 or more)

Bench Digital Multimeter

RS232C Interface

True RMS/AC Voltage & Current

Digital & Analog Display

3990 Counts

Large 3 1/2 Digit Display

Data Hold, Max/Min Relative Measurement

Storage, Data Display, Recall

Back Light

ADP Measurement: 800mA+/10V (Digital/10V DC Contingency)

Continuous/10 ms Dual 10 ms

Only $99.00!

NEW!

Digital Multimeter

Raytek Mini Board Cameras

- L.P. Low Power Consumption
- 15 Volt
- CCD Area Image Sensor for Long Camera Life
- Built-In Electronic Auto Iris for Auto Light Compensation
- No Bloom/No Blooming
- 0.1 Lux Min Illumination (B/W), 1 Lux Min Illumination (color)

VMBLT1020 B/W 2.1mm(D)x5.5mm(L), $54.00 any qty.

VMBLT1020W B/W Weatherproof, 1.1mm(D)x5.8mm(L), $79.95 any qty.

VMBLT1020V B/W Weatherproof, 1.1mm(D)x5.8mm(L), $79.95 any qty.

VM3010P-3 33mmx33mmx18mm, Pinhole lens, $99.95 any qty.

VM3010A-1 33mmx32mmx23mm, Standard lens, $99.95 any qty.

New!

DC to AC Power Inverters!

150 watt up to 3000 watt models!

150w modified sine wave: $29.95 (G-12-015B)

300W modified sine wave: $39.95 (G-12-030)

150w pure sine wave: $69.00 (G-12-050)

300w pure sine wave: $109.00 (G-12-300)

800w modified sine wave: $139.00 (G-12-800)

1000w modified sine wave: $179.00 (G-12-1000)

3000w modified sine wave (phase corrected) (G-12-3000)

$499.00

See Our Website for DETAILED SPECS!!

Removable Hard Drive Rack with Auto Door and Cooling Fan

- On / off switch
- ABS plastic
- Worldwide patent pending function
- CE Approved
- For IDE Interface

One 5 1/2" B/W Video Monitor

- Pure sine wave: $69.00 (G-12-015B)
- Modified sine wave: $29.95 (G-12-030)

Accurate and stable line regulation make the DC to AC power inverters the best choice for lab and educational use.

Line Regulation: 2% ± 1% /1 min

Load Regulation: 1% ± 0.5% /0.5 min

LED Accuracy: Voltage 1% ± 2 digits

Current ± 1% ± 2 digits

Wave Line Noise: 506 Hz

Dimensions: 291mm x 158mm x 136mm

See our web-site for many other power supply deals.

CIRCUIT SPECIALISTS, INC. 220 S. Country Club Dr., Mesa, AZ 85210 800-528-1471/480-464-2485/FAX: 480-464-5824 CIRCLE 233 ON FREE INFORMATION CARD

www.americanradiohistory.com
FEATURES

INTRODUCING THE ALP .................................................................William Sheets and Rudolf F. Graf 26
The ALP can sample and loop audio, as well as remote-key a transmitter.

THE VISIE-TALKIE ........................................................................Grego Banshuk 24
A classic re-printed from April 1945's Radio-Craft. Take note of the author's name.

BUILD THIS HOME APPLIANCE WATT METER/WATT-HOUR METER .................Fernando Garcia 32
Now you can track your energy expenditure appliance by appliance.

PRODUCT REVIEWS

GIZMO® ..........................................................................................7
Feast your eyes on the latest consumer electronics that range from in-wall speakers to pocket PCs.

DEPARTMENTS

PROTOTYPE ........................................... Maria Orlando 15
Quantum dots and particle accelerators are just two of this month's highlights.

COMPUTER BITS ................................................................. Ted Needleman 18
Thinking of using a dedicated server? Explore the options available for running your own Web site.

PEAK COMPUTING .......................................................... William Sheets and Rudolf F. Graf 20
Putting last month's workstation to the test using high-end graphics rendering.

ALL ABOUT ................................................................. William Sheets and Rudolf F. Graf 20
The op-amp, a workhorse found in nearly every benchstock, is this month's topic.

AMAZING SCIENCE ............................................................ John Iovine 42
Find out how to build a PC interface for a robotic arm.

SERVICE CLINIC .............................................................. Sam Goldwasser 46
Take a detailed look inside laser pointers and see what makes them work.

Q&A ................................................................. Dean Huster 49
Here you will find answers to questions, problems resolved, and stories swapped.

BASIC CIRCUITY ............................................................... Charles Rakes 54
Here are some quick and basic projects to inspire even the most jaded inventors.

AND MORE

EDITORIAL .............................................................................. 2
NEW LITERATURE ..................................................................... 3
YESTERDAY'S NEWS ................................................................ 4
NEW GEAR ............................................................................. 5
POPTRONICS SHOPPER ................................................. 59
ADVERTISING INDEX ....................................................... 80
FREE INFORMATION CARD .................................................. 80A


A stamped self-addressed envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

As a service to readers, Poptronics publishes available plans or information relating to newsworthy products, techniques, and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, Poptronics disclaims any responsibility for the safe and proper functioning of reader-built projects based upon or from plans or information published in this magazine.

www.americanradiohistory.com
Hide and Hugo Seek!

We decided to have some fun this month by playing a game with our readers. The name of the game is Hide and Hugo Seek, and it's easy to play and win. Three images of Hugo Gernsback's head have been hidden within the pages of this issue. All you need do is find the three heads, write the page numbers where they were found on a postcard, and mail the postcard to: Hide & Hugo Seek, 275-G Marcus Blvd., Hauppauge, NY, 11788. There will be twenty contestants randomly chosen from all the correct entries that have been postmarked no later than April 30, 2002. Winners shall receive a prize package of various goodies from Uncle Hugo's Voltage Vault. No purchase is necessary, so if you cozy up with a copy of Poptronics at your local bookseller or library, you can play too! So, what are you waiting for? Go find Hugo's head.

In other news...the latest boom in technology is sure to be focused around fuel cells. Readers may remember the fuel-cell series that appeared in "Amazing Science" during February, May, and June of 2001. Author John Iovine told our readers about the various versions of these alternative fuel sources, and then he even showed us how to make our own energy-yielding cells. Now, everywhere from Texas to Tokyo, investors are backing ventures that are researching and developing alternative forms of energy that would incorporate fuel cells. Japan's National Space Development Agency (NASDA) and Tokyo's Institute for Laser Technology are working together to develop one such project, "New Sunshine." Mashiro Mori of NASDA told members of the Associated Press about this program, and how it would employ Low Earth Orbit (LEO) satellites that would collect solar energy to be fed to a solar pump. The solar pump transfers photons of sunlight into a solid-state laser. The laser amplifies the sunlight into approximately ten megawatts of energy. Finally, the laser is aimed at a tank of seawater that has been treated with a breakdown catalyst (titanium dioxide). The tank also has an optic array mounted above it for concentrating the incoming beam fired from the LEO satellite. The resulting blast of energy would be used to rip apart water molecules. This is only one of several alternatives to ordinary electrolysis. Opponents have argued over the fact that it takes electricity to create electricity in the case of electrolysis. Another popular alternative is the so-called "bug-batteries," which use living microbes to break down various hydrogen-yielding compounds. What's this mean to us? Well, experts don't foresee a widespread availability of fuel-cell cars until at least 2010, but there is no doubt in my mind that fuel-cell companies, cooperatives, and ventures will be popping up like prairie dogs. By the way, this is April's issue and we've included our traditional April Fool's feature. This time we relied on an old pro of the goof genre. The joke's on us though, because as absurd as this story scoured over fifty years ago, fantasy became reality.

Happy Reading,

Chris La Morte
Managing Editor
Teach Yourself Algebra
For Electric Circuits
by K. W. Jenkins
McGraw-Hill
Two Penn Plaza
New York, NY 10121-2298
800-2MCGRAW
$34.95
www.books.mcgraw-hill.com
This self-tutoring guide, specially geared for those who work with electric circuits, is a useful self-enrichment tool for upgrading math skills and learning the methods that support today’s technological growth. It contains hundreds of practical problems with detailed solutions as well as over 300 illustrations for easier comprehension. Also included are circuit-focused applications and special help with the algebra of logic and matrices.

The Audiophile’s Project Sourcebook
by G. Randy Slone
McGraw-Hill
Two Penn Plaza
New York, NY 10121-2298
800-2MCGRAW
www.books.mcgraw-hill.com
$29.95
The clear, illustrated schematics and instructions provided in this book allow audio enthusiasts to build high-quality, high-power electronic audio components and testing equipment. The author gives easily comprehensible explanations of the electronics at work, as well as a practical foundation needed for experimentation and modification of existing audio equipment. Other projects include voltage amplifiers, balanced input driver/receiver circuits, graphic equalizers, and effects circuits.

Digital Electronics Guidebook
by Myke Predko
McGraw-Hill
Two Penn Plaza
New York, NY 10121-2298
800-2MCGRAW
www.books.mcgraw-hill.com
$34.95
Intended for electronics hobbyists and students who want to understand digital logic, this book features more than 20 projects for designing, constructing, and interfacing TTL (Transistor-Transistor Logic) circuits. From constructing your own simple 8-bit computer to creating and debugging applications, the author explores the art of digital electronics through step-by-step instructions and demonstrations of project-assembly techniques.

Teach Yourself Electricity and Electronics,
Third Edition
by Stan Gibilisco
McGraw-Hill
Two Penn Plaza
New York, NY 10121-2298
800-2MCGRAW
www.books.mcgraw-hill.com
$34.95
Learn the fundamentals of computing, communications, robotics, and entertainment devices through this introductory course in electronics. The text offers a user-friendly, independent-study approach, complete with practical examples, learning-enhancing illustrations, and test-yourself questions. Perfect for both hobbyists and students, this edition presents simple circuit design, new information on wireless technologies, advanced applications in artificial intelligence, and more.

Robots, Androids, And Animatrons, Second Edition
by John Iovine
McGraw-Hill
Two Penn Plaza
New York, NY 10121-2298
800-2MCGRAW
www.books.mcgraw-hill.com
$19.95
Build your own walking, talking, thinking robot with the projects covered in this book on amateur robotics. Providing you with the building blocks of electronics and motion control, the book enables you to construct a robotic arm that responds to your spoken command, put together basic modules to create sophisticated robot designs of your own, and more. First-time robot builders and advanced hobbyists can complete these projects without programming or assembly language skills.
**Dateline: April 1952 (50 years ago)**

In this issue, a *Radio-Electronics* editorial on collision-proof cars begins to explore the possibility of electronically-controlled cars. Brakes programmed to activate when a car comes within two or three feet of another object would be installed on the front fender, therefore limiting collisions. In the "Theory and Engineering" section, Mohammed U. Fips humorously shows how sound can be neutralized by a dead-beat heterodyne. Readers also learn how to make a rain detector that sounds an alarm with a single drop and how to construct a voltage-regulated power supply.

**Dateline: April 1972 (30 years ago)**

Summer months usually mean more time in the car. In this issue, *Radio-Electronics* gears up readers with add-on electronics for a more comfortable ride. Articles explain how to soup-up your car in time for vacation with ignition systems, RPM limiters, Dwell stretchers, or cassette players. For those who prefer to stay indoors during the hot months, other articles explore the difference between amplitude and tilt controls for the television, how to tell if the tuner is bad, or a way to develop a new surround sound system, from any direction, using omnisonics.

**Dateline: April 1992 (10 years ago)**

This issue of *Popular Electronics* is devoted to improving the quality of at-home technology, without spending a fortune. For $25 or less, readers learn how to construct an enlarging light-meter for more professional darkroom print developing. The quality of low-budget audio projects is enriched with bass and treble booster controls, and guidelines are presented for choosing the best all-around audio equipment. In addition, combining an agitator with an imbalanced motor and a heat lamp makes it easier and quicker to etch printed circuit boards.
Safe Transport

Safe transportation of your equipment is as important as choosing the right tool for each job. The SKB Roto-X Series of Rotationally Molded Shipping Containers ($235-$675) provide the ultimate protection for all shipping environments. The cases' exterior design allows for efficient stacking and storing and feature a recessed twist-latch padlock housing. You can add an interior foam lining and external wheels for easier transport.

JENSEN TOOLS, INC.
7815 S. 46th St.
Phoenix, AZ 85044-5399
800-426-1194
or 602-453-3169
www.jensentools.com

CIRCLE 60 ON FREE INFORMATION CARD

Generating A Pulse

Expanding on its already extensive Model 500 series of digital delay/pulse generators, BNC has added the 555 4-Channel Digital Delay Generator ($2270) to the list. The 555 Generator provides pulses of 2, 4, or 8 with a 1-ns resolution. Each output can be individually adjusted by programming the controls from the font panel or via the GPIB or RS232 interface. Other adjustments, such as setting the delay from 0–100 seconds, are made this way, too.

BERKELEY NUCLEONICS CORP.
3060 Kerner Blvd. #2
San Rafael, CA 94901
800-234-7858
www.berkeleynucleonics.com

CIRCLE 63 ON FREE INFORMATION CARD

Hand-Held Radiation Detector

Taking a versatile and durable hand-held radiation monitor into the field is essential for measuring alpha, beta, and gamma rays. The Gamma Scout Radiation Detector ($330) measures all three at 4-, 2-, and .02-MeV, respectively. Field applications and data logging are simplified with the on-board memory and serial port, along with an extra-large, easy-to-read LCD display mounted on the face of the Novodour housing. The Gamma Scout also features a Geiger-Muller tube detector and comes with an ultra-long-life 10-year battery.

SCIENTIFICS
Edmund Scientific
Dept. A021-C999
60 Peace Ave.
Toms River, NJ 08755
716-874-9091 or 800-728-6999
www.scientificsonline.com

CIRCLE 61 ON FREE INFORMATION CARD

Illuminating Measurements

AEMC introduces two new light meters, Models C.4811 ($119) and C.4813 ($165), that measure illumination on four ranges in either footcandles or lux, from .1–20 kfc/lux. The C.4813 also features a fifth range of 200 klux for higher sensitivity and responds better to common light sources. The two meters have a removable, optical sensor designed to match the response of the human eye. They include a 3½-digit back-lit LCD, as well as PEAK, HOLD, and MAX functions.

AEMC INSTRUMENTS
200 Foxborough Blvd.
Foxborough, MA 02035-2872
800-343-1391 or 508-695-2115
www.aemc.com

CIRCLE 62 ON FREE INFORMATION CARD

Then There Was Color

It took 25 years for color to be added to televisions to enhance the viewer's experience. It took only two years after the launch of the ScopeMeter 190 Series of handheld oscilloscopes for Fluke to add two full on-screen color test tools. The 196C (MSRP $2695—without software) and 199C (MSRP $2995—without software) help make identification and differentiation of individual waveforms considerably easier while maintaining and improving the capabilities previously featured within the series, from a faster update rate to a new triggering mode.

FLUKE CORP.
P.O. Box 9090
Everett, WA 98206
800-447-5853
www.fluke.com

CIRCLE 64 ON FREE INFORMATION CARD
Network Cable Testers
The Model 230A Multi-Network Cable Tester ($69) and the Model 231A Deluxe Multi-Network Cable Tester ($79) are portable, lightweight, and battery-powered. They can be used for testing cables such as 10Base T, 100Base Tx, 356A, Token Ring, and more. Both models feature a protective rubber boot, belt clip, and a built-in remote terminator-storage compartment. The accompanying remote unit allows the user to test installed cable either from the wall plate or patch panel.

B&K PRECISION CORP.
1031 Segovia Circle
Placentia, CA 92870-7137
714-237-9220
www.bkprecision.com
CIRCLE 65 ON FREE INFORMATION CARD

High-Temp Wire Connectors
Designed for applications in high-temperature conditions up to 150°C (302°F), these Hi-Temp Wire Connectors (from $5.50-$10.50 per bag of 100) are fire-retardant and heat-resistant. The high-dielectric, thermoplastic shell provides superior flash-over protection and prevents exposure of bare wire. Available in four sizes, these connectors are perfect for HVAC, automotive, consumer, electrical, and industrial applications.

GARDNER BENDER
P.O. Box 3241
Milwaukee, WI 53201-3241
800-624-4320
www.gardnerbender.com
CIRCLE 67 ON FREE INFORMATION CARD

AC Multitester
The open-jaw clamp-on feature of Model 38393 AC Multitester ($79) enables the user to test one wire after another in a circuit box or control panel without opening and closing the jaws. It measures AC current to 200 A, resistance, frequency, capacitance, and duty cycle. Unique twin LCDs (2000-count ammeter and 4000-count multimeter) display AC current and test-lead function simultaneously. Other specs include data hold, continuity beeper, diode, and relative for non-current function.

EXTECH INSTRUMENTS
285 Bear Hill Road
Waltham, MA 02451-1064
781-890-7440
www.extech.com
CIRCLE 66 ON FREE INFORMATION CARD

Sound-Off
A two-scale, direct-reading decibel meter allows the Sound Level Meter (model 30387-32) ($160) to be used in home, at school, or for industry. The low-scale indication ranges from 40-80 dB, while the high scale ranges from 80-120 dB. This lightweight and compact test tool features a battery check and calibration settings, along with a 1- X 2-inch window.

SCIENTIFICS
Edmund Scientific
Dept. A021-C999
60 Pearce Ave.
Tonawanda, NY 14150
716-874-9091 or 800-728-6999
www.scientifics.com
CIRCLE 66 ON FREE INFORMATION CARD

Bit Driver
Featuring an extra-strong magnet for safe bit retention, this ¼-inch hex Bit Driver ($25) meets safety standards and has been tested for use up to 1000 V. The tool comes with six ¼-inch hex bits—one 0.31 slotted, one 0.47 slotted, two Phillips #1, and two Phillips #2. It may be used with most 1-inch long ¼-inch hex drive bits, and the six-bit storage compartment with the rotating window in the handle allows easy bit selection.

JENSEN TOOLS
7815 S. 46 Street
Phoenix, AZ 85044-5399
602-453-3169
www.jensentools.com
CIRCLE 69 ON FREE INFORMATION CARD
Mobile XM Antenna

XM Satellite Radio provides a huge selection of digital, commercial-free music and talk radio channels. The TRK-SR1 antenna ($99.95) helps you listen to XM radio in your car. It attaches to a rear or side window using a special acrylic adhesive for a simple, “no-drill” installation. The antenna passes DC power and RF signals through the glass surface to an interior coupler that is then hard-wired to the XM receiver. Everything required for installation is included, as is a protective sleeve for use in car washes.

Terk Technologies Corp., 63 Mall Dr., Commack, NY 11725; 631-543-1900; www.terk.com.

CIRCLE 50 ON FREE INFORMATION CARD

In-Wall Speakers

Get room-filling sound without filling the room with large speakers, with the CAS Series Model 3.1 in-wall loudspeaker ($1500 each). The Baffle Isolation System prevents the speaker from transferring vibrations to the surrounding wall, reducing resonance and providing superior clarity. The three-way speaker uses Ceramic Metal Matrix Diaphragm technology in its 9-inch woofer, 3½-inch midrange, and 1-inch tweeter. This technology is said to deliver unmatched clarity and tonal accuracy throughout its frequency range. This easy-to-install unit’s Listening Window Selector lets you tailor its performance for smooth frequency response throughout the listening area.


CIRCLE 51 ON FREE INFORMATION CARD

Hands-Free Car Talk

There are no tangled cords with the EarBoom Winder ($34.95), compatible with any mobile phone with 2.5mm jacks and with Nokia 8000/3000 series phones. It lets you talk hands-free and then retract the cord and stow the EarBoom at the touch of a button. The device can be clipped to a belt, purse, or pocket to keep it in easy reach. It includes six EarGels—a pair each in small, medium, and large. EarGels fit comfortably inside the ear, boosting and channeling sound directly into your ear canal.

JABRA Corporation, 9171 Towne Center Dr., #500, San Diego, CA 92122; 800-327-2230 or 858-622-9955; www.jabra.com.

CIRCLE 53 ON FREE INFORMATION CARD

Progressive-Scan Video Processor

Designed for use with 31.5-kHz display devices, progressive-scan monitors/receivers, flat-panel display systems, DTV monitors, and front- or rear-projection systems, the TB-6001 TrueScan Progressive Scan Display Interface ($800) accepts any NTSC S-video, composite-video, or component-video source. With reversed 3-2 pull-down processing for any film source, the device corrects for the different frame rates used in film and video for performance that is free of motion artifacts, jagged edges, and redundant or wrong fields. Special 2-2 pull-down processing offers crisp video images, and 4:4:4 video-processing technology doubles the horizontal resolution for greater picture detail.


CIRCLE 54 ON FREE INFORMATION CARD

Medicine Reminder

How do you keep track of the pills and vitamins you take on a daily basis? If your hit-or-miss method results in more misses than hits, look into the Automatic Vitamin & Pill Organizer ($69.95). Delivering the proper dosage at the press of a button, it can be programmed for a week’s worth of four doses per day or 28 days of single doses. An alarm clock beeps, a light blinks, and a message flashes on the LCD when a dose is due; and the scheduled pills rotate into position to be released into the handy cup.

The Sharper Image, P.O. Box 7031, San Francisco, CA 94120-9703; 800-344-4444; www.sharperimage.com.

CIRCLE 52 ON FREE INFORMATION CARD
HDTV Monitor

The handsome 34PW9847 34-inch direct-view HDTV monitor ($4499) has a black high-gloss finish and features a matching stand with an integrated analog clock. Its flat picture tube creates a distortion-free, crisp image. Digital Natural Motion, progressive scan, line doubling, and Active Control features enhance the image; and the Pronto universal touchscreen remote rounds out the home-theater experience.

Philips Consumer Electronics; 64 Perimeter Center East, Atlanta, GA 30346; 770-821-2400; www.philips.com.
CIRCLE 55 ON FREE INFORMATION CARD

Big-Sounding Mini-System

The Soundgear SG-3030 high-performance mini-system ($399) is equipped with a three-disc CD changer and a full-logic dual-well cassette deck. The distinctively styled system boasts 200 watts of power and three-way loudspeakers. Patented VMAX digital signal processing produces realistic, three-dimensional surround-sound audio using just two speakers. The system includes an AM/FM tuner, clock with sleep timer and dual wake-up alarms, and three-position EQ and Bass Boost controls.

JBL, Inc.; 250 Crossways Park Drive, Woodbury, NY 11797; 800-336-4525 or 516-496-3400; www.jbl.com.
CIRCLE 56 ON FREE INFORMATION CARD

Mobile Amp

Get your car rocking with the XA4300 ($229.95) four-channel mobile amplifier, which provides 100 watts × 2 and 50 watts × 2 into 4-ohm load (150 watts × 2 and 75 watts × 2 into 2 ohms). The amp can be bridged to provide 300 watts to one channel, while still providing 50 watts × 2 rms—ideal for powering both subwoofers and satellites from the same amp. Other features include a remote bass control, a selectable crossover, and variable bass boost.

CIRCLE 58 ON FREE INFORMATION CARD

Powered Up

Providing big sound in small spaces, the RL-28W ($499) powered subwoofer features unique, stacked dual 8-inch woofers in a slim-profile cabinet. Powered by a robust 200-watt rms discrete amplifier, the subwoofer delivers dramatic bass response measured from 35 to 120 Hz (+2 dB). It offers continuously variable output and crossover controls, allowing its sound to be precisely matched to other components.

CIRCLE 57 ON FREE INFORMATION CARD

Taking the Floor

Bose might be known for tiny, inconspicuous speakers and components, but it's no slouch when it comes to floor-standing speakers, either. The 701 Series II ($998) speaker system features patented Direct/Reflecting speaker technology for balanced stereo sound. The speakers deliver deep, powerful bass without the port noise or compression often found with conventional speakers, and dedicated amplification gives low frequencies even more impact. The 701 is compatible with amplifiers up to 300 watts per channel, rated 4 to 8 ohms.

CIRCLE 59 ON FREE INFORMATION CARD
1-GB CompactFlash Card

The world’s highest capacity standard CF Type I CompactFlash card to date, with an amazing 1-gigabyte of memory, is able to store more than 1000 digital images, more than 20 hours of digital music, or several hours of video. The 1-gigabyte CompactFlash Card can be used in digital cameras, music players, and other portable electronic devices. Priced at “less than $800,” you might expect it to come with one or more of those items, but huge storage capacity doesn’t come cheap!


Home Networker

Home computer users can now access the Internet from two different computers at the same time without running any cables, using the Hewlett Packard/RCA H950 SystemLink ($249.95) and existing electrical wires and outlets. The external USB-to-powerline network adapter allows shared Internet access, remote printing, multi-user game playing, and transferring and sharing files. It sends digital signals over existing wires at rates of up to 2Mbps. The expandable system can handle up to 20 computers with add-on SystemLink nodes. The basic package includes two plug-in nodes, two parallel cables, two USB cables, and software.


Compact Power Protection

Aimed at SoHo computer systems, the Ellipse Premium uninterrupted power supplies (UPS)(starting at $220) are only three inches deep, yet pack enough battery power to keep a Windows NT server running for an hour (depending on configuration). An advanced voltage regulator allows the UPS to ride through deviations in input voltage without discharging the battery during momentary brownouts. The 650, 800, and 1200-VA models each include Solution-Pac power-management software for Windows 95/98/2000, NT Novell Netware, SCO Unix v.3.0 and Openserver 5.0, and Linux.


PC Phone Home

The Maestro Pocket PC ($649) connects easily with an Audiovox CM-9100 cell to provide complete Internet access without the need for an add-on modem or an additional wireless ISP. The small, lightweight unit features both 32 MB of SDRAM and 32 MB Flash ROM, as well as built-in CompactFlash and SD card slots. It’s equipped with an Intel Strong ARM 206-MHz processor and Windows-powered Pocket PC 2002 software. Packaged with the cell phone, Maestro is being offered through wireless carriers.

**Business Buzz**

**ROOT TRACER**
Genealogy enthusiasts can make sure their family trees are accurate at www.FamilyTreeDNA.com, which now offers 21-marker Y-chromosome DNA testing to analyze for genetic matches between males, and mitochondria (mtDNA) testing for females. A perfect match in the 21-marker DNA test indicates that the two subjects share a Most Recent Common Ancestor (MRCA) within 8.3 generations. The tests help people connect with relatives when the conventional paper trail ends, allow individuals to determine if they have a common ancestor, and help verify the accuracy of surname-based family tree projects. When two test subjects show identical markers, they are notified of the results (provided both parties have signed a release form).

**ONE-Gbit NAND FLASH CHIP**
Toshiba and SanDisk have introduced the first commercial one gigabit NAND flash memory chip, effectively doubling the amount of storage that the companies can put in their flash memory cards. The new chip will be manufactured with the same multi-level (MLC) technology currently used to produce the 516-Mbit NAND, which allows two bits of data to be stored in one memory cell. Two 1-Gbit dies also can be stacked in a single TSOP (thin small outline package) to produce 2 Gbits of memory. Use of MLC technology in embedded chips or removable cards is expected to greatly expand the storage capacities of cell phones, digital cameras, MP3 players, and streaming audio and video.

**FLEX-FUEL PICK-UP**
General Motors is offering the first full-size pick-up truck with the option to operate on ethanol (E85) fuel. Ethanol, a renewable fuel made from starch crops including corn, produces less air pollution than gasoline. E85 vehicles meet the U.S. Department of Energy's stringent mandates for alternative fuel-powered vehicles. The E85 compatibility feature will be available in 2002 as a special equipment option on select 1500 series Chevrolet Silverados and GMC Sierras equipped with the 5300 Vortec engine. Monsanto Company, a global provider of technology based solutions and agricultural products, already has ordered 50 E85 Silverados.

**Building a Better Bandage**

Research Team Leader Professor F. Joseph Schork holds a bottle of biocompatible skin barrier that, when applied like a bandage over an infected wound, lets in air and water while guarding against germs.

How can you keep an infected wound clean and treat it in harsh battlefield conditions? Researchers at the Georgia Institute of Technology are developing a gel designed to treat soldiers suffering from infected burns or abrasions in isolated areas where no other medical equipment is available.

**A Second Skin**
When the new liquid emulsion—called biocompatible skin barrier—is applied to a wound, it acts as a sort of second skin, forming a protective layer that is permeable to air and water, but keeps out dangerous microorganisms. The gel also contains control-released antimicrobial agents to actively treat the wound. The gel can be either sprayed or rolled on to create a translucent, durable layer that allows the wound to be examined as it heals, without removing the barrier. The gel layer could endure rain, mud, and other conditions for as long as two weeks.

**Stepped-Up Testing**
Developed at Georgia Tech's School of Chemical Engineering under the leadership of Professors Jan W. Gooch and F. Joseph Schork, the gel is undergoing clinical trials at the U.S. Army Institute of Surgical Research at Fort Sam Houston in San Antonio, TX. The recent military action in Afghanistan has changed the original timetable for completion, and human clinical trials were moved up to early 2002.

“It is imperative that the most advanced, life-saving innovations accompany the troops,” Gooch said. “We must...
recognize the unique needs of our armed forces for as many advances as possible in the area of trauma medicine and treatment delivery.” FDA approval could come in less than a year.

