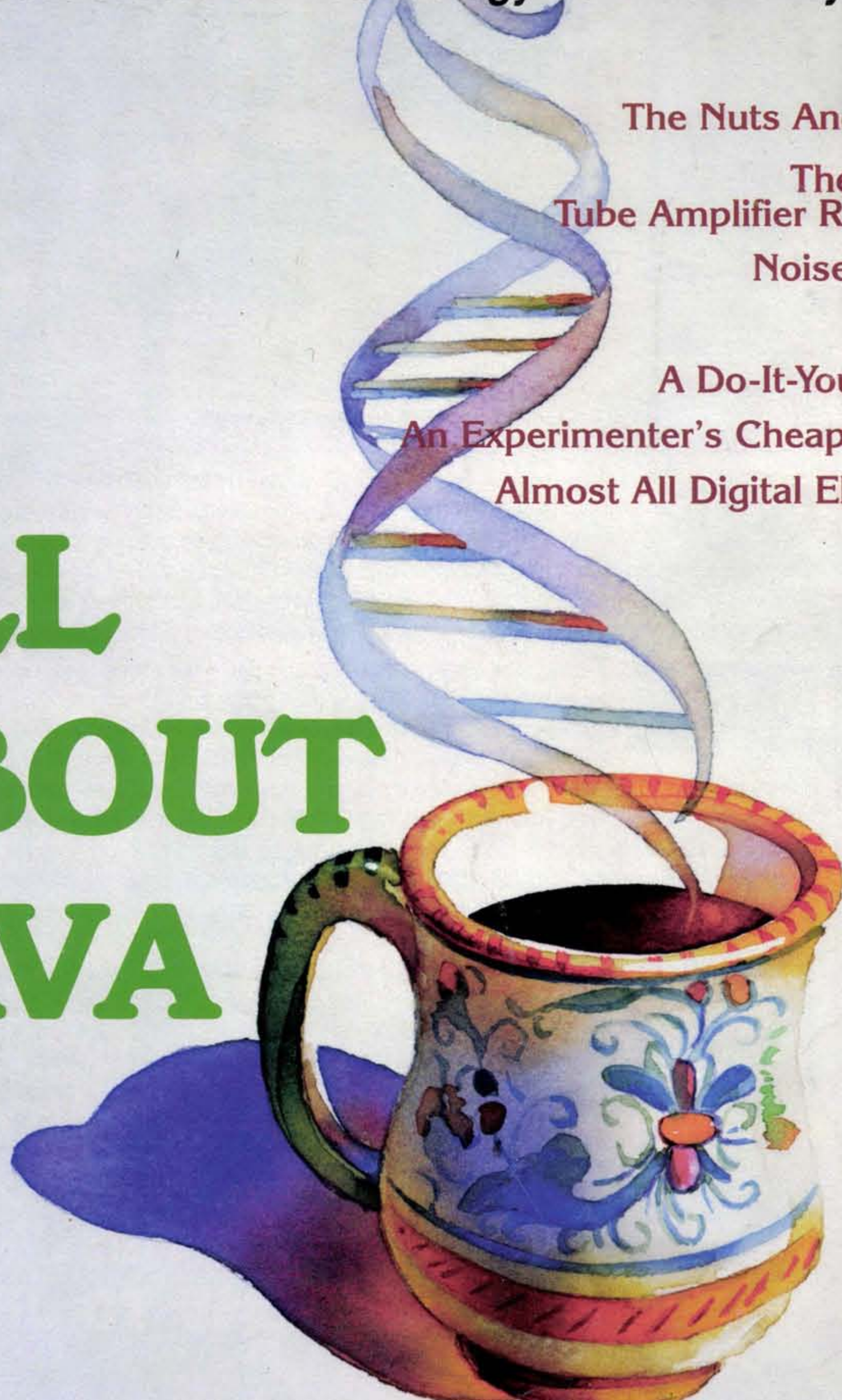
NUTS & VOLTS MAGAZINE

OUR 18th YEAR

$3.50
VOL. 18 NO. 4
APRIL 1997

Exploring Electronics And Technology For The Hobbyist And Professional

ALL ABOUT JAVA



04>

0 74470 89295 3

NUTS & VOLTS MAGAZINE

Published Monthly By
T & L Publications, Inc.
430 Princeland Court
Corona, CA 91719
(909) 371-8497
FAX (909) 371-3052

E-Mail
editor@nutsvolts.com
URL
http://www.nutsvolts.com

Subscription Order ONLY Line
1-800-783-4624

Publisher
Jack Lemieux
N6ZTD

Editor
Larry Lemieux
KD6UWV

Managing Editor
Robin Nelson
KD6UWS

On-The-Road Exhibit Coordinator
Audrey Lemieux
N6VXW

Subscriptions
Abby Madain

Classified Ads
Lisa Wharton

CONTENTS

VOLUME 18 NO. 4 APRIL 1997

ARTICLES

COLUMNS

DEPARTMENTS

Cover Photo: © DNA Helix Coffee Smoke by Marlies Merk Najaka/SIS

EDITORIAL CONTRIBUTIONS

Nuts & Volts Magazine encourages article submissions and queries. Send a SASE for a copy of our writer's guidelines.

All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well. If return of materials is requested, include a SASE with your submission.

Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

CHANGE OF ADDRESS

If you are moving, notify us AS SOON AS POSSIBLE so we can continue your subscription without interruption.

Your magazine WILL NOT automatically be forwarded to you by the post office, so it's important to submit your change of address directly to Nuts & Volts.

We will not be able to replace missed issues of the magazine due to unreported address changes.

When you send in your new address, include a current mailing label from the magazine with your account number on it. If you do not have a mailing label, be sure to include your old address and the name(s) under which the subscription was submitted.

INDEX TO CLASSIFIED ADS

NOTICE TO ADVERTISERS

All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints or typographical errors. Nuts & Volts Magazine assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in Nuts & Volts. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action or expense arising from advertising placed in Nuts & Volts.

Please send all subscription orders, correspondence, UPS, overnight mail and artwork to: 430 Princeland Court, Corona, CA 91719.

The closing date for each issue is the 10th of the prior month, e.g., the closing date for the June issue is May 10th. Ad copy to be typeset by Nuts & Volts should be received one week prior to the closing date.

Call or write for current advertising rates.

To Subscribe to NUTS & VOLTS

Send payment to the address below or call 1-800-783-4624 and use your Visa or MasterCard.

USA ONLY
$19.00 — One Year **$35.00 — Two Years**

MAILED FIRST CLASS — FOREIGN ONLY
$37.00 — Canada/Mexico **$100.00 — Foreign/Air Mail**
$50.00 — Foreign/Surface

Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719

Nuts & Volts Magazine is published monthly for $19.00 per year by T&L Publications, Inc., 430 Princeland Court, Corona, CA. Application to mail at 2nd class postage rates is pending at Corona and San Diego. POSTMASTER: Send address changes to Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719.

TNR TECHNICAL, INC.

Your Largest Stocking Distributor For SANYO Batteries

Call for Competitive Pricing

FREE CATALOG

Receiver & Transmitter Packs • Laptops, Camcorder, Cellular
Sealed Lead Acid, Lithium, & More

Immediate Delivery • Custom Assemblies • Technical Support • Full Production Facilities
301 Central Park Drive • Sanford, FL 32771
(New Location, Same Owner!)

Fax 407-321-3208 **800-346-0601**
email - tnrbattery@aol.com Web - http://www.batterystore.com

Write in 35 on Reader Service Card.

FOR ALL YOUR CABLE TV NEEDS

TOLL FREE **1-888-56-CABLE**

Write in 125 on Reader Service Card.

LEARN THE SECRET. How to silently activate any phone/line and monitor. And without ID detection. For info, send $5 refunded with first order to: ILIADIS, PO Box 350562, Jacksonville, FL 32235-0562.

WANTED: ICOM IC-03AT 220MHz handhelds. Will consider non-functional radios. **Top dollar offered.** Contact Alan Sanders, Communications Specialists, Inc., 426 West Taft Avenue, Orange, CA 92865-4296. 1-800-854-0547, FAX 1-800-850-0547.

I WANT it and I want it now. I want all of your SIMM memory. IBM, Mac, new, used, even defective. I want it all. Highest $ paid. Now selling memory. We can beat any printed price in Nuts & Volts. Call 1-800-4-MEMORY now! Voice/FAX.

HAM GEAR FOR SALE

QUALITY PARTS at surplus prices. All new, never used distributor and OEM overstocks. Call IME, 817-561-2999 or write PO Box 170415, Arlington, TX 76003.

NEW CATALOG, RF parts, shortwave kits, transceiver kits, iron powder and ferrite cores, hard to find parts, more. Two stamps to Dan's Small Parts, Box 3634, Missoula, MT 59806. Ph/Fax 406-258-2782. Online catalog http://www.fix.net/dans.html

MILITARY RADIOS: Easily made battery adapters for military radios & other electronics. Get "Power Up," big new 96 page manual of instructions, diagrams. Use readily available commercial batteries in PRC-6, -8, -9, -10, -28, -25, -47, -74, -77, TRC-77, AN/PRR-9, AN/PRT-4, RT-77, URC-68, more, also mine detectors, night scopes, radiacs, field telephones, etc. Only $14.95, plus $5 S/H ($6 Canada). NYS residents add $1.66 tax. CRB Research, Box 56-NVV, Commack, NY 11725. Visa/MasterCard welcome. Phone: 516-543-9169.

NATIONAL RADIO manuals and MCL2000 parts lists. SASE. Maximillian Associates, 11 Plymouth Lane, Swampscott, MA 01907.

THE ALC245M AUTOMATIC VOLUME CONTROLLER will keep your transceiver or scanner's volume constant from a whisper to a scream. $29.95 S&H $5. Other models also available. **FREE BROCHURE.** C&S Electronics, PO Box 2142, Norwalk, CT 06852-2142. Phone: 203-866-3208 Fax: 203-854-5036. E-Mail: CANDSELECT@worldnet.att.net

KENWOOD HF TRANSCEIVER TS530S, box, books, Shure, 444D. Like new $350 plus shipping. 510-222-4445.

ELECTRONICS BOOKS. Thousands of titles. Electronics meet. Aviation at Marine, Manhattan Beach 7-11am, last Saturday each month. We also buy. Lee and Margaret Johnson, 805-525-8955.

LOW PRICED, new & used commercial equipment, scanners, ham gear, linear amplifiers, CB accessories. Free catalog. Call 909-873-1319 or fax on demand 909-820-1885. E-Mail: HRH6@aol.com or write LML, 424 E. Shamrock, Rialto, CA 92376.

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

NEW PRODUCTS FROM S&S: UPGRADE YOUR OLD RIGS! Digital Dial has 10Hz resolution HF, 100Hz VHF and frequency range 50KHz to 230MHz; kit $99.95; assembled $149.95. **Digital VFO** with 1Hz resolution; kit $139.95; assembled $189.95. S&H $7.50 (Continental US). GUARANTEED TO WORK. For info, send **SASE**. Call/write to order: S&S Engineering, 14102 Brown Road, Smithsburg, MD 21783. 301-416-0661. E-Mail: N3SAD@aol.com or see http://www.xmetric.com/sseng

FOR SALE: Central Electronics CE100V xtmr, $500; Allied AX-190 sw rcvr, $250; Ameco 2 & 6 mtr xtmr, w/50-144-220 MC VFO, $225; Sommerkamp Ft Dx-150 ham xcvr, $250. All excellent to mint cond. w/manuals. KE6QYO, 910-278-3912.

COMPUTER INTERFACES. Modes Wefax, Color Ham Fax, Color SSTV, CW, RTTY, AMTOR, PACKET, PROSKAN, JVFAX, HAMCOM, MSCAN, BAYCOM, and more. CW IDers voice IDers. PROSKAN dual op-amp interface $39.95 + $4 S/H. Send #10 SASE for catalog. A&L Engineering, PO Box 226, Montgomery, IL 60538-0226.

HAM GEAR WANTED

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

EZ-EP DEVICE PROGRAMMER - $169.95

INEXPENSIVE - Best programmer under $200.
PORTABLE - Attaches to PC parallel port.
FAST - Programs 27C010 in 23 seconds.

VERSATILE - Supports devices 2716 thru 27080 plus EE and Flash to 32 pins. Reads and writes binary, ASCII hex, Intel Hex, and Motorola S formats.

SERVICE - Information and software updates via BBS or voice. 30 day money back guarantee.

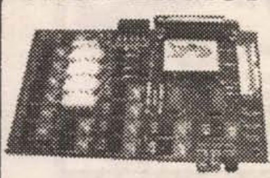
ADAPTERS for additional devices are available.

EP-51 (8751,C51)	$39.95	EP-PIC (16C5x,61,71,84)	$49.95
EP-51-PLCC	$59.95	EP-750 (87C750,751,752)	$59.95
EP-SOIC28/32	$49.95	EP-SEE (24xx,93xx Serial EE)	$34.95
EP-11 (68HC11)	$59.95	EP-16 (16bit EPROMs)	$49.95
EP-55 (8755)	$39.95	EP-49 (8742,48,49)	$49.95
EP-PLCC32	$49.95	EP-PEEL(18v8,20g10,22v10)	$59.95

M²L ELECTRONICS 310/837-7818
3526 Jasmine; Suite #4 Mon-Fri 9-5
Los Angeles, CA 90034 **BBS/FAX:** 310/841-6050
URL -- http://www.cs.ucla.edu/csd-grads-gs3/loving/www/m2l.html
CA - add 8.25% tax. UPS Ground - $5; 2 Day - $10; Overnight - $17 COD $4.75

Write in 94 on Reader Service Card.

STEPPER MOTOR CONTROLLER



ADDRESSABLE STEPPER MOTOR CONTROLLER: JWP1X-1A
$199.95

NON-ADDRESSABLE STEPPER CONTROLLER *KIT*: REN1X-1A
$29.95

Controls up to 4 unipolar stepper motors per controller with 8 digital inputs with a throughput of 500k bytes / sec. Up to 256 Controllers can be stacked on a single parallel port.

Can be used for the following tasks:
- CNC Conversion
- Telescope Guidance
- Robotics
- Manufacturing
- Positioning Platforms
- Animatronics

DIGITIAL I/O CONTROLLER

ADDRESSABLE DIGITAL I/O CONTROLLER: JWP1X-3
$179.95

NON-ADDRESSABLE DIGITAL I/O *KIT*: REN1X-3
$29.95

8 Bit Digital I/O controller, 8 buffered digital outputs and 8 buffered digital inputs that function at 500k bytes / second. Up to 256 Controllers can be stacked per parallel port.

Can be used for the following tasks:
- Robotics
- Automated Manufacturing
- Animatronics
- Controlling Solenoids
- Servos
- Digital Prototyping

PARAMAX INC.
1 (800) 473 - 8080

http://www.digitalage.com/VM/Paramax
Paramax products also available through:
FORD Electronics: **(714) 521 - 8080**

Write in 199 on Reader Service Card.

HAM GEAR WANTED *cont.*

WANTED: ELECTRONIC EXCESS "NEW" ICs, SEMICONDUCTORS, CAPACITORS, RELAYS, FANS, MOTORS. Late model TEST EQUIPMENT. Your NEW but excess electronics could be exactly what I'm buying. LYNN JOHNSON CONSULTING. 408-274-3559 V/FAX, lyntec@ccnet.com WEB http://www.angelfire.com/ca/ljehome/index.html

CB/SCANNERS

VINTAGE TUBE CBs. LSASE list. RR3 Box 2075, Fort Kent, ME 04743. 207-834-6273, evenings/weekends.

RED BOOK CB MODIFICATION. Antennas, audio, modulation, PLL/VCO, synthesis, mixer crystals, sliders. $25. KEN'S, 2825 Lake, Kalamazoo, MI 49001. 616-345-4609.

WANTED TO Buy: Radio Shack scanners, model PRO-43 or 34 preferred. 513-392-1676 anytime.

KONNEX DISTRIBUTING. Call 310-216-7929. PO Box 451372, Los Angeles, CA 90045. CBs, antennas, meters, transistors, microphones, accessories. Best prices.

BILL'S CB & 2-Way Radio Service: CB/ham/scanners, AM/FM/SSB/CW export/domestic radios by Galaxy, Mirage, Palomar, Connex, Cobra, Superstar, RCI, Uniden Midland, Maxon, and more. Linear amps, antennas, books, manuals, mics, meters, sound toys, frequency expansion and modulation kits. $3 for list of products, refundable on first order. Technical advice is free. Call: 408-782-0064. Write: PO Box 306, Morgan Hill, CA 95038-0306 MC/VISA.

TOMCAT'S BIG CB Handbook, by Tom Kneitel! 221 pages, illustrated. Everything they never told you about AM, SSB, DX, Freeband, legal and otherwise. Only $15.95 (+$5 postage, $6 to Canada). CRB Research, Box 56, Commack, NY 11725. (NYS residents add $1.73 tax). MC/Visa OK. Phone orders 516-543-9169.

FEDERAL FREQUENCY Directory! Kneitel's "Top Secret" Registry of government Frequencies, New 8th Edition. 268 Pages! FBI, DEA, Customs, Secret Service, BATF, Immigration, Border Patrol, IRS, FCC, State Dept., Treasury, CIA, etc. & surveillance, bugs, bumper beepers, worldwide US military, 225 to 400 MHz UHF aero band, Canadian listings, & more. Ultimate "insider's" directory! Standard reference of law enforcement, news media, private security, communications industry & scanner owners. $22.95 + $5 shipping ($6 to Canada). NY State residents add $2.31 tax. CRB Research Books, Box 56-NVT, Commack, NY 11725. Visa/MC welcome. Phone orders 516-543-9169 weekdays (ex-Wed.) 10 to 2 Eastern.

SALES, SERVICE: CB equipment, radios, modifications, power mice, echo-reverb boxes, kits, meters, filters, antennas, noise toys, mounts, hard-to-find items. Partial list $1, complete list $4. D&R Electronics, 10 Park St., Thomaston, CT 06787. 860-283-9492.

NEW: SCANNING USA, from the publishers of Scanning Illinois. Nationwide newsletter with public safety, aircraft, railroad, shortwave, federal/military, tech, more! Samples $3. Twelve issues for $19.95. SASE checks to: 2054 Hawthorn, Joliet, IL 60435. Make payable to Alex Blaha.

SCOPEBOOSTER KITS close out. Nov. '96 issue, $39.95, S&H $4.50. Technology Systems, PO Box 1401, Torrington, CT 06790-1401.

CB RADIO Hacker's Guide! Wow! Big 150 pages; pictorials, diagrams, text. Peaking, tweaking & modifying 200 AM & SSB CB radios. Improved performance, extra capabilities! Which screws to turn, which wires to cut, what components to add: Cobra, Courier, GE, Midland, Realistic, SBE, Sears, Uniden/President. $19.95 plus $5 shipping ($6 Canada). NY State residents add $2.06 tax. CRB Research, Box 56-NVV, Commack, NY 11725. Visa/ MasterCard accepted. Phone order M-Tu-Th-F, 10-2 Eastern Time, 516-543-9169.

240+ CHANNEL CB/HAM commercial radios: AM/FM/SSB/CW export/domestic: RCI, Motorola, Uniden, Cobra. Mics, antennas, linears, meters, books, night scopes, and tons more stuff! Catalog $3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244.

"CB MODIFICATION SECRETS," new 200-page guide by author of "CB Radio Hacker's Guide." More easy AM/SSB CB upgrades & enhancements: Cobra, Realistic, Uniden, President, etc. Freq. expansion, VFO, clarifier unlock, VOX, Roger Beep, anti-theft device, receive preamp, more. Only $21.95, plus $5 S/H ($6 to Canada). CRB Research, Box 56, Commack, NY 11725. NYS res. add $2.22 tax. Visa/MC orders call: 516-543-9169.

NEW UPDATED/MORE INFO ULTIMATE MODIFICATION BIBLE VOL 6 1000 mike wiring CB and ham, 500 CB modulation boost, 200 CB PLLs, 200 ham radios, 30 scanner modifications, over 200 pages. KDC SOUND, PO BOX 8622, GRANGERLAND, TX 77302. Send $29.95 (SORRY NO CODs) to order: VISA, MC, DISC. 1-800-256-9895. OTHER CALLS 409-231-3753.

SCANNER MODIFICATION HANDBOOK. Big! 160 pages! More than 20 performance enhancements for PRO-2004 and PRO-2005. Restore cellular, increase scanning speed, add 6,400 memory channels, etc. Step by step instructions, photos, diagrams. Only $18.95, +$5 shipping ($6 Canada). (NYS residents add $1.98 tax.) CRB Research, Box 56, Commack, NY 11725. Visa/MC welcome. Tel. 516-543-9169.

ROGER BEEPS/keyup tones superior quality high reliability professional grade devices. Single and multitone. $19.95 to $29.95. For more information, faxed or mailed literature and orders please call **Daltronix**, 908-493-1658.

Write in 57 on Reader Service Card.

NOISE-CANCELLING RADIO MICS

by Gordon West

Radio communicators who may prepare for emergency communications take great pride in checking every detail of their radio system. Such was the case of an emergency communication team who would be handling emergency medical radio traffic at the local airshow. They tested and re-tested their entire radio network to make absolutely sure that everything would work perfect on their big day.

The one-day airshow came and went, and the majority of the communications were laced with problems. Half the time, the well-tested repeater system cut out on voice syllables. The other half of the time, crowd noise and the roar of jet engines drowned out many of the emergency communicators on the front line. As you can imagine, the problem was NOISE.

The well-seasoned radio technician is quick to recognize that repeater dropout on voice syllables is a simple case of over-deviation by the transmitting station. Every time a communicator would talk louder to beat the background crowd noise, the repeater would self-limit the incoming 4 KHz deviation level, and clamp out loud syllables beyond 4 KHz.

The new low-cost ham radio from Kenwood features a mike circuit that won't creep up to overdeviate when crowd noise gets loud.

"During the initial tests, the communicators would be talking in a normal tone of voice, and were not trying to shout over crowd noise," comments David Lee W6ZL, a Southern California radio communications technician.

"Radio communicators preparing for a big noisy event should always test their deviation limits by close-talking the microphone, and literally shouting in the mic to insure they don't drop out of the repeater's pass band," adds Lee.

This problem of "over-deviation" is magnified when radio communicators add external speaker/microphones and headsets at the last minute. Often times, the accessory mic elements are "hotter" than the built-in mic, almost guaranteeing over-deviation, and repeater and base receiver syllable dropout. What the radio operator didn't realize during the initial tests was that he or she was not literally shouting into the microphone — trying to overcome crowd noise and talking extra loud so they could hear their own speech.

The constant elevated crowd noise, coupled with the background roar of the airshow participants, leads to some amplified/equalized transmit audio circuits averaging out the noise level and taking it up to 4 KHz, and then saturating on the first syllable of the close-talked microphone. Some base-station microphones can eliminate this problem by putting them into the manual mode, and cranking the level extremely low. Other microphone systems may employ a variable automatic gain control (AGC) system which can be re-adjusted to compensate for a constant background noise floor. On handheld equipment, there are no AGC adjustments, other than taking the mic pot and deviation pot and adjusting them lower than normal for an expected loud and noisy environment.

Some professional communicators may use professional headsets with a noise-cancelling microphone element. There are also noise-cancelling remote lapel mics, plus noise-cancelling base-station microphones that have two entrances (apertures) for sound entrance.

"Shure Astatic and others use a screen approach to allow sound access to the back of the mic element," comments Adolph Santorine N8JBC, President of The AWS Group (Wheeling, WV; 304-233-2223).

Aviation and big-crowd headsets from Telex may use a two-aperture approach, with a slot on the top and the front.

"Newer radios are beginning to use Electret microphones for noise cancellation where two microphone transducers are wired 180 degrees out of phase," adds Santorine. This is the approach that some headset makers in the communication electronics field have taken — headsets that seemingly block a constant roar of noise, yet allow nearby conversations to come through loud and clear. If you haven't tried on a pair, do it! Fascinating.

Commercial-grade mobile radio noise-cancelling microphones may have an opening in the back of the diaphragm, similar to the single port cardioid mic, and a special dynamic cartridge to obtain short distance audio.

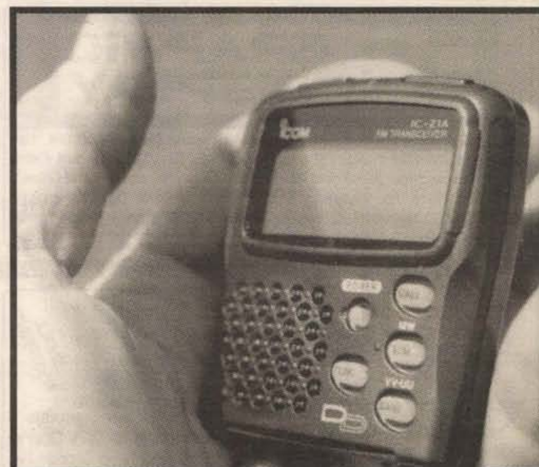
"A noise-cancelling microphone is designed in a manner to effectively discriminate between spherical and plane soundwaves," comments Stan Maire, Chief Engineer, Acoustics at the Astatic Corporation. "Speech soundwave energy radiates from the mouth, and closest to the mouth, soundwaves are spherical. The more distant unwanted soundwaves will consist of plane waves," comments Maire of Astatic.

When you speak into the microphone, your voice sound pressure is greater on the front of the mic than on the back, producing maximum diaphragm movement. Unwanted noise at a distance greater than one-half inch from the microphone is dramatically decreased because of phase differences and defractional effects. This allows the radio operator to be heard "loud and clear" with almost no background noise getting through to the transmitted signal.

The Heil headsets feature a mike element tuned for voice frequencies only. Keep the mike element close to your lips to minimize engine roar. *(Pictured Chip Margelli K7JA)*

"A competitor of ours developed a new noise-cancelling microphone for helicopter radio reporting. It worked so well that people began calling the radio station and accusing them of giving the report from the station, instead of up at the helicopter, because the typical helicopter sounds could not be heard," muses Stan Maire of Astatic.

Stan points out that the first noise-cancelling



This ICOM remote head mike features a mike element that reduces low background frequencies, and brings up voice frequencies.

The new standard radio has a special mike element that minimizes road noise pick-up.

microphone was developed by Electro Voice during World War II for use in tanks. In 1960, Shure Bros. offered the controlled magnetic noise-cancelling microphone and, most recently, the Astatic Model 631 and 632 microphones with noise-cancelling capabilities are the best on the market. The noise-cancelling microphones can also be made with ceramic cartridges, too. Ceramic cartridges lead to better noise-cancelling capabilities, especially in mobile vehicle installations.

Frequency response is another big consideration when selecting an optional microphone element with or without noise discrimination characteristics. Many amateur radio operators choose Heil microphone/headsets because of the capabilities of selecting different types of mic elements with specific frequency responses. The Heil headsets may not be classified as noise-cancelling microphone systems, but their tight frequency response could lead them into a category of noise discrimination — especially where the noise falls well beyond the pass band of the mic element and its normal human voice speech response.

"And there is the issue of microphone compatibility with a specific type of mobile, base, or handheld radio," comments one two-way radio manufacturer who has seen both good and bad choices for the microphone element.

Carbon microphones may offer high output and great efficiency, but they hiss from the carbon granules and also require DC power. Not many crystal microphones are around because of their heat-sensitivity. Ceramic microphone elements are lightweight, inexpensive, simple to produce, and offer fair frequency response without the problems of humidity and high temperature.

Dynamic microphones are quite common in radio communication circuits, and they work with sound pressure variations causing a diaphragm to move a lightweight coil of wire in a field of a permanent magnet, inducing current flow in the coil. The dynamic microphone offers good uniform frequency response, but the disadvantage is a higher cost to manufacture, critical manufacturing process, and dust and moisture must not be allowed to migrate into the lightweight coil assembly.

Another popular radio communications microphone element is the Electret where sound pressure variations on the diaphragm force the diaphragm to move in relationship to a back plate, creating a capacitor effect with one plate on the diaphragm, and the other plate on the back of the mic.

Varying the thickness of the dielectric between the plates of a capacitor varies the capacitance. The dielectric in the Electret mic is air. The Electret microphone is very small and light, and offers high output for its size, and offers good frequency response. But the Electret microphone requires a small power source and electronic impedance matching circuitry, and close frequency response tolerances are difficult to obtain.

"Any radio system attached to an after-market microphone system should always be calibrated on a professional service monitor deviation meter," comments Bill Alber WA6CAX. "Too many times, we may see a nice microphone system improperly matched to a great radio transceiver. But with just a little adjustment, the new microphone and the existing radio can be made very compatible, including the use of noise-cancelling microphone circuits."

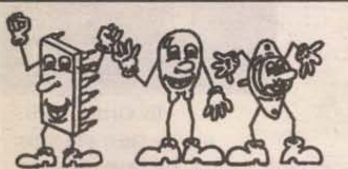
If you're thinking of changing the microphone on your radio system, or adding a headset microphone to your handheld, get together with the headset and microphone manufacturer, and let them know exactly which radio you plan to add their system to. This way, you will get the noise-cancelling or noise-reduction mic element that will best meet your communication needs. **NV**

For a free fact guide on noise-reduction mike elements and headsets, write to:

Bob Heil Mics
c/o Labone
Marissa, IL 62257
Phone 618-295-3000/Fax 618-295-3030

Write in 31 on Reader Service Card.

PENTIUM INTEL Zappa motherboards, P75 to 133, w/IDE, hi-speed I/O on board, w/cables, mini AT size, w/docs, $69, $199/3. CPUs available 486 & Pentium call. Best prices. Closeout DEC 486DX33PC pizza box WS, barebones, case, PS, 2M VRAM SVGA, 2S, 1P, & MP, IDE, H&F cont., Tolken Ring, Ex SCSI-2. New bulk packed size: 15"x2.5"x17" SVGA monitor 1280x1024, mouse, 101 keyboard, software $319. Have CPUs, motherboards, 486 & Pent. computers, 256K VGA video cards $12. All at super prices. On the web, WWW.BNFE.COM BNFE, Rte. 1S, Peabody, MA 01960. V508-536-2000, F508-536-7400. In our 33rd year.



WANTED: ELECTRONIC EXCESS "NEW" ICs, SEMICONDUCTORS, CAPACITORS, RELAYS, FANS, MOTORS. Late model TEST EQUIPMENT. Your NEW but excess electronics could be exactly what I'm buying. LYNN JOHNSON CONSULTING. 408-274-3559 V/FAX, lyntec@ccnet.com WEB http://www.angelfire.com/ca/ljehome/index.html

BUILD YOUR OWN IBM COMPATIBLE COMPUTER for as little as $399 with help of an easy-to-view 75 minute video tape that shows you how. This award winning VHS tape will show you how to save time and money by assembling any 286, 386, 486 or Pentium computer from available parts in a step-by-step easy to follow procedure. It's easy when you know how. Order your personal tape today while the limited supplies last for only $29 (reg. $59.95) plus $2.95 P&H. Free bonus gift. Send check to: **EVP, PO Box 2201, Northlake, IL 60164-0201** or call: **1-800-754-5096** now!

800MB TAPE BACK-UP WITH TAPE FOR ONLY $49! Colorado DJ-20 includes 250MB tape and software. Works in any PC from existing floppy controller. Works with Windows 95, DOS, Win 3.1. Novell certified. Transfers 120MB in 13 min. Compatible with all QIC-40/80 tapes. **The best insurance from disk crashes, viruses, theft, accidental erasure and easiest way to transfer files and copy CDs.** Refurb. 90-day warranty. Equiptek, 415-244-9438, M-F, 9-5 PST. E-Mail: equiptek@pacbell.net

PENTIUM MOTHERBOARDS 100/120/133/150/166/200, Triton VX chipset, Plug-N-Play BIOS, 3ISA/4PCI, 256K Pipeline cache $109, Triton II-HX boards with 512K cache $129. **CPUs:** Pentium @ $137/173/299/336/499. **MMX:** 166 $499, 200 $699. **IBM/cyrix 686** P150/166/200+ @ $135/178/299. **AMD** K5-75/100-133 @ $44/88/108. 12-speed **CD-ROM**, audio button $109, 72-pin **SIMMs**, 60ns EDO, 16MB $89, 8MB $49. Call for current pricing, other parts and illustrated catalog. 1-year warranty. tech-specialities, Inc., 5703 Heffernan, Houston, TX 77087-4113. 1-800-864-5391 for orders and tech support fax: 713-307-0314.

CHAFFIN ELECTRONICS INC. Call us for all your IC needs. Let us save you $$$$. Call Sales 614-574-4456, Sales 614-574-6906, FAX 614-574-2124.