The gel is expected to have benefits for civilian disaster victims or burn victims, as well.

Who's Using the Net?

It's a rainy Sunday, and you've just crossed off the last item on your wife's "Honey, do" list. With the afternoon looming ahead, do you grab the remote and make a beeline for the easy chair and some channel surfing or head into the den toward the PC and some Net surfing?

Chances are, the TV will come out the winner (especially if you're a sports fan). Yet, according to the UCLA 2001 Internet Report, the Internet is making inroads into America's TV-viewing time. Internet users—and more than 72% of Americans had Internet access in 2001—watch 4 1/2 hours less television each week than those who are not Web surfers. If an anti-social, geeky image arises in your mind, banish it. The study also found that Internet users get more exercise and spend more time with their families than do non-users.

Charting The Net Results

The last time a new technology with the potential to change the way our society interacted, learned, shopped, and was entertained—namely, television—was introduced, not many people viewed it as an instrument that would change the very fabric of our culture. No one bothered to embark on a comprehensive study of the impact it would have on our lives and our society.

Researchers at the University of California Los Angeles (UCLA) are making sure the early years of Internet use do not go unexamined. Beginning on June 8, 1999, UCLA launched an in-depth exploration of how computers, information technology, and their users are shaping and changing society. “The UCLA study will provide the first long-term exploration of how life is being transformed by computers and the Internet, with year-to-year comparisons of the social and cultural changes produced as people use this extraordinary technology,” said Jeffrey Cole, director of the UCLA Center for Communication policy and principal investigator of the study. Dubbed "Surveying the Digital Future,” this study is also the first to analyze these broad questions about the Internet on a global scale.

Funded by the National Science Foundation, AOL, Microsoft, Disney, Sony, GTE, Pacific Bell, and the National Cable Television Association, the study will survey Internet use in over 2000 American households and, in conjunction with international partners, in Europe, Asia, Latin America, and Africa, as well. UCLA's Center for Communication Policy will conduct the U.S. survey and will coordinate the global partner projects to be directed by teams in each country.

"Surveying The Digital Future"

In the U.S. study, the same 2000 households will be surveyed each year, tracking changes in Internet use as the technology evolves and noting both direct and indirect effects of the Internet on life and society. “For example, the automobile initially made it easier to visit grandma on Sunday afternoons, before long, it contributed directly to the suburbanization of America. The Internet will have direct effects on the behavior of individuals, but will also inspire a host of other changes, many of which are unimaginable today.” Of special interest are those households currently unconnected, which will provide "before-and-after" scenarios once they begin using the Internet.

Although the overall study was designed as a long-term project, annual reports will analyze current findings and trends. The 2001 UCLA Internet Report, titled “Surveying the Digital Future,” compares the responses of Internet users and non-users, and new...

Research Notes

SETI AWARDS

The SETI (Search for Extraterrestrial Intelligence) League received Technology Achievement Awards from the Central PA Chambers of Commerce for two engineering projects: The Lunar Reflective Calibration Beacon for Radio Astronomy won second place in the "Best Application of Technology" category, and the Array2k: Phasing Multiple Antennas for a Next-Generation Radio Telescope placed second in "New Technology Projects." The "Moonbounce" Beacon reflects microwave signals off the surface of the moon. The earth-moon-earth beacon allows amateur and professional radio astronomers to calibrate their receiving systems by providing a stable reference signal emanating from a known point in the sky. The Array2k design combines 16 or more standard satellite TV antennas into a single, powerful radio telescope.

LIFE IN THE NANO-FAST LANE

When molecules move through liquid—just like when you try to move through traffic—it's easier and quicker in the fast lane. Scientists at Pacific Northwest National Laboratories (PNNL) have shown that liquids have a nanoscale "fast lane," a discovery that could be crucial to future nanoscale devices. Using a "soft landing ion system," PNNL researchers measured motion at the molecular level in organic solvent films and found that the solvent's outer surfaces were considerably less viscous than their interior.

VACUUM CLEAN-UP

The U.S. Department of Energy's Los Alamos National Laboratory is using a giant vacuum to clean up contaminated sediments from the south fork of Acid Canyon in New Mexico, where treated and untreated radioactive liquid waste was discharged for 20 years, beginning in 1944. Despite previous attempts to clean up the most highly contaminated areas, the Los Alamos county-owned property, home to hiking trails and a skateboard park, still contains several isolated "hot spots" along the streambed. The $1.2-million cleanup project will remove between 200 and 300 yards of contaminated soil and sediment, depositing it, and any dust generated, in specially designed containers for disposal at the Laboratory's low-level radioactive waste-disposal area.
bies (less than one year online), experienced, and "very experienced" (five or more years) users. It also compares 2001 results with those from the previous year's report. Five major areas were covered: who is online and who is not, media use and trust, consumer behavior, communication patterns, and social and psychological effects.

So, Where Do We Stand?

Internet use is widespread and growing—72.3% of Americans have access to the Internet (up from 66.9% in 2000), and users spend an average of 9.8 hours a week online (up from 9.4 hours). On a scale of 1 (not at all satisfied) to 5 (completely satisfied), the Net rated an overall score of 4. The most satisfying feature of the Internet is users' ability to interact with others. Teenagers, in particular, find the Internet an easy way to interact with friends and strangers. Users in every age group said that e-mail made it easier to keep in touch with people they don't usually speak to otherwise. In addition, the 18.8% of users who said that they had met someone in person whom they had originally met online averaged six new friends met in person in 2001, up slightly from 2000.

Of those households that are not online, most cited "no computer" or "lack of access to a computer" as the reason—and 44% of non-users expect to be online within the next year. Only 21.4% said they had no interest in using the Internet (down from 33.3% in 2000).

Money Matters

Of course, the dot-com crash could not be ignored. "The broad issue we considered in 2001 was: How did a backdrop of economic meltdown affect users and non-users of the Internet? Would Internet users lose faith in online technology? Would Internet use decline? Did the collapse of the Internet boom affect online purchasing and other use?"

Internet shopping remains strong, despite the atmosphere of economic turmoil. In 2001, 48.9% of Internet users made a purchase online, down slightly from 50.7% in 2000. Shifts away from traditional retail buying were substantially lower in 2001, with 32.8% saying that online purchasing has "somewhat reduced" or "reduced a lot" their purchases from retail stores (compared to 65.2% in 2000). Fewer Internet shoppers said they expect to make more purchases online (43% compared to 54.5 in 2000). Not surprisingly, 43.3% agree or strongly agree that adding sales tax for online purchases would reduce their Internet shopping.

"Several trends about online buying continue to develop—especially regarding credit-card security—that could have major effects on the evolution of Internet commerce," Cole noted. In both 2000 and 2001, users expressed deep concerns about credit-card security. Nearly all new users (98.6%) had some worries about credit-card safety when shopping online. Very experienced users are somewhat more comfortable, but not much—89.1% express some concern, and 57.2% remain very or extremely concerned.

"Americans have widely divergent views about credit-card security when used in traditional purchasing compared to online shopping," Cole said. "Restaurant patrons who think nothing of leaving a signed credit card receipt on a table in a busy café are nevertheless extremely concerned about online security. Without question, broad shifts in perceptions about Internet security must occur before online purchasing can truly flourish."

Privacy, Please

Privacy is an issue that transcends credit-card security. More than half of Internet users and close to three-quarters of non-users agree or strongly agree with the statement that "people who go online put their privacy at risk." When or if they purchase goods online, 94.5% of all surveyed express some concern about the privacy of their personal infor-
Wired Kids

When the researchers asked adults for their opinions on their children's use of the Internet, the results were largely favorable. For example, 88.2% said the kids were spending the right amount of time, or too little time online; 96.5% said that their children's grades had stayed the same or improved since using the Net; and 91.8% said the children spend the same amount of time, or more time, with friends. However, both users and non-users agreed that children could gain access to inappropriate material online.

In most cases, family time has not been adversely affected by Internet use. Only the "more experienced" users reported spending less time with family than before they went online. New users, very experienced users, and non-users all reported about the same amount of time spent in family activities such as eating dinner and playing games or sports together. In fact, the only "family" activity that appears to suffer from Internet use is television viewing. In 2001, 23% of the adults reported that their kids now watch less TV than before they began using the Internet. Non-users watch the most TV (10 hours a week), Newbies clock 9.4 hours, and very experienced users watch only 6.7 hours of TV a week.

Spin Doctoring

One of the fundamental questions pondered by physicists is: Where do protons get their spin? Spin is a property of elementary particles as basic as mass and electrical charge. Researchers at the U.S. Department of Energy's Brookhaven National Laboratory (BNL) are using the facility's largest particle accelerator to investigate that question. The Relativistic Heavy Ion Collider (RHIC) has accelerated beams of polarized protons to the highest energy ever and is experimenting with colliding the beams.

"These will be the first-ever experiments where the protons in two colliding beams are all spinning in a controlled direction," said Thomas Roser, head of the Brookhaven accelerator group running the project. The program was jointly initiated by BNL and Japan's RIKEN-BNL Research Center. Collaborators from other national and international laboratories have worked to develop the RHIC spin program. They hope to learn more about the structure of matter and the strong force that holds together the components of protons.

A lot is already known about protons. They are made of smaller particles called quarks, which are held together by emitting and absorbing particles called gluons, the carriers of the "strong" force. Gluons can be likened to strong springs that connect the quarks. All of these particles have an intrinsic property known as spin, which is something similar to the Earth spinning on its axis.

Questions still exist. Although physicists have long believed that a proton's spin was simply the sum of the spins of its three component quarks, the quarks account for only about 20% of the proton's spin. So what accounts for the other 80%?

The most likely scenario is that the gluons also somehow contribute to the spin. "Unlike any previous experiments, collisions of spin-aligned (polarized) protons at RHIC will allow us to tease apart the individual contributions of both the quarks and the gluons," said Gerry Bunce, the Brookhaven physicist leading the spin program. Beams of polarized protons allow scientists to use the quarks in one beam to probe the properties of the gluons in the other beam. The products resulting from a very-high-energy collision between a quark in one beam and a gluon in the other beam—subatomic particles and energy—can reveal the properties of the colliding pair, including the gluon's spin. RHIC's PHENIX and STAR detectors will analyze the collision products to produce this information in complementary but overlapping ways. Another detector will explore the force between the colliding protons and analyze how the force is affected by spin.

One difficulty is keeping the beams polarized. After initial polarization, the beam moves through five accelerators, all composed of magnets that can interfere with the polarization because spinning protons are like tiny magnets. The solution to this problem is a specialized set of magnets called Siberian snakes, whose corkscrew-like design causes the direction of the magnetic field to spiral along the direction of the beam. In each of RHIC's two 2.4-mile-circumference rings, two snakes are located at opposite sides. As the beam moves through the snakes, the magnetic field flips the polarization, or direction of the spin, and simultaneously averages out many smaller effects of the accelerator magnets. This allows the team to maintain stable polarization. In addition, spin rotators, which allow scientists to select the spin direction at the collision points, and polarimeters that measure the exact degree of polarization were used.
Looking to jump on the Dot Com bandwagon? The world of e-business is hopping with new opportunities, improved services, and easier applications and procedures. Anyone at any level of computer comprehension can start his or her own Web site. From finding an appropriate domain name to designing and running your site, the process has become much simpler and more straightforward over the past couple of years.

We will cover almost everything you need to know about starting your own Web site, from the initial steps of establishing your domain name to creating and setting up your site on the Internet. Whether or not you are a computer genius is practically irrelevant. That’s like saying you should be a skilled superintendent in order to run a business out of an office building. There are experts in the field just waiting for you to give them the go-ahead. They will take your hand and guide you through the details, assisting you every step of the way, ready to answer all of your many, many questions.

THE PROCESS

Where, exactly, do you begin? First, you need to outline your objectives. What is it that you want to do or accomplish? What are your goals? This article will focus mainly on those individuals who are interested in running some kind of online business, although those of you who simply want a Web site for personal use or public service will benefit as well.

After you have a plan in mind, such as what it is you want to sell, how much of it you plan to sell, and how you see your business progressing in the future, then you can begin to think of a name for your site.

THE DOMAIN-NAME GAME

The domain name, or Web site name, is actually an integral part of your site’s success. From Internet searches to ease of remembrance, the name you choose is vital to your business. There are literally hundreds of domain-name registration sites that will search available Web site names for you, and then register the one you finally decide on—providing it isn’t already taken. Some of these companies are listed in the “Source Information” section at the end of the article.

This part of the process can be fun, challenging, and truly exhausting. Since the name you give your Web site is so crucial, you should devote some time and thought to finding the perfect one. Beware, however, since there will most likely be some complications along the way.

Let’s say you have discovered a state-of-the-art weight loss plan, and you plan to market and sell it through a Web site. At first, you’ll be extremely excited to register your “jellybelly” exercise program. You can picture the graphics, the logo, the packaging. Then you find out that “jellybelly” is taken. Dismayed, but not yet hopeless, you think of another neat name: “chunkymonkey.” Again, you are let down—that name is also not available. So after hours of brain-strain, you muster up other names, names that are not so thrilling, but acceptable. At the end of it all, you settle for “flab-yabs,” a far cry from what you originally envisioned.
The lesson here is this: Think of a couple of dozen names before you log on to the registration Web site. The process of typing each name on the screen and searching for its availability is tedious and grueling enough; but if you don't have back-up names on hand, you will begin to feel frustrated and disgusted, as well. It is remarkable that so many millions of names are taken. Don't take the registration process for granted. You may think that your name is so unique that no one else in this entire world would ever think of it—but think again.

The cost of a domain name should run in the ballpark of $3 a month (plus the $20 or so for the hosting company, which we will get into a little later.) The most common extension, and most familiar to the general public, is ".com." There are other extensions including ".net," ".org," and other up-and-coming ones such as ".biz," ".info," and ".name." Though they are less popular at the present time, these may prove to be appropriate choices in certain instances. It would be a good idea to look into the benefits and disadvantages of all of them. A wise decision, though a bit more costly, would be to scoop up all of the extensions. Just because your Web site is called "chicchefs.com," doesn't mean there won't be a "chicchefs.biz" popping up in the near future. Also, try to pick a domain name that is easy to spell and pronounce. You also want to refrain from using words that can be spelled or understood two different ways, such as: "tail" and "tale," "buy" and "bye," and "sent" and "scent."

One last rule of the name game is to make sure the name is right for your business. There is a fine line between limiting yourself too much and not being clear about what it is your Web Site does or sells. For example, Yahoo, Monster, and Amazon all cleverly picked names that were catchy, yet potentially limitless in flexibility. Remember, though, that these mega-giants have a tremendous marketing budget and have spread their name through the Web like wildfire.

You want to pick a name that will not stifle your ability to expand your business—like naming your site niftysocks.com—as you might decide to sell hats, scarves, and slippers in the future. Don't be too vague, however, as this could work against you. Picking a name like "Google" just wouldn't have the same desired effect for most of us.

AND YOUR HOST IS...

A Web host places your Web site onto the Internet through an outside server. Only in very rare instances would you attempt hosting the site yourself. Self-hosting a site requires a high-grade computer with lots of memory and disk space, and a technical person to oversee the server 24/7—it's just not practical for most people.

Your best bet is to find a company—there are hundreds out there—who will host your site for you. These out-sourced servers have extensive memory and disk space, 24-hour monitoring to limit downtime (host's servers are almost never down), customer support, and security features to protect you from hackers.

There are many desirable features to bear in mind when choosing a Web host. Though many of them offer very similar packages, you want to narrow down one that is right for you. Here are some conditions to guide you through the selection process:

- **Customer Support**—There is nothing more frustrating than running into a technical glitch, or needing an answer to a question pronto, and there is no one around to ask. Most of the more established sites offer ongoing support at all hours of the day and night, and they are usually staffed with knowledgeable, helpful representatives.

- **E-commerce Capabilities**—Many hosting companies can also provide a shopping cart and secure online payment system. If you plan to engage in monetary transactions through your Web site—if customers are paying for items with credit cards—then both of these features are essential.

- **Disk Space**—Most small e-business Web sites take up less than 10MB of file space. Actually, most use between 1 and 3MB. Just be sure that your Web host can provide you with the 10MB to be safe, as you don't know what the future holds for your site.

- **Data Transfer Allowance**—This refers to the amount of traffic passing through your Web site, or the amount of files that are viewed each month. Typically, Web hosts allow for a certain amount of traffic (1 or 3GB of data allowance per month, for example) with overages subjected to additional charges. Similar to deciding on a telephone-calling package for your home phone to complement your calling habits, you should use a host who will fit your traffic needs.

**LET'S CREATE A WEB SITE!**

Now for the fun part—creating your Web site. If you have some basic computer skills and you are up for a small challenge, you may want to consider building your Web site yourself. One of the most popular Web design software packages, FrontPage 2002, is a very affordable (around $100), user-friendly program that has everything you need to build your own site. FrontPage is so commonly used that most hosting companies even provide special customer support for FrontPage users to assist them in uploading their site to the Internet.

Although FrontPage comes with a basic manual, you will need the book FrontPage 2002: The Complete Reference, which provides detailed instructions and guidance through the program's more complex components.

If you think you'd like to become an expert Web site designer and have some extra time on your hands to learn more advanced capabilities, then HTML may be a valuable tool. Do understand, however, that HTML is not at all necessary. FrontPage is a comprehensive and more than adequate

**SOURCE INFORMATION**

Here is a sample of companies who provide Web services:

- **Domain Name Registration**
  - www.domain.com
  - www.domaindirect.com
  - www.networksolutions.com
  - www.register.com

- **Hosting Companies**
  - www.hosting.com
  - www.hostindex.com
  - www.hostsearch.com
  - www.interland.com
  - www.verio.com

- **Web Designers**
  - www.bizbuyer.com
program and can provide most of the “bells and whistles” you’d be looking for in a professional Web Site.

Once your Web site is a completed work of art, you still have to publish it onto the Web. It doesn’t just magically appear on the World Wide Web once you have designed it. You should contact the company you registered your domain name with, and they will instruct you in connecting your site to the Web.

CALLING ON OUTSIDE HELP

There are some good reasons why you may consider calling upon the experts to design your Web site for you. Maybe you need a higher level of sophistication, like customized functions, high-end graphics, database integration, and more. Maybe you just don’t want to tackle the construction of a Web site—there’s a good chance you are just too busy.

On average, Web designers charge around $1000 to create a typical 5–10 page site. The real dilemma is finding one you want to work with. You can start by asking around. A personal reference is usually a good bet, since you can find out all the details about your prospective creator.

If you dare to type in “Web designer” on a search engine, expect to scroll through hundreds, maybe thousands, of listings. That is why it is important to keep certain criteria in mind during your search.

Take a look at their portfolio. I don’t mean the big black leather art case you see artist’s lug- 
ing about on interviews. I mean visit some of the sites they have created. Have them give you a sample list of Web sites that they consider is their best work. Do they appeal to you? Is that what you are looking for in a Web site?

Ask for a list of previous customers. Ask the following questions of their clients: Did they stick to the schedule? Were they easy to get a hold of? Did they provide the service you expected? How pleased are you with the outcome?

Of course, compare services and prices when you finally narrow down your search. Cheaper isn’t necessarily better. Make sure that you are being offered quality work, and that the prices are fair. Remember that your Web site is going to be on view for the entire Internet world.

AND OFF YOU GO!

You should now have some vague understanding of this whole Web site creation business. At first, as with anything you are unfamiliar with, it seems like a dense cloud of confusion. With a little bit of insight and a whole lot of motivation and patience, you could be well on your way to owning a piece of the World Wide Web!
In the last column, we started discussing how to assemble your own monster workstation. If you missed this column, we defined a workstation as a PC that has been designed especially to handle very graphic or compute-intensive tasks.

We also described how we assembled our own “Monster” workstation around a Thunder 860 motherboard from Tyan Computers. This motherboard accommodates two Intel Xeon CPUs, which are specifically designed for use in a multiprocessor environment. The motherboard requires a special power supply, which was included with the tower case from Evercase Technologies that we used. Kingston Technology provided us with four 256MB RDRAM RIMMs; Maxtor sent us two of its newest 80GB ATA/133 hard disk drives; and we installed two different types of DVD burners, one from Pioneer and the other from Hewlett Packard.

When constructing a multiprocessor system, you need to be careful, as only some versions of the Windows operating system actually provide support for more than a single CPU. Windows NT 4.0, 2000 and XP Professional all provide this support; and we used Windows XP Professional on the “Monster.”

APPROPRIATE BENCHMARKING

Strangely enough, building the “Monster” wasn’t the most difficult part of the project. Once we had the components in hand, the system went together in a matter of about 90 minutes. The most difficult parts of assembly were routing the drive cables around the plastic wind-tunnels that are part of the Xeon processors, heat sink design, and bringing up the ATA/133 controller that Maxtor included with the pair of drives they provided. Originally, we were going to use a RAID controller, which is why we requested two identical hard disk drives. When Maxtor sent their new ATA/133 drives and controller, we changed our minds.

The problem with just plugging in the ATA/133 controller is that Windows XP Professional doesn’t recognize the new disk controller on the initial install. We plugged the Maxtor drives into the IDE controller on the Tyan motherboard to install Windows XP Professional. When the “Monster” was set up, we simply plugged in the new ATA/133 IDE controller that Maxtor provided with its drives and moved the hard disk data cable to that controller.

More of a challenge was coming up with an appropriate benchmark. There are SMP (symmetric multiprocessing) benchmarks available as shareware and freeware, but that doesn’t really help compare a dual 2-GHz Xeon system to a 1.7-GHz Pentium 4 PC, which doesn’t perform SMP.

More germane is the output of most available benchmarks, which give scores in units that won’t mean much to the average Poptronics reader. Utilities such as Dr. Hardware and SANDRA do include benchmarks for multiprocessor systems. However, Drystones and Whetstones don’t intuitively transmit the actual benefits of going for a system like the “Monster.”

Since our initial intent in building
the system was to create the ultimate system for performing DVD transcoding (the process of turning AVI video into MPEG-2), we anticipated creating a benchmark using one of the many DVD authoring packages we use. Unfortunately, none of them actually take advantage of having dual CPUs available. Some applications, such as Adobe Premiere, have plug-ins that use multiple processors when available. However, we decided against basing our benchmark on these.

Eventually, we decided to base our benchmark on TrueSpace 5.1 from Caligari Corporation (www.caligari.com). TrueSpace 5.1 is an affordable modeling and animation system, just the sort of application many Poptronics readers might actually use. The process of rendering a model, especially animated in a virtual 3D space, is extremely compute-intensive and provides a perfect type of benchmark. Best of all, TrueSpace 5.1 is multi-threaded and takes advantage of multiple CPUs where available. You can download a trial copy of TrueSpace from Caligari's Web site if you'd like to play with it.

Caligari graciously offered us the use of a benchmark script it developed with AMD, which AMD uses internally for benchmarking its own processors and system designs. After playing with the software for a short time, we were able to develop our own benchmark, which uses a small missile flying an elaborate path around the screen. This missile is shaded and lit from a constant point source, so each frame rendered needs to take this into account when constructing the image. The total sequence takes 759 frames. If enough readers request it, I will make available a copy of our benchmark so that you can compare your own PC to our “Monster” system.

**AND THE WINNER IS!**

Using an appropriate benchmark like the one we constructed easily demonstrates the benefit of a multi-processor system like the “Monster.” The 1.7-GHz Pentium 4 PC we use for most tasks around here took just about 2 seconds to render each of the 759 frames of animation. Rendering the complete animation took 25 minutes and 43 seconds.

The Xeon-based “Monster” was almost exactly twice as fast, taking 12 minutes and 35 seconds to accomplish the same task.

When assembled, our workstation cost just under $4300 to put together, not counting a keyboard, mouse, monitor, or any application software. That's a pretty hefty price tag for a personal computer. It is not, however, all that expensive for a workstation.

There aren't a lot of vendors that sell workstation-level computers directly to an individual end-user. Most of these sales are made to companies through a VAR (value added reseller) network. So making direct-cost comparisons between a do-it-yourself approach and commercial purchase isn’t easy.

We did find a similar workstation available from Polywell Computers, a vendor whose PCs we've tested in the past and generally like very much. This well-known vendor of PCs has a dual Xeon workstation model available that you can order from its Web site. They don't, as of this writing, offer the dual DVD-RW option we incorporated into our “Monster.” You can, however, use the vendor's custom configuration option on the PolyStation 930X4 Dual Xeon workstation to get pretty close to what we put together. If we added a second DVD-RW drive to the configuration, the price at this writing would come out just under $6000. That's a terrific price for a workstation this highly configured.

That makes our $4300 workstation an even better bargain. There are a few differences between “theirs” and “ours.” We could not get the Polywell configurator to eliminate the keyboard and mouse, and the PolyStation required a sound card, while our motherboard provided onboard audio. On the other hand, we configured the PolyStation with two 80GB Maxtor ATA/100 drives, while our “Monster” uses two of Maxtor's newest ATA/133 drives with a second IDE controller. The ATA/133 drives are a lot more expensive than the ATA/100 models, but provide better performance as well. An upcoming “Peak Computing” column will test these and several other hard disk upgrade options.

**WHY BOTHER?**

Now that we have it up and running, we are actively experimenting to see what applications we get better results with when we run them on the “Monster.” Predictably, while the “Monster”

(Continued on page 58)
Basic Op-Amps

The operational-amplifier (op-amp) is a staple item in electronic circuits and is a building block that is often one of the main components in linear, audio, and video circuitry. This device is basically a high-gain amplifier that is used in conjunction with feedback networks to make up a circuit whose properties are determined by linear-passive components, such as resistors, capacitors, inductors, as well as nonlinear components (diodes, varistors, thermostors, etc). The term "operational-amplifier" comes from the use of these devices in analog computers that were used decades ago to perform mathematical operations (addition, multiplication, differentiation, integration, summation, etc) on input quantities. The term has stuck and is still used, even though analog computers have largely departed the scene, having been replaced by digital computers long ago. Today's operational-amplifier is a sophisticated device, composed of many transistors, diodes, and resistors, all in a chip and packaged in various configurations.

There are thousands of types of op-amps available, from flea-powered microwatt units to units capable of handling a few hundred watts of power—from a few cents to many dollars in cost. As you may imagine, the specs and performance requirements, as well as reliability, temperature range, and packaging, all affect cost. Op-amps that can do many ordinary jobs very well are available for under 50 cents, owing to low-cost plastic packages, large-scale integration, and high-volume production. Technologies commonly used are bipolar, FET, CMOS, and combinations. Some large or high-power op-amps are made using monolithic fabrication methods.

**An Ideal Amplifier**

From a circuit viewpoint, for the purposes of explanation, an ideal amplifier is used to represent an op-amp. An ideal amplifier has the following properties: infinite forward gain, bandwidth and input impedance with zero output impedance, noise voltage, DC offset, bias currents, and reverse gain. (See Fig. 1.) In practice, all op-amps have some bias current that flows in the inputs—almost negligible for JFET and CMOS types, but more significant in bipolar types. This current must be considered in high-impedance circuits, in DC and instrumentation amplifiers, and in circuits that must operate over a wide temperature range. In addition, even if you were to short the op-amp inputs together, you may not get zero output voltage, but some random DC level.

This DC voltage can be considered as an equivalent DC input offset voltage present at the input. DC offset can also be produced from equal input bias currents flowing through unequal resistance in the inverting and non-inverting input circuits. This will produce a DC input voltage differential at the input. Some op-amps have external pins to which a potentiometer can be connected to balance out or otherwise cancel this voltage, bringing the DC output to zero under zero-signal input conditions. These are widely used in instrumentation amplifiers and related applications where nulling or zero adjustments are required. All amplifiers generate some noise, which is due to thermal and semiconductor junction effects, and can be considered as an equivalent input noise...
Also, input mum. dB mode rejection ratio. Imperfection this inverting exact same voltage as supply. Positive supply and negative full common situation. These are some-where noise must be kept to a minimum.

A real-world op-amp has a lot of gain (>1000X voltage gain) and a fairly high input impedance (>100K). Generally there are two inputs shown, an inverting and a non-inverting input, and one output referenced to ground (but not always, differential outputs are sometimes used in certain applications). One of the inputs may be grounded in many common applications where a single-ended signal source is present. This is a common situation. There are limitations on the DC levels allowable on the inputs and limitations on the available output voltage swing.

Op-amps are available that allow a full output voltage swing between the positive (Vcc) supply and negative (Vdd) supply. These are sometimes referred to as rail-to-rail capable. In addition, if the exact same voltage is present on the inverting and non-inverting inputs, ideally the output voltage should be zero. This is not always so, and the degree of imperfection is called the common-mode rejection ratio. This is usually 60 dB or better, with 70–80 dB as a minimum. Note that this may vary with input voltage levels to some degree. Also, variations of power supply voltage may show up as equivalent input signals. The degree to which the op-amp rejects this information is called the supply-voltage rejection ratio. It is usually better than 60 dB and typically 70–80 dB or better. After all, nothing is perfect in life.