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

MICROSTEP DRIVERS & CAM SOFTWARE: full/2/3/4/5/6/7/8. 3 & 6 amp starting at $117. Software: Plotcam motion $149, Z-trace toolpath from PCB gerber $299. heater@greater.net MSG/FAX 407-452-7197, 407-459-2729. http://mall.greater.net/mall/ddt

www.usedcomputer.com - The Used Computer Mall™ at http://www.usedcomputer.com on the world wide web lists nearly 1000 dealers who buy, sell, and trade used computer equipment, and supply parts and service, too. They are well indexed by brand and type of equipment, so that you can quickly find the dealers you need. Visit the mall today to fill all of your used computer equipment needs.

MONITOR TECHNICIANS! 10 step program for successful analysis; diagnosis, and repair of high voltage and power supply problems in computer monitors. Booklet available for $20 from Computer Vision, 6905 Indian Bay Rd., Montague, MI 49437.

ROGER'S SYSTEMS SPECIALIST. SCSI fast wide cables, ten Base T cables and hubs, bi-directional 1284 I-EEE printer cables, micro-centronics type $1.50. 9 ft. modem cable $1 each. Pentium ball bearing fans $2 ea. Hundreds of items. Call for catalog. Most orders shipped same day. Visit our web site www.rogerssystems.com 1-800-366-0579.

MONITOR ADAPTERS. Convert OEM. (incl. PGA) 31.5KHz & above monitors with BNC connectors to PC use. Model VA10 VGA to RGB+ Sync $45. Model VA11 VGA to RG/Sync-B $55. VA12 VGA to PGA (DB9) $45. Rich, Pikul & Assoc., 101 Glenfield Dr., Festus, MO 63028. 314-937-0335.

PC-COMPATIBLE MBs 386-16-40 with RAM $25. 20-40 meg MFM hard drives $20-35. IBM-XT MBs with RAM, great controllers $15. 5-1/4 1/2 HT 360K 1.2 meg $15-$25. 486 MBs, no CPU $25. Monitors CGA, EGA, MONO, VGA $25-$100. We buy all types of computers. Call for flyer. 860-267-8763.

SIMM 1, 2, 4, 8, 16, 32 meg: All are brand new. 1 meg 30 pin 70ns/60ns $14/$16, 4 meg 30 pin 70ns/60ns $37/$39, 4 meg 72 pin 70ns/60ns $27/$29, 8 meg 72 pin 70ns/60ns $49/$52, 16 meg 72 pin 70ns/60ns $85/$89, 32 meg 72 pin 70ns/60ns $165/$169. All SIMM modules available. 1 yr. warranty. Call Yub Sung, 603-893-5866, Salem NH for current price/availability.

BLOWOUT! TIMELINE INC. BLOWOUT!

Over 10 years and 28,000 customers and still growing

Liquid Crystal Displays

240x64 dot LCD with built-in controller.
AND 4021ST-EO. *Unit is EL back-lit.* $69.00 or 2 for $129.00 or
OPTREX. DMF5005 *(non back-lit)* $49.00 or 2 for $89.00
20 character x 8 line 7¼L x 2¼H — *The built-in controller allows you to do text and graphics.*

Alphanumeric—parallel interface

16x1	$7.00	20x2	$10.00	40x1	$8.00
16x1 (lg. char.)	$10.00	20x4	$15.00	40x2	2 for $20.00
16x2	$7.00	20x4 (lg. char.)	$10.00	40x4	$20.00
16x2 (lg. char.)	$10.00	24x2	$10.00	4x2	$5.00
16x4	$15.00	32x4	$10.00		

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

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$25.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$20.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

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

Laser Products

HeNe Laser Head (10Mw max. output) TEMOO, 15.5" long MFG: NEC **$99.00**
Laser Power Supply (for HeNe tube) **$89.00**

LASER SCANNER ASSEMBLY $19.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.00**

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

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

POLYGON MOTOR UNIT & DRIVER $79.00
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

Network

Proteon ProNet-4 Model p1347 Token Ring Board $49.00
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

Pos & Bar Code

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

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

Power Supplys

SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts
73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
68 WATT Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4A
60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

Charge Coupled Devices

"The Spy In The Sky" $49.00 — **MATRIX TYPE**
Thomson 576X550 pixel CCD
400-1,100nm resolution and responsivity. **$500.00 Original cost device**

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

4096 element CCD $15.00
1024 element CCD $10.00 — **LINEAR TYPE**
2048 element CCD $10.00 • 1728 element CCD $10.00

Monitors

Non-Enclosed TTL
Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $25.00 • 7 inch Amber $25.00
9 inch Amber or Green $25.00

5" COLOR MONITOR $39.00 — 2 for $69.00
• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • *Mfr. Samtron*

9" monochrome SVGA MONITOR $79.00
Fully Enclosed – Tilt and swivel type. **Mfr: WEN**

Miscellaneous

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

IBM 370 option XT and AT emulation boards $25.00

Hacker Corner

US made Micronics 486 VLB ALL in ONE $69.00 or 2 for $129.00
motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

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

CAMERA BLOCK $99.00 or 2 for $169.00
FOR ROBOTICS AND EVERYTHING ELSE
Unit is for Hi Band 8mm CamCorders, includes 8X zoom lenses, D/D converters, built-in CCD 2/3 in, 420 thousand picture elements, complementary mosaic filters. Excellent performance. High resolution, high sensitivity, low lag, low smear, good color reproduction, no distortion, 1/60-1/10000sec variable speed digital shutters, TTL auto focus, auto white balance, one-push auto white balance, auto/manual iris and gain up switch. Can be controlled by a 4bit micro computer. Remote controlling is possible for zoom and focusing. **NOTE:** We have Composite or PAL (European Standard) Units. **MFR: SONY**

CELL SITE TRANSCEIVER $79.00 2 for $149.00
These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

POINT OF SALE BANK TERMINAL $39.00 or 2 for $69.00
• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix - Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 Crystals • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS-232 Interface (8 Pin "RJ" Connector) • NI-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCM CIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2L x 6-1/4W x 2-1/2 D • Original cost over $450.00

.6" COMPOSITE MINIATURE COLOR DISPLAY $99.00
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal.
250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

2539 W. 237th Street, Bldg. F, Torrance, CA 90505
Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
L.A. & Technical Info: **(310) 784-5488** Fax: **(310) 784-7590**
OEM INQUIRIES WELCOME

Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

Write in 47 on Reader Service Card.

PIC Emulator

PICE-6 from **$295**

- *Real-Time In-Circuit Emulator* (to 10 MHz)
- Supports PIC 16C62X, 16C6X, 16C7X, and 16C84
- Single step and run to Breakpoints
- Includes Assembler and Simulator
- **Programmer** for PIC 16C5X, 16C6X, 16C7X, 16C84, and 17C4X in DIP packages, only ***$155***

Learn 8051 *on PC !*

With our 80C552 SBC connected to your PC's printer port, learn to write the 8051 program, debug and test it on PC.

- ***8051*** core processor (**80C552**) with 8 channel 10-bit ***A/D*** and ***PWM***
- 24 more I/Os and RS-232 port
- 32K ROM and 64K RAM
- Includes Assembler, Disassembler, Simulator, plus monitor and example programs, only **$225**

ROMY-16
EPROM EMULATOR

Emulates ROM or RAM in 8- and 16-bit systems for **$195** (2716-27256) or **$245** (2716-27010). Window/menu driven interface. 15 day money-back guarantee.

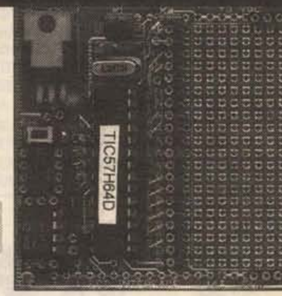
J&M Microtek, Inc.
83 Seaman Road, W Orange, NJ 07052
Tel:(201)325-1892 Fax:(201)736-4567

Write in 191 on Reader Service Card.

A Simple Solution. FBASIC TICkit™

Starting as low as $49

Run FBASIC programs without the delays and difficulty of assembly coding. Simple to use, easy to learn, complete small projects quickly with the FBASIC TICkit.™ Suitable for both beginners and experienced engineers.



Internal RAM: 48 bytes	Interactive Debugging
Max EEprom: 65535 bytes	EEprom Arrays and Structure
Signed 32bit Math	44780 LCD Module Routines
300% faster than Stamp I	9600 Baud Serial Routines
I²C Peripheral Buss	16 Multi-purpose I/O Lines

Ask us about the new – I²C X-*Tender Peripheral!*

Buffered RS232 Serial · Hardware PWM & Stepping · Real Time Clock
8 Additional I/O Lines · 5 Channel A/D · 128 Bytes SRAM

QUESTIONS? Call us at (303) 440-5590 or visit our home page at www.csn.net/versatech

To Order Call:
Phone: (303) 440-5590
fax:(303) 440-9467
bbs: (303) 440-7828
e.mail: versatech@csn.net

VersaTech Electronics
P.O. Box 18476, Boulder, CO 80308

FLOPPY DRIVE REPAIRS $1-$25. PCs, PS2, Mac, Apple II, 8". Since 1983. 6 month warranty. 1-800-458-6778. ISR, 2217 Downing Ln., Leander, TX 78641.

TANDY/RADIO SHACK Model 1/3/4,1000 Support. Monthly magazine, software, parts, repair. Computer News, POB 50127, Casper, WY 82605-0127. 307-265-6483.

ZENITH COMPUTER parts, boards, peripherals, keyboards, new and used computers. Call Les or Mike at: Surplus Trading Corp., Benton Harbor, MI. 616-849-1800.

19" RACKMOUNT PC chassis: Heavy duty, 4U, 8 slots expandable to 12, two (one hidden) 3.5"/two 5.25" drive bays, front panel fan, mini tower power supply not included, $229 with this ad! Monitor chassis $285, keyboard chassis $145. We do business COD, cashier's check only. **Computronics Technology,** 972-242-8087.

PHONELINE SIMULATOR. Authentic dial tone, busy signals, 20Hz ringing. Easily tests or demonstrates phones, modems, faxes, voice mail, etc. "Ring-It" deluxe kit $149. Includes PCB, all electronic parts, microcontroller, documentation. Custom enclosure $34.95. Fully assembled $325. Shipping $6.50. Major credit cards accepted. Digital Products Company, 134 Windstar Cir., Folsom, CA 95630. 916-985-7219, Fax 916-985-8460, E-Mail: DigProd@aol.com

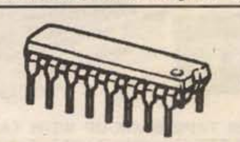
ZENITH COMPUTER PARTS SupersPort 286/386 keyboards, new, $25 each. Power supplies $40 each. Many other parts for Zenith computers. Call Surplus Trading Corp., 616-849-1800. We ship UPS COD.

ENTIRE STOREHOUSE FULL of classic Apple collectibles. II, II+, IIe, IIc, III computers, monitors, drives, cards, cables, docs, software, bunches more. Closeout at $590. Synergetics Surplus, 3860 West First Street, Box 809, Thatcher, AZ 85552. 520-428-4073. synergetics@tinaja.com VISA/MC.

CRTs CHEAP. Buy direct from the manufacturer. Save money. Mfg. all CRT types since 1950. **3 year warranty**. Reg-Res 19" tubes $75; 25" $100; hi-res 13" tubes from $80. We specialize in **hi-resolution** video/computer CRTs. **T.M.C.** 215-226-0749/215-223-0388.

WHOLESALE: TONER AND PARTS, OEM and compatibles, for copy machines and laser printers. Call **NAMETECHS:** Phone/Fax: 630-789-8393.

PUT TV IN YOUR PC: EXPRESSTV. Tuner/Video capture card! 125 channel capability. List $129.99 only $89.95 + $4.95 shipping/handling. PC handheld remote control: control your PC's multimedia functions from across the room! List $49.95 only $27.50 + $3.95 S/H. Both for only $110 & $5.95 S/H. Send check or MO or info: <fred@ptd.net> 215 Wallace Street, Stroudsburg, PA 18360.



WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 310-494-4851 OR FAX 310-494-4913.

PICSTART DEVELOPMENT system and programmer for PIC microprocessors. $50 805-987-6615.

EASY PIC'n

MICROCONTROLLER BOOK

How to get started using PIC16CXX microcontrollers

- Programming techniques
  - Program design
  - Flow charts
  - Instruction set
  - Addressing modes
  - Bit manipulation
  - Subroutines
  - Sequencing
  - Lookup tables
  - Interrupts
- Writing source code using a text editor
- Using an assembler
- Interfacing
  - Circuits
  - I/O conversion
- Timing and counting
- Using a PIC16/17 programmer
- Experiments
- Lots of examples

PIC is a trademark of Microchip Technology Inc. in USA

$29.95 + $3 mail in US VISA, MC, MO, Check
CA residents please add 7.25% CA sales tax

SQUARE 1 ELECTRONICS

P.O. Box 501, Kelseyville, CA 95451
Voice (707) 279-8881
FAX (707) 279-8883
http://www.zapcom.net/~squareone

Kable Works INC.

Zenith ST1000's
$25.00

Also available:

SA-8550 SA-8580 SA-8590
DPV-5 DPV-7 DPBB-7
Pioneers, Basics & more!

CALL 800-899-5000 TO ORDER!

Check out our new web site @ http://www.kableworks.com

All ZTACS available including 1600's - All converters are unmodified

Write in 219 on Reader Service Card.

MILLIONS IN scrap gold are about to hit the market in the form of old computer junk. I'm making a bundle recycling this material and you can join me. Call 24-hour message: 603-645-4776.

MACINTOSH SYSTEMS repairs, parts and peripherals. Low prices on new, refurb, and used Macs and peripherals and all Mac parts. Repairs of whole units or repair or exchange of parts. Mac Shack 716-377-9230, FAX 716-377-9573. Visa/MC accepted. www.vivanet.com/~macshack

COMPUTER BOOKS, parts, cables, and misc. below wholesale. Great for Computer Swap meets, hamfests, flee markets. For free catalog write: Computer News, PO Box 50127, Casper, WY 82605.

IBM 2-meg, 27-pin SIMMs $9.95 each. 640 meg full height SCSI hard drives (new) $99 each. 80 meg half height SCSI hard drives (Quantum) $39.95 each. UltaStor 34F VLB SCSI controller card and software $49.95 each. AlMet Recycle & Surplus 904-673-1281.

SEALED BID AUCTION every Tuesday. 100+ lots. Minimum bid $26 for computers, parts, furniture, industrial items. Dealers welcome. Open to the public. Consignments accepted. WeirdStuff Warehouse, 384 W. Caribbean Dr., Sunnyvale. Andy 408-743-5650 X325. andy@weirdstuff.com

BUYING & Selling IBM computer parts. Repairing most IBM compatibles, C-64, Timex, and other classic machines. SASE for info. Computer Classics, RT-1, Box 117, Cabool, MO 65689. 417-469-4571. FAX 417-467-4571.

MONITORS REPAIRED. "Computer Vision" has flat fee repair of monitors; 14", $70; 17", $90. E-Mail to phillip833@aol.com

TRS-80 MODELS 1, 3, 4, 100 Pocket Computer, COCO. Hardware, software, repair/replacement parts, accessories. #10 SASE for list. Pete Bumgardner, 100-D W. Falls St., Kings Mountain, NC 28086. 704-730-0893.

KROHN-HITE #310CR band-pass filter $50. Allison Labs variable HC & LC filter #2B $50 (have 2). Spencer-Kennedy variable electronic filter #302 $50. Allison Labs dual low pass/high pass band reject filter #210 $50. Help with shipping. 810-989-4600.

SONY/AMIGA MULTISCANS 15", 0.26DP 15.7 thru 36KHz CGA thru SVGA (1024 x 768 I). $175. Generic VGA color monitors from $125. Expert Sony repair, parts available. **Dealer discounts.** Refurbished guaranteed. Pikul & Assoc., 101 Glenfield Dr., Festus, MO 63028. 314-937-0335.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 513-847-2300 OR fax 513-847-2350.

PLOTTERS: HP 7580B drafting plotter (sizes A-D) $1,300. **HP 7586B** (sizes A-E) $1,850. **HP 7595A** DraftMaster I (sizes A-E) $2,000. **HP 7475A** $220. **HP 7550A** $350. Excellent condition, warranty. Pepper Systems, 214-353-0257 (FAX 214-902-9511).

12VDC TO 110VAC power inverters. OK for use with computers, TV, VCR. From 50W @ $29 to 1500W @ $440. Call 1-888-282-3593.

PENTIUM 133 computers, Intel chipset, PCI motherboard, 16MB RAM, 1.3GB hard drive, 12x ROM, sound, SVGA display. $1,350. Phone 1-888-282-3593.