**What's To Gain?**

Op-amp power supply connections are sometimes shown in diagrams, especially if decoupling capacitors and resistors are necessary, but more often shown elsewhere in the schematic, as they play no part in the primary circuit function other than to power the amplifier. Many general-purpose op-amp chips have two or four separate operational-amplifiers in one package, with common power-supply connections. In practice the ideal amplifier criteria requirements are met only approximately, but as will be shown, close enough for most purposes.

Practically, an op-amp will have a gain of 10,000 or more, an input impedance of megohms, and a 3 dB bandwidth of several tens of hertz or more. If an amplifier has a 3 dB bandwidth of 40 Hz and a gain of 100,000 times, this is a gain bandwidth product of 4 million hertz, or 4 MHz. (40 × 100,000). It is advantageous in many feedback applications to have the gain falling at 6 dB per octave or 20 dB per decade at frequencies beyond the corner frequency (that frequency at which the amplifier gain has fallen 3 dB or 70.7 percent of its DC value).

Since the op-amp is used mainly in feedback circuits having much lower closed-loop gain, these performance figures are good enough in many cases. In fact, even a single high-gain (100X) common-emitter transistor amplifier stage can be treated as an op-amp if feedback is employed, with surprisingly little error. In many cases, a single transistor will work almost as well as a more expensive op-amp device. One example is a simple audio amplifier stage from which a moderate gain (5–20X) is required. This will be shown in an example later.

**Op-Amp Families**

One of the most popular op-amps of all time is the venerable LM741, its dual
version LM747 and their many descendants. The JFET input TLO8X series is also very popular, coming in single (TLO81), double (TLO82), and quadruple (TLO84) units. The TLO81 and TLO82 come in 8-pin DIP packages, while the TLO84 comes in a 14-pin DIP package. These op-amps operate well from 5–12-volt experimenter supplies and require both a plus and minus supply. These are also cheap and widely available. Other general-purpose types are the LM324, LM1458 (bipolar), and LM3900, along with all their variations and flavors. There are many others, but those mentioned are easily obtained by the hobbyist wishing to experiment with them, cheap, and in plentiful supply. Many manufacturers make them, so obsolescence should not be a problem for a long time.

We will use the TLO8X series for circuit examples, as they are general-purpose JFET types. The TLO8X series allows the use of higher resistance values and therefore smaller capacitor values, which is often more convenient from a design standpoint. The TLO8X series has an open-loop (no feedback used) voltage gain of over 10,000 and having JFET inputs, an input impedance of a million megohms. The gain bandwidth product (obtained by measuring frequency where gain falls to unity) is rated at 4 MHz for the TLO8X series. Op-amps are available with gain bandwidth products to several hundred MHz and even higher, and these are used in video and RF applications.

**Feedback And Formulas**

Figure 2 is a basic op-amp application, a simple gain stage. Amplifier A is a basic op-amp with a very high-input resistance. Resistors R1 and R2 make up a feedback network, a simple voltage divider. The voltage at the junction of R1 and R2 is V2/(R1 + R2). In feedback amplifier work, the gain of the feedback network is commonly designated by the Greek letter β (beta). This gain is the ratio of output voltage to input voltage and is usually less than one—in many cases, much smaller than one. It may often be a complex number, having both real and imaginary components. Since practical feedback networks consist of resistors, capacitors, and sometimes inductors, they therefore have defined magnitude and phase characteristics. It may also be nonlinear, using diodes, varistors, and other nonlinear devices.

For the following discussions we will limit β to being linear and a purely real
number, as this simplifies the math. Most experimenter circuits will not involve complex feedback networks, but the reader should be made aware that this is not always the case.

In Fig. 2, the output voltage from the op-amp is \( V_{out} = A \times e \) in. \( A \) is the gain of the amplifier (generally 10,000 or more). In a practical op-amp circuit powered by 5–15 volt supplies, \( V_{out} \) will be at most \( \pm 5 \) to \( \pm 15 \) volts. Therefore, \( e \) in will be this voltage, \( V_{out} \) divided by the gain of the op-amp (10,000 or more). This says that \( e \) in is very, very small, in the millivolt or microvolt range. However, \( V \) in from the outside world is the input voltage we are applying to the circuit and could be a volt or more, such as a line-level audio signal, etc., while \( e \) in is very much smaller. The circuit adjusts itself so that the ratio of \( V_{out} \) to \( e \) in equals the gain of the amplifier, which we will take as 10,000. This requires \( V_{out} \) to be such that the portion of \( V_{out} \) at the junction of feedback network \( R1 \) and \( R2 \) exactly equals \( V \) in minus \( e \) in, so the total voltage difference across the inverting and non-inverting outputs is \( e \) in. This occurs when:

\[
V_{out} = \frac{R2}{R1+R2} = V \text{ in} - e \text{ in}
\]

But, \( V_{out} = A \times e \) in, where \( A \) is the gain of the amplifier. Define \( R2/(R1+R2) \) as \( \beta \), the feedback factor equal to the ratio of \( R2 \) to \( R1 \) and \( R2 \). For example, if \( R1 = 9K \) and \( R2 = 1K \) then \( \beta \) equals 1/(9+1) or 1/10, or 0.1. This means that one tenth the output voltage is being fed back via the feedback network. By substituting the previously mentioned equalities in the first equation:

\[
A \times e \in [\beta] = V \text{ in} - e \text{ in}
\]

If you add like quantities to both sides of the equation, it still is valid. Therefore, if you add \( e \) in to both sides of the equation:

\[
A \times e \in [\beta] + e \text{ in} = V \text{ in}
\]

Noting that \( e \) in is common to both terms in the left side of the equation, it can be factored out:

\[
e \text{ in} \times [A \times \beta + 1] = V \text{ in}
\]

But \( e \) in must equal \( V_{out} \) divided by \( A \), the gain of the op-amp, so that:

\[
(V_{out} / A) \times [A \times \beta + 1] = V \text{ in}
\]

The effective circuit gain is what we want, i.e. the ratio of \( V_{out} \) to \( V \) in. We are inputting a signal represented by \( V \) in and would like to know the magnitude of \( V_{out} \) that will result. If both sides of the equation are first multiplied by \( A \), then divided by \( V \) in, and then finally by the entire quantity in brackets \( [A \times \beta + 1] \), we get an equation that expresses the ratio of \( V_{out} \) to \( V \) in as a function of \( A \), the op-amp gain, and \( \beta \), the feedback factor:

\[
\text{Gain} = \frac{V_{out}}{V \text{ in}} = A / (A \times \beta + 1)
\]

\( A \times \beta \) means the product of these two quantities. Since the order of multiplication does not change the product, \( A \times \beta = \beta \times A = \beta A \) (realizing the \( \times \) stands for multiplication we can get rid of it). Also, the order of addition of two quantities does not affect the sum. Then the equation appears as:

\[
\text{Gain} = \frac{A}{1 + \beta A}
\]

This is a very important equation when working with op-amps or most any feedback amplifier. It applies to a lot of things. The ratio of \( A \) to \( 1 + \beta A \) yields not only the gain, but affects other circuit-performance factors, as well. In a real-world case, if \( A \) is 10,000 and if \( \beta \) is 0.01 or more (it generally is), note that the product of \( \beta \) and \( A \) will be greater than 100. Then, a very nice simplifying approximation can be made. It is true that for any quantity \( X \) much larger than 1 (10 times or more would qualify), 1 plus \( X \) approximately equals \( X \) with an error of around 1/X times 100 percent. As an example if \( X \) were 10 then 10 \( \approx \) 11 approximately with an error of 1/10 \( \times \) 100 percent, or ten percent, which is obviously true. If \( X \) were 100, then \( 1 + 100 \approx 100 \) with an error of 1/100 \( \times \) 100 percent, or 1 percent. Note that in our case where \( A \) is 10,000 and \( \beta \) is 0.01, the product \( \beta A \) is 100 and \( 1 + \beta A \approx \beta A \) within one percent. Therefore, if in any case \( \beta A \) \( > \) 1, we can rewrite the equation as:

\[
\text{Gain} = \frac{A}{1 + \beta A} = \frac{A}{\beta A} = 1/\beta
\]

(Note that \( A \) is common to numerator and denominator and can be cancelled out.)

In other words, if the product of the op-amp gain \( A \) and the feedback factor \( \beta \) is much larger than one, the value of \( \beta \) determines the overall gain of the op-amp circuit. The product \( \beta A \) is called the open-loop gain. The overall circuit gain with the feedback loop in place is called the closed-loop gain. The beauty of this concept is that, given a large enough value of \( A \), the gain and other parameters of a feedback amplifier or any other system employing feedback can be closely controlled by a network of components that can be specified to any degree of accuracy needed. The value of \( A \), component tolerances, drift, noise, temperature effects, and all things

(Continued on page 41)
IT was a memorable morning on February 1, 1945 that 'the Editor-in-Chief of Radio-Craft called me into his sanctum. The air seemed electrified and there was a notable tension in the office. The Chief asked me to sit down and much animal or human eye. Take your own eye and what do we find? The eye is equipped with a lens the same as your television transmitter, but where is the scanning apparatus? There isn't any. The light impulses fall on the retina which has the so-called visual purple, then there are a number of so-called rods and cones. These are connected by means of nerve conductors through the optical nerve with the human brain. Scientists now know that we see by electro-chemical means.

"Now then, it should be possible to duplicate, or at least approach the optical elements of the animal eye and translate all this into a modern up-to-date non-scanning television."

"But damn it all, your engineers will have nothing to do with it, so it is about time that Radio-Craft did something to show the television people what really can be done. I have here a number of sketches illustrating how the problem can be solved. I have sketched and labored on it and I have worked out all the theoretical elements as you will see when you inspect the sketches for which a Patent has been applied, to safeguard this revolutionary invention. You will notice that I am using as the transmitter an electro-chemical layer spread over a special disk of plastic into which thousands of fine wires have been embedded, leaving only the ends of the wires projecting."

"The end of each wire in turn goes to a new instrument which I call the condensorator. This condensorator is made up of different sizes of tinfoil or other material and in this manner each wire connects with a sort of condenser, each having a different capacity from that of the next one. There is a common return for the opposite plate as shown in the diagrams. Thus each wire has a different potential charge from the other. By a simple special means shown in my plans, each electrical impulse therefore is preserved and transmitted, because each wire end modulates the condenser circuit in its own way."

"This is made possible by development of a new plastic, which has a minus dielectric constant of very high absolute value. Thus the thousands of fine wires can be bunched very close together with no more effect on each other than if they were an inch or more apart. You will note that the lines are of different lengths, and that they are further end-loaded with special ceramic condenser-type units. These have the effect of tuning each wire to a slightly different natural frequency. In the Condensorator a variable-frequency oscillator sweeps the gamut of the frequencies of these tuned leads, and is modulated in amplitude according to the strength of the light falling on the part of the chemical layer connected to the wire tuned to each..."
Here I draw a merciful curtain over what transpired during those eventful 60 days that followed: 

I need not tell you how difficult the work was, but once I got the hang of the Chief’s Visie-Talkie I picked up enthusiasm as my assistant and I went on with the work. Sure enough, the scheme worked out just as imagined by the big Boss. In about 40 days we actually had results and could see each other in the crude laboratory model. By this time the Old Man had produced the general mechanical design of the Visie-Talkie also and we galloped nicely along on the home stretch.

On account of the great importance of the invention we worked behind locked doors all the time. We had been admonished never to leave the plans out in the open and we had a big burglar-proof safe in the laboratory where the drawings were always safely cached whenever we had to be absent. This was not often, because most of the time we slept in the laboratory and took turns on the cot provided for the purpose. During the last few remaining days we put the finishing touches to the Visie-Talkie and we even found a way to project the received image on its ground-glass screen in full natural colors, just as is done by the human eye. This was a little wrinkle which my assistant and I threw in for good measure.

There was also the little matter of static which we had to take care of so that the image would not flicker from static bursts from nearby automobiles and other man-made static annoyances. This problem we finally licked on the very last day.

Came the big moment when I marched triumphantly into the Big Chief’s office and placed the now completed Visie-Talkie on his desk. My assistant stayed in the outer office and when the Old Man picked up the set (which automatically turns on the current when you open its little door) my assistant started to talk and his image and voice came over perfectly, much to the Chief’s delight.

"I knew it was easy to do it," said he, "and now we have something that we can show these hide-baked television engineers and teach them a non-scanning television lesson. As I figured it, the Visie-Talkie can be marketed for $29.85 a pair, in the post-war period. There’ll be millions in it!"

The big Boss beamed his full satisfaction and he must have been particularly happy, because he gave me two cigars, one for myself and one for my assistant. This was indeed mighty praise from the Great One. He insisted on keeping the two instruments on his desk and his parting statement was that he was much pleased that I came through exactly on the dot of the 60th day. As I backed my way out of his office I could not help noticing the historic date on his big wall calendar. It read:

APRIL 1st.
Introducing
The ALP

WILLIAM SHEETS, K2MQJ AND RUDOLF F. GRAF, KA2CWL

Often there is a requirement for a simple voice record-playback unit for use with a transmitter. This unit should be able to record a message and then play it back. These messages are usually of short duration (one minute or less) and often continuously repeat. Applications include warning and safety messages, announcements, talking signs used in real estate sales, transmitter identification, or any other similar application. Another use for such a device is in ham radio, for automatically controlling a transceiver, repetitively calling CQ, and switching to receive between calls to listen for an answer. This is a very repetitious and tedious task, especially when conditions are poor or band occupancy is very light. This situation also arises often in VHF-UHF weak signal work. When a response to the CQ is finally received, the identifier is then overridden and the operator takes over control. This can really save one's voice. Any radio amateur that has operated in contests, field day, or enjoys working DX will appreciate this.

There are many ways to implement this function. The traditional solution has been a tape deck using a short tape, often a continuous loop or a cassette, and, more recently, a solid-state memory chip. Inexpensive tape decks and memory modules can be pressed into service, but often there is really no adequate control method to set the frequency of the repeating message. Often, it is necessary to control an associated device, such as an audio system, or radio transmitter such as the MPX2000, the MPX96, or the AM88 that are available from North Country Radio. As a result, an auxiliary device or circuit often has to be constructed and interfaced to accomplish this. This complicates a seemingly simple task. The ALP (Audio Loop Player) to be described offers a solution to these problems.

Basically, the ALP performs the following functions:

- Recording a voice message up to one minute in duration.
- Playing that message back on demand once or repetitively.
- Providing a keying function for a transmitter or other device.
- Providing adjustable delay between message repeats.

Circuit Operation. The circuit (see Fig. 1) consists of a voice chip, ISD2532P or ISD2560P (32- or 60-second recording time, respectively), and a variable-delay circuit to generate reset and delay timing pulses. A mode switch that has three positions (record, single or play once, and loop) is included, as well as a keying circuit that provides a switch closure to ground. The keying circuit can switch a positive level up to 30 volts and sink up to 200 mA to ground, which should be adequate for many transmitter or transceiver T-R control applications. The circuit operates from a 9-volt to 12-volt supply, negative ground, and draws about 25 mA during playback and about 3 mA on standby.

Sample/loop audio, and remote keying for your transmitter rig.
DC current draw is largely due to the built-in audio amplifier in the IC. This chip can produce about 50 milliwatts into a 16-ohm load and is adequate with an efficient speaker volume. Frankly, in a noisy environment (city street with normal traffic) more audio is needed. The speaker is used for monitoring the audio playback. However, a pair of common 32-ohm stereo headphones works very well also.

In the intended applications, a speaker is not necessary and was omitted from this device. Two 3/4-inch stereo jacks are used, one for audio monitoring via 32-ohm headphones, using the ring and tip to get a mono series connection of the L and R earpieces, with the ground (shell) left floating. The other, for interfacing with a transmitter, is connected differently. The ring is used for audio, the tip for keying, and the shell for common ground. More than adequate audio is available for driving most any modern transmitter via the mike connector.

The chip samples the audio to be recorded at an 8-kHz rate. This sampling limits the upper-frequency response to theoretically 4 kHz. Practically, since ideal filters do not exist, the modulation frequency is limited to 3.4 kHz. The low-frequency response is determined by external components but is usually limited to 200 Hz, giving a 200-3400 Hz audio bandwidth. This bandwidth is the one used in most speech communication applications and also ensures good intelligibility. The audio is sampled and the samples are stored in a sample-and-hold-memory array, in analog form, and then placed in an EEPROM array. There are up to 480,000 cells. At 8000 samples per second, this allows 60 seconds (480,000 audio samples). This would require about 3.8 megabits (480 kBytes) of conventional digital memory (8-bit accuracy and resolution) plus A-D and D-A converters to achieve the same results. There are 600 rows in the memory. Each row is addressed individually. By addressing given rows, selective storage and retrieval is possible. Each row has 4 EOM (end of message) locations giving 2400 possible end of message locations. A signal at pin 25 of the voice chip called EOM (active low) goes from high to low. The edge of this pulse signal marks the end of a message in this application and configuration of the chip. Refer to the schematic for the following discussion.

Chip IC3 is the heart of the circuit, and is the voice-recording and playback chip (voice chip). Pins 1–10 are used to configure addressing and operating modes. Audio is inputted from a small electret mike, MIC1. Resistors R16 and R17 are load resistors for the
mike, and DC power is supplied through filter network R15 and C12. Coupling capacitors C10 and C11 couple mike audio into the internal mike preamplifier pins 17 and 18. Components R12 and C8 connected to pin 19 determine the automatic gain control (AGC) characteristics of the audio amplifier. Mike audio appears at pin 21 and is capacitively coupled via C9 and R11 to the analog audio input pin 20. The anti-aliasing filters are internal and are part of the chip, and they cut off at 3400 Hz. Pin 11 is an auxiliary audio input and can be used to feed the output amplifier when in the playback mode but not actively playing a message. It has about 10K ohm input impedance and unity gain. It is not used in this application.

Audio output from the playback amplifier appears at pins 14 and 15, which is a differential output and can drive a 16-ohm load with up to 50 mW of audio. From the memory array, it will provide 12.5 mW of audio. The signals at pins 14 and 15 are 180 degrees out of phase. Audio can be taken through a capacitor from either pin to ground as long as there is no DC path to ground from either pin 14 or 15. It is not recommended to use an impedance speaker or headset lower than 16 ohms to ground either pin 14 or 15 or to short them together. Audio is taken in this application through C6 and C7, with R13 and R14 providing a DC return for the audio output. These capacitors are connected to the output jacks for both monitoring and audio to the transmitter. Again, audio can be taken from one side to ground, or between the two audio output leads, as the signals are 180 degrees out of phase.

Pushing button S1 (start button) starts the cycle and grounds pin 23 of the voice chip, which starts a playback cycle. Pull-up resistor R10 holds pin 23 normally high. The state of pin 27 determines whether the cycle is record or play. If pin 27 is low when pin 23 is taken low, a record cycle is initiated. Pin 27 is held low when mode switch S3 is in the record position. R9 is a pull-up resistor, while LED1 and R8 serve as a record indicator, as LED1 will light when pin 27 IC3 is low. The chip will start in the 000 memory location. Pin 25 will go high and run until an end of message signal appears at EOM pin 25. Depending on the length of the previously recorded message, it is zero to 60 seconds after the cycle is started. If stop button S2 is pressed, this will bring pin 24 high, which stops and resets the cycle, irrespective of the particular point in the cycle. Useful for stopping a message, it can also stop the recording cycle after a message has finished being recorded. It is not necessary to use the full storage capability of the chip, and any length from 0-60 seconds (32 seconds with the ISD2532 chip) can be recorded and played back.

When pin 25 goes low at the end of the cycle, several things happen. In the mode that we are using in this circuit, pin 25 is high when the cycle is running and low when it is not. This is used to drive LED 2, which serves as an activity indicator. When LED2 is lit, transistor Q1 is biased on. Its collector is brought out to the switch-out lead and is used as an external control device. Q1 and LED2 are off during inactive periods between cycles. When pin 25 goes low, IC2B, a monostable multivibrator, generates a short low-going pulse. This pulse length is determined by R1 and C3 and resets the voice chip via R2 and pin 24. It also triggers a variable delay monostable circuit consisting of IC2A and associated components R3, potentiometer R4, and C4. R4 is used to set the delay, which is one to about 12 seconds. This circuit is used only in the loop mode and at the end of the delay as set by R4, triggers IC3 by momentarily bringing pin 23 of IC3 low via C5, as long as S3 is in the loop position. If S3 is in the one-shot position, IC3 is not re-triggered and must be re-triggered by pushing S1. In the record mode, S3 grounds the base of Q1, preventing activation of the device controlled by Q1 (if used) and lighting LED2 during periods when pin 25 is high (during cycle). Pin 27 is also grounded, lighting record LED1, and enabling the record mode.
The circuit operates from 5 volts provided by IC regulator IC1, an LM78L05.

Diode D1 provides reverse-polarity protection for the circuit. Capacitors C1 and C2 are noise-filtering and bypass capacitors. Except for external-audio and control jacks, push button and power switches, and battery, all parts mount on the circuit board.

Construction. The construction of this project involves stuffing a small PC board with a number of parts and carefully checking your work. You can use the foil patterns in Figs. 2 and 3 as references when etching your own boards. There are no set-up adjustments. The board can be mounted in a small plastic housing. A plastic case with a battery compartment that takes a common 9-volt alkaline radio battery was used. The board may be mounted in the case as shown in the lead photo, or you can use the board as part of another system or piece of equipment. There are no high frequencies or low-level signals that require special precautions, nothing being critical. The PC layout as shown is strongly suggested. The voice chip IC3 may produce noisy audio with a poor layout and inadequate ground plane.

Install all parts in the PC board. See the parts layout diagram (Fig. 4) for the location of the PC board parts. Note that there are several points that are soldered on top of the PC board—these must be soldered for proper operation. Figure 5 is a wiring diagram for use during the construction process.

Do not forget the jumper shown in the parts layout. Use a small scrap of bare wire passed through this hole.
Fig. 5. This Wiring Diagram will come in handy when the time comes to make all the necessary wiring connections. Be sure to follow along with this guide in order to avoid frustrating faulty wiring.

and solder to both sides of the PC board. This provides ground for a number of connections throughout the circuit, and the PC board will not work without it. Check your work and carefully inspect for solder bridges and proper component polarities and orientation. Sockets may be used for IC2 and IC3 if desired (they’re not included in the kit so purchase them separately). If everything is OK, connect small (16 ohms or higher) impedance earphones or a small speaker to C6-R13 and C7-R14 output terminals. Actually, a ¼-inch jack and a pair of 32-ohm headphones (FM stereo pocket radio type) is usable and recommended. Connect a 9-volt battery to D1 (positive) and ground (negative). Reversal of battery connections will cause the circuit to not operate, but no damage should occur (assuming D1 is correctly installed!). Figures 6 and 7 can be used to construct a case for the project. A drill template is shown in Fig. 6 and a label is shown in Fig. 7.

Checkout. Place S3 in the record position. LED1 should light. Now press S1 (start button). LED2 should light. Speak into the microphone in a normal voice and when you are done, press S2 stop button. LED2 should go out. Now place S3 in the middle (one shot) position and press S1. You should hear the message and LED2 should light. Also, Q1 (switch output transistor) should turn on. You can check this with a small 12-volt bulb or an LED-1K resistor series combination connected between the collector of Q1 and the
positive battery lead—it should light up. The message should complete and LED2 should extinguish. Also, Q1 should stop conducting as indicated by the bulb or test LED. Press S1 again, and the message should start up again. S2 should stop it and reset the chip if pressed.

Set R4 delay control fully counterclockwise. Now place S3 in the loop position and press S1 again. The cycle should start up. Let it finish and it should almost (Continued on page 40)

**PARTS LIST FOR THE ALP**

**SEMI CONDUCTORS**

IC1—78L05, voltage regulator, 5 volts/100mA  
IC2—CD4528, dual retriggerable/resettable monostable-multivibrator  
IC3—ISD2532P (32s) or ISD2560P (60s), voice chip  
LED1—Light-emitting diode, red  
LED2—Light-emitting diode, yellow  
D1—1N4007, general-purpose rectifier  
Q1—2N3569, NPN-Si, audio frequency pre-amp

**RESISTORS**

(All resistors are ¼-watt, 5% units unless otherwise noted.)  
R1, R9, R10—100,000-ohm  
R2, R16, R17—10,000-ohm  
R3—3300-ohm  
R4—100,000-ohm, potentiometer (PT10YH)  
R5, R7, R8, R13, R14, R15—1000-ohm  
R6—470-ohm  
R11—4700-ohm  
R12—470,000-ohm

**CAPACITORS**

C1, C2, C6, C7—10-µF, 16-volt electrolytic  
C3—1-µF, 50-volt electrolytic  
C4—470-µF, 6.3-volt electrolytic  
C5—.01-µF, ceramic  
C8—4.7-µF, 25-volt electrolytic  
C9, C10, C11—.1-µF, Mylar  
C12—100-µF, 16-volt electrolytic

**ADDITIONAL PARTS AND MATERIALS**

S1, S2—NO push-button switch  
S3—Two-pole, three-position slide switch  
J1—Audio jack, 3.5-mm stereo  
J2—Keying jack, 3.5-mm open circuit  
MIC1—Electret microphone

**NOTE:** The following parts are available from: North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804-0053: Complete kit consisting of a drilled and etched circuit board, all parts that mount on it, and complete documentation—$32.50 plus $5 postage and handling (within US). A suitable case is available from the same source—$17.25. New York State residents add sales tax for purchases. Call 914-235-6611 or check Web site www.northcountryradio.com for latest prices.

Fig. 6. Using the template above you can drill the required holes into the case. All of the components should fit easily into the unit and holes must be cut for the switches and LED indicators.

---

### LOCATION OF INTERNAL BOSSES

A 7/16 inch  
B #7 DRILL  
C 9/32 inch  
D #28 DRILL  
E 1/4 inch  
F 0.2 x 0.6 inch

### HOLES TO BE DRILLED
BUILD THIS
HOME APPLIANCE
WATT METER/
WATT-HOUR METER

FERNANDO GARCIA

IMPORTANT WARNING NOTICE:

The device described in this article involves the use of materials and substances that are hazardous to health and life. Unless you are experienced in the construction and safety considerations that apply to high-voltage devices of this nature DO NOT attempt to implement or use this information contained in this article. Although all possible measures have been taken to ensure the accuracy of the information presented, Gernsback Publications Inc. and the author are not liable for damages or injuries, misinterpretation of directions, or the misapplications of information.

Why do I need a watt meter? A very valid question to ask. As the West Coast energy shortages have shown, we are tremendously dependent on electrical energy. Unfortunately, new power-generating plants are not welcome in most communities, as all of them—whether fossil fuel, nuclear, hydro, or even wind-powered—have some environmental impact. Mix the environmental concerns with politics, and one can glimpse the mess electrical utilities have become.

The purpose of this article is not to discuss the messy details of energy, but what the average person can do to alleviate the problem. The answer is, quite a lot, by energy conservation measures. No, I'm not advocating that you set your thermostat at 85°F in the summertime. The key is smart conservation measures, the type that still allow you to maintain comfort and productivity, while reducing energy consumption. You know a few basic tricks, for instance, replacing incandescent bulbs with compact fluorescent lamps. Those are the obvious ones, but how about the not-so-obvious energy wasters?

Your house is full of them, from battery chargers to electronic appliances that, when turned-off, in reality only go into a standby mode. The power consumption in that mode can be surprisingly high. There they sit, day in and day out, consuming more than their fair share of watts, just doing nothing but waiting for somebody to turn them on.

By far, the worst offenders are TVs and VCRs, if only by the sheer number of appliances installed. There have been many studies related to energy waste in home appliances that you can read about on http://eetd.lbl.gov/ea/standby/Articles/Purdue.html and other similar Web sites. Some studies claim that standby power comprises 5% of total energy consumption in the US and about 13% in Japan! That is quite a lot of energy!

Fortunately, most newer appliances that are Energy-Star compliant are designed to consume 1 or 2 watts at most in the standby mode. How do you know if it is worthwhile to replace your old TV with a new one? The Watt-Hour Meter described in this article can help in your decision.

Even if you do not plan on replacing household appliances, being a power-hound is actually enlightening and a lot of fun. You can actually see how setting your fridge just a little cooler can jump its energy consumption dramatically. Attach the meter to your computer, and you can see how much it costs you to...
leave the monitor on while you download that large file. Investigate how much it takes to mow your lawn with that rechargeable lawnmower.

The bottom line is that energy awareness actually saves you money. You can feel better knowing that you are doing your share to improve the environment.

**Watt Meter Circuit Description.** The electronic watt-hour meter is divided into two sections: the first measures the actual power and the second integrates this power consumption to obtain energy (watt-hours). If you only use a watt meter, this second section could be left off.

The inspiration for this article is an old National Semiconductor application note, AN-265, which was first published in 1984 and can still be found at their Web site. The note was written for seasoned engineers and it suffers from a drawback that would preclude it from being published on a hobbyist magazine: a substantial portion of the circuit is connected without isolation to the "live" AC voltage. The app note does warn about using an isolation transformer to prevent electric shock, but I decided this project should be intrinsically safe.