SIEMENS PRINTER 40. New, versatile, heavy duty daisywheel impact printers. $1,700 value. $59. Scott's Electronic Surplus. 562-491-3181. FAX: 562-491-3182.

PC INTERFACE IC: EDE300 provides convenient PC interfacing. Ideal for data logging and device control. Download our data sheet or call E-Lab Digital Engineering, Inc. 712-944-5344. Visa/MC. http://www.netins.net/showcase/elab

AST/AT&T Pentium systems from $550, IBM P120+ multimedia computer systems from $650. 386 systems $225, 486 notebooks, laser printers 8 ppm $325, CD-ROMs $30. Sound cards $15, SCSI adapters PCI Adaptec 2940 compatible $39. Call CCI 714-778-0450.

ZENITH LAPTOP BATTERIES. Mastersport ZA-4-1 "NEW" $50. Supersport 2.5 amp-hour for ZWL 184 "NEW" $30. Surplus Trading Corp., Benton Harbor, MI. 616-849-1800.

APPLE MAC systems IIsi and MAC Plus complete with color monitor $200-$275. 6809-68hc11 SBC with software $25-$65. Motorola 68020-68030 bds. VME SUN $25-$75. 860-267-8763.

MONITOR SPECIAL: VGA $110, EGA $65, CGA $55. 90 days guaranteed. Call TFD Services 714-542-1037.

COMPUTER SOFTWARE

I WANT it and I want it now. I want all of your SIMM memory. IBM, Mac, new, used, even defective. I want it all. Highest $ paid. Now selling memory. We can beat any printed price in Nuts & Volts. Call 1-800-4-MEMORY now! Voice/FAX.

LINUX! LINUX! LINUX! If you aren't purchasing your Linux products from us, you are paying too much! We offer the major distributions (Yggdrasil, Slackware, Red Hat, etc) at **great prices!** We also carry a full range of books. Contact us at **www.cheapbytes.com** and use our secured web server. E-Mail: sales@cheapbytes.com Fax: 209-367-8518. Cheap*Bytes, PO Box 2714, Lodi, CA 95241.

18,000 + TECHNICAL REPAIRS for **TVs, VCRs, PROJECTION TVs, CAMCORDERs, AUDIO** on disk. Installs on your hard drive. Easy look-up by model/chassis number. **FREE DEMO. HIGHER INTELLIGENCE SOFTWARE, 60 FARMINGTON LANE, MELVILLE, NY 11747. 1-800-215-5081/516-643-7740.**

ENGINEERING SHAREWARE. Printed circuit design, logic simulation, pspice, Autocad shareware. Over 700 engineering programs. Free catalog. CD-ROM available. Sector Systems Company, 416 Ocean Avenue, Marblehead, MA 01945. 617-639-2625.

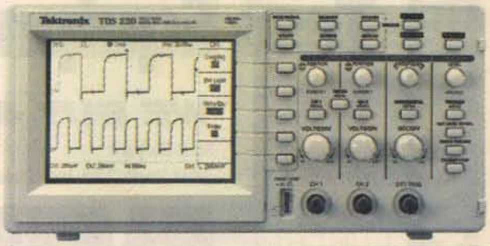
SHAREWARE CATALOG. Over 3,000 programs, free game on every catalog disk. Great prices, bonuses, free disks. Data Mate, Box 2811, Ronkonkoma, NY 11779.

Write in 179 on Reader Service Card.

NOW YOU CAN OWN A NEW STATE-OF-THE-ART OSCILLOSCOPE!

TEKTRONIX TDS 210 AND TDS 220 DIGITAL REAL-TIME OSCILLOSCOPES

Digital Real-Time



IS THIS THE GREATEST BREAK-THROUGH IN INSTRUMENTS EVER?

(ISN'T IT TIME TO RETIRE YOUR ANALOG SCOPE?)

Most electronic enthusiasts have only dreamed of owning the latest high-performance test equipment for personal use. However, high-performance equipment has always been very expensive. As a result, many have been forced to struggle with older, inadequate equipment obtained at flea markets & surplus sales. The revolutionary new Tektronix TDS 210 & TDS 220 digital real-time oscilloscopes have changed all that! For the first time, enthusiasts can afford a state-of-the-art instrument. A price versus performance comparison shows no other oscilloscope compares with the TDS Series digital scopes. In fact, you can buy the TEK TDS 200 series for less than the cost of many ham radios or home computers. These new units are just as easy to operate as your older analog scope. You be the judge…read the discussion points below & see if you don't agree that these units will expand the oscilloscope market to many thousands of new users.
If you're still not convinced after reading the information below, please call for our free 8 page brochure on the TEK TDS 200 Series scopes. This may be the most significant instrument development in decades. **PURCHASE NOW AND RECEIVE A VALUABLE ACCESSORY ITEM FOR FREE!**

VERY AFFORDABLE

Digital scopes used to be very expensive. The Tektronix TDS 210 & 220 are priced at half the cost of most entry-level digital scopes. The Tektronix TDS 220 sells for $1695 and is competitive with most 100 MHz analog scopes. The TDS 210 sells for $995 and is competitive with most analog scopes of any type, and the maintenance cost of both is expected to be significantly less than an analog scope. Both units come complete with 2 probes and carry a full three year warranty from Tektronix.
YOU CAN AFFORD ONE TODAY! We have a variety of payment methods available to make owning one of the TEK TDS 200 Series a reality for you. Also, for a limited time, you will receive a valuable accessory item **FREE** with each instrument. HURRY, CALL TODAY.

EASY TO OPERATE

Users of digital scopes have complained that they are difficult to use. This has been particularly true in manufacturing & educational environments where an analog scope is generally adequate. Tektronix has addressed this problem by providing analog-like controls & operating modes. Many of the panel controls are similar to analog controls. Routine functions like gain, sweep speed, vertical/horizontal positioning, and other functions are as accessible as analog controls. Automated digital functions are controlled by a simplified menu system on the display screen. Menus are user selectable in 10 languages. The TDS 200 series screen is a bright, high-contrast, backlit, liquid crystal display (LCD) with a wide viewing angle. The LCD maintains full contrast at all sweep speeds & modes, so any signal that triggers the scope will be clearly visible.

Authorized **Tektronix** Distributor

FRONT PANEL CONTROLS

The TDS 200 Series front-panel controls are scaled and designed similar to a classic analog scope. Familiar front-panel controls like vertical scaling, trigger level, cursors, and trace positioning are all accessed with conventional knobs. The analog user will find these controls to be responsive and linear, just like those on analog instruments. Digital features like automatic waveform measurements and waveform storage reside within a flat menu structure that is easy to reach and easy to understand. Most features are activated by a single button-push.

THE TDS 200 SERIES DISPLAY IS EASIER TO READ

The TDS 200 Series display is a bright, backlit LCD screen(11.5 cm x 8.6 cm size) with a wide viewing angle. Its clarity matches any analog scope, and thanks to DRT (Digital Real-Time, see paragraph below) acquisition, it does not rely on vague waveform "shadows" to convey the signal details. DRT oversampling (10X on TDS 220, 16X on TDS 210) captures fast edges, transients, & ordinary repetitive waveforms equally well. Unlike earlier LCDs, the TDS 200 Series display has a wide viewing angle that enhances off-axis legibility. Life expectancy & reliability are much better than traditional CRT displays. LCDs employ newly developed technologies that have been proven to maintain usable contrast longer than CRTs. Because LCDs do not rely on critically-aligned beam-positioning elements, they are more impact-resistant & more durable than CRTs.

DIGITAL REAL-TIME TECHNOLOGY

The TDS 200 Series oscilloscopes rely on Tektronix's proven Digital Real-Time oversampling technology to provide extraordinary waveform quality, update rate, & stability. Both scopes sample at 1 GS/s (at least 10 times their bandwidth). You can capture signal details that are invisible on analog scopes. DRT samples fast enough to reconstruct high-speed edges & transients with unmatched clarity. Call for our 8 page brochure which explains in detail the difference between DRT & other sampling architectures such as Equivalent-Time(ET) sampling. Each channel in a TDS 200 Series scope is supported by a separate DRT acquisition system. DRT scopes deliver a clear, easily understood display, minimizing the distortion & aliasing common to conventional undersampled digital storage oscilloscopes.

SMALL & LIGHTWEIGHT

The TDS 200 Series oscilloscopes weigh only 3.25 lbs. and measure only 12" x 5.95" x 4.74". This is approximately ONE-FOURTH the size of most benchtop scopes. They fit well on congested benches & are easily relocated. They should function well in field-service applications, eliminating the need for an expensive portable oscilloscope.

Free with TDS 220 Purchase

P5100 High-Voltage Passive Probe (a $199 value)! You Get Both for ***only $1695.***
Offer Valid for a Limited Time Only - Call Today for a Price Quote on Quantity Purchases and Accessory Packages!

Features	TDS 210	TDS 220
Bandwidth	60 MHz	100 MHz
Channels	2	2
Max Sample Rate	1 GS/s on ea. channel	1 GS/s on ea. channel
Sweep Speeds	5 ns/div to 5 s/div	5 ns/div to 5 s/div
Vertical Sensitivity	10 mV/div to 5 V/div at full bandwidth; 2 mV/div to 5 mV/div at 20 MHz	10 mV/div to 5 V/div at full bandwidth; 2 mV/div to 5 mV/div at 20 MHz
Record Length	2500 points/channel	2500 points/channel
Price	$995	$1695

Includes 2 P6112 passive probes; user manual, power cord, NIST-traceable certificate of traceable calibration

IDEAL FOR MANUFACTURING, QC, EDUCATION, SERVICE APPLICATIONS

The TDS 210 & 220 provide five pre-programmed automatic measurements that allow users to quantify waveforms quickly by measuring period, frequency, cycle RMS, mean, & peak-to-peak. Users can complete routine measurements automatically, in less time. The TDS 200 Series scopes include five automatic setups (similar to autoranging on a dvm), two stored reference waveforms, & stored panel setups (setups are not lost even if power is turned off).
••Educators can use the low-cost TDS 200 Series oscilloscopes to easily train students on digital instruments similar to those they will encounter in industry.
••Service & Repair Shops will find troubleshooting easier when DRT exposes signal details that otherwise may remain unseen.

MEASUREMENT ATTRIBUTES UNIQUE TO DIGITAL TOOLS:

- "Freeze"(stop) the signal
- Store/recall the waveforms
- Make automatic measurements
- Make hardcopy records (no need for scope camera & film)
- Capture one-time transient events
- View pre-trigger waveform details
- Use automatic setups
- View flicker-free waveform display

TDS 200 SERIES ACCESSORIES

We recommend these accessories to fully utilize these scopes.

AC220 Soft-Side Carrying Case........................$65
TDS2CM RS-232, GPIB, & Centronic Printer Interface..............................$250
TDS2HM Centronics Compatible Printer Interface...........................$150
P6112 100 MHz Replacement Probe...............$75

Free with TDS 210 Purchase

DMM150 Digital Multimeter (a $69 value)! You Get Both for ***only $995.***
Offer Valid for a Limited Time Only - Call Today for a Price Quote on Quantity Purchases and Accessory Packages!

All Of These Units Are Sold With A Full 3 Year Warranty From Tektronix.

TUCKER ELECTRONICS

800.527.4642
214.348.8800 • Fax 214.348.0367
1717 Reserve Street, Garland, TX 75042 or
P.O. Box 551419, Dallas, TX 75355-1419
www.tucker.com

Payment Options

Business Financing Available or Pay with MasterCard, VISA, American Express & Discover, Net 30 Days (on approved commercial accounts) & in special circumstances, COD.

FedEx. Federal Express Shipping Available

Write in 167 on Reader Service Card.

COMPUTER SOFTWARE *cont.*

FREE DISK CATALOG and discount coupon! Inexpensive, quality, IBM shareware and CD-ROMs. <ASP> vendor: **MOM 'N' POP'S SOFTWARE**, PO Box 15003-N, Springhill, FL 34609-0111. 352-688-9108.

IBM SHAREWARE, free catalog, $1 disk, 35¢ specials, huge selection, 100% virus free. PMA, Box 2424, Scottsdale, AZ 85252. 602-496-6547. Specify disk size.

THE RELIABLE bulletin board service, software for all needs. Call 718 area code USA: 987-1932, 987-2913, 987-1617, 987-1660.

FREE HACKING/phreaking/trubbleware diskette catalogue. Incredible subject matter. No commercial programming and NO SHAREWARE here! Peregrine Dynamics, 720 Portage Trail, Cuyahoga Falls, OH 44221.

COMPUTER EQUIPMENT WANTED

I WANT it and I want it now. I want all of your SIMM memory. IBM, Mac, new, used, even defective. I want it all. Highest $ paid. Now selling memory. We can beat any printed price in Nuts & Volts. Call 1-800-4-MEMORY now! Voice/FAX.

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

WANTED: TERMINALS + PRINTERS: DEC, Wyse, IBM, ADDS, Okidata, Data South, Epson, C.ITOH, etc. Call for quote on any surplus computer equipment. Call Jeremy, 603-673-8077.

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-231-6478/540-763-2321).

HP CALCULATORS wanted: models 10, 70, 81, 97S, and calculator watch for private collection. Bob Morrow, 317-855-2348, rkmorrow@aol.com

WANTED: COMMODORE 512K expanders, 1351 mice, Snapshot V.5. Amiga 1200, 2000, & 4000 computers. Low prices needed. Must work. 801-466-8084.

WANTED: EPSON FX-100 PRINTER. 1-800-804-8655.

WANTED: PRE1980 Microcomputers for museum collection. Microcomputer magazines and manuals also needed. 703-231-6478, 703-763-3311.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 513-847-2300 OR fax 513-847-2350.

TEST EQUIPMENT

TEK 501-1 POWER SUPPLY $90. **TEK PG502** 250MHz pulse generator $190, **TEK DM501** 4.5 digit DMM $85. All with 30-day warranty. For more great deals on refurbished test equipment visit our Web site at http://www.odulo.com/corp/equiptek or call 415-244-9438.

SURPLUS TEST EQUIPMENT

HEWLETT PACKARD

11664C, Detector	$150
11683A, Range Calibrator	$700
182T/8755C, Swept Amplitude Analyzer	$850
214A, Pulse Generator, 0.08V to 100V	$200
3200B, VHF Oscillator	$300
3310A, Function Generator	$250
3310B, Function Generator, .0001Hz-5MHz	$250
3311A, Function Generator, .01Hz-1MHz	$225
334A, Distortion Analyzer	$250
339A, Distortion Analyzer	$1750
3437A, Voltmeter	$200
3455A, Digital Voltmeter	$400
3456A, Digital Multimeter, 6.5 Digits	$800
35677A, S-Parameter Test Set	$2700
3575A, Phase Gain Meter 1Hz-13MHz	$1000
3581A, Wave Analyzer	$500
3581C, Selective Voltmeter	$800
4084B, Switching Matrix Controller	$3000
4141B, DC Source Monitor	$10,000
4192A, LF Impedance Analyzer	$11,500
4262A, LCR Meter	$1750
4342A, Q-Meter, Opt. 001, 10KHz-32MHz	$1750
435B, Power Meter	$600
436A, Power Meter w/HP-IB Interface	$1300
44428B, Output Actuator Assembly (New)	$250
4800A, Vector Impedance Meter	$800
4945A, Transmission Impairment Measurement Set	$3000
5314A, Frequency Counter, 10Hz-100MHz	$200
5328B, Universal Counter	$1250
5334B, Universal Counter	$1650
5335A, Frequency Counter, opt. 10/20	$1200
5340A, Frequency Counter, 10Hz-18GHz	$800
5342A, Frequency Counter, Opt. 001/002	$2500
5342A, Frequency Counter, Opt. 001/002/011	$2800
5345A, Universal Counter	$750
5354A, Frequency Converter	$800
5355A, Frequency Converter	$1000
5356A, Converter Head	$950
5359A, Time Synthesizer	$1200
5370A, Universal Time Interval Counter	$1500
54201A, Digitizing Oscilloscope, 300MHz	$3000
54201D, Digitizing Oscilloscope	$3500
6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A	$800
6011A, DC Power Supply 0-20V, 0-0.120A	$1250
6033A, DC Power Supply, 0-20V, 0-30A	$1700
6034A, DC Power Supply, 0-60V, 0-10A	$1650
6038A, DC Power Supply, 0-60V, 0-10A	$1850
6177C, DC Current source	$700
6186C, DC Power Source, 0-300V, 0.100 MA	$850
6227B, Dual Power Supply, 0-25V/0-2A	$600
6291A, DC Power Supply, 0-40V, 0-5A	$650
7090A, Graphics Plotter	$2500
740B, DC Standard Voltmeter	$450
8007B, Pulse Generator, 100MHz	$550
8012B, Pulse Generator	$750
8013B, Pulse Generator	$750
8350B, Sweep Oscillator Mainframe	$4750
83545A, Oscillator Plug-in, 5.9-12.4GHz	$2500
8410B, Network Analyzer System w/8412A, 8743A & 8411A	$600
8411A/018, Frequency Converter .11 to 18GHz	$500
8445B, Automatic Preselector	$450
8447A, Amplifier, 0.1-400MHz	$300
85020A, Bridge, 10MHz-4.3GHz	$500
85031B, 7MM Calibration Kit (New)	$500
85050B, 7MM Calibration Kit	$1750
85051A, 7MM Verification Kit	$650
85051B, 7MM Verification Kit	$1500
8505A, Network Analyzer	$2500
8552B, IF Section Plug-in	$500
8552B & 8553B, Spectrum Analyzer w/141T Mainframe	$1200
8552B & 8555A, Spectrum Analyzer w/141T Mainframe	$1450
8557A/182T, Spectrum Analyzer .01-350MHz	$1300
8558B, Spectrum Analyzer, 100KHz-1500MHz, w/182T	$2200
8565A, 10MHz-22GHz Spectrum Analyzer	$4000
8569A, Spectrum Analyzer, .01-22GHz	$6500
8569B, Spectrum Analyzer, .01-22GHz	$7500
86290A, RF Plug-in, 2-18GHz	$1500
8640B, Signal Generator, Opt. 002, .5-1024MHz	$2100
8640B, Signal Generator, Opt. 1, 2	$2200
8654A, Signal Generator, 10-520MHz	$600
8660C/100, Synth. Signal Generator	$1350
86601A, RF Plug-in, .01MHz-110MHz	$350
86602B, RF Plug-in, 1-1300MHz	$650
86603A, RF Plug-in, 1-2600MHz	$1500
8660C Opt. 100, Signal Generator, 1-1300MHz w/86602B RF Plug-in & 86632A Mod. Plug-in	$3000
8672A, Synthesized Signal Generator, 2-18GHz	$10,500
8711A, Network Analyzer, Opt. 1E1,1C2	$6500
8745A, S-Parameter Test Set, 100MHz-2.0GHz	$700
8754A, Network Analyzer System w/8748A & 8750A	$4500
8756A, Network Analyzer	$2500
8901B, Modulation Analyzer	$9000

TEKTRONIX

2236, 100MHz Oscilloscope w/Counter/Timer/DMM	$1550
2337, 100MHz Oscilloscope w/DMM	$1650
2440M, 300MHz Digitizing Oscilloscope	$7500
2445B, 150MHz Four Channel Oscilloscope	$4500
475, 200MHz Oscilloscope	$650
475A, 250MHz Oscilloscope	$800
485, Oscilloscope, 350MHz	$900
492, Spectrum Analyzer, 50KHz-21GHz, Opt. 02/03	$5000
494AP, Programmable Spectrum Analyzer, 10KHz-21GHz	$18,500
577/D1, Curve Tracer w/Storage	$1850
577/D2, Curve Tracer w/177 Fixture	$1700
7104, 1GHz Mainframe W/(2) 7A29, 7B10, 7B15	$3000
7A42, Four Channel Amplifier Plug-in	$650
7B92A, Delaying Dual Time Base to 500MHz	$250
7D20, Programmable Digitizer	$500
7L12, Spectrum Analyzer, 100KHz-1.8GHz	$1800
7L14, Spectrum Analyzer, 1KHz-2.5GHz	$3000
7L18, Spectrum Analyzer Plug-in, 1.5-18GHz Capable of 60GHz with Mixers	$2500
AF501, Band Pass Filter Plug-in	$300
AM503, Current Probe Amplifier	$450
DC5009, Counter Plug-in	$575
FG502, 11MHz Function Generator	$300
FG504, Function Generator Plug-in, .001Hz-40MHz	$850
FG507, 2MHz Function Generator	$975
I241, Color Logic Analyzer w/(4) 1240D1 Cards	$1250
OF150, Fiber Optic Cable Tester	$2000
PG501, Pulse Generator	$275
PG508, Pulse Generator Plug-in, 50MHz	$600
PS5010, Programmable Triple Power Supply Plug-in	$700
PS503A, Tracking Power Supply Plug-in	$175
RTD710, Digitizer	$2500
SG505, Precision Audio Oscillator Plug-in	$450
TR503, Tracking Generator for 492/4/5/6	$850

MISCELLANEOUS

Boonton 102F, AM/FM Signal Generator, DC-1040MHz	$2000
EIP 548A, Microwave Frequency Counter	$3200
Fluke 332D, Voltage Standard	$650
Fluke 335D, DC Voltage Standard	$1000
Fluke 5100B/03/05, Multifunction Calibrator	$6000
Fluke 5100B/05, Multifunction Calibrator	$5000
Fluke 5101B/03, Calibrator	$6000
Fluke 5200A, AC Voltage Calibrator	$2000
Fluke 5200A/5215A, AC Voltage Calibrator w/Power Amp	$3850
Fluke 5440B, Precision DC Voltage Calibrator	$5500
Fluke 5450A, Resistance Calibrator (New)	$2000
Fluke 6160B, Synthesizer, Opt. 09	$1000
Fluke 7220, Frequency Counter, 10Hz-1300MHz	$350
Fluke 845AB, Null Detector	$800
Fluke 8502A, Digital Multimeter	$300
Fluke 8505A, 6.5 Digit Digital Multimeter	$400
Gigatronics 605, Signal Generator, 6-18GHz	$3000
Hughes, Amplifier 18-26.5GHz, 1 Watt	$2500
Keithley 195A, System DMM w/Temp.	$700
Krohn-Hite 3100R, Tunable Filter	$150
Krohn-Hite 3103/R3103, Tunable Filter/ Rack Version	$275/$225
Krohn-Hite 3202/R3202, Tunable Filter/ Rack Version	$500/$350
Krohn-Hite 3342, Tunable Filter	$1000
Phillips PM5715/11, 50MHz Pulse Generator (New)	$1500
Pwr. Designs 4050D, DC Power Supply, 0-40V/0-5A	$400
Sorensen QRD 40-2, Power Supply, 40V-2A	$150
TTC T-BERD 209, T Carrier Analyzer	$2000
Wan. & Golt DA30, Protocol Analyzer	$5000
Wavetek 166, Pulse Function Generator	$1000
Wavetek 178, Automatic Synthesizer	$1850
Wavetek 186, Phase Lock Generator, 5MHz	$400
Wavetek 2002, Signal Generator, 1-2500MHz	$1750
Wavetek 2002A, Signal Generator, 1-2500MHz	$1500
Wavetek 3000, Signal Generator, 1-520MHz	$900
Wavetek 3000-200, Signal Generator	$900
Wavetek 3001, Signal Generator 1-520MHz	$1000
Wavetek 801, Pulse Generator, 5Hz-50MHz	$800
Wavetek 802, Pulse Generator, 5Hz-50MHz w/Delay	$600
Wavetek 907A, Signal Generator, 7-12.4GHz	$850
Wayne/Kerr 3220, 20A Bias Unit	$2000
Wiltron 560A, Scalar Network Analyzer	$1000
Valhalla 2701C/TL-3, Programmable Direct Voltage/Current Standard	$1450
Valhalla 2705, AC Voltage Standard	$3000

VISIT OUR INTERNET SITE AT:
http://home.earthlink.net/~rssurplus/rssurplus.html

R & S Surplus
MasterCard
1050 E. CYPRESS STREET, COVINA, CA 91724
VISA

(818) 967-0846 · FAX (818) 967-1999

10TH ANNIVERSARY SALE! HP 3488A switch/control unit $925. **HP 59306A** relay actuator (6-SPDT, HP-IB and lighted push-button) $260. **HP 59307A** dual VHF switch (2-SP4T, HP-IB and lighted pushbutton) $230. **HP 59401A** HP-IB bus analyzer $350. **Stanford Research SR 510** lock-in amplifier $1,750. **HP 4274A** LCR meter (5-1/2 digit, 100Hz-100KHz) $3,800. **HP 3314A** .001Hz-20MHz function generator, lin/log sweep, etc. $2,800. **HP 8015A** 50MHz pulse generator $375. **HP 8016A** ECL/TTL word generator $295. **HP 8161A/020** 100MHz programmable precision dual channel pulse generator $3,300. **HP 8175A/002, 005** 50MHz digital/analog signal generator: TTL/CMOS pods, dual arbitrary waveform channels $3,300. **HP 5334A** 100MHz auto rise/fall time, etc. counter $850. **HP 5345A** 500MHz counter with HP-IB $725. **HP 5370A** 100MHz time interval counter (oven time base) $1,600. **Fluke 720A, 721A, 750A, 845AR** DC voltage calibration system components $2,500. **Fluke 540B** transfer standard $800. **HP 7580B** drafting plotter (sizes A-D) $1,300. **HP 7586B** (sizes A-E) $1,850. **HP 7595A** DraftMaster I (sizes A-E) $2,000. **HP 7475A** $220. **HP 7090A** measuring plotter $2,100. Excellent condition! All with warranty. Pepper Systems, 214-353-0257.

LOGIC ANALYZERS: Fluke 9010 $490 (includes docs and fancy case), pods $90; Tek 1230 $590, pods $145; Global Specialties LTC-2 $79. Synergetics Surplus, 3860 West First Street, Box 809, Thatcher, AZ 85552. 520-428-4073. synergetics@tinaja.com VISA/MC.

FLUKE 5200A AC voltage standard $1,000; Fluke 5215A power amplifier $800; Fluke 332D DC voltage standard $200; HP 432B digital power meter $150; Eaton 2075-2A noise-gain analyzer $2,000; Fluke 1953A counter/timer $150; HP 435A power meter $150; HP 654A test oscillator $175; HP 3490A voltmeter $125; HP 1715A 200MHz oscilloscope $350; HP 1720A 275MHz; oscilloscope $400. Credit cards accepted. Jim Stevenson, Phone: 908-722-6157, Fax: 908-722-6391. http://www.stevensonlabs.com

OSCILLOSCOPE SALE: Tektronix 485 (350MHz) $850; Tektronix 475 (200MHz) $595; Tektronix 454A (150MHz) $375; Tektronix 453 or 453A (60MHz) $275; Tektronix 466/DM44 $675; Tektronix 7704A (200MHz) $250; Tektronix SC501 $125; Tektronix 475/DM44 (200MHz) $695; Tektronix 434 (25MHz storage) $375; Phillips 3302 $175; Ballantine 1042A $250; Ballantine 1066B (15MHz) $175; HP 1725A (275MHz) $425; HP 1740A (100MHz) $250; Kikusui C056100M (100MHz) $275; Hitachi V1060 $475. All equipment comes with probes and manual. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

SCOPES & PLUGS TEK 221 handheld 5MHz **3.5 pound** scope $575 complete; 2235 w/manual, probe $750, 2236 $900, all with warranty. **7904 frame $350**; 7633 or R7633 as new 100MHz storage mainframe $275; FULL SYSTEM DISCOUNT CALL; 7603 7A26, 7B53A $365: **7704A** 7A26, 7B53A, 7B80 **$475**; 7A13 $135; 7A16A $50; 7A16P $75; 7A18 $50; 7A19 $100; 7A24 $150; **7A26** $53; 7B10 $175; 7B50 $65; 7B53A $85; 7B80 $85; 7B85 $80; 7B92A $125; 7D12 $100; 7D13 $100; 7D15 $250; 7M13 $100; DC-503 $125; DC-505 $175; DC-509 $375; PG-501 $200; PG-502 $300; PG-508 with manual $500; 7S11 $175; 7S12 sampler plug-in $275. **Heads** S-3 $100; S-3A w/manual $125; **TM-5006** frame $300; PG-501 $200; PG-508 with manual $500; SC-502 15MHz dual trace scope $350; SC-503 10MHz storage $450. Other TM call **Psitech Plus** 707-745-4804. Request bi-monthly fax listings, Fax 707-747-5277.

GENERATOR/OSCILLATOR SALE: Wavetek 145 $275; Wavetek 270 $400; Tektronix 2901 $150; Data pulse 101 $50; Ballantine 6130A $75; Ballantine 6310A $175; HP 212A $75; HP 226 $100; KAY 5070B $175; HP 4204A, HP 8640/001/003 $850; HP 8640B/323 $450; HP 214A $175. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

MO-TECH DISTRIBUTORS

YOUR MIDWEST PANASONIC CONVERTER WHOLESALER

PANASONIC

	10 PC	20 PC	50 PC
TZPC1453G2	$63-	$61-	$59-

"Top of the line converter" featuring sleep timer, parental lock, standard/HRC switchable, last channel recall, favorite channel memory, and 83 channel capable.

	10 PC	20 PC	50 PC
TZPC1003	$49-	$44-	$42-

One of our best selling converters featuring sleep timer, parental lock, last channel recall, favorite channel memory, and 80 channel capability.

	10 PC	20 PC	50 PC
TZPC175DG2	$89-	$85-	$82-

Our "Top of the line" converter with volume control. Featuring sleep timer standard/HRC switchable, parental lock, last channel recall, favorite channel memory, and 83 channel capable.

PHONE (810) 566-7262
FAX (810) 566-7253

Stamp Applications: Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

by Scott Edwards

The Electronics Q & A column here in *Nuts & Volts* is an amazing resource. Q & A editor TJ Byers will go to any length to find the answers to his reader's questions. Recently, he came to me.

A reader had come into possession of a real stoplight, and wanted to know how to build a circuit that would realistically sequence the red, yellow, and green lights. TJ half kiddingly suggested a player-piano arrangement of motors, cams, and switches, and referred the question to me for a Stampified solution.

So, this month, we'll learn how to sequence a traffic light, with special emphasis on storing and retrieving data with Lookup tables. We'll also have a peek at new Stamp peripherals that store data, keep time, and control motors.

Stamp Gives the Green Light To Efficient Programming

A model traffic signal and some neat Stamp peripherals

Playing Traffic Cop

It hardly seems necessary to discuss what a traffic signal does, since we spend way too much of our time looking at examples — usually lit up red in our direction for an interminable time.

But it's my habit to describe a problem by making sketches and jotting notes and calculations before I set out to write a program. In this case, I drew a pair of traffic signals at a hypothetical intersection. One light would control a north-south street, the other east-west.

I identified six states for the lights in a normal traffic sequence, as shown in Figure 1. For the sake of simplicity, I decided that this intersection would be the timer-controlled variety, not demand-controlled by the presence or absence of traffic. After all, the reader probably wants his light to sequence continuously, without the need for somebody to pull up in a Chevy.

The lights remain in each of the six states for varying amounts of time, ranging from less than a second for both-red, through two seconds for yellow, to eight seconds for red/green. I picked the times arbitrarily. I made a note to make sure that the program allowed any timing parameter to be changed easily.

Figure 2 shows how I rigged a simulated stoplight with red, yellow, and green LEDs. Note that you may have to fiddle with the series resistor values in order to get more-or-less equal brightness from the three different colors of LEDs. Each color of LED has a different forward voltage and efficiency.

Equipped with my two models — a mental model of stoplight operation and a physical model of the lights themselves — I was ready to program.

Looking at my sketch (Figure 1), I determined that the job boiled down to retrieving two pieces of information from a lookup table; the patterns of the six lights and the length of time they should remain in that pattern. PBASIC includes a Lookup instruction that allows you to fetch data from a table based on its position or index. An obvious approach would be to prepare two lookup tables: one with bit patterns and the other with times.

However, I wanted to illustrate a couple of PBASIC capabilities that many users forget: **(1)** Lookup-table entries can be up to 16 bits long; and **(2)** The stamp2 host program can perform compile-time math that can make a program more readable without taking up additional program memory.

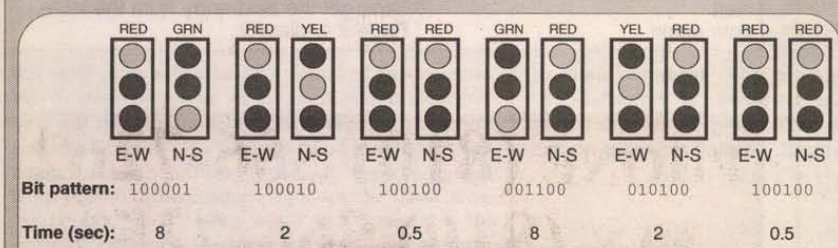


Figure 1. Stoplight sequence.