Therefore, as shown in the schematic of Fig. 1, for safety's sake this design employs both a voltage and a current transformer (T2 and T3 respectively) in addition to its own power-supply transformer, T1. One may ask if the power-supply transformer could not be used as the voltage-sampling transformer. The answer is absolutely not; the supply current substantially reduces and distorts the output voltage. In addition, the transformer's magnetizing current, when operating close to its rated voltage, is quite large, which further distorts the voltage waveform. The key here is to employ a fully unloaded transformer operating at a voltage far below its primary ratings. Therefore, the dedicated voltage-sense transformer only sees a high impedance load and its primaries are connected in series to provide a 230-volt rating. When operated at normal 120-volt household voltage, the waveform distortion is kept at a minimum. You will later understand why distortion is a key parameter.

The current sample from T3 is converted into a voltage by resistor R3 and amplified by op-amp IC3a and gain set by R4 and R5. The voltage sample from T2 is divided down R1 and R2, and the inevitable phase shift equalized by C1. In both instances, this condition-
Fig. 2. Shown here are some waveforms that provide insight to the circuit operation. In this instance, the load was a room heater that had a small fan.

It is necessary to obtain the proper values at ±10 volt peak-to-peak at the circuit’s maximum input range (130-volt rms and 10-amp rms). These are fed to the analog multiplier’s X1 and Y1 inputs, where the circuit magic resides.

To design and build a multiplier using discrete components and op-amps is a tricky and difficult matter; fortunately, Analog Devices has in its catalog several monolithic analog multipliers. The low-cost device AD633 is used (IC5) in this project.

It can be shown that if two periodic waveforms are multiplied, the result is a waveform which contains an AC component at twice the original frequency, plus a DC component. How large is the DC component? One-half the product of the two values times the cosine of the phase angle. In equation form (and I promise this is the only equation I will show)

\[
\text{DC level} = \frac{1}{2} \times V \times I \cos(\alpha).
\]

Every student of electrical engineering will immediately recognize this as the equation used to compute AC true power.

We can measure this DC voltage in a properly calibrated scale and read true power. We must first get rid of the AC component, which would be measured in seconds. This is clearly an undesirable situation; the instrument would be unable to measure the power peaks that most equipment draws briefly during start-up. Therefore, to achieve the desired attenuation and fast transient response, a high-order filter is a must. Unfortunately, filter orders higher than three are pretty tricky to build and require all sorts of nonstandard component values.

Again, a semiconductor vendor comes to the rescue. Linear Technologies offers a variety of monolithic switched capacitor filters. These types of filters are tunable by varying the clock frequency, usually require very few external passive components, and high-order filter configurations are easily achieved. Filter IC6, an LTC1062 device, goes a little further. It is a DC-accurate topology, which is important if we plan to recover the DC-component precisely. Capacitor C10, along with the ratio pin 4 tied to the proper logic level, sets the internal clock frequency and thus its cutoff frequency. This frequency is set to 30 Hz. The device is a fifth-order filter; therefore, the desired 60-dB attenuation to the AC component is achieved. Capacitor C8, along with the equivalent resistance presented by R12, R15, R16.

Fig. 3. These are pulses from an "electronic load," which in this case was a computer and monitor. Electronic loads are characterized by the fact that the current waveform is not sinusoidal but pulsed.

Poptronics, April 2002

34
and P2, sets the proper transient response for the filter. They also divide down the DC component such that the voltage present at J3 (adjustable by pot P2) is exactly one volt per kilowatt. This setting allows a digital multimeter or high-impedance analog meter (set to the 2-volt scale) to directly read the true power.

At the project's maximum rating (1300 watts), this would mean 1.3 VDC. Capacitor C9 eliminates any clock feedthrough from IC6. Although all devices are quite accurate, some small DC offset is inevitable. Thus P1, along with R13 and R14, injects a small trimmable offset to ensure that the output reads as close to zero volts DC when no load is applied.

Comparator IC4a and b, along with resistors R6 through R9, capacitor C11, and LED D7, is a current-overload indicator. One would think that by monitoring the power, one would be aware of impending current overload. This is not always the case, as described in the sidebar. "Power Factor, Crest Factor, and No Power." Although a continuous overload will eventually blow the line-protection fuse F1, a milder overload due to a high-crest factor may yield completely erroneous results if the maximum range to the multiplier is exceeded.

Figure 2 shows some waveforms that provide insight to the circuit operation. In this instance, the load was a room heater that had a small fan. The power pulses, with a frequency twice that of the mains voltage, may be seen at the bottom trace.

Figure 3 shows the pulses from an "electronic load," which in this case was a computer and monitor. Electronic loads are characterized by the fact that the current waveform is not sinusoidal but pulsed. You can see that the analog multiplier still performs its job properly.

Watt-Hour Meter Description. A bipolar ±15-volt supply is provided by transformer T1, diodes D1-D4, fil-
These all while time integration by Voltage hold function. P3, R22, an analog IC3b. The unregulated portion from the bills integrating section.

The next section.

Logic unregulated is fed to the front end's sensors, so that none of the power it consumes is measured.

The above paragraphs describe the power-measuring section, but you want to build the energy-measuring section. Energy, as you may recall, is power integrated over time, which is what your local utility bills you.

Figure 4 shows the digital integrator. The DC component from the low-pass filter is buffered and amplified by IC3b. This is fed to a voltage-to-frequency converter IC8. Voltage-to-frequency conversion is a straightforward analog-to-digital conversion, which easily lends itself to time integration by simply counting its pulses. Altogether, P3, R22-R25, and C14 form the timing components, while C15 is the capacitor for the internal sample-and-hold function. The exact frequency is adjusted via P3. These all are critical components, as explained later.

Resistor R19 cancels the input bias current offset. Resistor R26 is a pull-up resistor to +5 volts, which is used to feed the pulses to the logic circuits.

The variable frequency pulses are applied to IC9, a 14-stage counter, which divides the frequency down. The net result is that at its Q14 output, there will be a pulse every 3.6 seconds for a properly calibrated circuit when measuring a 1-kilowatt load. Thus, in an hour (3600 seconds), there will be 1000 pulses, meaning a kilowatt-hour energy measurement. Of course, the pulse-repetition frequency will proportionately increase/decrease with a load increase/decrease.

The pulses are counted and displayed by a 4-digit counter/display driver IC10. The digit drive is multiplexed; therefore, the drivers, in the assistance of Q2-Q5, the display’s four digits. The display (IC11) should be of the common cathode type.

Individual segments and the decimal point are fed via a current-limiter-resistor network, R27. All four decimal points are used to monitor watt-hour activity; they flash at a repetition rate much faster than that of the least significant digit change. This is useful when measuring low-power loads where a single digit increment may require tens of seconds. Thus a signal far down the divider chain (Q8) is taken and applied to an emitter follower, Q1, to drive the points.

Momentary pushbutton switch S1 is used to reset all counters to zero, which starts a measuring period.
Constructing And Calibrating The Project. **WARNING:** Before you attempt to build this project, remember that hazardous voltages and substantial currents are present in the primary side of the circuit. Use at least 16-AWG wire for the line cord and the internal wiring, which is shown bold solid on the schematic. If you plan to use a metal enclosure, ground it via the line cord’s green wire. Insulate exposed metal surfaces.

Since the hazardous voltage section is all confined to the transformer’s primaries, either point-to-point wiring or a dedicated printed board may be used for the rest of the project.

A suitable board layout is shown in Fig. 5. There is no silkscreen on the bottom layer; it is shown only for guidance purposes (Figs. 9 and 10 show foil patterns for the PCB). In this particular board layout, I decided to mount all heavy, heat-producing, and high voltage-carrying components outside it. Therefore, all transformers, bulk capacitors, and voltage regulators are located out. These bulky devices are better suited to be wired point-to-point on a separate pressboard. Please also note that all components are mounted on the top board layer, like any normal assembly. The exceptions are the overload LED and the four-digit, seven-segment display. Therefore, you may mount the board on the wall of an enclosure, where the appropriate holes for the indicator and the display may be cut out.

If you use the transformers specified in the parts list, follow the connections to the pin numbers exactly. Since a transformer is AC in, AC out, one may think that the actual phasing of the pin connections is of no consequence. Well, for this project it is. The transformers must be wired in the proper phase for the project to work. The silkscreen on the board has a square on the hole where the transformer’s dotted terminal should be wired.

The project’s display is used to measure watt-hours only. As previously mentioned, there are a pair of female banana jacks where you may connect a DMM to measure power. As an option, you may wish to have a watt readout all the time and use a dedicated panel meter instead. There are many types available, but ensure that the meter is set to read 2 VDC, and that its input can measure a voltage referenced to its supply common. Beware of this last constraint; some panel meters require a floating power supply from the voltage you are attempting to measure.

You will require access to some test equipment to properly calibrate the project. You will need two DMMs to simultaneously monitor the AC line’s voltage and current. One of the meters should have a 10-amp AC measurement capability. Of course, if a wattmeter is available, that’s even better. A third DMM to measure DC voltage is required to make life easy; however, if none is available, you can swap the meter you are using to measure AC voltage. You will need some means of measuring frequency, either with a dedicated counter, a multimeter equipped with that function, or a scope. Be aware that if a scope is used the accuracy may be ±3%, unless it has cursors or an automated frequency measurement capability. You will need a purely resistive high-power load, between 1000 and 1300 watts. I used a fanless room heater, but a bank of incandescent lamps will also do the job. A variable autotransformer (variac) is also very useful, but not absolutely necessary.
After you have built and thoroughly checked your assembly, remove fuse F1. Apply power to the unit and measure that all of your internal supply voltages are present and within ±5%. Then with a DMM in the 200-mV DC range, adjust P1 such that the voltage between Test Point A and common is as close to zero as possible.

Remove power, connect the DMM that will measure current in series with the load (the empty fuse holder is a good place to attach the ammeter), and the other DMM in parallel to the load. Connect the load and reapply power. If you have access to the variac, start all the way from zero volts and slowly increase to the rated voltage, usually 120 volts. At this time, your load will be fully on, and you will have a reading on both the current and voltage DMMs. Multiply those readings to obtain your wattage and adjust P2 to obtain that same reading for a DMM (or dedicated panel meter) set in the 2-volt DC range and connected across J3.

Lastly, set your frequency counter or oscilloscope at Test Point B and adjust the frequency according to the following formula:

\[
\text{Frequency} = 4.551 \times \text{Power reading}
\]

where the frequency is in Hertz and the power reading is in watts.

Push switch S1 momentarily to reset the counter to zero. The decimal points will be flashing and moments later the counter will increment. Reinstall the fuse. This completes the calibration and verification of the instrument.

**A Word About The Project’s Accuracy.** Remember that the accuracy of your finished project depends on the accuracy of the instrumentation you used to calibrate it. I performed the initial calibration and troubleshooting with the limited equipment I have at home and then went to my local college where I could borrow the electrical lab and some equipment for a short period of time to perform the final calibration.

To retain the accuracy of the calibration, you must be aware of the sources of drift and what can

**POWER FACTOR, CREST FACTOR, AND NO POWER**

Unlike the simple task of calculating DC power which you obtain by just multiplying voltage and current, the calculation of AC power is a little more complex. For most instances, there will be a phase difference between the voltage and current. This phase displacement causes the true power to be a fraction of the product of voltage and current. This fraction is called the power factor and in mathematical terms it is the cosine of the phase angle between voltage and current.

When the load is purely resistive, the phase angle is zero and you know that the value for the cosine of zero degrees is one. Only in this instance can one calculate power by simply multiplying voltage and current readings. Most loads will have small phase angles (or in electrical terms, a high-power factor), and, as seen on Fig. 6, the power pulses are for the most part positive. On the other hand, as the phase angle increases to 90 degrees, the cosine value declines steadily to zero. This is seen in Fig. 7, where the larger phase displacement of about 60 degrees causes the power pulses to spend a substantial time below zero. The average power thus decreases. Although the peak-to-peak power is identical. You may reach a point with very low-power factor loads where you may have very substantial values of voltage and current, but the actual average power value is very low. These computer simulations agree with the actual measured waveform of Fig. 2 and 3.

You could be overloading the circuit unknowingly. Although no damage is done, the power readings will be erroneous. The overload LED will alert you of this condition.

Another problem occurs with so-called “electronic loads.” As its name implies, it is a load consisting of an electronic appliance, whether a computer, TV set, or audio amplifier. Electronic loads receive their current in brief intervals of the total 60 Hz period and sit idle the rest of the time. This is shown in Fig. 8. Although the rms current value may be moderate, these peaks may be quite high. This is a waveform with a high crest factor. Crest factors are the ratio of peak to rms values, and for a sine wave its value is 1.414. Electronic loads present crest factors from 2-3 and even higher. Therefore, you could possibly be measuring a load drawing moderate amounts of power with a very high peak current value. Again, no damage will be done, but the power readings will be all wrong. Again the overload LED will alert you of this condition.
be done to avoid them, in short, four words: careful selection of components.

In particular, capacitors C14 and C15 should be polystyrene or polypropylene. Avoid ceramic, Mylar, polyester, or electrolytic caps in those positions. The trimmer potentiometers should be cermets, not carbon films. Maintain the use of metal film. 1% resistors in the areas where I specified them. Lastly, if you can get the “A” suffix versions of IC3 and IC8 (LF412A and LM331A), their offset will be much lower.

Although sense-transformer errors have been minimized by the techniques described above, there is still some residual phase offset, which is clearly seen in Fig. 2. In this instance, the load was purely resistive, and the voltage and current waveform’s zero crossing should have matched. As previously described,

![Fig. 9. Here is the foil pattern for the bottom of the PCB.](image)

**PARTS LIST FOR THE WATT-HOUR METER**

**SEMI-CONDUCTORS**
IC1—LM340-15, positive-voltage regulator
IC2—LM320-15, negative voltage regulator
IC3—LF412A, dual BiFet op-amp
IC4—LM393, dual comparator
IC5—AD633 Analog Multiplier
IC6—LT1062, 5th-order switched-capacitor filter
IC7—LM340-5, positive-voltage regulator
IC8—LM331A, voltage/frequency converter
IC9—CD4060, 14-stage binary counter
IC10—74C925, counter/4-digit driver
IC11—LDQ-N516RI, 4-digit, 7-segment common cathode red display
D1—D4—1N4002 diode
D5, D6—1N4737A Zener
D7—Red LED
Q1—Q5—2N2222 NPN transistor

**RESISTORS**
R1—21,500 ohms, 1%, ½-watt
R2—30,100 ohms, 1%, ½-watt
R3—13,600 ohms, 1%, ½-watt
R4, R25—9000 ohms, 1%, ½-watt
R5—110,000 ohms, 1%, ½-watt
R6, R21, R26—51,000 ohms, 5%, ½-watt
R7, R8, R19—100,000 ohms, 5%, ½-watt
R9—3000 ohms, 5%, ½-watt
R10, R11—470 ohms, 5%, ½-watt
R12, R15—40,200 ohms, 1%, ½-watt
R13—300,000 ohms, 5%, ½-watt
R14—1000 ohms, 5%, ½-watt
R16, R17, R18, R20—26,700 ohms, 1%, ½-watt
R22—8450 ohms, 1%, ½-watt
R23—90,900 ohms, 1%, ½-watt
R24, R28—47 ohms, 5%, ½-watt
R27—270 ohms × 8 dip network
P1—50,000 ohms, single-turn potentiometer
P2—5000 ohms, multi-turn potentiometer
P3—2000 ohms, multi-turn potentiometer

**CAPACITORS**
Use 10%, lowest available voltage (usually 100 volts) for film and ceramic capacitors, unless noted.
C1—0.47 µF, Mylar (see text)
C2, C17—470 µF, 25-volt, electrolytic
C3—220 µF, 25-volt, electrolytic
C4—C7, C12, C16—0.1 µF, ceramic
C8—0.33 µF, Mylar
C9—3.3 nF, Mylar
C10—330 pf, 5%, polypropylene
C11, C13—0.1 µF, Mylar
C14—0.01 µF, 2%, polystyrene or polypropylene (see text)
C15—1 µF, polypropylene (see text)

**ADDITIONAL PARTS AND MATERIALS**
T1—6 VA-size, 115+115 primary, 14+14 secondary, Tamura 3FD-428
T2—1.1 VA-size 115+115 primary, 8+8 secondary, Tamura 3FD-216
T3—10-amp, 250:1 current transformer, Coilcraft CS2106 or similar
F1—12-amp, 250-volt, slo-blo fuse and fuse holder
J1—Male AC plug
J2—Female AC receptacle
J3—Red and Black banana plugs
SW1—N.O. Momentary switch.

**PARTS AVAILABILITY**
If there is enough interest, a PC board for the project may be offered for sale. Contact the author at fernando.v.garcia@worldnet.att.net.
capacitor \( C_1 \) compensates for this. If you have access to a dual-trace oscilloscope, you may wish to tweak the capacitor value to accomplish this. In my case, I required an additional 0.1 \( \mu F \) in parallel with \( C_1 \). If you have no oscilloscope to adjust the project, the phase error will still be quite small.

If you substitute the current transformer specified in the parts list, you may need to adjust \( R_3 \) to provide the voltage-level ratio indicated in the schematic. You may notice that this is usually lower than the manufacturer's suggested resistance value. This is another trick to increase accuracy.

Final Words On Using The Watt-Hour Meter. I distinctly recall when reading National Semiconductor's app note being puzzled about the substantial increase in a refrigerator's electrical consumption as the thermostat was set just 2° C (3.6° F) cooler. This is very true. You may monitor the amount of energy you can save by turning off your computer's monitor when downloading a large file. Perhaps the biggest surprise came from the amount of power the bedroom TV and VCR consume when they are off! These consumed as much as 23 watts while idling, while the newer TV and VCR in the living room, both Energy Star compliant, consume well below 3 watts.

**THE ALP (continued from page 31)**

immediately repeat. The delay between finishing and restarting should be controllable with \( R_4 \). If a longer maximum delay is desired, proportionally increase the value of \( C_4 \) as needed. Note that pressing \( S_2 \) will stop and reset the cycle, but it will start up again later as determined by the setting of \( R_4 \). In the loop mode, complete stopping is obtained by moving \( S_3 \) to the one-shot position.

See the figures for suggested package layout and a suitable label for the front panel.

---

"I don't think needing baby food jars to put spare parts in is a good reason to have another child."

---

www.americanradiohistory.com

AmericanRadioHistory.Com
ALL ABOUT
(continued from page 23)

affecting $A$ become less and less relevant to the circuit performance as the value of $\beta A$ increases.

We do not mean to pull a snow job here, but you should spend whatever time is needed to understand these concepts, as they are the heart of the theory. Once understood, op-amp circuits will be a breeze to work with.

Virtual Ground

In a practical op-amp circuit $e$ in is very small, since the value of $A$ is at least several thousand. Since $e$ in is that voltage appearing across the input of the op-amp (see Fig. 3), if one input terminal of the op-amp is connected to ground or has zero signal on it, the other input will also be very close to ground. Note again that $e$ in is at most a few millivolts in practical circuits. Under all signal levels this will be true, provided the op-amp is not driven into saturation or another region where the gain falls to a low value. This gives rise to the term virtual ground, since the op-amp input is always very close in voltage to ground. The input terminal in many applications is the inverting input, with the non-inverting input grounded or connected to a source of zero signal. Additionally, the amplifier itself has a high-input impedance, often measured in megohms. The input current to the op-amp itself is negligible and zero for all practical purposes. Therefore, in Fig. 3, the input current $I$ in $R1$, equal to $V_{in}/R1$, has to equal the feedback current in $R2$, equaling $V_{out}/R2$. Since these currents entering and leaving any junction must equal zero (Kirchoff's current law, the law of continuity—and plain common sense), it follows that the positive current flowing in $R1$ must be cancelled by a current flowing in $R2$, except for a tiny current flowing into the op-amp, which is zero for all practical purposes. The only way this can happen is if $V_{out}$ equals $-V$ in $(R2/R1)$.

Note that there is an inversion in phase, since the currents must cancel. The voltage gain is simply the ratio of $R2$ to $R1$. The two resistors set the gain. If multiple inputs are desired, extra input resistors and input sources can be added as in Fig. 4. The output voltage is given as:

$$V_{out} = -\frac{V_{in} R2}{R1 + V_{in} R}$$

This is called a summing amplifier (see Fig. 4) and the junction of all the resistors at the input is called the summing junction. Since the input of the amplifier is a virtual ground, there is almost complete isolation between all the input sources. This circuit makes an excellent audio mixer with virtually no cross-talk effects. By varying the values of the input resistors, $R1$–$R2$, different gains can be obtained for the various inputs.

As far as AC signals are concerned, a high-gain single-transistor amplifier circuit can approximate the behavior of an op-amp in these circuits if the collector is considered the output, the base the inverting input, and the emitter the non-inverting input. Naturally DC biasing arrangements are needed and there are DC level considerations, but the principles of feedback still apply. (see Fig. 5).

Several op-amp circuits will be discussed in the next part of this article.
Robotic Arm & IBM PC Interface

This month we are building a PC interface (IBM compatible) for OWI’s popular Robotic Arm Trainer. The PC interface, see Fig. 1, allows one to control the Robotic Arm either interactively in real time or allows the computer to control the arm autonomously by replaying a script file.

Robotic arms, I believe, are the most widely used industrial robots. They are versatile and can be retrofitted for various tasks by changing the end manipulator. For instance, welding manipulators for spot welding robots, spray nozzles for spray painters and cleaners, grippers for pick and place, and routers for material cutting, just to name a few.

Designing and building a robotic arm from scratch is a difficult project. It is far easier to assemble a pre-fabricated robotic arm from a kit, and OWI Company offers such a kit. It is an inexpensive robotic arm kit that is suitable for interfacing to a computer.

Gross Anatomy

The robotic arm is primarily made of lightweight injection molded plastic. The DC motors used in the robotic arm are small, high rpm, low-torque motors. To increase torque, each motor is integrally connected to a gearbox assembly. While the gearboxes increase the motor’s torque, the robotic arm is not capable of lifting or moving a great amount of weight. The maximum recommended lifting capacity is 4.6 ounces (130 grams). Here is a quick rundown of the arm’s specifications:

- Five axes of motion.
- Base can rotate left and right—350 degrees.
- Shoulder moving range—120 degrees.
- Elbow moving range—135 degrees.
- Wrist rotate CW and CCW—340 degrees.
- Gripper open and close—55 mm (2.2 inches)0.
- Product Dimensions—Maximum length outwards—360 mm (14.2 inches).
- Maximum height upwards—510 mm (20.1 inches).
- Lifting Capacity—Maximum—130g (4.6 oz.) Power.
- Power Source: 4 “D” batteries (not included).

What makes the arm suitable for computer control is the fact that it uses five small DC motors to produce motion in the base, shoulder, elbow, wrist, and gripper. The motors are controlled via a “wire” that we can tap into, meaning that each robotic motor (and its associated function) is controlled by wire supplying electrical power.

Basic Motor Control

To understand the basic function of wire control as we are using it in this project, let’s look at how two digital signals can control a single DC motor, see Fig. 2. Controlling a motor for clockwise (CW) and counter-clockwise (CCW) directions requires two complementary PNP and NPN transistors. Each transistor functions like a switch, controlling the current to the DC motor. The direction of the current controls which way the motor spins; clockwise (CW) or counter-clockwise (CCW)—each transistor controls the opposite direction.

Notice when both transistors are turned off, the motor is off. Only one transistor (per motor) should be turned on at a time. If both transistors are accidentally turned on, it will
be the equivalent of creating a short circuit. Similarly, each DC motor in the robotic arm is controlled by two complementary transistors on the interface.

**PC Interface Construction**

The PC interface schematic is shown in Fig. 2. There is nothing critical about the circuit, and it may be built on a breadboard. For those who purchase the kit, the parts placement on the PC board is shown in Fig. 3.

Begin construction by first identifying the component side of the PCB. The component side has the white line drawings of the resistors, transistors, ICs, and DB25 connector. All components are mounted on the component side.

In general, after soldering a component to the board, clip away any excess wire from the under side of the PCB. It's a good idea to follow the sequence for mounting the components. Begin by mounting the 100K resistors (color bands brown, black, yellow, gold, or silver) labeled R1 through R10. Next, mount the 14- and 20-pin sockets in the U1 and U2 position. Mount and solder the DB-25 right-angle connector. Do not force the DB-25 pins through the board; it is a precision fit. If necessary, gently rock the connector in, making sure not to bend any pins. Mount the slide switch and the LM2940 voltage regulator. Mount and solder the TIP120 and TIP125 transistors. Finish the project by mounting the eight-position three-inch connection cable. Insert the two ICs, the 74HCT154 and 4049, into their respective IC sockets. Be sure to orient the chip indentation on the top.
side of the chip with the indentation on the white line drawing.

**How The Interface Works**

We need two complementary transistors to control each of the five DC motors. That works out to ten output lines to control the five motors. The PC parallel port has eight available I/O lines. To increase the number of output lines, the robotic arm interface incorporates a 74HCT154 (4-16 decoder) IC. By using just four lines off the parallel port (lines D0-D3), we can add up to sixteen output lines, although we only need and use ten output lines.

**PARTS LIST FOR THE ROBOTIC ARM**

- 5 TIP 120 NPN transistors
- 5 TIP 125 PNP transistors
- 1 74HCT154 1/4-inch decoder
- 1 8-position, 3-inch long Molex cable
- 1 DPDT PC-mounted switch
- 1 DB25 right-angled PC-mounted connector
- 1 PC board
- 10 100K, 1/4-watt, resistors
- 1 LM2940 voltage regulator
- 2 program diskettes

The Robotic Arm Interface Kit ($44.95) contains all of the above parts.
OWI Robotic Arm Trainer ($84.95)

Available from:
Images Company
39 Seneca Loop
Staten Island, NY 10314
718-698-8305
All Major credit cards accepted

**Connecting The Interface To The Robotic Arm**

The robotic arm uses a single 6-volt power supply consisting of four "D" cell batteries in the base. The PC interface takes power from the arm's 6-volt power supply. The power supply is used like a bipolar ±3-volt power supply. Power is tapped from the 8-conductor Molex connector to the arm base.

Connect the interface to the robotic arm, using the 3-inch long 8-conductor Molex cable. The Molex cable connects to the connector on the base of the robotic arm. Make sure the Molex connector is firmly and properly seated.

Connect the interface to the computer's printer port. Keep the interface turned off until the Windows program is running. If the interface is turned on before the program is run, the existing (left-over) information (status) left on the printer port may activate the robotic arm.

**Installing the WIN 95/98 Program**

The program for the interface may be downloaded freely from the Internet. Go to [www.imagesco.com/catalog/RoboticArm/RoboticArm01.html](http://www.imagesco.com/catalog/RoboticArm/RoboticArm01.html). Download and unzip the file. Install the program by running Setup.exe. For those who purchase the kit, insert the 3.5-inch diskette labeled "Disk 1" into the computer's floppy drive and run the set-up program.
Connect the interface to the robotic arm, using the 3-inch long 8-conductor Molex cable. The Molex cable connects to the connector on the base of the robotic arm. Make sure the Molex connector is firmly and properly seated.

(setup.exe). The set-up program creates a directory named “Robotic Arm” on the computer’s hard drive and the needed files are copied into this directory. A “Robotic Arm” icon is created on the “Start Menu.” To run the program, click on this icon in the start menu.

Using the Windows Program
Start the program. The program’s opening screen is shown in the photo below. Operating the robotic arm interactively is easy. Simply click on any function button to command the robotic arm to perform that function. When the function is active, its button color changes to green. Click on the button a second time to end (deactivate) the function (button color turns back to red).

Creating Script Files
To program motion and automation, use script files. A script file is a list of timed instructions that control the robotic arm. Creating script files is simple. To create a script file, click on the “Interactive” button. The button label changes to “Program” and puts you into the “programming” script-writing mode. Clicking on a function button will activate the robotic arm function as before, but, in addition, the function information is entered into the yellow script table on the right side of the screen. The step number is placed in the left-most column, starting with one and increments with each new function. The function name is entered in the middle column. When the function button is clicked the second time, the function stops as before and the elapsed time from starting to stopping the function is entered into the third column. The time elapsed is incremented in quarter seconds.

Continuing in this manner, a user may program up to 99 functions, including timed pauses, into a script file. Script files may be saved to and loaded from the local directory. Script files may be set to replay up to 99 times by typing a number in the Repeat box and hitting start.

To stop writing into a script file, click on the interactive button. This puts the computer back into the interactive mode.