Listings 1 and 2 are the result. The programs are thoroughly commented, so I won't repeat that stuff here. Suffice it to say that these are very compact programs with plenty of room left over for your customization.

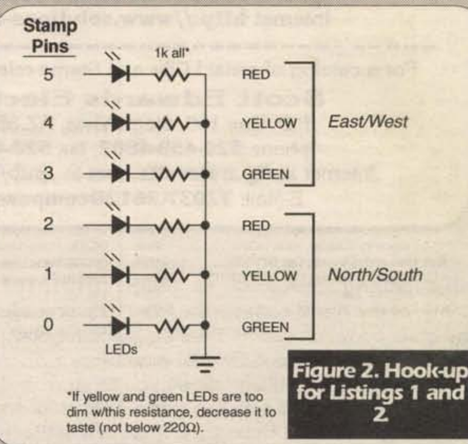


Figure 2. Hook-up for Listings 1 and 2

New Stamp Peripherals

Solutions Cubed, a California electronic-design firm that does new-product development, has rolled out four new modules designed to work well with the Stamps. They recently sent me samples of their four Mini-Mod (miniature engineering module) products for evaluation. Figure 3 is a family portrait. Three of the modules are serially-interfaced peripherals that serve mass storage, timekeeping, and motor-control functions. The fourth is a smart power supply that derives regulated 5V from a pair of AA batteries. Prices range from $25.00 to $30.00.

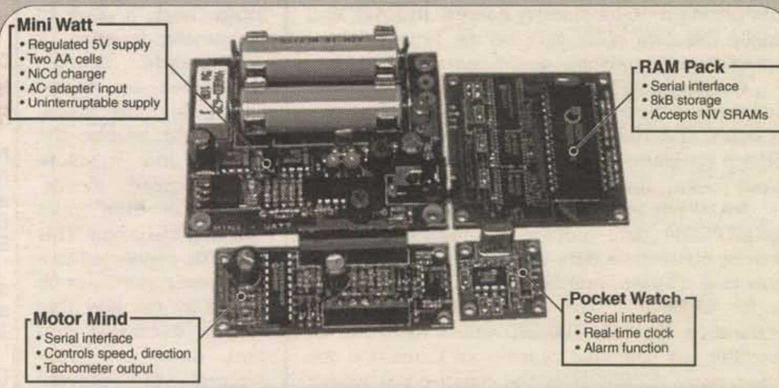


Figure 3. Mini-Mods family of Stamp-friendly peripherals.

The RAMPack and Pocket Watch serial peripherals have a neat feature — they automatically sync to the baud rate (1200, 2400, 4800, or 9600) of incoming serial data. They

Sources

For more information on the BASIC Stamp, contact:

Parallax, Inc.
3805 Atherton Road, #102, Rocklin, CA 95765
phone **(916) 624-8333**
Internet **http://www.parallaxinc.com**

For Mini-Mods mentioned in this article or custom design work, contact

Solutions Cubed
3029-F Esplanade, Chico, CA 95926
phone **916-891-8045**; fax **916-891-1643**
Internet **http://www.solutions-cubed.com**

For a catalog of serial LCDs and Stamp-related products, contact:

Scott Edwards Electronics
P.O. Box 160, Sierra Vista, AZ 85636-0160
phone **520-459-4802**; fax **520-459-0623**
Internet at **ftp.nutsvolts.com** in **/pub/nutsvolts/scott**
E-Mail: **72037.2612@compuserve.com**

Listing 2. Stoplight control for BS2

```
' Program: STOPLITE.BS2 (Sequence a stoplight from a lookup table.)
' This program generates proper green-yellow-red sequencing for a
' pair of traffic signals controlling an intersection. I refer
' to one street as "EW" (east-west) and the other as "NS" (north-
' south). Pins are connected to LEDs as follows:
'          P5  EW/red        P2   NS/red
'          P4  EW/yellow     P1   NS/yellow
'          P3  EW/green      P0   NS/green

' ====Constants===
' The program uses six 16-bit constants to represent the states
' of the lights (lower 6 bits) and the length of time to leave
' the lights in those states (upper 10 bits). Here's how the
' constants are organized:
'      Duration (ms)      Pattern of lights
'                  \        /
'        |=========|=====|
' The BS2 host software permits compile-time math (math done on
' the PC before downloading to the Stamp), which we'll use to
' combine two sets of constants — one representing light patterns
' and another times. This allows you to change the timing of
' the lights (or the bit patterns, if you wired the lights
' differently) without worrying about how the bits are packed
' into their 16-bit packages.

NSgrn       con %00100001    ' Make NS green, EW red.
NSyel       con %00100010    ' Make NS yellow, EW red.
allRed      con %00100100    ' Make both lights red.
EWgrn       con %00001100    ' Make EW green, NS red.
EWyel       con %00010100    ' Make EW yellow, NS red.

NSgoTime    con    8192      ' Set NS green duration (in milliseconds).
yelTime     con    2048      ' Set duration of any yellow.
EWgoTime    con    8192      ' Set EW green duration.
redOverlap  con    512       ' Set red/red overlap time.

' The bit-pattern and timing constants are combined as follows:
' The time is logically ANDed with %1111111111000000, which
' clears the lower 6 bits to 0s while leaving the upper 10
' bits intact. The result is logically ORed with the 6-bit
' light pattern, which copies the 1s of the pattern into the
' lower 6 bits. If this ANDing and ORing is unfamiliar, check
' out Stamp Applications #14, Apr. '96 for a quick lesson
' in Boolean logic. (See the N&V web site or contact the
' magazine for back issues.)


top10       con     %1111111111000000  ' Mask off lower 6 bits.
btm6        con     %0000000000111111  ' Mask off upper 10 bits.

NSgo        con NSgoTime & top10    |  NSgrn    ' 16-bit time/bit pat.
NSwarn      con yelTime & top10     |  NSyel    ' "
allStop     con RedOverlap & top10  |  allRed   ' "
EWgo        con EWgoTime & top10    |  EWgrn    ' "
EWwarn      con yelTime & top10     |  EWyel    ' "
' ===Variables===
seq         var    nib              ' Current state (0-5) of stoplight
sequence.
lkup        var    word             ' Number from lookup table.
' ===Program===
DIRS = %00111111                    ' Set lower six pins to output.
again:                              ' Endless loop.
for seq = 0 to 5                    ' For each of six stored patterns/times..
  lookup seq,[NSgo,NSwarn,allStop,EWgo,EWwarn,allStop],lkup
                                    ' Get bits.
  OUTS = lkup & btm6                ' Copy lower 6 bits to pins.
  pause lkup & top10                ' Set delay to upper 10 bits.
next                                ' ..and get the next entry from the table.
goto again                          ' Repeat endlessly.
```

perform this magic by requiring that a synchronizing character of 055h (01010101 binary, or the ASCII code for the letter 'U') precede any other communication. Here's a quick rundown on the features of the individual modules:

RAMPack: RAMPack allows you to store and retrieve up to 8 KB of data in a static RAM chip. As shipped by Solutions Cubed, the RAM in RAMPack is the volatile kind that loses data when power is removed. However, the device is compatible with battery-backed nonvolatile RAM packages. Just pry the original RAM chip out of its socket and pop in the NV RAM device.

Storing data in RAMPack requires that you send the sync byte, a write instruction (0), the number of bytes to store (1 to 8), two bytes comprising a 16-bit starting address in RAM, and finally the data bytes themselves. So a minimal complete write package would contain six bytes.

Reading data back from RAM follows a similar sequence: sync byte, read instruction (1), number of bytes, and 16-bit address. RAMPack gives your Stamp program about 500 µS to set up for serial input (Serin), then transmits the requested data.

RAMPack looks like an interesting alternative to EEPROM data storage in applications that require continuous data recording. EEPROMs can only take a limited number of write cycles, and the larger EEPROMs have the most limited write-endurance, typically 100,000 writes. RAM can be rewritten an unlimited number of times. On the other hand, EEPROM is the hands-down winner when maximum battery life is required, since the Stamp can drive it directly, and it draws little current (a few microamps) when inactive.

Pocket Watch: This module is a real-time clock with alarm function. The alarm is an output pin that can signal the Stamp, light an LED, or power a small buzzer.

Pocket Watch understands instructions that set and read the time and alarm, and turn the alarm on and off. Unlike most other real-time clocks — which express time in binary-coded decimal (BCD) numbers — Pocket Watch uses byte values for seconds, minutes, hours, days, months, and years.

Pocket Watch is significantly easier to interface to the Stamps than a normal real-time clock chip. It's sole disadvantage is higher current draw. Pocket Watch draws a constant 5 mA (about the same as a BS1). Most real-time clock chips run on a few microamps while keeping time, and perhaps 1 mA while communicating with a controller.

Motor Mind: Robotics enthusiasts take note: Motor Mind is a complete two-amp H-bridge motor controller with 2400-baud serial input and a built-in tachometer function. It understands instructions that set motor speed in 256 steps, brake and reverse the motor, and measure motor speed. A dedicated "override" input can stop the motor. This could be connected to a limit/panic switch, or be driven by circuitry that senses excessive current draw or temperature to prevent damage to the motor or electronics.

Mini Watt: This unit is a combination regulated power supply and intelligent battery charger. It can provide up to 200 mA continuous current at 5V from a pair of rechargeable NiCd batteries. It automatically handles the details of charging the batteries from an AC adapter input, while maintaining an uninterrupted supply at the 5V output.

Wrap-up

These engineering modules are a real bargain at the prices Solutions Cubed is charging. They are probably meant to serve as advertisements of the company's engineering services — much the way car companies build concept cars to show off their design prowess. If you can use these neat modules as-is, snap 'em up. If you need custom design work for a project, call these guys. They understand Stamps, and have successfully converted Stamp-based designs into commercial products. **NV**

Stamp Apps

Listing 1. Stoplight control for BS1

```
' Program: STOPLITE.BAS (Sequence a stoplight from a lookup table.)
' This program generates proper green-yellow-red sequencing for a
' pair of traffic signals controlling an intersection. I refer
' to one street as "EW" (east-west) and the other as "NS" (north-
' south). Pins are connected to LEDs as follows:
'          pin5    EW/red        pin2    NS/red
'          pin4    EW/yellow     pin1    NS/yellow
'          pin3    EW/green      pin0    NS/green
' ====Constants===
' The program uses six 16-bit constants to represent the states
' of the lights (lower 6 bits) and the length of time to leave
' the lights in those states (upper 10 bits). The usual way
' to create such constants is to define the bit patterns
' and the times separately, then have the compiler add or
' logically OR them together. Unfortunately, the simple STAMP
' host program doesn't have this feature, so we'll have to do
' it by hand. Here's how the constants are organized:
'                  Duration (ms)   Pattern of lights
'                        \               /
'                  |==========|=====|
SYMBOL NSgo   = %0010000000100001  ' NS green/EW red, 8192
ms.
SYMBOL NSyel  = %0000100000100010  ' NS yellow/EW red, 2048
ms.
SYMBOL allRed = %0000001000100100  ' NS red/EW red, 512 ms.
SYMBOL EWgo   = %0010000000001100  ' NS red/EW green, 8192
ms.
SYMBOL EWyel  = %0000100000010100  ' NS red/EW yellow, 2048
ms.
' ===Variables===
SYMBOL seq = b11   ' Current state (0-5) of stoplight sequence.
SYMBOL lkup = w4   ' Number from lookup table.
' ===Program===
dirs = %00111111       ' Set lower six pins to output.
again:                 ' Endless loop.
for seq = 0 to 5       ' For each of six stored patterns/times..
  lookup seq,(NSgo,NSyel,allRed,EWgo,EWyel,allRed),lkup
                              ' Get bits.
  pins = lkup & %00111111     ' Copy lower 6 bits to pins.
  lkup = lkup & %1111111111000000  ' Strip off lower 6 bits.
  pause lkup                  ' Set delay to upper 10 bits.
next                          ' ..and get the next entry from the table.
goto again                    ' Repeat endlessly
```

HP 141T, 8555A, 8552B, $2,000; HP 141T, 8554B, 8552B, $1,800; HP 8553B, $500; HP 8660A, $250; HP 86290A, 2-18 GHz, sweep plug-in, $1,800; HP P532A, wavemeter, $150; Fluke 332B voltage calibrator, $600; HP 3320B, $400; HP 3330B, $500; Rockland 5100 synthesizer, $400; HP 334A, distortion ana., $450; HP 332A, $300. Send for test equipment sales list. A-Comm Electronics, 7198 S. Quince Street, Englewood, CO 80112. 303-290-8012.

WANTED: LATE model TEST EQUIPMENT and test equipment MANUALS, HP, Tektronix, and others. Fax your for sale list to 410-750-1192 or mail to US Surplus, PO Box 37, Ellicott City, MD 21041, Attn: Ron Baublitz. Phone # 410-750-1083, E-Mail: ussurplu@clark.net

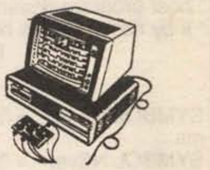
POWER METERS WITH SENSOR SALE: Boonton 42AD $250; Boonton 42BD $325; Boonton 4200 $400; General Microwave 476/4240A (NEW) $300. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: ast mrktg@wrench.toolcity.net

TEST EQUIPMENT: HP 8656A sig. gen. $1,950. HP 3325A/002 synthesizer/function gen. $1,450. HP 11600B/11602B transistor fixtures $450. HP 8018A/001 serial data gen. $500. HP 8444A/059 tracking gen. $950. HP 3575A phase meter. $750. HP 141T/8554B/8553B/8552B spec. analyzer, $2,150. HP 5315B universal counter $450. Ailtech 7370 system noise monitor $400. **KDM Electronics** TEL 219-420-0063, FAX 219-426-0607.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 513-847-2300 OR fax 513-847-2350.

EQUIPMENT MANUALS we have 1000's of service and operators manuals for all types of test and measurement equipment from 1950 to present. All test equipment manufacturers are represented. Call, write, or fax your want list. Please include mfg.'s manual P/N unit serial numbers if known. **Manuals Plus**, Box 549, TAD #601, Tooele, UT 84074. 801-882-7188, FAX 801-882-7195.

STACO ENERGY Products 3PN1010 variable transformer, input: 120VAC, output: 0-120/0-140 volts (switchable) @ 10 amps. Very good used condition, $75 (less than half of the current new cost). **HP 5065A option 02 rubidium frequency standard**, excellent condition, $1,600. **Sencore SC61 waveform analyzer** w/brand new Sencore probes, $750. **Leader LFG-1300S sweep function generator**, 2MHz w/variable symmetry, very good condition, $225. **Leeds & Northrup 4360 precision shunt**, 0.1Ω, 15A, excellent condition $600. **Texscan 7272 VHF field strength meter** 5-405 MHz, AC/ni-cad, $165. **Gelman HV power supply**, 0-500 VDC, 125mA, dual meters, $100. **Power Designs 2K20 POWER SUPPLY**, 0-2000 VDC, 20mA, VG condition $225. **General Radio 1862C megohmmeter**, 500KΩ-2TΩ, $300. **B&K Precision 2040 CB signal generator**, int/ext mod, noise gen. step attn., etc. $250. **HP 353A** attenuator/patch panel, 0-110 dB x 1dB steps. Matching for 135, 600, 700 ohms. Brand new surplus! $50. 30-day guarantee. **Lehman Scientific** 717-244-7540, Fax 717-252-4266. Visa/MC.



BUILD A FIVE CHANNEL LOGIC ANALYZER FOR $50 AS PUBLISHED ON THE FRONT COVER OF ELECTRONICS NOW (January 1997)! No gimmick, but a real instrument with multiple trigger modes, data storage, print capability, large display area and easy command access/pull down menus. Double sided PC board $15; test clips and cable $20; remaining parts $15; complete parts kit $50; fully assembled unit with current version of LOGIC PROBE and free software updates $65. Check/money order or COD (additional $7). American MicroTech, Inc. 219-482-3896, PO Box 8304, Fort Wayne, IN 46825-8304.

SUCH A DEAL! On-line auction of popular test equipment. Check out Metric's "Auction" at http://www.metricsales.com There's nothing else like it!