Animatronics
Script files may be used for computer automation or animatronics. With animatronics the underlying mechanical robotic system is usually covered and hidden from sight. For instance, if you covered the robotic arm with a child’s sock puppet and programmed a small show, you would be programming an animatronic or electronic puppet. Animatronics is the entertainment side of automation.
Laser Pointers and Diode Laser Modules

This month I am inaugurating a somewhat new direction for “Service Clinic.” Over the past several years, this series has covered many areas of consumer-electronics repair—most of which I can discuss above the level of an informed carrot. While some areas like television sets haven’t been dealt with, computer monitors have—and these share about 90 percent of the same problems and solutions. Rather than repeating topics, which seems wasteful of space, or treating TVs or other major topics in depth (which puts people to sleep), this series will now cover a variety of mostly shorter topics, some involving repair, some involving general electronics, and some involving lasers and related areas. In other words, although the name of the series is still “Service Clinic,” it may actually deal with almost anything. I may still cover a few other major areas of repair, but the era of the never-ending repair saga is over!

Laser Pointers

Even if you haven’t used one or don’t own one, it’s hard to avoid having seen them. How do they get an entire laser inside a gadget that fits in your pocket? What’s the real story on the safety of these things? Why is the green variety so much more costly than red ones? For that matter, how can the red ones be so inexpensive? Can the output power of a laser pointer be increased safely (to you and the pointer)? What other modifications are possible? In this and the next “Service Clinic,” we’ll cover these fascinating topics and more.

Even if you don’t do presentations and don’t own a cat, a red laser pointer represents by far the least expensive real laser readily available and can have all sorts of other applications—so the following material may still be of interest.

Fig. 1. In comparison, a red laser contains less parts than a green laser. The green laser requires a separate optics-module, called a DPSS, to produce the proper wavelength.

History

In the old days, before CD players, and before the laser was invented, you used a stick to point out something on a screen or blackboard (this was even before whiteboards!). The earliest optical pointers used tiny incandescent bulbs, a lens, and mask or transparency to project a dot or arrow. Such devices were about as big as a full-size (D-cell) flashlight, required a separate power pack attached by wires, and probably plugged into the wall. Performance was not all that great since the beam could not be collimated as well as a laser, but, nonetheless was a major advance over the stick. However, since they used an incandescent lamp, any color was possible using optical filters. Given the brightness or lack thereof, white was most common.

The first laser-based laser pointers used helium-neon (HeNe) lasers with their high-voltage power supplies packaged as compactly as possible. They still required a separate power pack or bulky case, which included heavy batteries.

Being true lasers, the beam was very clean and well collimated. Both red and green HeNe laser pointers were produced (yes, HeNe lasers come in green). The real laser pointer revolution came about as a result of the development of inexpensive visible laser diodes. Laser diodes are only slightly larger than a grain of sand and run on low-voltage low current. They can also be mass-produced—originally driven by the CD player/CD-ROM revolution, barcode scanners, and other applications where a compact low-cost laser source is needed. Now manufactured by the millions, these laser diodes cost well under $1.

Safety

There have been some recent articles (mainly in the U.K.) about eye injuries resulting from careless or malicious use of common laser pointers. In the U.S., there have been numerous news reports that would lead the average person to believe that the absolute end of civilization as we know it will result from the proliferation of these devices. Although the potential for eye injury is typically what comes to mind when one thinks of a laser, the possible side effects—or collateral damage—that may result from aiming one at somebody is at least as likely a cause for the current wave of hysteria.

Keep in mind that what gets reported in the popular press is not exactly rigorously reviewed for scientific accuracy. If it turns out that the outcome wasn’t quite as originally reported, any correction for a front-page story is usually to be found in fine print buried on page 17!

Actual substantiated instances of long-term or permanent effects on vision resulting from momentary or unintentional exposure to a laser pointer’s beam—or even from prolonged intentional misuse—appear to be all but non-existent. Flash blindness is possible, but this is temporary and will clear up on its own.

The above applies where the laser pointer has been manufactured and tested to meet CDRH (Center for Devices
and Radiological Health, part of the FDA Class IIIa safety limits or below. Note possible eye damage increases where these devices originate from countries with less rigorous quality control, where an internal current adjust pot can be twiddled, where laser-diode output power is greater, or where there is intentional abuse.

With respect to direct personal danger, potential damage to vision is the only real consideration—there is no risk from radiation, and there isn’t enough power in a beam of less than 5 mW to burn anything. However, from a public policy and regulatory perspective, there are actually three areas of concern:

1. Flash blindness from momentary exposure or permanent damage to vision from prolonged intentional misuse. Laser pointers are usually rated Class IIIa or less, which means that the power is low enough that the eye should be protected from permanent damage by natural pupil contraction, blink, and aversion reflexes.

2. Distraction and collateral damage—you wreck your car because someone directed a laser pointer at you while you were driving.

3. Misinterpretation of intent—you get blown away by someone with a BIG gun who thinks you are targeting them with a laser sight. Or, you are arrested and thrown in the slammer for aiming a laser pointer at a cop (this happened recently).

I am in favor of tough laws to make (2) and (3) crimes with appropriate punishments. Such behavior should not be tolerated. However, in the remainder of this section, I only really want to address the vision issues (1).

While I absolutely agree that intentionally aiming a laser of any kind into someone’s eye is basically stupid (unless you have having laser eye surgery), one must be careful in interpreting the meaning of press reports that describe momentary exposure to the beam from a laser pointer waved around an auditorium resulting in instant total loss of vision in all three eyes! One would have to direct the beam into the pupil of the eye from a close distance for a few seconds or more without either the eye or pointer moving, twitching, or blinking. Distance is significant for two reasons. Laser pointer beams diverge (especially cheap ones), so less energy is able to enter the pupil of the eye as the source moves further away; and it is harder less likely for it to remain stationary and centered on such a target a few millimeters across.

In fact, despite the great amount of press coverage lately—and such reports resulting in the passage of laws in some places banning laser pointer sales to minors (or to anyone), there are very few if any confirmed reports of permanent vision damage attributable to these things. The irresponsible aiming of a laser pointer at a person that might result in tragic consequences, whether from distraction or misinterpretation of intent, is far more likely to be a problem in today’s world—and justifiably so.

**Specifications**

Here are some of the things that manufacturers use to rate and promote both red and green laser pointers (see Table 1). However, given the quality control (or lack thereof) and constant shifting suppliers, none of this can be taken too seriously.

- **Wavelength**—This may be specified but doesn’t trust it too much. Usually, lower (e.g., 640 nm versus 660 nm) is better since visibility is a strong function of wavelength.

- **Relative and Factor**—The term “relative” refers to the visibility compared to the 555 nm peak of human vision; while the “factor” compares the brightness to that of an older 670 nm pointer. Note that visual perception of brightness is not linear. Thus, a 1 mW 532 nm green laser pointer isn’t actually going to appear 28 times brighter than a 1 mW 670 nm red model. What it means is that a 1 mW green pointer will appear similar in brightness to a 28 mW 670 nm red one (if such a thing existed, but anything above 5 mW true power isn’t legal).

- **Output power**—Power ratings are often made deliberately confusing like “<5 mW,” which could mean almost anything! Even among identical models, there can be significant variation, especially for green laser pointers.

- **Distance/Range**—By itself, this is basically a totally useless number. Do they mean on a moonless night under smog-free conditions? Light doesn’t travel a specific distance and stop or suddenly become too dim to be seen.

- **Beam Shape/Quality**—Without significant effort, the output of a red diode laser pointer is not a nice round spot like that of a HeNe laser. More expensive pointers may have the necessary optics to do a decent job of beam shaping but most do not. Sometimes, the beam shape will be shown in the catalog or Web site listing, probably to convince you to upgrade to the model with the rounder spot.

- **CW or Pulsed**—As far as I know, all red laser pointers produce a continuous (CW) beam. However, due to the way modern green laser pointers work, there are significant advantages in terms of efficiency and thus battery to use a pulsed system. As a practical matter, it doesn’t much matter to the user unless the pointer is moved rapidly in which case the pulsed beam will show up as discrete.
spots rather than a continuous line.

- **Adjustable focusing lens**—While this may at first appear to be highly desirable, in the end it may turn out to be a nuisance—going out of focus on its own and prone to constant fiddling. (Of course, a piece of adhesive tape or dab of glue can cure this malady.) However, make sure that the pointer you acquire has had its focus properly set at the factory!

- **Multiple pattern-generating optics**—This type of thing appears really neat and cute. In my opinion, it has limited value, at most. Pattern generating reduces the overall brightness of the projected spot and, except for a basic arrow, just detracts from a presentation.

- **Battery**—The amount of time claimed for a set of batteries may be optimistic. Some/most may assume something about the usage pattern in a pointing application (as opposed to cat teasing) like "25 percent on, 75 percent off." The brightness of some pointers decreases significantly as the batteries are drained while others remain exactly the same and then poop out without warning.

- **Life expectancy and warranty**—Sometimes there will be a spec like "2000 hour lifetime." This is probably mostly relevant for the expensive green DPSS laser pointers and may be reasonable. Certainly, anything over 1000 hours is adequate for a pointer used as a pointer within one's (human) lifetime (or until it becomes obsolete). However, any lifetime claim isn't of much value unless there is an enforceable warranty!

By now, you're probably totally confused. My advice: Use the specs for guidance, but if you really care about the quality of your laser pointer, try a few out which come with money back no-questions-asked warranties and keep the one you like. If, on the other hand, you just want to use the pointer for presentations (what a concept!) and not to stroke your ego, the cheapest red one will probably be just fine.

**What's Inside a Laser Pointer?**

The description below applies to most red laser pointers sold today (pen or key-chain type). We'll discuss green laser pointers next time. A common red laser pointer contains the following components (see Fig. 1):

- **Laser diode**—This will have a 3- to 5- mW maximum output. Better or older ones will be in a can package like that in the diagram; newer cheaper ones will just be a bare chip mounted on a heatsink. See the photos for some typical packaged laser diodes, as well as a laser diode without the cover. The actual laser is the chip mounted on the fat vertical post.

- **Power source**—These are typical AAA Alkaline cells or watch-style button cells. Depending on design, the battery must produce 1.5 V to 4.5 V or more.

- **Power regulator**—Many of the visible laser diodes used in laser pointers have very precise current requirements. Too little and they don't last; too much and they turn into poor imitations of Leeds or die entirely. The cheapest pointers today apparently use laser diodes that have a somewhat wider tolerance and just

(Continued on page 53)
Boo! Lean is Scary

Q

I have a Boolean equation as follows:

\[ \overline{C} (\overline{B} + \overline{D}) + \overline{A} (\overline{B} + D) + ABC = W \]

I need to convert this into NAND format using DeMorgan’s. I have a basic understanding and know the two DeMorgan laws, but am struggling to apply them to this length of the equation. If you could give me some direction, it would be much appreciated.—A.W., United Kingdom

A

The key to NAND conversion is to get the equation into the “sum-of-products” form where it looks like a conventional algebra equation of multiplied terms that are added. To do that, we can distribute the “c” and “a” of the first two terms out just as we would in conventional algebra. At this point, I should warn readers that the rules of conventional algebra don’t often carry across into Boolean algebra. This is one exception.

The equation now becomes:

\[ \overline{C}B + \overline{C}D + \overline{A}B + AD + ABC = W \]

Now, we’re in the “sum-of-products” form. The quick DeMorgan move on this equation is to invert the entire thing and then invert it back, resulting in a double vinculum over the entire equation. Double inversion has the same logic as no inversion. The equation becomes:

\[ \overline{C}B + \overline{C}D + \overline{A}B + AD + ABC = W \]

Now, over each “OR” sign, we can break the lower vinculum and change the “OR” sign to an “AND” sign. This ends up converting the ORed NANDs to NANDed NANDs. The equation transforms into:

\[ \overline{C}B \overline{D} \overline{A}B \overline{A}D \overline{A}B C = W \]

Notice that \( \overline{C}B \) is simply \( \overline{C} \) and \( \overline{B} \) NANDed together. So is \( \overline{C}D \); and \( \overline{A}B \); and \( AD \); and \( ABC \).

At this point, it may appear that you’re in deeper manure than where you started, but you’ve just ended up with your circuit in all-NAND form. The output of each of these five NANDs is NANDed together. The circuit looks like that of Fig. 1.

Combinational logic can be very messy at times. That final 5-input NAND is an ugly thing to behold. You’d have to use an 8-input 7430 with the three extra inputs enabled by tying them off to a logical HIGH. It takes four different ICs to implement this circuit.

One cute trick to cut down on a lot of IC connections is to use a multiplexer such as the 74150 to mimic this logic. Beginning with a truth table of the original equation as shown in Fig. 2, we connect the 16 data inputs to HIGHs and LOWs depending upon the desired output with that particular DCBA input, as illustrated in Fig. 3. For instance, with a binary 0111 (decimal 7) input, the output should be a HIGH. Since the 74150 has an inverted output, we connect the D7 input to a LOW. When selected, it will be inverted to a HIGH at the output.

Using a 74150 like this won’t work well if it’s driving high-speed logic—for that matter, neither will the NAND circuit of Fig. 1. Combinational logic, whether individual gates or a multiplexer like the 74150, is “glitchy” logic. Propagation delays through individual gates can create “glitches” or unwanted narrow logic pulses between state changes. If the circuit is used to drive a human-observed display, there should be no problem; but high-speed clocked logic can be falsely-triggered by these glitches.
Kelvin Revisited

Q Your description of 4-wire resistance measurement is good. I have a few additional comments. I wrote about the “Low-Ohms Tester,” an add-on device for a DMM in “Expanded Resistance Ranger for your DMM” (Popular Electronics, December 1995) and about a separate meter, “Low-Ohms Meter” in “Using Digital Panel Meters” (Popular Electronics, October 1996).

When you are making repeated measurements, it’s convenient to only use two clips, with two wires from each clip going to the meter or adapter. As I wrote, this can be a problem because of the resistance along the length of the clip. Steel alligator clips can’t be used, but solid copper clips can be used for a 3- or 3½-digit readout. For a 4- or 4½ digit readout, the resistance of copper clips is too high. You can buy “Kelvin clips,” which have the two jaws insulated from each other, with one wire going to each jaw. At that time, and still today, I only know of one source for these clips. They are made by Mueller, but the only supplier I know of is Hosfelt Electronics, Steubenville, OH 43952-1158; 800-264-6464. They are high, $7.50 each, but when there’s only one source....

You can get 0.1% resistors from Mouser Electronics, but I think if I were building a 4- or 4½-digit device today, I would use a 15-turn pot to set the current and a good 4½-digit DMM to measure the current for calibration.—Bill Stiles, via e-mail

A Bill, I had forgotten all about mentioning Kelvin clips. I had actually bought a couple of pair for use at the school when I was in Oklahoma, and I believe it was from Hosfelt. It was one of those things that I instantly ordered, because I’d never seen them offered by anyone before. I’ve made some specialized “tweezer” style test leads for working with surface-mount resistors, so I don’t see that it would be that difficult for the enterprising experimenter to make Kelvin clips for repetitive 4-terminal resistance measurements. A little epoxy and file work while sacrificing another pair of alligator clips could produce a primitive, but functional set of Kelvin clips.

You have to be very careful of your ammeter method of setting the current as you mentioned at the last. Between voltage and current measurements, current measurements present the most error because of the extra resistance the ammeter inserts into the circuit. If you set the current with the DMM and then pull the DMM out of the circuit, depending upon the range of the ammeter, you’ll pull anywhere from 0.1 to 10 ohms out of that series circuit. The current will increase enough to blow your subsequent voltage measurement out of the water.

That’s why I prefer to find a very accurate, low-value resistance that will drop around 0.1-0.2 volts at design current and just leave it in the circuit where I want to measure the current. I can then use the voltmeter to measure the voltage drop and calculate the current from that. Next, I use the same DMM to measure the voltage across the “unknown” resistance, giving me far greater accuracy. If the DMM happens to be a little off, it probably won’t matter because it’s likely that you’ll be using the same voltage range for both measurements. The Ohm’s Law calculation of resistance will not be hurt because this meter error will divide out in the calculation.

As long as the reference resistance for setting the current is accurate, the DMM is stable and repeatable, and the number of significant figures on the DMM reading back-up is the precision you’re trying to achieve, using the same meter for both voltage measurements should yield final results that are comparable to the accuracy of the reference resistor.

Now, back to the Kelvin clips. You can make your own if you have the time and the patience, and if getting a root canal doesn’t sound more appealing at the moment. The root canal will start to look better as you get into this project.

Begin with four new alligator clips and a small piece of 0.007-inch- (0.19-mm) thick double-sided glass-epoxy cir-

Fig. 4. The initial preparation for making a Kelvin clip (a) consists of grinding off the teeth of the lower jaw and (b) cutting a groove in the underside of a second alligator clip, as described in the text. The upper jaw is still attached in (a), but not shown for clarity.

Fig. 5. A wire is soldered into the groove (a) made in the jaw section that was removed, and (b) these transplanted teeth are soldered to the insulating double-sided circuit board previously installed. The completed Kelvin clips are identical and have the lower jaw insulated from the upper jaw. Current is supplied to the upper jaw while a voltage reading is taken from the lower jaw.

AmericanRadioHistory.Com
circuit-board material. This is really thin stuff. I have a lot of it. If you need some, send me an SASE (I stress the “AS” in the middle) and I’ll slip you enough so that you can make two clips and several mistakes.

Remove the wire-securing screw, if any. Hold the clip open with pliers (wind a few turns of rubber band around the plier handles so they’re self-closing) and use a Dremel tool or file to grind down and deburr the lower jaw of the clip, as shown in Fig. 4a. On the underside of a second clip, make a deep groove along the length of the jaw toward the middle, as shown in Fig. 4b. This groove should be deep and wide enough to lay in and solder a small-gauge stranded wire. Now cut off the lower jaw where marked with the dashed line in Fig. 4b and deburr the cuts you’ve made.

Clean up both sides of a ¥/4- × 1 inch strip of the circuit-board material. Sandwich the board and a ¥/4-inch-thick piece of cork between the jaws of the first clip so that the cork is pressing the board against the detoxified lower jaw. Solder the board in place onto the lower jaw. You want the solder to wick under the board so that you can later grind it off flush with the side of the clip.

Solder a six-inch-long, 24- or 26-gauge stranded wire into the groove you cut into the jaw section, as shown in Fig. 5b. You’ll have to run the wire under the spring of the first clip so that it pokes out the “handle.” At this point, if the light has not yet dawned, you’re about to find out why Kelvin clips are expensive. Position the jaw section directly over the lower jaw of the first clip, with the piece of cork and the spring tension of the upper jaw holding things in place. Sight down the throat of the clip, making sure that the transplant jaw is exactly over and aligned with the lower jaw, checking both sides for symmetry. Now, you get to solder this jaw section to the circuit-board material. Be careful that the wire doesn’t pull out as you solder. Again, make sure you use enough solder and get things hot enough that the solder wicks under the jaw. However, don’t get the clip hot enough that you melt the insulation on the wire. Teflon-insulated wire would be a nice touch here. See your nearest electronics surplus store for that.

Now use some shop scissors to trim away the extra board material from around the clip. Then use the grinder or a file to make the board material flush with the sides of the clip. I recommend that the direction of grinding/filing be along the length of the clip so that the burrs don’t short the two sides of the board together.

Time for an ohmmeter check. Put the cork back between the jaws to keep them open. On a high-resistance range, check the resistance between the upper jaw and the teeth of the lower jaw. It should be “infinite,” showing an open. If it doesn’t, get a really strong magnifying lens and check along the edge of the circuit board, looking for stray burrs that may be shorting the two sides together. The wire may be shorting to the spring or the main part of the clip if the insulation isn’t snug against the board. In that case, go back up to the paragraph that starts, “Begin with four new alligator clips.”

If the meter shows an open, you’re almost done. Solder a heavier-gauge stranded wire to the wire hole (or the...
vacant screw hole) in the clip, taking care that you don’t melt the insulation of the first wire. Run both wires out the back of the clip and use two layers of heat-shrinkable tubing to hold everything in place. Then apply a dab of epoxy in the channel of the clip as a strain relief to hold the wires in place, especially the one going to the isolated jaw.

That’s one clip done. Repeat for the second clip. If all went well, you should have a pair of Kelvin clips and a pair of clips in need of dental transplants that you can give to a “friend.” In use, the larger wires will connect to the current source, and the smaller wires will connect to the voltmeter.

And Revisited...

Q In reference to the 4-terminal resistance measurement, your answer was correct and well-written, but to me it is incomplete. I really would like to know how to make a constant current source of 2-, 3- or 5-significant-digit accuracy. A 10-milliamp source would have to be accurate to 1 microamp to get that accuracy.—W.A.

A That’s a tough one. I may play around with that idea, but 0.1% (or better) accuracy is a little tough to achieve with off-the-shelf parts. I’m one of those guys who appreciates having accurate test equipment on my bench, but at home I just have to make do with what I can cobble together. The digital multimeter that most hobbyists own is probably their most accurate item of test equipment, and so is a good foundation upon which we can build our test circuits. My solution to the 4-terminal problem was designed to work without using exotic circuits and was intended for the occasional need to make low-resistance measurements.

A good regulated power supply and a stable, low-value resistor work very well as a “pseudo-constant current” source. Once set up, they will remain relatively stable long enough to make a decent measurement of the unknown resistance. I’ll take your request into consideration and try to come up with a simple design that will work for this application. Meanwhile, take a look at Chapter 4 of Walt Jung’s IC Op-Amp Cookbook (Sams 0-672-22453-4) where he discusses all kinds of Howland voltage-controlled current sources. That happens to be an excellent text on op-amps that every hobbyist should have on the bookshelf.

Batteries on Vacation

Q I want to add an extra “house” battery for my “Class B” van. I’ve been told by one person to just add the second battery positively to positive, negatively to negative. Another told me to book them up like that and then run the positive from the charger to the positive of battery #1 and the negative from the charger to the negative of battery #2. What’s right here?—V.G., via e-mail

A Adding an extra battery involves nothing more than simply putting the second battery in parallel with the first, the two positive posts of both connected together and the two negative posts connected together. They should be connected together by wiring that is the same size or larger than what was connected to the original battery. The original charger wires can connect to the posts of either battery, as long as you connect positive to positive and negative to negative. All of that is the easy part. Now for the precautions.

Don’t forget that lead-acid automotive batteries liberate all kinds of hydrogen gas. Hydrogen (starts with the same letter as Hindenberg) is explosive, and batteries must be vented to outside air so that hydrogen doesn’t accumulate in a confined space.

Never install a brand-new battery in parallel with an older battery. Although it may seem a waste, get rid of the original battery and put two new, identical twin batteries in the coach. Use the original battery on your trolling motor or something else that needs a single deep-cycle battery. Connecting a new battery alongside an old battery would be like hitching a Clydesdale draft horse alongside a Shetland pony. The unmatched batteries could set up a current loop between them where the new battery would discharge into the older battery. If the water level in the older battery had ever been allowed to fall below the tops of the plates, it will begin to increase its rate of self-discharge and pull the charge down on the new battery, as well. Parallel-connected batteries are not unusual in trucks and busses. The general rule-of-thumb should be this: If you have to replace one, replace them all.

Don’t forget to use deep-discharge marine/RV or golf-cart batteries in RV applications. Conventional car and truck batteries are designed for short, very heavy bursts of current for starting an engine and will have shortened lives if allowed to go dead too many times. A deep-discharge battery is designed for lower discharge currents rather than high “cold-cranking amps” and is able to be deeply discharged and recharged with no harm. Although the amp-hour rating of similar-sized batteries of both types might be the same, the starting battery will be capable of high current for a short period of time while the marine/RV battery will be capable of lower currents for a long period of time.

The negative-battery clamp, which is connected to chassis ground, is always the first battery connector to be removed (both of them) and always the last one(s) to be connected. This keeps inadvertent slips of the wrench to the chassis from causing a short circuit when removing the positive connections.

National Radio Institute

Reader Malcolm Leonard sent me a few copies of the National Radio-TV News and the NRI Journal from the early 50s and late 60s, respectively. These bimonthly publications from the National Radio Institute are really fun to read. One issue indicated that the starting salary for a new technician in 1951 was around $280/month. Some of the test equipment that was built as part of the course is used for theory lessons in these little magazines and sometimes whole schematics are shown. They’ll be a great resource in my quest to be able to supply schematics for these “orphaned” items of equipment. Malcolm, thank you for your generosity. Readers, scour your attics and basements for these old correspondence course schematics. I’m still on the hunt and a long way from my goal.

Heathkit Help Hotline

Q I’ve subscribed to your magazine for several years and have found it to be a great source for electronics information. During the 70s, I put together several Heathkit projects with nearly all of them still working. The one not working is the Heathkit clock model GC-1107. I need the clock IC—the original part number was 443-848. If anybody can point me to a source, it would be greatly appreciated. Thank you.—D. A., Warner Robins, GA

A There were true tears shed by electronics hobbyists around the world (Continued on page 58)
have a resistor to limit current.

- **Collimating/correcting optics**—At the very least, there must be a lens to convert the highly divergent beam from the bare laser diode to one that is roughly parallel.

- **Some means of generating multiple patterns (optional)**—These permit the projected shape to be selected to be something other than a formless spot either by a built-in thumb-wheel type thingie or by replacing end-caps.

**Power Regulators in Laser Pointers**

Figure 2 shows an example of a discrete driver from a cheap laser pointer. (Laser diode driver ICs may also be found in better units; but since these still cost more than discrete parts, they are probably still less common.)

Since there is no absolute reference, output power depends somewhat on battery voltage. People have successfully modulated this module at a reasonable frequency (upper limit not determined) by removing or greatly reducing the value of the filter capacitor, C1. However, do this at your own risk!

**Difference Between Diode Laser Modules and Laser Pointers**

Collimated diode-laser modules and pocket-laser pointers both produce a spot of light. So why the typical huge difference in price? There can be variability in any type of product. While the desired output of a laser pointer and collimated diode-laser module is similar, how fussy the end-user is and how one gets there may not be.

Laser pointers are mass-produced, so this helps reduce costs. They generally have less complex and less robust drive electronics since the power source is supposedly well defined—a set of batteries. There may be no corrective optics for the astigmatism and elliptical aberrations of the typical laser diode—at a distance, your spot isn't a nice round Gaussian profile. There is probably just a single cheap plastic lens glued in place, though some models do have adjustable focus.

Diode laser modules are more of a specialty item used inside other equipment and for optics research and development. Production volumes are not as high. They usually (but not always) have high quality driver circuits designed to protect the sensitive laser diode from moderate abuse—noisy power, for example. Many have high quality optics including additional elements for correction of the laser diode aberrations. They usually have adjustable focus.

Figure 3 shows the typical circuit that might be used in a high-quality diode-laser module. While basically similar to the one in Fig. 2, it includes a soft-start circuitry, reverse-polarity protection, a reference to maintain output power constant regardless of power supply input voltage, and a modulation input.

In the end, it is probably the mass production that is the most significant factor in keeping costs down. There is also another difference between the two that relates to output power.

For a laser pointer, the power rating is the maximum you might see with fresh batteries, under the right conditions, on a very good day, or possibly just the 5 mW maximum for Class IIIa (which is the most that is legal in the U.S.A. for a laser pointer). Obviously, the seller wants to impress you with the specs for their product and not all are being entirely honest or forthcoming. The actual power could be much less and may decrease rapidly as the batteries are drained.

For a diode laser module (from a reputable manufacturer at least), the power rating is likely to either be what they actually measured for that sample or a guaranteed minimum value, and the actual output power could be greater. The CDRH safety sticker will still list an upper boundary, but it will likely be much higher than the module's power rating.

**Can I Boost the Power Output of a Laser Pointer or Diode Laser Module?**

The quick answer is probably not, or at least, not by much. I know that in your fantasies, you have dreamed about the possibility of creating a burning laser or Star Wars style light saber from a laser pointer. Unfortunately, neither of these is even possible theoretically. The best you could ever hope for would be to obtain 5 mW from a device currently outputting 2 or 3 mW.

While it might be feasible to increase the current to the laser diode, unless you know its specifications AND have an accurate laser power meter (much $$$), there is no way of knowing when to quit. Above their rated maximum optical power, laser diodes turn into DELDs (Dark Emitting Diode Lasers) or expensive LEDs. Exceed this rating for even a microsecond and your winny 3 mW output may be boosted to precisely 0.0 mW. This is called Catastrophic Optical Damage (COD) to the microscopic end-facets of the laser diode. There can also be thermal runaway problems or a combination of both of these depending on design—or lack thereof. However, if you have a bag of these gadgets and are willing to blow a few, feel free to experiment.

**Wrap-up**

Next time, we'll continue with some of the more technical aspects of red laser pointers, as well as the much more complex green ones. There is much more information on laser pointers and almost anything else laser related on my Web site www.repairfaq.org under "Sam's Laser FAQ.”

**TABLE 1**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Relative</th>
<th>Factor</th>
<th>Color</th>
<th>Type</th>
<th>Reference Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>555</td>
<td>1.000</td>
<td>33</td>
<td>Green</td>
<td>HeNe laser</td>
<td></td>
</tr>
<tr>
<td>543.5</td>
<td>0.974</td>
<td>30</td>
<td>Green</td>
<td>DPSS laser</td>
<td></td>
</tr>
<tr>
<td>532</td>
<td>0.885</td>
<td>28</td>
<td>Green</td>
<td>Red HeNe laser</td>
<td></td>
</tr>
<tr>
<td>632.8</td>
<td>0.237</td>
<td>8</td>
<td>Orange-red</td>
<td>Red diode laser</td>
<td></td>
</tr>
<tr>
<td>635</td>
<td>0.217</td>
<td>7</td>
<td>Orange-red</td>
<td>Red diode laser</td>
<td></td>
</tr>
<tr>
<td>640</td>
<td>0.175</td>
<td>5</td>
<td>Orange-red</td>
<td>Red diode laser</td>
<td></td>
</tr>
<tr>
<td>650</td>
<td>0.107</td>
<td>3</td>
<td>Red</td>
<td>Red diode laser</td>
<td></td>
</tr>
<tr>
<td>660</td>
<td>0.061</td>
<td>2</td>
<td>Red</td>
<td>Red diode laser</td>
<td></td>
</tr>
<tr>
<td>670</td>
<td>0.032</td>
<td>1</td>
<td>Red</td>
<td>Red diode laser</td>
<td></td>
</tr>
</tbody>
</table>
Built anything lately? Feel a need to make electrons flow? Need a fix of solder flux? If your answer to any of these is yes, stick around and take a dose of our electronic “BC” elixir. This month we’re going to continue with more magnet and motion circuits for your enjoyment. As I mentioned in last month’s visit, these are not offered as step-by-step construction projects, but as a guide to hopefully encourage creative construction of your very own motion machine.

**Horizontal Rotating Wheel**

Last month we finished up with a vertical-rotating wheel utilizing a Hall-Effect device as the timing sensor. This visit we’re going to start off with a dual-driver coil circuit with the rotating wheel in the horizontal position and an IR-LED timing sensor. The electronics and mechanics of this whirling wheel are very basic in design and can be easily modified. As long as the basic concept is followed, the rotating wheel can take just about any shape or form—let the process of metamorphosis take over.

**The Circuit**

One common feature of our motion projects is the simplicity of the electronics. The complete circuit is shown above. A combination of an IR-LED emitter and phototransistor operate in unison as the timing sensor.

**PARTS LIST FOR THE HORIZONTAL WHEEL CIRCUIT (FIG. 1)**

LED1/Q1—IR LED and phototransistor package, RadioShack #276-142, or similar combination
Q1—IRF520 power HEXFET
D2—1N4002 1-amp silicon diode
R1—1000-ohm, ½-watt, 5% resistor
R2—47,000-ohm, ½-watt, 5% resistor
L1, L2—See text.

Fig. 1. The complete circuit is shown above. A combination of an IR-LED emitter and phototransistor operate in unison as the timing sensor.

Fig. 2. This rotating wheel is a 9-inch circle cut from a ⅛-inch thick piece of fiberboard material. Any non-metal material can be used for the wheel.
ic circuitry—this one is no exception. The complete circuit is shown in Fig. 1. A combination of an IR-LED emitter and phototransistor operate in unison as the timing sensor. The output of the sensor is directly coupled to the gate of an IRF520 power HEXFET. The HEXFET's output supplies drive current to the dual-drive coil combination during the time that the IR light source is blocked from the phototransistor. When the IR light source is not blocked, the voltage at the collector of Q1 is near ground level, keeping the HEXFET turned off. A 1-amp silicon diode, D2, helps protect the HEXFET from the reverse voltage developed across L1 and L2 when the drive current ceases to flow.

The rotating wheel, Fig. 2, is a 9-inch circle cut from a ⅛-inch thick piece of fiberboard material. Any non-metal material can be used for the wheel. Eight donut-style magnets are mounted in an equally spaced arrangement around the bottom side of the wheel.

The eight magnets are mounted with the same magnetic poles facing out. It really doesn’t matter which pole, north or south, as long as they are arranged in the same manner. The two coils are connected to produce a magnetic field at their top to repel the magnets on the wheel. This arrangement produces a push each time a magnet passes over a coil. Also, this scheme reduces the down pressure on the single-support bearing and allows the wheel to nearly float as it turns.

Interrupting the IR light source between the IR emitter and phototransistor generates the timing pulse that sends the signal to the HEXFET, telling it to turn on. Eight metal flags are mounted to the bottom of the wheel in alignment with the eight magnets that break the IR light path to send a turn “on” signal to the HEXFET. The location of the flags and the timing control can be seen in Figs. 2 and 3. Greater details of the timing control unit are shown in Fig. 4. This assembly is attached to the motor’s baseboard with a single 8-32 screw, washer, and nut. This arrangement allows the assembly to move back and forth to control the direction of rotation and operating speed.

The turning wheel and the base are of the same dimension, cut from fiberboard, wood, or any non-metal material. The wheel contains the eight magnets, eight timing flags, and the single bearing support. I made the simple, but very efficient, bearing assembly from scrap brass stock; however, other similar material will suffice. I used a piece of brass rod ¾-inch in diameter and threaded one end to mount to the baseboard (see Fig. 3). The bearing support that mounts to the turning wheel was made from a piece of ¾-inch brass rod. I drilled and tapped the top for a ⅛-inch bolt to attach the support to the rotating wheel (see Fig. 3). The opposite end was drilled to a diameter slightly larger than the ⅛-inch diameter support rod. The actual depth of the hole is drilled to allow a distance of about ¾ to ⅛-inch spacing between the magnets and the top of the two drive coils. Also the secret of the efficient bearing arrangement is the small ball bearing that sets on the top of the ⅛-inch support rod. This allows the wheel to ride on the very smooth top of the ball, reducing the bearing friction to a very low level.

The two drive coils were wound on old relay-coil cores with about 110 feet of number 28 enamel-covered copper wire. Each coil measured about 7 ohms. The coil locations are shown in Fig. 5, along with the location of the timing unit.

As previously mentioned, these drawings were taken from my rotating wheel and are only provided to give enough general information so you too can build your very own version.

**New Toy**

Our next project is a modern day ver-

---

**PARTS LIST FOR THE FLYWHEEL AND ASSEMBLY (FIGS. 2-5)**

Non-metal material for flywheel and for timing control, eight donut magnets. thin metal material for eight flags, ¼-inch diameter brass rod, ¾-inch brass rod misc. hardware, etc. See text for details.
Fig. 5. The coil locations are shown here, along with the location of the timing unit.

Fig. 6. The circuit for this spinning wheel is very similar to the circuit in our last project. The timing is based on the interruption of an IR light source, and the drive coils are powered by a power HEXFET. On the previous model, the blocking of the IR light source sent a power pulse to the coils; however, in this circuit the opposite takes place. A power-output pulse is sent each time that the phototransistor is exposed to the IR light source. In our last circuit, the gate of the HEXFET was connected to the collector of the phototransistor, and on this circuit the gate is connected to the emitter. This simple change inverts the HEXFET's output that drives the drive coils. In this circuit, when the IR source is blocked from the phototransistor, the voltage at its emitter is zero and the HEXFET remains off. The phototransistor only draws current when an IR light source is detected.

The timing wheel is made of thin metal with four openings to allow the IR light to pass through when in position for an output drive pulse.

A side view of the spinning wheel is shown in Fig. 7. The base and side supports are made of cast iron and will still run when connected to a 3-volt DC source.

The circuit for this model spinning wheel, shown in Fig. 6, is very similar to the circuit in our last project. The timing is based on the interruption of an IR light source, and the drive coils are powered by a power HEXFET. On the previous model, the blocking of the IR light source sent a power pulse to the coils; however, in this circuit the opposite takes place. A power-output pulse is sent each time that the phototransistor is exposed to the IR light source. In our last circuit, the gate of the HEXFET was connected to the collector of the phototransistor, and on this circuit the gate is connected to the emitter. This simple change inverts the HEXFET's output that drives the drive coils. In this circuit, when the IR source is blocked from the phototransistor, the voltage at its emitter is zero and the HEXFET remains off. The phototransistor only draws current when an IR light source is detected.

The timing wheel is made of thin metal with four openings to allow the IR light to pass through when in position for an output drive pulse.

A side view of the spinning wheel is shown in Fig. 7. The base and side supports are made of cast iron and will still run when connected to a 3-volt DC source.

The circuit for this model spinning wheel, shown in Fig. 6, is very similar to the circuit in our last project. The timing is based on the interruption of an IR light source, and the drive coils are powered by a power HEXFET. On the previous model, the blocking of the IR light source sent a power pulse to the coils; however, in this circuit the opposite takes place. A power-output pulse is sent each time that the phototransistor is exposed to the IR light source. In our last circuit, the gate of the HEXFET was connected to the collector of the phototransistor, and on this circuit the gate is connected to the emitter. This simple change inverts the HEXFET's output that drives the drive coils. In this circuit, when the IR source is blocked from the phototransistor, the voltage at its emitter is zero and the HEXFET remains off. The phototransistor only draws current when an IR light source is detected.

The timing wheel is made of thin metal with four openings to allow the IR light to pass through when in position for an output drive pulse.

A side view of the spinning wheel is shown in Fig. 7. The base and side supports are made of cast iron and will still run when connected to a 3-volt DC source.

The circuit for this model spinning wheel, shown in Fig. 6, is very similar to the circuit in our last project. The timing is based on the interruption of an IR light source, and the drive coils are powered by a power HEXFET. On the previous model, the blocking of the IR light source sent a power pulse to the coils; however, in this circuit the opposite takes place. A power-output pulse is sent each time that the phototransistor is exposed to the IR light source. In our last circuit, the gate of the HEXFET was connected to the collector of the phototransistor, and on this circuit the gate is connected to the emitter. This simple change inverts the HEXFET's output that drives the drive coils. In this circuit, when the IR source is blocked from the phototransistor, the voltage at its emitter is zero and the HEXFET remains off. The phototransistor only draws current when an IR light source is detected.

The timing wheel is made of thin metal with four openings to allow the IR light to pass through when in position for an output drive pulse.

A side view of the spinning wheel is shown in Fig. 7. The base and side supports are made of cast iron and will still run when connected to a 3-volt DC source.
ports are made of soft iron. The four magnetic transfer rods are cut from ¼-inch soft iron-rod material (see Fig. 8). The timing wheel, see Fig. 9, may be made out of metal or any opaque material that will not allow IR light to pass through.

The spinning wheel (flywheel) is made from fiber or any similar non-metal material and is cut to the same size as our previous horizontal wheel. The size of the spinning wheel is not important as long as all other components are sized accordingly. The reason that the 9-inch diameter size was chosen is because I had a number of surplus fiberboard wheels on hand for project use. The four ½-inch diameter magnetic transfer rods are equally spaced around and within ¼-inch of the wheel's edge. These rods may be press fit in place or by a keeper screw through the rim of the wheel. They must all be of the same length and mounted with equal lengths extending on each side of the spinning wheel.

The flywheel is attached to the ½-inch brass rod with a bushing that bolts in place in the center of the flywheel. The ¼-inch rod that supports the flywheel passes through both end supports, which are equipped with small ball bearings. The optical timing wheel is mounted on the ½-inch shaft, see Fig. 7, and the IR assembly is connected to the support as shown.

The two drive coils were taken from old telephone exchange equipment and measure about 30 ohms each; however, the coils may be hand wound on soft iron rods or may be old relay coil cores. A core of ½-inch diameter by ⅛-inch long wound with about 300 ft. of number 30 enameled covered copper wire will do just fine, or any similar winding that offers a coil resistance of 20 to 36 ohms. Higher resistance coils will work but will require operating at a higher supply voltage and lower operating voltage for lower ohm coils.

The spacing between the magnetic transfer rods and the two coils should be somewhere between ⅛ and ¼ inches. Actually, the spacing between the coils should be made to pass through the IR light. The spinning wheel (flywheel) is made from fiber or any similar non-metal material and is cut to the same size as our previous horizontal wheel.

**PARTS LIST FOR THE NEW TOY CIRCUIT AND ASSEMBLY (FIGS. 6–9)**

LED1/Q1—Mouser part #512-H21A1. or build using RadioShack part #276-142.

Q2—IRF511 Power HEXFET

D2—1N4002 1-amp silicon diode

R1—2,200-ohm, ¼-watt, 5% resistor

R2—10,000-ohm, ½-watt. 5% resistor

L1, L2—See text for details.

**ADDITIONAL PARTS AND MATERIALS**

⅛-inch iron material, ½-inch brass rod, ⅛-inch iron rod material, misc. materials. See text for details.

---

Fig. 8. The four magnetic transfer rods are cut from ¼-inch soft iron-rod material. The diagram above can be used as a placement guide for the iron rods.

Fig. 9. The timing wheel may be made out of metal or any opaque material that will not allow IR light to pass through. The spinning wheel (flywheel) is made from fiber or any similar non-metal material and is cut to the same size as our previous horizontal wheel.
and magnetic transfer rods should be as close as possible for the most efficient operation.

**Phasing The Coils**

There are two methods of operating the spinning wheel. One is to have the two coils connected in a way that each end facing the magnetic transfer rod is of the same magnetic pole. This method will spin the wheel by attracting the transfer rod to the two coils. Either method will work, but I prefer using the repelling arrangement.

**Setting The Timing Wheel**

Start with the cut-outs in the timing wheel aligned with the four magnetic transfer rods in the flywheel. Position any one of the transfer rods so it centers between the two coils. Then adjust the timing wheel so one of the cut-outs just barely allows the IR light to reach the field and the other a “S” pole field. This method will spin the wheel by attracting the transfer rod to the two coils. Either method will work, but I prefer using the repelling arrangement.

PEAK COMPUTING
(continued from page 19)

makes a good game machine, most games don’t take advantage of the dual processors and run almost as well on the standard 1.7-GHz P4 we used for comparison.

The “Monster” would earn its keep if you had extensive mathematical analysis to perform. Applications such as SPSS are available in multiprocessor versions and would really zoom on the dual Xeon platform. So would many CAD or printed circuit board layout applications.

Be careful, though, if you are thinking of duplicating our project for your own use. Check with the vendor and make sure that their application actually does support dual processors. If it doesn’t, you might as well run it on a standard high performance single-CPU P4.

With applications that do support dual-CPU systems, you’ll find that a personal workstation like the “Monster” truly does provide Peak Computing!

Q & A
(continued from page 52)

when Heathkit ceased the mainline production of kits. For years, they were our main source for reasonably-priced test and ham equipment and a variety of household electronic kits. They almost immediately ceased support for the kits they had already sold.

You do have a couple of resources available to help out. Don Peterson has a Web site devoted to Heathkit parts and manuals at www.d8apro.com/heath.htm, where you’ll also find links to other Heathkit sites. One of those links is Tom’s board at http://pluto.beseen.com/boardroom/q/51675/, where you can post questions to a Heathkit-targeted audience. There you’ll also find a link at the top to Tom’s manual archive in the U.K. where Heathkit schematics can be freely downloaded. One or more of the links that you’ll find on these two sites are operated by former Heathkit technicians who have squirreled away a ton of inside information that may be helpful to you.

Check the number on the top of the chip and any references in the manual. It was aggravating whenever Heathkit “house numbered” chips, for most of the integrated circuits they used were otherwise off-the-shelf items that could be purchased anywhere if you only knew the “real” type number. Kits such as their “Most Accurate Clock” did use two or three custom-programmed chips that can no longer be obtained except through the salvage of a hangar queen. The on-line auctions may be another source for an identical clock that may have a good clock chip, while the remainder of the unit is junk.

Good luck in your search and repair mission, and if you find a really nifty Heathkit resource that wasn’t picked up directly from one of the sites listed above, let me know here at “Q & A.”

Writing to Q&A

As always, we welcome your questions. Please be sure to include:

1) plenty of background material,
2) your full name and address on the letter (not just the envelope),
3) and a complete diagram, if asking about a circuit; and
4) type your letter or write neatly.

Send questions to Q&A, Poptronics, 275-G Marcus Blvd., Hauppauge, NY 11788 or to q&a@gernsback.com, but do not expect an immediate reply in these pages (because of our backlog). We regret that we cannot give personal replies. Please no graphics files larger than 100K.

IT’S NOT WORTH THE WEIGHT.

For better health and fitness, exercise.

American Heart Association

© 1992, American Heart Association
SUPPLEMENT TO POPTRONICS APRIL 2002

www.americanradiohistory.com

MICRO CAMERAS - WIRELESS VIDEO
CALL OR GO ON-LINE TO ORDER YOUR FREE
PRODUCT CATALOG

DIGITAL MONITORING & RECORDING SYSTEM

"YOUR WEB BROWSER IS YOUR REMOTE EYE!"

The PV-140 Series PCI cards are the solution for digital security using a PC. Turn your own PC into a commercial grade digital security system in a few minutes. The system brings together several separate components that priced individually could send a small business or home owner to a loan officer.

The PV-140 Series integrates a color quad processor, multiple zone video motion detector, multiplexer, and a real time digital video recorder (DVR).

PV-140-A - $299.95
PV-140-B
Works Great With Our Wireless Receivert, Too!

Each card can connect up to 4 cameras.

GFR-2400 - 2.4GHz Receiver

MOTION DETECTION - ALARM RECORDING - NOTIFICATION

5" COLOR WIRELESS OBSERVATION SYSTEM

ADD UP TO 3 ADDITIONAL CAMERAS!

Now you can enjoy peace of mind with our new wireless observation system. Comes with a 5" wireless color monitor, a wireless color camera. Just Plug-4-Play for perfect wireless video any time! Great for around the house, office or technical field work.

MH-SC01 - $479.95

VIDEO HEAD "SNAKE" CAMERA

The MH-SC01 features a fully adjustable focus from 0.5 inches to infinity. It contains a true color CCD chip rather than a CMOS type sensor for excellent resolution. Each comes complete with a 20" camera head cable and a power cable.

MICRO VIDEO HEAD "SNAKE" CAMERA

B/W INFRARED LIPSTICK CAMERA

Designed for surveillance applications, the LP-850W B/W Infrared Camera operates in extreme low-light conditions. Recently developed technology allows this camera to see in total darkness up to 20 feet away with built-in LEDs. Excellent for mounting on a wall or ceiling. Infrared light is controlled by an auto-sensing photo cell.

Call today for more information!

MH-2SCT $599.95

2.5" COLOR TFT FLAT SCREEN MODULE

Our new color 2.5" TFT module can be used for a variety of purposes such as: custom automotive dash installations, boat installations, cover ultra-compact surveillance packages, and more.

UNIT IS ONLY 5.8mm THICK!

Dimensions: 61.6(L) x 49.3(W) x 5.8(H)mm

(Driver board not shown)

VIDEO MOTION DETECTOR

The VDM-01 is the answer to waiting hours in front of a monitor searching for the event that occurred. This 4-zone video detection unit will allow you to place 4 areas of interest on the camera screen. The sensitivity can also be adjusted so false triggers do not set your VCD to record, imagine a zone on the cash box or a zone on just one bin box in your inventory room. No more waiting hours of uneventful video on your surveillance tapes. Set-up one of these systems as part of your office or company wide security system and you will be amazed. This is a great management tool for revealing the non-productive habits in the office. This system is compatible with any time-lapse or real time recorder with alarm inputs.

VDM-01 - 199.95

OTHER MODELS TO CHOOSE FROM!

MB-1250HRVF Color Vari-focal Hi-Res
4mm-6mm Lens 1.26" x 1.26" x 2.38"
$169.95

MB-1250HRP Color Pinhole 5.9mm Lens 1.27" x 1.27"
$109.95

MB-650U B/W Audio 4.3mm Lens 1.18" x 1.18"
$39.35

MB-1250P Color Pinhole 5.9mm Lens 1.27" x 1.27"
$89.35

MB-810B Infrared B/W 3.6mm Lens 1.77" x 1.77"
$69.95

800-752-3571
Tech 404-872-0721 • Fax 404-872-1038
WWW.POLARISUSA.COM

CIRCLE 228 ON FREE INFORMATION CARD

470 Armour Drive NE • Atlanta GA 30324-3843
AM & FM LOW POWER TRANSMITTER KITS

If you are interested in building quality low power transmitters for AM, FM Stereo, and Television transmission, see our website for more information. Kits covering the frequency range of 150 KHz to 1300 MHz. are available, for Amateur, experimental Part 15 uses, hobby, and radio control use.

NORTH COUNTRY RADIO

Visit our website www.northcountryradio.com

Sales: PO BOX 53 New Rochelle N.Y. 10804 Tel 914-235-6611
Technical: PO Box 200 Hartford NY 12838 Tel 518-854-9280

---

WELLER SOLDERING STATION - MODEL WLC 100
- Variable power control (5 to 40 watts)
- Replaceable heating element
- Quality light-weight pencil iron

LOWEST PRICE 20MHZ

INSTEK OSCILLOSCOPE
MODEL GOS-620
Dual Channel - 20MHZ
(Includes Probes)

SOLDIERLESS BREADBOARD

Solderless Breadboard Kit 119.95

DC POWER SUPPLIES
MODEL HY3003 - DIGITAL DISPLAY
Variable output, 0-30 VDC, 0-3 Amp

MODEL HY3003-3 - TRIPLE OUTPUT
Two 0-30 VDC, 0-3 Amp

INSTEK FUNCTION GEN.
With INT/EXT FREQ. COUNTER
3 MHz, Digital Display
MODEL 8216 $199.00

ALLIGATOR LEADS
SET OF 10

SOLDERING IRON 3-WIRE
HIGH PERFORMANCE
360501 $36.95

RSM - TELECOMMUNICATIONS TRAINER
HANDS-ON TELEPHONY, LAN, CATV EXPERIENCE
WITH ONE SELF-CONTAINED UNIT

T-Comm Trainer (TCM-100) $109.95
Lab Manual / Work Book $29.95
Component and Supplies Kit $37.95
Tool Kit $19.95

SOLDERLESS BREADBOARD
300 tie points. MB102PLT
model features 3 binding posts and aluminum backplate.

Part No. MB102 $15.95
MB102PLT 8.95

SOLDERING STATION

WELLER SOLDERING STATION

Frequency. Rubber Holster Included

20MHZ AC/DC MODEL (INCLUDES PROBES)

INFORMATION CARD

FREE CATALOG

MORE Low-Priced Items In Our FREE 256-Page Catalog


In NJ: 732-381-8020
365 Blair Road • Avenel, NJ 07001-2293
800-792-2225

email: electron@elexp.com
Tenma to the Test

**Triple Output DC Power Supply**

Features:

- Triple output: 0-30V/ 0-10A adjustable output plus 5V and 12V fixed outputs
- 0-3A adjustable current limiting
- Constant voltage or current operation
- Overload and short circuit protection
- Current limiting indicator
- LCD digital ammeter and voltmeter
- High current binding post output for 0-30V supply and easy snap on output terminals for 5V and 12V supplies
- Power requirements: 120VAC, 60Hz

Order # 72-6628

Reg. $159.00

**Only! $119.00**

**Tenma Autoranging DMM with RS-232**

Features:

- 3½ digit, 1000 count LCD display
- Auto/manual range selection
- AC/DC Voltage and current
- Current overload protection
- Capacitance
- Temperature with built-in sensor and external probe
- Frequency and duty cycle measurement
- Diode test
- Continuity beeper
- RS-232 communication
- Relative value display
- Auto power off
- Meets IEC1010 safety standards
- for 600V CAT II applications
- Includes test leads, holster, 9V battery, temperature probe, owners manual, RS-232 software and cable

Order # 72-6870

Reg. $149.00

**Only! $39.95**

**Tenma 20MHz Oscilloscope with Function Generator**

Features:

- Dual channel
- Dual trace
- Built-in 1MHz function generator with sine, square and triangle wave output
- 4000V/µs output for 0.5A
- Rectangular CRT with internal graticule
- 2KV acceleration voltage
- High sensitivity 1mV/div
- Display modes: CH-1, CH-2, DUAL, ALT, CHOP, ADD, CH-2 INV
- Input coupling: AC/GND/DC
- CH-1 output signal
- Sweep modes: A, X, Y, 10MHz
- Trigger modes: AUTO, NORM, TV, V, TV-H
- Trigger sources: CH-1, CH-2, ALT, LINE, EXT
- Trigger slope: + or -
- 2µA input for intensity modulation
- Power requirements: 115/230VAC, 50/60Hz
- Includes two 10:1 probes and owners manual

Order # 72-6895

Reg. $429.00

**Only! $399.00**

**Tenma Oscilloscope/Test Equipment Cart**

Features:

- Slanted top allows technician to view equipment at a convenient angle
- Lower shelf for storage
- Heavy-duty casters
- Adjustable back support with bumpers prevents damage to equipment
- Gray
- Dimensions: 16" (W) x 19" (L) x 33½" (H)
- Weight: 25 lbs

Order # 21-1925

Reg. $644.95

**Only! $74.95**

**Tenma Infrared Thermometer with Laser Pointer**

Features:

- Provides easy non-contact infrared temperature measurement
- Simply aim, trigger and read the temperature

Order # 72-6748

Reg. $39.95

**Only! $29.95**
Be an FCC LICENSED ELECTRONIC TECHNICIAN

EARN MORE MONEY

The Original Home-Study course prepares you for the "FCC Commercial Radiotelephone License" at home in your spare time. This valuable license is your professional "ticket" to thousands of exciting jobs in:

- Communications
- Radio-TV
- Microwave
- Maritime
- Radar
- Avionics & more

You can even start your own business!

No previous experience needed! No need to quit your job or go to school. This proven course is easy, fast and low cost!

GUARANTEED TO PASS — You get your FCC License or your money refunded.

Send for FREE facts now!
Mail coupon today or call
(800) 932-4268 Ext. 240
www.LicenseTraining.com

COMMAND PRODUCTIONS
FCC LICENSE TRAINING - DEPT. 240
P.O. Box 2824 • San Francisco, CA 94126
Please rush FREE details immediately!

Name ____________________________
Address __________________________
City __________________ State _____ Zip ______

CIRCLE 321 ON FREE INFORMATION CARD

---

RF Modules

www.abacom-tech.com

ABACOM Technologies
Tel: +1(416)236 3858
Fax: +1(416)236 8866
abacom@abacom-tech.com

BASIC MICRO INC.
Microcontrollers Made Easy!

The AT M

Get more from your projects! More commands, faster code execution, built in real-time graphical code debugging, no more 2k program size limits, hardware and software interrupts, multitasking, enhanced math capabilities plus much more!

BASIC Stamp II Compatible

Built in Hardware:
- Over 340 Kbytes of RAM
- 256 Kbytes of Flash EPROM
- External & Internal Interrupts
- 3 10-bit A/D Converters
- 2 Capture & Compare
- Internal Adjustable Waveform
- - External Waveform
- 3 Timers
- 2 PWM
- 1 UART
- 12C SPI

Software Features:
- Graphical Debugging (GDB)
- More Software Commands
- 32 Bit Integer Math
- 32 Bit Floating Point Math
- Easy to use code editor
- Expanded Basic Library
- Firmware upgradeable
- Unlimited Support
- Free Software Updates
- Plus much more!