WANTED: USED TEST EQUIPMENT. CONTACT: ALEX TOROK, AST GLOBAL MARKETING, Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

TEST EQUIPMENT SALE: The following equipment is offered at $250 each PPD CONUS. All items include manual, accessories and have been lab tested. DATA Precision 3500 5-1/2 digit DVM, GR 1236 IF Amplifier, GR 1531AB Strobotac, ENI 300L Amplifier, FLUKE 1953A Frequency Counter, HP 432A Power Meter plus cable, HP 435A Power Meter plus cable, HP 428B Milliammeter w/probe, HP 400F AC Voltmeter, HP 400FL AC Voltmeter, HP 182C Oscilloscope Mainframe, HP 652A Test Oscillator, HP608E signal Generator, HP 606A Signal Generator, HUNTRON TRACKER 1005B-S1, KROHN-HITE 4100 Pushbutton Oscillator, TEKTRONIX 7603 Mainframe, TEKTRONIX 575 Curve Tracer, WAVETEK 154 Function Generator. Call/Fax/E-Mail Brian at Kentronix 908-681-3229, 908-681-3312 Fax, brian@kentronix. com E-Mail, PO Box 2444, Farmingdale, NJ 07727.

WANTED: ALL MAKES OF TEST EQUIPMENT. WE WILL TAKE YOUR EQUIPMENT IN ON CONSIGNMENT OR PAY TOP DOLLAR FOR GOOD NEW OR USED LATE MODEL TEST EQUIPMENT. AMERITEK, BIRD, CUSHMAN, EIP, HP, IFR, MARCONI, MOTOROLA, NARDA, RYCOM, SMITH-MYERS, TEKTRONIX, AND OTHERS. CALL 1-800-476-2526. E-MAIL TO Alcomtest@aol.com

OSCILLOSCOPE, PLUG-INS: Tektronix RM567, clean, call for details. Dozens large (tube and other) plug-ins; examples: 11B1/2 time bases, 10A2 dual trace amplifiers, $10-$50. **COUNTERS:** 4 HP 5245L, 500MC and 3GHz plug-ins, $200 all. 510-569-8008 voice/fax.

OSCILLOSCOPES TEKTRONICS 2464 CTS with service manual $350. Oscilloscopes BK 50MHz $175. Digilog logic analyzer with pods and manuals $200. Voltmeters, spectrum analyzers, cell phone analyzers. Call for flyer. We buy test equipment. 860-267-8763.

HTTP://WWW.TECH-SERVICES.COM HP 5328A high stability counter $500. .01-40 GHz spectrum analyzer $1,500. Wavetek 145 function/pulse $300. Marconi TF2300A modulation meter $500. HP 105 frequency standard $600. Gary N6ZD, 408-385-0301, 408-385-7519, FAX 408-385-0261. **HTTP://WWW.TECH-SERVICES.COM**

LOWEST PRICES! Check out Metric's "Bargain Basement" at http://www.metricsales.com Most items under $125!

TEST EQUIPMENT FOR SALE: QUALITY RECONDITIONED TEKTRONIX, HP, BOONTON, FLUKE, WAVETEK, ETC. CONTACT: ALEX TOROK. AST GLOBAL MARKETING, 11365 Airport Road, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

TEKTRONIX EQUIPMENT: 184 time mark generator, $150; 109 pulse generator, $100; 106 squarewave generator, $200; 130 LC meter, $200; 475A, 250MHz scope, $600; 620 XY display, $250; dual 620 side by side rack mount, $500; 634 video display, $250; 7603 3 slot frame, $250; 7904 500MHz 4 slot frame, $500; 7834 400MHz storage frame, $500; TM506, $200, TM504, $150; TM503, $130; 7623A, 7A26, 7A26, 7B53A, $650; 7A11, $300; 7A26, $200, 7A19, $150; 7B80, $200, 7B92A, $250; C51 camera and back for 7000 series scopes, $150; DM501A 4.5 dig DVM, $200, FG503, $300; R468 100MHz dual channel 10MHz dig storage, $600; PG501, 50MHz pulse gen., $200; PS501-2, $150; PS503A, $200, T922, 15MHz dual channel scope, $200; TM515 5 slot frame, $250; SG502, $300. A-Comm Electronics 303-290-8012.

HP 1741A 100MHz storage oscilloscope $350; HP 5005A signature multimeter $150; HP 5328A 512MHz counter $250; HP 5335A universal counter $750; HP 8683D 2.3-13.0 GHz signal generator $2,800; Narda 7000A/7206 microwave multimeter $550, Tektronix 134 amplifier $75; Tektronix 466/DM44 100MHz storage oscilloscope $500; Wavetek 270 function generator $500; Wavetek 1001 sweep/signal generator $200; Tektronix 485 350Mhz oscilloscope $600. Credit cards accepted. Jim Stevenson, Phone: 908-722-6157, Fax: 908-722-6391. http://www.stevensonlabs.com

HP 8656A SYNTHESIZED SIGNAL GENERATOR. 100KHz to 990MHz, 100Hz resolution, +13 to –127 dBm. AM, FM, AM/FM modulation, HP-IB, large LED readout. These units have been upgraded with the newer (8656B) attenuator assemblies. Fully tested, with manual. $2,700. Brian Kent, Kentronix, PO Box 2444, Farmingdale, NJ 07727. 908-681-3229, or Fax 908-681-3312. E-Mail: brian@kentronix.com

WANTED! TEST equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. 1-800-432-3424.

WE BUY electrical power systems test equipment. This includes the following manufacturers: **Multi-Amp** (now AVO Multi-Amp), **Biddle** or James G. Biddle (now AVO Biddle), **Megger** (now AVO Megger), **Associated Research, AEMC, EIL, Programma** or any other test equipment used for testing high voltage equipment and components. The test equipment that we are looking for is used for testing high voltage transformers, circuit breakers, cables, and protective relays. FAX 972-564-9139 or phone 1-800-261-9139 for quote. **Phase-3 Power Test Equipment.**

SELL: TEKTRONIX PG508 generator, $400; Tek P6046 differential probes $250 ea.; HP 1335A XY display scopes $250 ea.; Fluke 5205A amplifier, $1,000; chart recorders, HP 7155B, $300; HP 7100BM, $300; HP 740A voltage std., $200; HP 8405A vector voltmeter, $500; Leitz Wetzlar microscope illuminator, $200; Tektronix 2215 scope, $450; GR1001A signal generator, $200; GR1234 VSWR meter, $150; HP 3586B selective level meter, $800; Tektronix 335 portable scope, $400. A-Comm Electronics, 303-290-8012 fax 303-290-8133. E-Mail: ACOMM@worldnet.att.net

TEKTRONIX 2430A digital oscilloscope. 150MHz, 100 MS/s digitizing, GPIB interface, excellent condition, recent NIST calibration. Comes with Tektronix K213 lab instrument cart. $3,500. 803-732-4863.

T-BAR EXPLORER DM-1 digital data line monitor for central site and field service use in isolating protocol and code related problems in data communications networks. Programmed BISYNC/ASCII. 5" CRT. Compact 14 pounds. New $150 w/manual. Louis Gold, Box 3636, Woodbridge, CT 06525.

10TH ANNIVERSARY SALE! RF EQUIPMENT: HP 8761B coaxial switch (18GHz, SMA) $90. **HP 33300D (70dB), 33304D (11dB), 33305D (110dB)** latching step attenuators (18GHz, 2W, SMA) $190, 225, 265. **HP 5342A/001** counter (18GHz, oven option) $2,000. **HP 11869A** adapter for 8350B $350. **HP 436A, 8481A** power meter, sensor $1,650. **HP 86290B, 8620C** sweep oscillator (2-18 GHz) $2,200. Excellent condition, with warranty. Pepper Systems, 214-353-0257.

RACAL-DANA 9009N automatic AM/FM modulation meter. Automatically tunes from 8 to 1500MHz. FM deviation is from 1.5 to 150KHz in 7 ranges. AM modulation is from 0 to 100% in 5 ranges. Sensitivity is from 40 mV to 7V. Small unit like the Marconi TF 2304. Excellent, with manual. $365 ppd CONUS. Quantities available. Brian Kent (Kentronix), PO Box 2444, Farmingdale, NJ 07727. 908-681-3229, 908-681-3312 FAX, E-Mail: brian@kentronix.com

INVENTORY REDUCTION SALE. Boonton, RF millivoltmeters: 92A $95; 92B $145; 92C $245; 93AD True RMS voltmeter $375. Probes & volume discount available. **Hewlett Packard** 3400A True RMS voltmeter $100. 435A power meter $175. **Psitech Plus** 707-745-4804. Request bi-monthly fax listings, Fax 707-747-5277.

Write in 159 on Reader Service Card.

SPY EQUIPMENT

AI-6600 Phone Tap Detector

DETECTS:
- Radio Frequency Taps
- Series and Parallel Taps
- Line Impedance Taps
- Extension Phone Listeners

$149.95

AI-2100 Vibrating Transmitter Detector

DETECTS:
- Body Wires
- FM Wireless Mics
- AM Transmitters
- UHF Transmitters

$189.95

AI-5500 Complete Safety System

DETECTS:
- All Phone Taps and Extension Phone Listeners
- All Body Wires, Wireless Mics, AM/FM and UHF Transmitters

DEFEATS:
- All Body Wires, Transmitters and Distance Microphones with its built-in white noise generator

$379.95

TRVD-900 Transmitter / Tape Recorder & Video Detection System

DETECTS:
- Body Wires • FM Wireless Mics
- AM Transmitters • UHF Transmitters
- Tape Recorders • Video Equipment

Alerts User By Vibrating and/or Illuminated LEDs

$495.00

WSS-100 Wireless Surveillance System
Sees & Hears Everything!

FEATURES:
- 2.4 GHz Video / Audio Transmitter
- 4 Channel Receiver • 300' Transmission Range
- Black & White CCD w/ Auto-Iris Lens
- 410(H) TV Line Resolution • FCC Approved Frequency

$649.95

Items May Be Purchased by Credit Card, Certified Check, Money Order or C.O.D.

Send $6.00 for 32-Page Catalog (FREE w/ Purchase)

AMERICAN INNOVATIONS, INC.
119 ROCKLAND CENTER ~ SUITE 315 - NANUET, NY 10954
VOICE: (914) 735-6127 • FAX: (914) 735-3560
HTTP://WWW.SPYSITE.COM • E-MAIL: AMERICAN@SPYSITE.COM

Dealers & Distributors Welcome

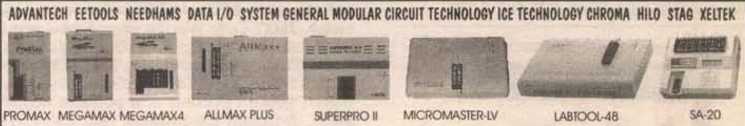
Prices valid thru 9/1/97

Write in 218 on Reader Service Card.

DEVICE PROGRAMMERS OVER 50 MODELS

QUALITY PRODUCTS * FREE TECHNICAL SUPPORT * AND NEVER UNDERSOLD

ADVANTECH EETOOLS NEEDHAMS DATA I/O SYSTEM GENERAL MODULAR CIRCUIT TECHNOLOGY ICE TECHNOLOGY CHROMA HILO STAG XELTEK

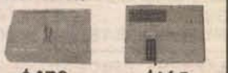


- $CALL Advantech Labtool-48 Universal
- $ 650 EETools Allmax Plus Universal (Printer Port)
- $ 409 EETools MegaMax 1 Gang Universal (PP)
- $ 509 EETools MegaMax 4 Gang Universal (PP)
- $ 419 Needhams EMP-20 Universal (Printer Port)
- $ 679 Needhams SA-20 8 Gang Stand Alone
- $ 739 Stag Orbit-32 E(E)prom Stand Alone
- $ 369 Xeltek SuperPro II Universal (ISA Card)
- $ 409 Xeltek SuperPro IIP Universal (Printer Port)
- $ 249 Xeltek SuperPro Lite Universal (Printer Port)
- $ 165 Xeltek Rommaster II Universal (Printer Port)
- $ 479 MOD-EMUPA Universal (New Sale Price)
- $ 629 ICE Technology MicroMaster LV (Printer Port)

Please Call For Refurb Demo & Used Programmers

General Device Instruments
Sales 408-241-7376 Fax 241-6375 BBS 983-1234
Web www.generaldevice.com E-Mail icdevice@best.com

MCT-EMUPA ROMMASTERII



$479 $165

Write in 162 on Reader Service Card.

WANTED! TEST equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. 1-800-432-3424.

HP 204B $100; HP 204C, $150; HP 209A, $200; HP 651A, $200; HP 651B, $200; HP 652A, $200; HP 653A, $250; HP 654A, $250. Plotters: HP 7475A six-pen RS 232, $150; HP 7475A HPIB, $250; HP 7470A, RS232, $150; HP 7035B, XY $200; HP 7044A, $400; HP 7045A, $400; HP 7046B, XYY, $600; HP 7550A graphics plotter, $400; HP 7562A log converter, $200; HP 7560A, $150; HP 1725A, 275MHz scope and DVM, $500; HP 1741A 100MHz storage scope, $400; HP 302A wave ana., $250. A-Comm Electronics, 303-290-8012.

HP 3551A TRANSMISSION TEST SET: Rack mount guaranteed w/manual. SALE $275. AST Global Marketing. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: ast mrktg@wrench.toolcity.net

PORTABLE SCOPES: Tek 222A (10MHz) handheld, battery-operated digital storage $1,500. **Tek 465** (100MHz) $425. **Tek 475A** (250MHz) $650. **Tek 475A/DM44** (250MHz, multimeter) $735. **Tek 466** (100MHz, storage) $695. All with bright CRTs; excellent condition, warranty. Pepper Systems, 214-353-0257.

FED-LOG on CD-ROM. Have you wondered what all those numbers were on government sales catalogs? Now be able to identify all government stock numbers for price, mfg., part number, description. $350 a set. Call TJ's Wholesale Surplus 904-897-6482.

WANTED: RADIO service monitors, IFR, Motorola, Marconi, HP signal generators, spectrum analyzers, and late model HP equipment. 716-763-9104 or 716-661-9964. Fax: 716-763-0371. http://www.madbbs.com/amtronix

SELL: HP 3580A spectrum analyzer, $900; HP 428B current meter and probe, $300; HP 5328A counter, $250; HP 5363B time interval probes, $200; HP 537A wavemeter, $200; HP 4800A vector Z meter, $600; HP 461A amplifier, $100; HP 465A amplifier, $80; HP 4943A TIMS, $600; HP 4944A TIMS, $600; HP 432A power meter cable and HP 8478A, $350; HP 59301A ASCII to parallel converter, $100; HP 606A signal generator, $300; HP 7562A log converter, $150. A-Comm Electronics 303-290-8012, FAX 303-290-8133.

HP DC-TRANSFER standard model 735A $125; FLUKE 731B DC reference standard $200; Electronic Association 25163X standard capacitor 100 uF $350. **Narda** 8100B RF radiation monitor, complete test set $200. All 30-day warranty. **Psitech Plus** 707-745-4804. Request bi-monthly fax listings, Fax 707-747-5277.

HP 8755A analyzer, 3-1164A detectors, 1-1165A modulator and manuals $500. HP 8620C mainframes $150. HP 432A with 2-478 mounts $175. HP 8660B/86602A/86631B $1,500. HP 1722B $650. 315-839-5883 after 7pm EST.

WANTED: LATE MODEL TEST EQUIPMENT (Tektronix, HP, Fluke). Also we buy test equipment manuals, catalogs. Pepper Systems, 214-353-0257; 214-902-9511 FAX.

S&N CELLULAR — The Electronics SuperStore

We offer a complete line of Cellular Programming Equipment

"7 WAY COPY KAT" includes Motorola EE3/9611, 96-G.E. Ericsson, Panasonic, Mitsubishi-Diamond Tel 5000 & 25X, Sony (H333), Audiovox 800, and N.E.C. P7

Sale Price

$3000 buys 2 Kats with 2 sets of Cables

1997 Special Packages For You Guy's On The Go.

Package A	Package B	Package C
1-Moto EE3/9611 ESN clip	1-Moto EE3/9611 ESN clip	1-Moto EE3/9611 ESN clip
1-951C Moto kopy cat w/4 cables	1-GE/Ericsson (95w40) ESN clip	**Package C - $800**
1-GE Ericsson (95w40) ESN clip	1-NEC 100 series ESN clip	Please visit our website at: http://www. ftlauderdale-online.com/SN/default.html
1-NEC 100 series ESN clip	**Package B - $1000**	
Package A - $1500		

- **NEC ESN Clip** - Programs Model #'s 110, 120, 180, 181 .... **$500**
- **NEC ESN Clip** - Programs Model #'s P700, P701, P760, P761 .... **$500**
- **GE, Ericsson ESN clip** - Programs Model #'s **G.E.** CT700, CT550, CT750, CT800 **Ericsson** Model #'s AH210 AH220, AH235, AH237, AH238, AH300, AH310, AH320 .... **$400**
- *NEW* **C-TEK Cable** - Turn OKI 900 or AT&T 3730 into a cellular monitor **$250**
- **GE Ericsson** - Programmable phone, modified & complete **$600**
- **OKI 900** - Programmable phone, modified & complete **$500**
  Chip installation only **$300**
  Chip only - **$175**

Call for Best Prices on Readers - EE3 Elite & Startac

Please call your courteous service representatives for complete details at:

(954) 974-6161

S&N Cellular • 934 University Drive • Coral Springs, Florida 33071

AGREEMENT FOR PURCHASING OF CELLULAR PROGRAMMING SOFTWARE AND EQUIPMENT Purchaser agrees not to use said software and equipment for any illegal purposes. This includes line fraud, computer fraud, cellular service fraud, and any other fraudulent acts according to all federal and local laws, including rules of the FCC title #18, section 1029, and all Florida statutes. All software and equipment is sold only to qualified buyers. All software is sold for educational purposes ONLY!!!