$59.95 Complete
Available in OEM Package

ATM Development Board
Develop your projects the easy way
For use with Basic Micro ATOMs, OEM ATOMs, and Basic Stamp 2 series
- Completely Assembled Board
- Solder-less Breadboard
- Build-in DB-9 Serial Connector
- Build-in Power Regulator
- Full Documentation

$69.95 Complete
Combo with ATOMs $119.95

Order online at http://www.bas micr o.com
Order by phone M-F 9AM to 5PM EST 1 (734) 425-1744

www.americanradiohistory.com
NEW! CREDIT CARD COMPUTER II

MVS PLUG-N-GO™ no cables/power supply to buy!
Low-power RISC cpu 10x faster than PIC. Z80. 8051
4m FLASH,ser,par,RTCC,4ch 12bit ADC,ISA104 bus
Built-in BASIC/Assembly, other compilers available
Friendly instructions, RS232 download (DOS/WIN)
Eval kit (1) S75, oem (1k) S21, CC computer I S14.20

640x480 VGA LCD $27
Controller for most single/dual scan LCDs
Works with lo-res (160x120, 320x240, etc.)
Use with PC or SBC, standard VGA BIOS
Source code demo shows VGA initialization
Adaptable for other CPUs (i.e. Z80, HC11)
oem (1k) S27, eval kit (1) S95 w/10"LCD $195

PC WATCHDOG CARD
No More Hangups!
Reboots PC on hardware software hang
J versions: Reset, Timer, Phone reset version oem S21.35, eval kit S75

PC SOLID STATE DISK
Replace mechanical drives with faster,
more reliable, more secure solid-state.
Use FLASH, NVRAM, UV EPROM.
Both DIP and PC MCLA versions from
32Kbyte (PCM1) to 1Gigabyte (PC D2)
starting at S14.20 oem (1k) S50.00 eval (1)

LO COST MINI-PC
Includes DOS, NV mem, ADC, RAM, clock, ISA bus
Ports for serial, parallel, LCD, keyboard
Program in Turbo C, BASIC, MAC, etc.
Complete, no costly development kits required
Lowest power lowest cost PC compatible available
XT: oem S27 eval S95 8X: oem S55 eval S195

STAMP DRIVE !!
Read/Write PC compatible hard disk, PCMCIA, Compact Flash.
RS232 to VTA adapter for Stamp, Z80, 8051, AV.R, PIC, x86, ANY cpu
- 4 gigabyte capacity
- low power (5ma @ 5v)
- baud 115.2k and above
eval S95, oem S27, IDE ver. S14.20

SINGLE CHIP COMPUTER
ZERO external components
Built-in BASIC / Assembly
RS232 program download
1k flash, 64e, 8irq, 2timers
15 I/O bits, ADC, 26 pin DIP
80mips faster than PIC/Z80
eval (1) S1.99 $7.00

SERIAL MINI-TERMINAL
RS232 terminal for Stamp, PC, Z80, AVR etc.
-super low current, powers from serial line
-LED backlit LCD, visible in all conditions
-115.2kbps, DB9 conn, simple commands
-specify 20 customizable or 16 tactile keys
eval (1) S75, oem (1k) S21.30, w/BASIC cpu $27

WWW.STAR.NET/PEOPLE/~MVS
MVS Box 803
Nash.,NH 03060
(508) 792 9507

MVS 5yr Limited Warranty
Free Shipping
Mon-Fri 10-6 EST

SERVING THE EMBEDDED COMMUNITY SINCE 1979!
Scrambling News
915 NW First Ave., Suite 2902, Miami FL 33136, 305-372-9427
Pay TV and Satellite Descrambling 2002 - New! - satellite and cable. Includes the latest information. $19.95 plus $1.75 shipping.
Hacking Digital Satellite Systems Video 2002 - New! - This 90 minute video focuses on the satellite television piracy business. $29.95 plus $3.50 shipping.
Scrambling News Online - Online service for those interested in satellite television news. $59.95/year.
Pay TV and Satellite Descrambling Series CD-ROM - all 13 volumes over 300 pages. $59.95 plus $3.50 shipping.
Best Deal - Everything listed above for only $99.95 plus $3.50 shipping.
www.scramblingnews.com

SUPREME SURVEILLANCE
JUST PUBLISHED! The EXTREME Covert Catalog details virtually every surveillance system on the World Market today. From the FB (and their superiors) latest anti-terrorist phone/camera/video taps, to bargain basement devices no one knows about. Complete specs and ordering information on hundreds of surveillance and investigative hardware and software products from 14 countries. Many, many new entries for covert audio and video supplies, computer busters, thru-wall viewers, night vision gear, fax interceptors, CIA designed lock defeating tools, etc.
"Absolutely fantastic! A technician’s dream come true. No frills, no filler, just raw spy metal. What a steal!" - Kevin Murphy, probably the top counter-surveillance expert in the U.S. E.C.C., 8 1/2 x 11", ISBN 1-860-230-20-4, 437 pages, index. $49.95

Press-n-Peel Transfer Film
PC Boards in Minutes
8.5" x 11" Sheets.
1. LaserPrint*
2. Press On**
3. Peel Off 4. Etch
* Or Photocopy
** Use standard household iron

Use Standard Copper Clad Board 20 Shs $30/40 Shs $50 100 Shs $100 Visa/MC/PO/CX/MO $5 S&H Foreign Add $7

Techniks Inc.
P.O. Box 463, Ringoes NJ 08551
ph. 908.788.8249 fax 908.788.8837
www.techniks.com
Visit Our E-Store On-Line!

SUPREME SURVEILLANCE

IC DEVICE PROGRAMMERS
LARGEST SELECTION OF PROGRAMMERS, EMULATORS & SIMULATORS WE ARE NEVER UNDER-BOUNDS FULL 30 DAY PRICE PROTECTION
PROGRAMMER SALES 800-760-3820

Universal Programmers
1195. Advantech Labtool-48
895. Needhams EMP-20
849. Ettolos Toppaz
849. Kelter Superpro L600
849. Kelter Superpro 2000
589. Advantech Labtool-140c
449. Kelter Superpro 200
419. Needhams EMP-20
419. Ettolos Megamax
379. Kelter Superpro LX
339. Ettolos Chipmax
299. Needhams EMP-11
299. Kelter Superpro Z
229. Ettolos Topmax W/B Gang
199. Needhams EMP-10
519 Megamax 4x6

General Device Instruments
Sucks (914) 393-1655 Fax (914) 392-4949
www.generalsevice.com

PCB Production
Double side—12c per in²
Four layers—20c in²
Six layers—32c in²
UL approved
(with solder mask, Silkscreen
Three weeks)
FREE Quote for 8-12L
PCB & membrane switch
MYLYDIA INC.
Call 626-292-2868
Fax: 626-292-2869
E-mail: tj2@ix.netcom.com

PICmicro MCU Development Tools
EPIC Plus
PICmicro Programmer $59.95
Program PICmicro MCUs in BASIC! DOS or Windows operation (including PICmicro C Software). PICBasic Compiler - $99.95
PICBasic Pro Compiler - $249.95

Experimenter Boards
LAB-X1 for 40-pin MCUs (shown) - $199.95
LAB-X2 for 28 or 20-pin MCUs - $99.95
LAB-X3 for 16-pin MCUs - $59.95

PICProto Prototyping Boards
$8.95 to $19.95
High-quality blank prototyping boards for PICmicro MCUs

www.melabs.com
Phone: (719) 520-5333
Fax: (719) 526-1567
Box 60039, Colorado Springs, CO 80960

Press-n-Peel Transfer Film
PC Boards in Minutes
8.5" x 11" Shs.
1. LaserPrint*
2. Press On**
3. Peel Off 4. Etch

* Or Photocopy
** Use standard household iron

Use Standard Copper Clad Board 20 Shs $30/40 Shs $50 100 Shs $100 Visa/MC/PO/CX/MO $5 S&H Foreign Add $7

Techniks Inc.
P.O. Box 463, Ringoes NJ 08551
ph. 908.788.8249 fax 908.788.8837
www.techniks.com
Visit Our E-Store On-Line!

CorelDRAW! Tech-Savvy Books, Manuals, Tapes

Supreme Surveillance
JUST PUBLISHED! The EXTREME Covert Catalog details virtually every surveillance system on the World Market today. From the FB (and their superiors) latest anti-terrorist phone/camera/video taps, to bargain basement devices no one knows about. Complete specs and ordering information on hundreds of surveillance and investigative hardware and software products from 14 countries. Many, many new entries for covert audio and video supplies, computer busters, thru-wall viewers, night vision gear, fax interceptors, CIA designed lock defeating tools, etc.
"Absolutely fantastic! A technician’s dream come true. No frills, no filler, just raw spy metal. What a steal!" - Kevin Murphy, probably the top counter-surveillance expert in the U.S. E.C.C., 8 1/2 x 11", ISBN 1-860-230-20-4, 437 pages, index. $49.95

EBasic
BASIC
PIC micro/56 MCUs
For PICmacros. M56 MCUs. For PICmicro - MCUs create a one-click solution that allows you to experiment and test code changes code-fly. From beginner to professional, bring your projects to life quicker and easier with MicBasic for PICmacros - MCUs.

Note - In Circuit Graphical Debugger built in! Priced from $99.95
Educational and dealer discounts available
Order online or call 1-734-425-1744
Basic 14.95. 34397 Plymouth, Livonia, MI 48150
See more online at http://www.basicmicro.com

PCB Production
Double side—12c per in²
Four layers—20c in²
Six layers—32c in²
UL approved
(with solder mask, Silkscreen
Three weeks)
FREE Quote for 8-12L
PCB & membrane switch
MYLYDIA INC.
Call 626-292-2868
Fax: 626-292-2869
E-mail: tj2@ix.netcom.com

PICmicro MCU Development Tools
EPIC Plus
PICmicro Programmer $59.95
Program PICmicro MCUs in BASIC! DOS or Windows operation (including PICmicro C Software). PICBasic Compiler - $99.95
PICBasic Pro Compiler - $249.95

Experimenter Boards
LAB-X1 for 40-pin MCUs (shown) - $199.95
LAB-X2 for 28 or 20-pin MCUs - $99.95
LAB-X3 for 16-pin MCUs - $59.95

PICProto Prototyping Boards
$8.95 to $19.95
High-quality blank prototyping boards for PICmicro MCUs

www.melabs.com
Phone: (719) 520-5333
Fax: (719) 526-1567
Box 60039, Colorado Springs, CO 80960

PCB Production
Double side—12c per in²
Four layers—20c in²
Six layers—32c in²
UL approved
(with solder mask, Silkscreen
Three weeks)
FREE Quote for 8-12L
PCB & membrane switch
MYLYDIA INC.
Call 626-292-2868
Fax: 626-292-2869
E-mail: tj2@ix.netcom.com

PICmicro MCU Development Tools
EPIC Plus
PICmicro Programmer $59.95
Program PICmicro MCUs in BASIC! DOS or Windows operation (including PICmicro C Software). PICBasic Compiler - $99.95
PICBasic Pro Compiler - $249.95

Experimenter Boards
LAB-X1 for 40-pin MCUs (shown) - $199.95
LAB-X2 for 28 or 20-pin MCUs - $99.95
LAB-X3 for 16-pin MCUs - $59.95

PICProto Prototyping Boards
$8.95 to $19.95
High-quality blank prototyping boards for PICmicro MCUs

www.melabs.com
Phone: (719) 520-5333
Fax: (719) 526-1567
Box 60039, Colorado Springs, CO 80960

www.americanradiohistory.com
Lone Star Consulting, Inc.
8900 Viscount, Suite 235
El Paso, TX 79925
915-474-0334
www.lonestartek.net

SPECIAL PROJECTS HARDWARE
Unique - Original - Made-to-Order - Special Needs
Electronics - Computer - Fore - Energy - Security - Data
Cards - RF - EM - Audio - Radios - "Trytide" - Plans - more!
Power Motors Educational Module • K.K Radar Emitter
Lincoln's Test Set • Bug A Tap Detector & Ekster
Shred Module • Stealth Paint "Elker" • Audio Assister
Multi-Use MagnetoMeter • Omnimax Tens Stimulator
Radiotech Sage • Neurotoxin Device • Ultrasonic
Stimulator • Ultrasound Shrinker • Ultrasonic Detector
Harassing EMF Jammer • EMF "Signature" Detector
"Auras" Detector • Super Conductor Detector • Unseen
Unknown Presence Detector • Subliminal Mixertamp
Infrared Detector • Secret Communicator • Levitizer
Flash Blaster 6.0 - Sense Communicator • many more

**TECHNICAL "LIFE COACHING" INTERNET DESIGN SERVICES**

PIC Programmer Kits
Super Value: $16.95
+ S&H $4.95
The PICPRO can program up to 40
ppi PICs including:
The popular 16F84 &
12C508 • Needs software (extra
$20) • Available assembled or start-
ing from $16.95 for the kit.
See www.electronics123.com for more info!
The PICCALL programmer can also program Atmel AVRIs:
In addition to the PICS, it can program • Free soft-
ware • PICALL programmer kit at $69.95
See www.electronics123.com for more info!

Video Camera module
Code: BB004
CMOS Camera Module. Black &
White. Size: 0.67"x0.67"x0.59". H:
Lens: 14.5, P.S. EA 300kHz~240V.
0.6" Dia. Package: 5 pins. Pin 3 is 1V p-p.
composite video (75 ohm). to mini.
$38 + $5 S&H

Running Lights kit
8 LEDs with 10 push button selectable patterns.
8 speed level's 80 combinations! $16 + $5 S&H

Toll Free: 1-888-549-3749 (USA & Canada)
Tel: (330) 549-3749
Receive a FREE catalog or visit on:
www.electronics123.com

spyoutlet.com
Security • Surveillance • Loss Prevention
Purchase your video cameras from
one of the largest importers
in the U.S.
• NEW weatherproof Bullet Cameras
• Spy Pinhole Cameras • Wireless Video
• PC Cards • Voice Changer
• Micro Recorders • Shotgun Mic
• Locksmithing • Bug Detectors
• NEW Phone Sentry Plus—Delets
telephone tapping and tapping
• UV Pens & Powder • Realtime 12 hr
Telephone Recording System
• GPS Vehicle Tracking System
And much more • Quantity discounts
www.spyoutlet.com
Printed Catalog send $5.00

Spy Outlet
2468 Nia. Falls Blvd
Tonawanda NY 14150 (716) 695-8660

Solar Panels
160 mW / Sun 8 Cells
200pc 2Kpc 20Kpc 200Kpc

Battery Holders
AA Singles, and Dual Side by Side
200pc 2Kpc 20Kpc 200Kpc

LED's
High Intensity HPWT-DL01
Similar to Lumex type SSL-LX3044SSYC
200pc 2Kpc 20Kpc 200Kpc

Call 1-847-612-2739

CABLE SECRETS!!!
Build your OWN cable box "test" devices!
Why pay $100.00 or more for a "test" device
that someone else made? Make your own!
Includes complete source code and plans
for the most commonly used cable boxes.
Unblock all of the channels on your box!
Or start your own lucrative business!
Complete source code.................. $75.95
Code for individual boxes.............. $29.95

DSS SECRETS — Vol. 2
Step-by-step instructions on programming
your own DSS access card.
Unlock all channels on your own card!
This is the most current information
on the market! Includes software,
plans, and hardware sources.
Book & CD-ROM.
DSS Secrets Vol. 2.......................... $49.95

VISA • MasterCard • American Express
To order, call Worldyde 1-800-773-6698
33523 Eight Mile Rd. 483-261 • Livonia, MI 48152
Visit us on the web at www.worldyde.com

QUICK and PAINLESS
Programmable Robotics!

• COMES PRE-ASSEMBLED
• PRICED LOWER THAN A KIT
• Great Features & Expandability
• Re-Programmable from your PC

JUST ADD 6 AA BATTERIES AND GO!
Blue Bell Design Inc.
www.bluebelldesign.com

Smart Cards
HIGHEST SECURITY
Complete system! Develops your own smart
application in easy to use BASIC language
• Security Systems
• Time Cards
• Access Control
• Home, Auto, Business
• Robots
• Data Security
• Emulation
• Theft Prevention

Smart Card Tool Kit comes complete with
• CyberMice SmartCard Programmer
• Application Development Software
• Extensive User Manual in printed form
• 3 Blank Smart Cards

Complete system only $79.95
We accept
VISA • Mastercard • American Express

To Order Call 1-800-773-6698 Worldyde.com,
33523 Eight Mile Rd # 83-261, Livonia, MI 48152
See more online at http://www.worldyde.com

QuickCard
X86 HC16 280

PIC Micro Tools
ISP-PRO 3.0
All-in-one Programmer

Use PIC Serial port (UBD w/adapters)
• Very Simple in use
• Free Software included
Complete with Windows IDE
Easy in-context programming
Supports PIC, Scryp, DUC and more
Adapter included!
Programming Interface Included
Includes 8 ft Cable

Optional Items Available:
• Basic Electronics Available
• or full super of basic
Twisted Staps

All for $50.00 Complete

Solderless Development Boards
Develop your projects in the easy way
Complete Assembled Board
To Circuit Programmed, SMD
Solderless Breadboard
• Stub is BU02 for M68020
Built in Power Connector
Programmable Dualcore
• Hex Interface
• AVR Interface
• PIC Interface
• DSK, B0, & B17
Adaptable to many models

Starting at $49.95
Join our on-line PIC forums
Lots of Information and help FREE!!!
F154 • Master Card • American Express
Order Online or Call 1-734-425-1744
Basic Miter, $49.95 Plymouth, Livonia, MI 48150
See more online at http://www.basicmicro.com

April 2002, Poptronics
65
Phillips Screwdriver, Desoldering $36.95
53240
5MHz Model 4011A CMOS pulse.

Residents add 8.25 Sales Linear, i, 5199.95 2H
Elenco Model 4011A
Universal Counter 160kHz - 2.8GHz Model F-2800

Features:
One instrument with four test and measuring functions: 1.3GHz Frequency Counter, 2MHz Sweep Function Generator, Digital Multimeter, and TTL CMOS pulse.

Elenco 3MHz Sweep Function Generator with built-in 60MHz Frequency Counter Model GF-8045
$199.95 Generating square, triangular, and sine waves, and TTL CMOS pulse.

Elenco Handheld Universal Counter 160KHz - 2.8GHz Model F-2800

Sensitivity:
- 500V (50kHz), 50V (500kHz), 5V (1MHz), 1V (10MHz), 100mV (100MHz)

Elenco 10Hz-1MHz Digital Audio Generator Model SG-9300

Features include AM modulation at 1.3MHz, FM modulation at 100MHz, and frequency sweep from 100kHz to 1GHz.

Elenco Oscilloscopes
Free Dust Cover and 2 Probes

Model XK-150 Digital Analog Trace

Model AX-700K Two IC Scope Kit

Electronic Educational Kits

Model AX-700K Two IC Scope Kit

OWI Model OWI-007 Robotic Arm Trainer

Model RCC-7K Audio Control Car Kit

Model K4001 70W Amplifier

Electronic Science Lab

Maxitronics 500-in-1 Electronic Project Lab Model MX-909

Everything you need to build 500 exciting electronic projects:
- Learn the basics of electronics
- Different types of electronic experiments
- Special lighting effects
- Audio and video projects
- Simple circuits
- Fun and games

- Includes breadboard and ICs
- Expands and extends simple circuits
- Provides a wealth of information
- Includes 11 parts
- Lab-style manuals included
- Requires 6 AA batteries

$149

Guaranteed Lowest Prices
C&S SALES, INC.
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (630) 541-0490 (630) 541-0710
http://www.cs-sales.com

CALL TOLL-FREE (800) 292-7711 Orders Only Secure On-line Ordering @ cs-sales.com

FREE 64 PAGE CATALOG! (800) 445-3201

CIRCLE 290 ON FREE INFORMATION CARD

www.americanradiohistory.com
Ivex Complete electronics CAD package


Ivex Complete Plus includes everything in Ivex Complete but with the enhanced capabilities of 650 pin versions of WinDraft and WinBoard plus the Advanced edition of Ivex Spice.

Ivex 350 and 650 pin versions have no feature limitations like competitive products on the market.

Fast expert technical support, free 24 hour Knowledge Base on the web, and professional full-featured tools have made Ivex the preferred choice for designers.

Ivex Complete Schematics Simulation PCB Layout Gerber Viewer $350

Visit the Ivex web site for complete product information and download full-function

www.ivex.com

Tel: (303) 848-6520 e-mail: sales@ivex.com

Do you make electronic prototypes?

If you prototype electronics, you should be using WinDraft Schematics. The Rapid Electronic Development (RED) tool that gives you the power to design prototypes faster, resolve errors smarter and transition to professional boards better.

WinDraft is a multi-purpose schematic design tool that you can put to work right away to make professional looking electronic design schematics. Crisp, clean schematics are much easier to read than the old hand-drawn ones you’ve had to struggle with before. Creating the perfect prototype of your design just got easier!

WinDraft goes way past prototyping, though. Once your design is finely tuned, use WinDraft to connect to PCB Layout tools for high-quality circuit boards that really make a statement about your product.

Need some reasons to use WinDraft for your prototyping?
Check out the facts:

http://www.ivex.com/prototyping

Free board quote pcxCite.com
The Internet source for PCB manufacturing.
YOUR LOCAL ONE STOP SHOP
FOR ALL YOUR ELECTRONIC NEEDS!

Over 5,000 products on display for you to browse through, including:
- Electronic Components
- Test Equipment
- Soldering Supplies
- Chemicals
- Tools
- Wire & Cable
- Books
- Datacom
- Prototyping
- Static Control and much more!

**Active** 8 Locations across the US!
- Baltimore Maryland
- Cambridge Massachusetts
- Cherry Hill New Jersey
- Chicago Illinois

**Active** AND 10 Locations in Canada!
- Calgary Alberta
- Edmonton Alberta
- Mississauga Ontario
- Montreal Quebec
- Montreal East Quebec
- Ottawa Ontario
- Quebec City Quebec
- Winnipeg Manitoba
- Vancouver B.C.

100 BONUS POINTS
Sign up today and get
Active Rewards Program
(new membership only. Points awarded on store purchases only)

www.activestores.com

New and Pre-Owned Test Equipment

New Equipment Specials

B+K Precision 2120B - 30 MHz Oscilloscope
- FREE Model 117B Multimeter
- 2 Channel, Dual-Trace
- 30 MHz Bandwidth
* TV Triggering
* (2) Probes Included
Sale Price $339.00

AVCOM PSA-37D - Spectrum Analyzer
- Satellite Downlink - Installation - Maintenance & Service
- Band 1: 10 - 1750 MHz
- Band 2: 3.7 - 4.2 GHz
- Carrying Case Included
- Line or Battery Power
Sale Price $2,395.00

Instek GOS-6103 - 100 MHz Analog Oscilloscope
- 100 MHz Bandwidth
- 2 Channel, High Sensitivity
- TV Trigger - Signal Output
- Cursor Readout
Sale Price $899.00

Leader LF 941 - CATV Signal Level Meter
- TV/CATV Coverage from 46-870 MHz
- Video/Audio Carrier Measurements
Sale Price $489.00

Wavetek Meterman HD160B Digital Multimeter
- Full Sealing Against Water, Chemicals, & Fluids
- True RMS
- Drop-Proof to 10 feet (3.3m)
Sale Price $159.00

Pre-Owned Oscilloscope Specials

Tektronix 465 - 100 MHz $499.00
Tektronix 465B - 100 MHz $649.00
Tektronix 475 - 200 MHz $749.00
Tektronix 475A - 250 MHz $949.00

- Professionally Refurbished
- Aligned & Calibrated to Original Specifications
- The Industry Standard of Oscilloscopes
- 1 Year Warranty - The Longest Available!!!
- See Website for Complete Specifications

See us on the Web!
www.testequipmentdepot.com

Test Equipment Depot
A Photonic Corporation Company
99 Washington St. Melrose, MA 02176
(781) 665-1400 • FAX (781) 665-0780
e-mail: sales@testequipmentdepot.com

TOLL FREE 1-800-99-99-METER

100 BONUS POINTS
Everyone has to start somewhere.

As CIE graduates have discovered, independent-study from The Cleveland Institute of Electronics can get you where you want to be. In a secure career in electronics.

Since 1934, CIE has been on the forefront of an ever expanding technological revolution.

Independent study is not for everyone. But, if you have the desire, the basic intellect and the motivation to succeed, CIE can make it happen. Our learning program is patented and each lesson is designed for independent study while our instructors are available to assist you whenever you feel you need help. Simply call or e-mail us with your questions and or instructor staff will be prompt, courteous and thorough with their response.

CIE offers personalized training to match your background with over ten career courses, an Associate Degree Program and a Bachelor Degree Program through our affiliation with World College. And every CIE graduate got started in a successful career the same way you can...by sending for your free CIE course catalog and judging for yourself if CIE’s for you.

---

Back then it was radio and TV, today it’s computer technology, programming and the electronics that make it all possible. Today and yesterday’s similarities are uncanny... Employers are looking for qualified applicants to hire and having a hard time finding them.

Students at CIE receive the training and the education needed to get hired and to succeed in challenging fields such as computer programming, robotics, broadcast engineering, and information systems management. CIE’s curriculum is unique from other independent-study schools in the respect that we not only provide hands-on training utilizing today’s technology we also instill the knowledge and understanding of why technology works the way it does. This is the foundation upon which every CIE graduate can trace their success back to and in which CIE’s reputation as a quality learning facility is based on.

---

START HERE...

YES! Please send me more information on:
CIE’s Associate Degree Program
CIE’s 12 Career Courses

Mail coupon to:
CIE
1776 E. 17th street
Cleveland, Ohio 44114

Name ____________________________
Address ____________________________
City ____________________________ State ______ Zip ______
Phone: ____________________________

Check for G.I. Bill Details
Active Duty Veteran

CIRCLE 320 ON FREE INFORMATION CARD
Separate LCDs

Serial LCDs work great with BASIC Stamps® and other microcontrollers. One-wire interface • simple serial protocol • low cost • high quality • in stock

BPI-216N
• 2x16 text LCD
• 2400/9600 bps
• $45 (non-backlit)

SGX-120L
• Mini graphics LCD
• 2400/9600 bps
• just $99

Many other models available—see www.seetron.com!

Scott Edwards Electronics, Inc.
www.seetron.com • 520-459-4802

Home Automation

World's Largest Source for Home Automation!
• Voice Control
• Gadgets & Motorized Devices
• Home Theater
• Phones & Intercoms
• X10 & Lighting Control
• Home Security & Surveillance
• Home Networking & Structured Wiring
and Much More...

800-SMART-HOME
www.smarthome.com
Free 144 pg. Color Catalog!

Table of Contents:
8.5x11 format. 205 pages. $34.95
+ $5 s/h in US. VISA, MC, AM, DS, MO.
CA residents please add 7.25% CA sales tax

Table of Contents:
http://www.stepperstuff.com

Stepper Motor Book
Easy Step'n
• For the experimenter.
• Determine surplus stepper motor specs using simple easy to build test equipment.
• Build microcontroller-based control systems (low charts and code examples).
• Build stepper motor drive circuits.
• Mechanical design considerations.
• 8.5x11 format. 205 pages. $34.95

Table of Contents: http://www.stepperstuff.com
+ $5 s/h in US. VISA, MC, AM, DS, MO.
CA residents please add 7.25% CA sales tax

Easy PIC'n - Beginner
• Programming Techniques
  Instruction set, addressing modes, bit manipulation, subroutines, loops, lookup tables, interrupts
  Using a text editor, using an assembler, using MPLAB
  Timing and counting (timer 0), interfacing, I/O conversion

PIC'n Up The Pace - Intermediate
• Serial communication - PICmicro to peripheral chips
• Serial EEPROM
• LCD interface and scanning keypads
• D/A and A/D conversion - several methods
• Math routines

PIC'n Techniques - Intermediate
• 6-pin PICmicro
  Timer 1, timer 2 and the capture/compare/PWM (CCP) module
  Talking to a PICmicro with a PIC using a terminal program
  Test equipment and data logger experiments

Serial PIC'n - Advanced
• Synchronous - bit-bang, on-chip UART, RS-232
• Asynchronous - SCI (Phillips Semiconductors)
  SPI (Motorola), Microwire (National Semiconductor)
  Dallas Semiconductor 1-Wire bus

P.O. Box 501, Kelseyville, CA 95451
Voice (707) 279-8881  Fax (707) 279-8883
http://www.sq-1.com

Our inventory includes microcontrollers and microcontroller development kits, such as PICmicro® microcontrollers, which are available for easy programming and debugging.
$59 PCBs
And our layout software is FREE!

Download ➤ Design ➤ Send ➤ Receive

Start A Career With High Wages,
Excellent Benefits and Job Security!!

With UCANDO’S extraordinary maintenance training programs you can quickly and easily enter a high paying field as a maintenance technician for a very small investment of time and money.

RC-M ONLY $165
RC-M is a 15 hour training course on relay ladder logic systems. Includes a 5-part video and workbook. Great Value!

PLC-M ONLY $198
PLC-M is a 32 hour training course on PLC systems. Includes (2) 4-part video's and workbook. This training is valuable.

HYD-M ONLY $209
HYD-M is a 32 hour course on Fluid Dynamics. Includes (2) 4-part video's and workbook. This Module is a must.

SC-M ONLY $215
SC-M is a 32 hour training course on AC & DC Servo Controllers. Includes (2) 4-part video's and workbook. Learn everything you need about AC and DC servo Control Systems.

Electronic Training Videos: Basic Electronics, Digital Electronics, TV Repair, LASER and Fiber Optic training videos available at very affordable prices starting at Only $35.00 each.

For information or to place an order call:
1-800-678-6113
www.ucando-corp.com
UCANDO VCR Educational Products Corp., Greenville, OH
GET THE NEW CATALOG TODAY!
New Kits, New LPFM, New Cameras
www.ramseykits.com

35 WATT LPFM STEREO TRANSMITTER
- 35W RF output, VSWR protected
- Automatic audio & power controls
- Digital synthesized PLL
- Full front panel control
- 110/220VAC, 12VDC operation
Whether your application is export or LPFM, the PX1 has you covered. From the over-rated continuous duty power supply & power amplifier to the 2 line vacuum fluorescent display, your station will be the easiest to setup and the most reliable for continuous operation. Full microprocessor controls provide a "virtual engineer". Check out www.ramseykits.com for full details.
PX1 35W Professional FM Stereo Transmitter $1,795.95

ELECTROCARDIOGRAM HEART MONITOR
- Visible and audible display of your heart rhythm
- Re-usable sensors included, just like visiting the hospital!
- Bright LED "beat" indicator
- Monitor output for oscilloscope display
Enjoy learning about the inner workings of the heart while covering the stage by stage electronic circuit theory of ECG/EKG systems. Be smart and learn at the same time!
ECG1 Electrocardiograph Heart Monitor Kit $34.95
CEG1 Matching Case & Knob Set $14.95
AC125 110 VAC Power Adapter $9.95
ECGP10 Replacement Reusable Probe Patches (10-Pack) $7.95

PLASMA GENERATOR
- Generate 2" sparks to a hand held screwdriver!
- Build your own plasma ball!
- 25KV at 20 KHz from a solid state source!
- Generates really impressive sparks, build your own plasma ball, light fluorescent tubes without wires! From a solid state source, generate over 25KV at 20KHz for the most dazzling displays!
PG13 Plasma Generator Kit $59.95
PS12 14VAC Output Power Supply $19.95

ION GENERATOR
- Generates negative ions with a blast of fresh air!
- 7.5KV DC negative, 400uA; that's a lot of ions in a small unit!
- Seedy state DC voltage, constant current, not pulsed!
Learn the basics of ion production by building this ion generator! Creates a continuous blast of fresh air charged with a lot of ions. Perfect for pollution and air freshening; just smell those ions! Solid state ion generation, you'll be amazed!
IG7 Ion Generator Kit $59.95
AC125 110 VAC Power Adapter $9.95

TOUCH-TONE TONE GRABBER
- New built-in RJ11 phone jack
- Large memory holds over 500 numbers
- Big bold 8 digit display, auto inversion of dashes
- New output latch jack
Dial direct phone numbers on the radio, repeater codes, control codes, anywhere touch-tones are used, you can read and store them! All new design for 2002. Capture those tones with the TG2!
TG2 Tone Grabber Tone Reader Kit $59.95
CTG2 Matching Case & Knob Set $14.95
AC125 110 VAC Power Adapter $9.95

RCA TO XLR AUDIO CONVERTER
- Connect consumer outputs to XLR inputs
- Let R & L audio gain adjustments
- So you're trying to connect consumer audio outputs with RCA connectors (unbalanced) to XLR (balanced) inputs. Always a problem...Not anymore with the R2XL1!
R2XL1 Unbalanced to Balanced Audio Converter Kit $49.95
CR2XL Matching Case & Knob Set $14.95
PWR25 12VAC Power Adapter $9.95

AUTOMATIC COLOR/BWIR CAMERA
- Color during the day, IR B&W at night!
- Automatically turns on IR illumination!
- Waterproof to IP57 standards!
- Black anodized housing with universal mount
Best of both worlds! This video camera is a water-proof COLOR camera during the day. When the light level drops, it automatically changes to B&W and turns on its built-in IR illumination, with 10 IR LEDs. Powered by 12VDC and terminated with a professional BNC connector. B&W only model also available if color is not needed. Both in heavy anodized black housing.
CCD309 Color/BW IR Waterproof Bullet Camera $169.95
CCD308 B&W IR Waterproof Bullet Camera $109.95
AC125 110 VAC Power Adapter $9.95

MINI B&W CAMERA WITH IR ILLUMINATION
- Built in IR illumination!
- Sees in total darkness!
- Black aluminum housing with swivel bracket
What a deal! This miniature B&W video camera has 6 high power IR LEDs built into it to provide illumination in total darkness! No need for external IR illuminators. Attractive black aluminum housing easily mounts at any angle with the built-in swivel bracket. Runs on 12VDC, and includes professional BNC output plug-in harness.
CCD303 Mini B&W IR Illuminated Camera $59.95
AC125 110 VAC Power Adapter $9.95
Check out all our other new cameras at www.ramseykits.com!

PROFESSIONAL FM STEREO RADIO STATION
- Synthesized 88 to 108 MHz with no drift!
- Built-in mixer -- 2 line inputs and one microphone input
- High power module available for export use
- Low pass filter for great audio response
Our FM100 is used all over the world by serious hobbyists as well as churches, drive-in theaters and schools. Frequency synthesized PLL assures drift-free operation with simple front panel frequency selection. Built-in audio mixer features LED bargraph meters to make setting audio a breeze. The kit includes metal case, whip antenna and built-in 110 volt AC power supply.
FM100 Super-Pro FM Stereo Radio Station Kit $249.95
FM100WT 1 Watt, Wired Version $399.95

SYNTHESIZED FM STEREO TRANSMITTER
- All new design & features for 2002!
- Fully adjustable RF output
- Our #1 kit for years has just gotten better for 2002! Totally redesigned, the FM25B has all the features you've asked for. From variable RF output, F connector RF output jack, line input, loop output, and more. Includes case, power supply, whip antenna, audio cables.
FM25B Synthesized FM Stereo Transmitter Kit $129.95

AND...OUR FAMOUS MINI-KITS
These are easy to build kits that can be used either stand-alone or as building blocks for more complex projects.
- TT4 Tickle-Stick Shocker $9.95
- BN9 Super Snoop Amplifier Kit $8.95
- BL1 LED Blinky Kit $3.95
- TD1 Tone Encoder/Decoder Kit $6.95
- TT7 Touch Tone Decoder Kit $19.95
- CP03 Code Practice Oscillator Kit $9.95
- UT5 Universal Timer Kit $8.95

Order Today! 800-446-2295
www.ramseykits.com
PARTS EXPRESS
ELECTRONICS & MORE
www.partsexpress.com

120 Watt Subwoofer Amplifier
Rated power output: 120 watts RMS into 4 ohms at 1% THD. Measured power output: 110 watts RMS into 8 ohms @ 0.1% THD. 156 watts RMS into 4 ohms @ 0.2% THD. Bass Boost: 5dB @ 35Hz. Signal to noise ratio: 98dB (A-weighted).
Dimensions: 8 1/4" W x 10 5/8" H x 4" D. Enclosure cut out: 7 1/4" W x 9 5/8" H. Voltage Selectable: 115/230V. 50-60Hz. 335W.
#300-792 $99.95 EACH

Sound Deadening Sheets
This multi-purpose, noise reduction material actually absorbs the vibration of any solid material. You can reduce interior noise levels 3-10 dB by applying the damping materials to the door panels, firewall, floor pan, trunk lid or any interior sheet metal panel.

JBL 12 Watt Stereo Amp Board
Dimensions: 4 1/2" L x 3 1/4" W x 2 1/8" H. Comes with hook-up diagram. Limited availability.
#329-030 $9.95 EACH

Piezo Tweeters
3-1/4" Piezo Tweeter
- Similar to KSN1005
- Power handling: 50 watts RMS/75 watts max.
- Frequency response: 3,500-27,000 Hz +SPL: 94 dB
#270-011 $1.25 (1-3) $1.25 (4-UP)

2" x 5" Piezo Horn
- Similar to KSN1016
- Power handling: 50 watts RMS/75 watts max.
- Frequency response: 3,500-27,000 Hz +SPL: 94 dB
#270-041 $1.25 (1-3) $1.25 (4-UP)

Piezo Horn Mid/Tweeter
- Similar to KSN1025
- Power handling: 60 watts RMS/75 watts max.
- Frequency response: 1,800-30,000 Hz +SPL: 90 dB
#280-062 $1.60 (1-3) $1.35 (4-UP)

6-1/2" Two-Way System
Great for front or rear speakers in your surround system. The 6-1/2" poly-propylene woofer and 1" textile dome tweeter were specially designed with home theatre in mind.
#300-036 $59.95 EACH

Speaker Surround Repair Kits
Don't throw away expensive loudspeakers just because the foam surround has dry rotted or has been punctured. With these new repair kits from Parts Express, you can save big bucks by repairing the foam surround and avoid costly loudspeaker replacements. Each kit contains supplies to repair two speakers and includes foam surrounds, plastic shims, four dust caps (two paper, two poly), a plastic bottle filled with 1 oz of adhesive, 5 foam swabs for application of glue, and complete repair instructions.

Part # Size Price
260-015 6-1/2" kit $19.50 17.90
260-016 6" kit 21.90 18.95
260-205 10" kit 22.50 19.50
260-206 12" kit 23.90 20.90
260-210 15" kit 24.50 21.90
340-076 1 oz bottle of speaker glue 5.95 5.25

Car Amplifier Power Stiffening Capacitors
Capacitors can be wired in parallel to increase value. One year manufacturer warranty.
Specifications: 120 VDC/24 VDC surge ©Esr.: < .0015 ohms ©Tolerance: -10%/+50% ©Temperature range: -40°C to 95°C

### FREE 308 PAGE CATALOG

Visit Us On The Web At www.partsexpress.com Or Call Toll Free 1-800-338-0531
725 Pleasant Valley Dr., Springboro, OH 45066-1158 KEY CODE: POM Phone: 513-743-3000 • FAX: 513-743-1677 • E-mail: sales@partsexpress.com

CIRCLE 275 ON FREE INFORMATION CARD

www.americanradiohistory.com
**World's Smallest 68HC11 Microcontroller Modules!**

**MicroStamp11™**
- tiny, light-weight (0.5 oz.)
- 1-inch x 1.4-inch 68HC11 module
- on-board 5V regulator
- MHz crystal (9.83MHz on Turbo version)
- choice of 8K or 32K EEPROM
- 32K RAM + 32K EEPROM on 64K version
- plugs into your breadboard like a DIP
- SCI (UART), SPI, Output Compare, Input Capture, timer, pulse accumulator
- all I/O lines and 2 interrupts brought out on 20-pin connector
- program in BASIC, assembler, or C
- easy code-loading with Docking Module
- **Starter Packages:**
  - 8K EEPROM (#MS11SP8K) ...............$49
  - 32K EEPROM (#MS11SP32K) ..............$77
  - 32K EEPROM (#MS11SP64K) .............$90

*Includes MicroStamp11 manual, PC software (freeWare assembler, SBASIC compiler, MicroLoad utility, and sample programs), serial cable, Docking Module, and accessories.

**Attention OEMs:**
Embed MicroStamp11 modules into your product! only $55 each (1000-loc. price, 8K version)

---

**Turn Your Multimedia PC into a Powerful Real-Time Audio Spectrum Analyzer**

**Features**
- 20 kHz real-time bandwidth
- Fast 32 bit executable
- Dual channel analysis
- High Resolution FFT
- Octave Analysis
- THD, THD+N, SNR measurements
- Signal Generation
- Triggering, Decimation
- Transfer Functions, Coherence
- Time Series, Spectrum Phase, and 3-D Surface plots
- Real-Time Recording and Post-Processing modes

**Applications**
- Distortion Analysis
- Frequency Response Testing
- Vibration Measurements
- Acoustic Research

**System Requirements**
- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win. 32s
- Mouse and Math coprocessor
- 16 bit sound card

**Priced from $299**
(U.S. sales only - not for export/resale)

**DOWNLOAD FREE 30 DAY TRIAL!**
www.spectraplus.com

---

**World's Smallest 68HC11 Microcontroller Modules!**

**MicroCore-11™**
- tiny 2-inch x 2-inch 68HC11 module
- 12 inputs/outputs plus 8 analog inputs
- RS232, 5V regulator, MHz crystal
- 32K SRAM plus 8K or 32K EEPROM
- plugs into your breadboard like a DIP
- easy programming from any PC
- ideal for building MicroMouse robots
- now available in Turbo version (9.83MHz)
- **Starter Package:**
  - 8K Starter Package #MC11SP8K ...............$68
  - 32K Starter Package #MC11SP32K ...............$93

Many other modules & accessories available. Visit our website at:
www.technologicalarts.com

---

**Harmony**
A PARTNERSHIP WITH A HEALTHY LAND

The earth has always provided food, water, and all that we need. Today, as in the past, American Indians recognize the importance of keeping the earth healthy. Give back to the earth.

Call for your free action packet.

1-800-THE-SOIL
United States Department of Agriculture
Natural Resources Conservation Service
Lithium Ion Battery Pack

Audiovox® BTE-600 7.2 V x 2000 mAh lithium ion battery pack. Great for use in any applications requiring rechargeable power. Lithium batteries have no "memory-effect" and do not need to be discharged before recharging. Consists of two cells in a fully-enclosed plastic case with a protective cover. Each cell is 2" long x 0.80" dia. Battery pack size: 2.45" x 1.92" x 0.95" thick.

CAT# BTE-600
10 for $3.00 each
$3.50 each

Piezo Alarm

Audible piezo alarm emits a solid, high-pitched tone of low to medium loudness. Operates on 3-15 Vdc 0.54" diameter x 0.3" PIC leads on 0.3" centers.

CAT# SBZ-412
$1.25 each
100 for 85c each
500 for 75c each
1000 for 60c each

Cheap (yet effective) LED Flasher

The simplest electronic flasher ever. Great for attention getting displays, party decorations, night time warning signals. A red 5mm LED with flasher chip is attached to a battery snap that snaps onto a 2 AA cell battery holder. Will flash for months on a set of batteries. Flash rate, approximately 120 flashes per minute. Batteries not included.

CAT# FSH-10
$1.00 each
100 for 70c each
500 for 60c each
1000 for 50c each

ORDER TOLL FREE 1-800-826-5432

CALL, WRITE FAX or E-MAIL for our FREE 96 Page CATALOG Outside the U.S.A. send $3.00 postage.

MAIL ORDERS TO:
ALL ELECTRONICS CORPORATION
P.O. Box 567
Van Nuys, CA 91408
FAX (818)781-2653
e-mail allcorp@allcorp.com

MODERN ELECTRONICS
COPY RENTAL TAPES WITH
OUR VIDEO STABILIZER

FREE CATALOG!
BEST DEALER PRICING!
DISCOUNTED PRICING!
30 DAY FREE TRIAL!
MONEY BACK GUARANTEE

Lynxmotion, When you're tired of playing with toys!

Introducing a pocket programmer with true Universal Output

Remote control from D terminal, 3rd pin (g.l.e. VisualBasic). Substitutes higher priced universal programmers - ALL11, MDD0 or LAB-TOOL-08 (AVASM51) providing virtually matching performance at only 1/2 (1/3 for older) price.

ORDER TOLL FREE 1-800-826-5432

LIMITED EDITION!f

ELECTRONIC GAMES

BP96—A number of interesting electronic game projects using ICs are presented. Includes 19 different projects ranging from a simple coin flipper, to a competitive reaction game, to electronic roulette, a combination lock game, a game timer and more. To order BP96 send $4.99 clearance (includes s&h) in the US and Canada to Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240. US funds only. Use US bank check or International Money Order. Allow 6-8 weeks for delivery.

9 out of 10 mice prefer the Consumer Information Catalog online. Catch it at www.pueblo.gsa.gov.
FCC Course with Certificate
A Powerful 19 Lesson Self-Study Program on one CD!

FCC Exam Review Course
After completing this course you will be ready to take the FCC examination for a General Radiotelephone Operator License.

The General Radiotelephone Operator License is required to adjust, maintain or repair any FCC licensed radiotelephone transmitters in the aviation, maritime and international fixed public radio services. It is issued for the lifetime of the holder.

Through the years Cleveland Institute of Electronics (CIE) has been able to compile a great amount of information concerning the types of questions that the FCC include in their examinations.

Because of the extensive FCC sample questions in this course, you can look forward with confidence to passing the FCC exam particularly if you heed the hints given throughout the course.

Here's what you'll get!
19 FCC Lessons on CD ROM
Every lesson is presented in a clear and easy-to-understand format which makes learning this material fun and easy. After each lesson you'll take an exam. You can take it on-line or fill out one of the answer sheets we provide and mail it. After you finish the 19 lessons we'll send you a Certificate of Completion from CIE.

CIE Instructor Assistance:
Use our toll-free hot line to access our faculty and staff if you ever need assistance with your course work.

Priority Grading:
Your exams will be graded and sent back to you within 24 hrs.

Certificate of Completion:
Earn a Certificate of Completion that's suitable for framing.

Why is an FCC License so valuable?
An FCC license is an excellent credential for career advancement because it's proof of a certain level of electronics know-how. Because it is a federal examination, the FCC license with its implied knowledge is accepted by industry nationwide.

Lesson Topics Include:
- Modern Modulation Methods
- Receiving Equipment
- Batteries, Control Motors & other Power Sources
- Digital & Data Commun.
- Frequency Modulation
- Transmission Lines & Wave Guides
- Transmitters
- Antennas & Wave Propagation
- Monochrome & Color TV
- Microwave Comm. Systems
- Tuned-Staged Operation
- Suppressed - Carrier Modulation and Single
- Detection & Frequency Conversion
- Lasers in Communications & Industry
- Communications by Fiber Optics
- FCC Review Lessons Pt 1
- FCC Review Lessons Pt 2
- Pointers & Practices for Passing FCC G.C. Exam Pt 1
- Pointers & Practices for Passing FCC G.C. Exam Pt 2

Learn PC Repair
- PC Diagnostic Video
- 200 + Page Training Manual
- PC Assembly & Configuration Video
- Micro-Scope Diagnostic Software (LE)
- CD-ROM - contains videos and manual
  02-020 .......................................................... $99.95

Motor Controls 101
This CD ROM trainer uses pictures, sounds, animations & interactive circuits to teach you the basics of motor control. A Certificate of Completion may be printed on your printer if you achieve a passing score on the included test.
  02-050 (not a CIE certificate) ................................... $99.95

Intro to Networks
Network Essentials CD Course
- Network Orientation
- Network Design
- Introduction to Network Media
- Network Interface Cards
  02-021 ............................................................... $14.95

CIE Bookstore: 1776 E. 17th, Cleveland, OH 44114 • 800 321-2155 • www.ciebookstore.com
Shipping & Handling: $0 - $30 $2.75, $30.01 - $50.00 $5.25, $50.01 - $100.00 $11.75, $100+ $15.75 CA, HI & OH residents must add sales tax.

CIRCLE 320 ON FREE INFORMATION CARD
PLASMA FIRE SABERS
Kits, Parts and Accessories

Specify blue, green, pur, red or yel
Moving light appears to evaporate into space
Badges scavenge in cheers for easy replacement

We stock all size and color blanks, maker adapters, tubes
digital drivers, and parts for authentic designs. Wireless
Interactive sound modules change tone with motion
SAB16 Assembld with 12" Blade. $39.95
SAB24 Assembld w/ 24" Blade $78.95 SAB24K Kt $99.95
SAB36 Assembld with 36" Blade $149.95 SAB36K Kt. $129.95

30" Spark
Tesla Coil
Create a spectacular display of nature's own
lightning. Many amazing experiments possible.
See coil in action on our web site!
BTC4 Plans........ $20.00
BTC4K Kt. ........ $99.95
BTC40 Ready to Use. $11995
Smaller Version 8"- 10" Sparks
BTC3 Plans......... $15.00 BTC3K Kt $349.95
BTC30 Ready to Use. $449.95
MINI TESLA COIL Lights 4" light tube
MTCO Plans...... $5.00 MTCC4K Kt $19.95
MTCO10 Assembld for 12vatts. $34.95

The Pocket Programmer

The Best just got Better!!!
The Best portable programmer that uses the printer port instead of an
internal card just got Better!!! Now
with easier to use Windows based software that programs E.Eeprom
Flash & Dallas parts. 25/27/28/29
series from 16k to 8Mbit. Adapters
available for MCU's 874X, 875X, Plc,
ATmel, PLCc packages, Bi-Prom's,
40-Pin X16 Eproms, Rom Emulator
to 32K X 8 (2716-27256) and More...

Only $149.95
Same Name, Address & Phone # for
19 Years.... Isn't it Amazing?

Intrinsics, Inc.
Box 13723 / 612 Newton St.
Edwardsville, KS 66113
Tel. (913) 422-2094 Add $7.00 COD
Fax (913) 441-1623 Add $6.00 Shipping
WWW.IN-KS.COM Visa/MC/Amex/Disc

494-6142
NEW ITEMS

Unbeatable PRICES!
CABLE TV

DESCRAMBLERS
CONVERTERS • FILTERS
VIDEO STABILIZERS

FREE
30 Day Trial
FREE
Product Catalog
FREE
1 Year Warranty

Let us point you in the right direction ...

Arrow Technologies
Omaha, Nebraska
TOLL FREE
1-800-554-ARROW
1-800-554-2776

www.americanradiohistory.com
CLASSIFIEDS

BUSINESS OPPORTUNITIES

$400 WEEKLY ASSEMBLING Electronic Circuit Boards/Products From Home. For Free Information Send SASE: Home Assembly-PT Box 216 New Britain, CT 06050-0216. FREE Courses. For free electronic courses via email, register a www.emailschool.com

CABLE TV

DESCRAMBLERMANIA! SAVE 80% ALL UNIVERSAL CABLE DESCRAMBLER CONVERTER MODELS! INDIVIDUAL AND BULK SALES! 1-800-246-0434 www.cableboxcentral.com

DISCOVER CABLE'S NEWEST BOXES! "DESCRAMBLES WHERE OTHERS FAIL" LOWEST DEALER PRICES GUARANTEED. 1-888-777-9123 ... 1-888-675-3687

MISC. ELECTRONICS FOR SALE

T&M ELECTRONICS. Large variety of electronic parts since 1966. Visit our Web site at www.tandelectronics.com

PLANS-KITS-SCHEMATICS

Carl's Electronics — Hundreds of electronic kits, plus the latest in spy and surveillance. www.electronickits.com

SATELLITE


Get your copy of the CRYSTAL SET HANDBOOK

Go back to antiquity and build the radios that your grandfather built. Build the "Quaker Oats" type rig, wind coils that work and make it look like the 1920's! Only $10.95 plus $4.00 for shipping and handling. Claggk Inc., PO Box 12162, Hauppauge, NY 11788. USA Funds ONLY! USA and Canada — no foreign orders. Allow 6-8 weeks for delivery. MA01

Do You Repair Electronics?

Repair Databases for TV, VCR, Monitor, UL Audio, FCC, and more. - Over 76,000 records - Private user forums - Live on-line chat rooms

SINGERS! REMOVE VOCALS


Crystal Sets: Volume V

Volume V of the Society newsletter includes six issues ending November 1995. Great for new members to get current, those wanting a bound copy for their reference bookshelf, or as a gift to get a friend started. Contents include: The Design of Unpowered AM Receivers, Radio Outfit in a Headset, A Crystal Set Revisited—Reconstructed, Grounded Loop-stick Tuner, The Matching Secret, and lots of membership correspondence. 8 1/2 x 5 1/2 paperback, $10.95 plus shipping — Electronic Technology Today Inc., PO Box 240, Massapequa Park, NY 11762-0240. US funds only. Allow 6-8 weeks for delivery. MA06

Air Force Reserve

ABOVE & BEYOND

Visit our web site at www.afreserve.com

Robot Kits, Programmable Robots, LEGO® Robots, Living Robots, Muscle Wires®, Home and Office Robots, Electronic Kits & More!

Request our FREE 48 page catalog with over 300 items!

www.RobotStore.com
800-374-5764

Mondo-tronics Inc.
PMB-N, 4286 Redwood Hwy, Dept. 171
San Rafael, CA 94903
Ph 415-491-4600 Fax 415-491-4696
info@robotstore.com
**Poptronics® Classified Advertising Order Form**

### Advertiser Information

- **Name**
- **Company**
- **Street Address**
- **City/State/Zip**
- **Telephone ( )**
- **Signature (required on all orders)**

### Payment Information

- **Charge my:**
  - [ ] Master Card
  - [ ] Visa
  - [ ] Discover
- **Account No.**
- **Exp. Date**

- [ ] Full payment enclosed. Prepayment discounts offered for multiple insertions (except on credit card orders).
- [ ] Payment for first insertion enclose; additional payments will be made prior to closing dates. Prepayment discounts not available.

### Do you want any special options? (where available)

- [ ] Boldface Type* Add 25% for entire ad
- [ ] Screened Background – Add 30%
- [ ] Special Heading – Add $35.00

The first word of your ad and your name will be printed in boldface caps, at no additional charge. For individual boldface words, add .50¢ each.

### In what month(s) would you like your ad to run?

- [ ] Entire year for publications selected above.

### Here's how to calculate the cost of your regular or expanded-ad classified:

\[
\text{Cost per Insertion} = \text{Rate} \times (\text{Number of Words} + \text{Rate for Boldface} + \text{Rate for Screened Background})
\]

<table>
<thead>
<tr>
<th>Magazine Rate x</th>
<th>(min. 15)</th>
<th>+ Boldface (add 25%)</th>
<th>Screened Background (add 30%)</th>
<th>Cost Per Insertion x Number of Months = Cost</th>
</tr>
</thead>
</table>

**Rates:**

- $3.50 per word

**Minimum 15 Words**

### Here's how to calculate the total cost of your advertising:

<table>
<thead>
<tr>
<th>Prepayment Discount:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full payment must accompany order, not applicable on credit card orders</td>
</tr>
<tr>
<td>Prepay for 6 insertions in one magazine, 5% 12 insertions in one magazine, 10%</td>
</tr>
</tbody>
</table>

**Subtotal**

**Less Prepayment Discount**

**Total Cost**

Please use a separate piece of paper to write your copy, or for any special instructions you may have.

**Have a Question? Call:** 1-631-592-6720 ext. 206

**Fax signed orders with credit card information to:** (631) 592-6723
When you buy products from these advertisers, please tell them you saw their ads in Poptronics® magazine.
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.

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 unrivalled 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 export systems to assist in designing active and passive filters.

Shareware/demo CD ROM with more than 20 programs $4.99 refundable with any purchase.

Order Form:
Please circle the products you would like to buy on the table below, calculate the total cost, fill in the rest of the order form and send it to us. NY residents add sales tax. Please allow 6 weeks for delivery.

<table>
<thead>
<tr>
<th>Product</th>
<th>Student</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Cds. &amp; Comps.</td>
<td>$50</td>
<td>$99</td>
</tr>
<tr>
<td>Digital Electronics</td>
<td>$50</td>
<td>$99</td>
</tr>
<tr>
<td>Analog Electronics</td>
<td>$50</td>
<td>$99</td>
</tr>
<tr>
<td>Electronic Projects</td>
<td>$75</td>
<td>$159</td>
</tr>
<tr>
<td>PICtutor</td>
<td>$179</td>
<td>$350</td>
</tr>
<tr>
<td>C for PICmicros</td>
<td>$179</td>
<td>$350</td>
</tr>
<tr>
<td>Digital Works</td>
<td>$50</td>
<td>$99</td>
</tr>
<tr>
<td>CADPACK</td>
<td>$75</td>
<td>$159</td>
</tr>
<tr>
<td>Analog Filters</td>
<td>$75</td>
<td>$159</td>
</tr>
<tr>
<td>Postage - USA</td>
<td>$5</td>
<td>$5</td>
</tr>
<tr>
<td>Postage - Canada</td>
<td>$5</td>
<td>$5</td>
</tr>
</tbody>
</table>

Name: ____________________________
Address: _________________________
Zip: __________ Phone: __________

Card Type: __________
Card number: __________

I have enclosed my check for $: ____________________
Signature: ____________________

Phone your order to us on: 631-592-6721
or send your order to:
CLAGGK Inc.
PO Box 12162
Hauppauge, NY 11788

Order online NOW from: www.poptronics.com
Working on your next masterpiece?

It's time for new tools.

multiSIM 2001 from $399
SCHEMATIC CAPTURE, SIMULATION & PROGRAMMABLE LOGIC
- Advanced modeless schematic capture
- Library of 16,000 parts supplied, with 12 million online
- Analog, digital and mixed-mode simulation
- Patented co-simulation of SPICE, VHDL and Verilog
- Suite of "virtual instruments" including oscilloscope, wattmeter, spectrum analyzer & network analyzer
- Design collaboration across the Internet

ultiBOARD 2001 from $399
POWERFUL PCB LAYOUT
- Powerful & easy-to-use PCB layout & editing
- Reroute while move (full rubberbanding)
- 3D board visualization
- Real-time design rule check
- Component push & shove with springback
- Extensive copper placement capabilities

ultiROUTE from $399
AUTOROUTING & AUTOPLACEMENT
- Benchmark test leader with superior routing results
- Combination of grid-based/gridless routing available
- Highly flexible router provides complete control
- Optimal part placement improves routing performance
- Supports manual wire pre-placement
- Pin and gate swap

commSIM 2001 from $399
NETWORK & COMMUNICATIONS SIMULATION
- Powerful, yet easy-to-use fast, accurate simulation tool
- Model & simulate end-to-end communications systems
- Analog, digital & mixed system design capability
- Industry-leading block libraries — channels, encoders/decoders, modulators/demodulators
- View simulation results in various methods — time domain, frequency domain, xy plots, log scale, eye diagrams and power spectra

sales: 800.263.5552 • http://www.electronicsworkbench.com

Electronics Workbench products are used by more designers than any other software of their kind. They will help you reduce development times and produce higher quality circuits — We guarantee it, or your money back!

We offer a portfolio of products to meet all your design needs: Schematic Capture, Component Database, SPICE/VHDL/Verilog HDL/RF Simulation, PCB Layout, Autorouting and now Network & Communications Simulation.

Ease-of-use continues to be one of our biggest strengths, letting you produce designs in the time it takes to install and configure most other programs.

Our unique combination of power and unrivaled ease-of-use allows us to offer this guarantee. Power means you get capabilities simply not available elsewhere, such as patented co-simulation of SPICE/VHDL/Verilog/RF all together.

That's why we are the EDA supplier of choice to over 150,000 users worldwide.

**FREE Virtual Lab with Poptronics Circuits!**
Check out the circuits from recent issues, including this month's! Tweak the circuits and see the instruments respond instantly. Download the Multisim demo with pre-built Poptronics circuits from www.electronicsworkbench.com/poptronics