Weeder Technologies

Add $4 ship/hand — **FREE CATALOG!** — Visa MasterCard — Pro-Kit™

PO Box 421, Batavia, OH 45103 weedtech@iglou.com 513-752-0279

Telephone Call Restrictor
Connects to telephone wall jack. Disables all phones on the line if attempting to either: dial a number that has been stored in memory "Block Group" mode or, dial a number that has not been stored in memory "Allow Group" mode. Use touch-tone phone to enter telephone numbers (or prefix) into non-volatile memory, and choose mode. Program or disable from any phone on the line using your private 4-digit password. **$35.00**

Caller ID / Computer Interface
Connects between a telephone wall jack and an RS-232 serial port. Decodes the caller ID data sent over the phone line and sends it to your PC/Mac in a pre-formatted ASCII character string. Create your own program to log the name, number, date, and time of all incoming calls. Block out unwanted callers to your BBS/modem. **$34.50**

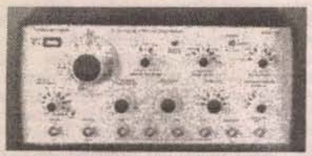
50 MHz Frequency Counter
Reads frequency from 1Hz to 50MHz and displays up to 7 digits on a 16x1 character LCD display. Auto-range feature provides floating decimal point and automatic placement of suffix (Hz, KHz, or MHz). Microcontroller based; allows for highly stable readout and very small parts count, board only 2" x 3" big. **$46.50**

RS-232 Digital Input/Output
Give your home-brewed PC/Mac programs a link to the outside world! 12 I/O pins can be configured individually for input or output. Turn on/off relays, triacs, etc. Respond to button presses, switch changes, 4x4 matrix decoding with auto-debounce. Stack up to 16 units on the same serial port for a total of 192 I/O points. **$32.00**

IR Remote Control Receiver
Learns and records the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. Seven individual I/O pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. Re-program over and over for use with different remote transmitters or configurations. **$32.00**

DTMF Decoder/Logger
Keep track of all numbers dialed or entered from any phone on your line. Connects to your telephone wall jack. Decodes all 16 touch-tones and displays them on a 16-character LCD display. Holds the last 240 digits in a non-volatile memory. Scroll through and view all telephone numbers dialed, credit card numbers entered, etc. Can also be connected directly to radio receiver's speaker jack. **$54.50**

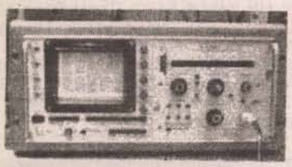
SPECTRUM ANALYZERS: HP 8555A, 8552B, 141T (.01-18 GHz) $1,600. **Tek 7L5/L3**, 20Hz-5MHz $1,400; with tracking generator $1,900. **HP 3580A** 5Hz-50KHz, 1Hz RBW, adaptive sweep, tracking generator: $790 (mech), $1,250 (LED). Excellent condition, warranty. Pepper Systems, 214-353-0257.



HTTP://WWW.TECH-SERVICES.COM Wavetek 145 function/pulse $300. .01-40 GHz spectrum analyzer $1,500. HP 5328A, high stability counter $500. Marconi TF2300A modulation meter $500. HP 105 frequency standard $600. Gary N6ZD, 408-385-0301, 408-385-7519, FAX 408-385-0261. **HTTP://WWW.TECH-SERVICES.COM**

TEKTRONIX 067-0521-00/1M1 $30, 067-0885-00 $150, 105 $40, 130 $50, 134 $40, 1441 $150, 191 $75, 1A1 $30, 2B67 $40, 321A $80, 3A1 $40, 3A3 $40, 3A6 $40, 3A75 $40, 3B4 $40, 3S2 $50, 453 $125, 454 $175, 475 $190, 502A $50, 5103/D13 $75, R561B $60, 564B $60, 575 $100, 585 $60, 7603 $100, 7613 $100, 7704 $125, 7A13 $125, 7A18 $50, 7A26 $75, 7B53A $75, 7B70 $75, 7B71 $75, 7B85 $125, 7D15 $125, AM-6565/U $60, DM501 $65, RG501 $150, RM41A $60, SG502 $150, TD-1085/U $75, TM503/GPIB $75. G&G 210-674-8771.

TEST EQUIPMENT: Tek 2235 scope $650. Tek RTD710 digitizer $3,000. Nicolet 4094 scope $2,000. Nicolet 2090 scope $800. Tek PG501 pulse generator $225. Wavetek 175 arbitrary wave gen. $800. Wavetek 186 phaselock gen. $400. Wavetek 180 function gen. $200. Micronetics programmable noise gen. $500. **KDM Electronics** TEL 219-420-0063, FAX 219-426-0607.



HTTP://WWW.TECH-SERVICES.COM .01-40 GHz spectrum analyzer $1,500. Wavetek 145 function/pulse $300. HP 5328A, high stability counter $500. Marconi TF2300A modulation meter $500. HP 105 frequency standard $600. Gary N6ZD, 408-385-0301, 408-385-7519, FAX 408-385-0261. **HTTP://WWW.TECH-SERVICES.COM**

WANTED: SERVICE MONITORS. WE PAY TOP DOLLAR BY NEXT DAY FEDEX FOR USED IFR, MARCONI, MOTOROLA, AND HEWLETT PACKARD SERVICE MONITORS. ANY CONDITION, WORKING OR NOT. DON'T LOSE MONEY. CALL 1-800-476-2526/FAX 601-868-0133. E-MAIL TO Alcomtest@aol.com

AFFORDABLE HP power sensor repair! Most 8481As repaired for $230 or less. We also handle 478As and many others. Call or fax for more information. Willamette RF, Inc., 541-754-7226, FAX 541-753-4629.

FILMOHM 7147 step attenuators 1-110 dB, 0-250 MHz, 75 ohms, $80; Honeywell 1858 Visorder with plug-ins, $600; Grayson Stadler 1701 audiometer, $300; GR1925 multifilter, $400; HP140T, 8554B, 8553B spec. analyzer, $1,500; HP 8016A, word generator, $500; HP 8018A serial data gen., $500; HP 8006A word gen., $150; HP 8406A comb. gen., $500; HP 2225A, printer HPIB, $100; Phillips 6672A 1GHz counter $450; EIP 371 source locking counter 18GHz, $1,200; Pulse Instruments PI 5800A data generator, $800. A-Comm Electronics 303-290-8012.

WANTED: HP 8902A measurement receiver, and late model Hewlett Packard equipment. 716-763-9104 or 716-661-9964.

HEWLETT PACKARD 334A distortion analyzer $325; KROHN-HITE 3202R tunable filter $200. Psitech Plus 707-745-4804, Fax 707-747-5277.

TRANSMISSION TEST SETS: Hekimian 41-01, dual digital displays, audio generator, measures level, frequency and noise $125/ea. 716-763-9104 or 716-661-9964. http://www.madbbs.com/amtronix

MICRODYNE 1100, 1200, 1400 series receivers all bands, FM and PM demods, SDU, IF filters. Aydin, Schlumberger, monitor systems bit syncs. 805-934-2058.

ANALOG METER SALE: Fluke 896A $250; Fluke 893A $75; HP 428A $50; HP 412A $50; HP 3400A $125; Keithley 414A picoammeter $150; Keithley 26000 logarithmic picoammeter $650; HP 428B DC-clip on milliammeter $125; Fluke 8300A01/02; Millivac AN/VRM 145B $50 (no probe); AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: ast mrktg@wrench.toolcity.net

BATTERY ANALYZER with PC interface. DOS or Windows software $279. **LaMantia Products**, 1136 Aldersbrook Road, London, ON, N6G 2X8. 519-472-5566 Fax 519-472-1702.

POWER SUPPLIES, ETC.: HP 6237B triple output: 0-18V, 1A; 0-20V, .5A dual tracking $425. **HP 6253A** 0-20V, 3A dual tracking $300. **HP 6255A** 0-40V, 1.5A dual tracking $350. **HP 6443B** 0-120V, 2.5A $375. **Tek PS 503A** $195. **Xentek** extreme isolation transformers for CLEAN POWER: 5KVA, 2.5KVA, etc., starting at $195. Excellent condition, warranty. Pepper Systems, 214-353-0257.

WAVETEK 1034A portable RF power meter, new in factory box complete system $575; Model 157 programmable waveform synthesizer $150. Psitech Plus 707-745-4804, Fax 707-747-5277.

HP 3330B frequency synthesizer $395; HP 3581 wave analyzer $295; HP 3570A network analyzer $295; HP 3571 tracking spectrum analyzer $295; HP 1725A 275MHz scope with mounted multimeter $425. ISA, PO Box 6955, Laguna Niguel, CA 92607. 714-488-0010, fax 714-488-0299.

VIDEO REPAIR equipment. Vectorscope, waveform monitor, oscilloscope, microwave counter, tools, and more! Call 716-392-7122 with fax number or address for list.

FREQUENCY COUNTER/CONVERTER SALE: KIP 331 microwave $400; HP 5255A $150; HP 5256A $150; HP 5328A/096 $200; HP 5345A (NEW) $450; Tektronix DC504 $135; Fluke 1912A $250. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: ast mrktg@wrench.toolcity.net

HP 4815A Z-METERS: Sandford Associates, the **TOTAL** service specialist with the HP 4815A RF vector impedance meter. Buy, sell, and restore, warranted to HP factory specs. Former HP factory tech/supv. with expertise, parts, tooling, and probe accessories. Tel/write: 110 Highview Terr., Hackettstown, NJ 07840, 908-852-7989. E-Mail: 72540.1345@compuserve.com

TUBE TESTERS: TS1487/ALM23 $195. Hickock 533A $375. EICO 667-02 $255. TV-7B/U $195. Scott's Electronic Surplus. 562-491-3181. FAX: 562-491-3182.

TEST EQUIPMENT: HP 435A power meter $400. HP 4261A LCR meter $500. HP 4955A protocol analyzer $1,000. HP 7035B/7046A/7046B plotters $600/$500/$350. HP 4192A LCR meter $8,000. HP 3400A RMS voltmeter $350. **KDM Electronics** TEL 219-420-0063, FAX 219-426-0607.

OPTICAL IMPULSE GENERATOR, TEK OIG-502. New, unused, complete documentation and accessories. 1996 cat. price $9,500, our price with warranty $1,750. 2 available. **SI-5010** programmable scanner as new $500. Psitech Plus 707-745-4804, Fax 707-747-5277.

TEK SCOPES! 465 $425, **475-DM44** $595, **465M** $400, **577D1 $1,500, 5441 w/plug-ins** $300, **7S12 w/S6 & S52** $1,100, **7904** $475, **7834** $475 **1401A/323 spec analyzer** $650, TEK C-30 camera fits 465/485, etc. mint $175, HP 3310A $100, Fluke 335A volt std $250. **Four Designs Co., 360-887-1555, FAX 360-887-1549.**

FEITEK HAS the test equipment you want at reasonable prices. We buy, sell, and trade HP, Tek, GR, etc. Call or fax Monday thru Friday, 9 to 5, 314-423-1770, or write us at Box 3423, St. Louis, MO 63143.

USED TEST EQUIPMENT. HP, TEKTRONICS, FLUKE. WHOLESALE PRICES. CALL TO RECEIVE LIST BY FAX OR MAIL. TJ'S WHOLESALE SURPLUS. 904-897-6482.

MONTHLY GEM: Stanford Research Systems SR-720 LCR meter, 100Hz to 100KHz test frequencies, .05% accuracy, binning, bias, five months left on transferable warranty, $1,450. Phone/fax Precision 505-988-5233.

TEKTRONIX: FG 504 40MHz function generator $725. **A6302 & AM 503** current probe & amplifier $850. **P6201 900MHz** active probe $325. **AM 502, 7A22** high-sensitivity differential amplifiers $375, $350. **TR 503** tracking generator $875. **7D20** digital storage plug-in $700. **390AD** digitizer $495. **5D10** waveform digitizer with readout $295. **520A** NTSC vectorscope $1,150. Excellent condition, warranty. Pepper Systems, 214-353-0257.

WAVETEK 1002, 500MHz sweep generator, $200, HP 8494/95G attenuators, tested, $100 each. Jeff, 503-690-8904.

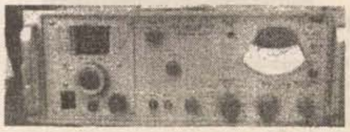
CALIBRATOR SALE: HP 6920B VCM $150; HP 738BR AC/DC $75; Fluke 335A $275. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

SELL: BOONTON; Tektronix FG504 40MHz function generator, $800; Associated Research 02100A, portable meter, $200; Tektronix DA4084 programmable distortion ANA and frame, $1,500; HP 8556A LF section, $300; Rockland 5100 programmable synthesizer, 1MHz-2MHz, $300; GR916 RF bridge, $300; Sulzer std. oscillator, $400; HP 3570A phase gain meter, $600; HLI 3701 communications test system, $200; HP 7225B HPIP plotter, $150. A-Comm Electronics 303-290-8012, Fax 303-290-8133.

MISCELLANEOUS SALE: Tektronix 1480R waveform monitor $450; HP 59303A D/A converter $100; Tektronix C-52 camera oscilloscope; Tektronix C-50 camera film back; Tektronix P6201 FET probe; Keithley 103A nano volt amplifier $125; HP 8410B network analyzer mainframe $250; HP 415E $50; HP 5006A $175; Tektronix 528A waveform monitor $350; Tektronix 655 HR-C monitor $250; Tektronix 655 HR-1 monitor $250. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

POOR MAN'S Spectrum Analyzer/Monitor Receiver Kit. 2 to 1,700 MHz. Basic kit only $78. Now available with switched resolution filters, tracking generator and direct digital frequency readout. Works with ANY scope or IBM compatible computer. Send stamped envelope for details. Science Workshop, Box 310B, Bethpage, NY 11714. http://www.science-workshop.com

DIGITAL METER SALE: Fluke 8600A $125; Fluke 8800A $125; HP 3465A $75; HP 3465A $75; HP 3465B $100; HP 3466A $175; HP 3490A $150; Racal-Dana 5001 $100; Tektronix DM50 $100; Tektronix DM501A $150; Tektronix DM502 $100; Solartron 6 1/2 digit (new) $500. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net



HTTP://WWW.TECH-SERVICES.COM Marconi TF2300A modulation meter $500. HP 5328A high stability counter $500. .01-40 GHz spectrum analyzer $1,500. Wavetek 145 function/pulse $300. HP 105 frequency standard $600. Gary N6ZD, 408-385-0301, 408-385-7519, FAX 408-385-0261. **HTTP://WWW.TECH-SERVICES.COM**

HP 8640B sig. generator opt. 1 & 3. High prefix #, $1,100. Distortion analyzer HP 334A, $295. HP 333A $220. All good & op. serv. manual included. Call Peter 609-392-5895.

TEST EQUIPMENT SALE: HP 419A null meter, $200; HP 8750A and cable, $350; HP 5245L $150; HP 5100A, 5110A synthesizer, $400; HP 86222A, $1,000; microwave systems PLS, microwave oscillator synchronizer, $300; Sulzer 5B-5P standard oscillator, $300; Singer Stoddart NM37/57; Sierra Misco 4001 solar radiation recorder, $250. A-Comm Electronics, 7198 S. Quince St., Englewood, CO 80112. 303-290-8012. Fax 303-290-8133. E-Mail: ACOMM@worldnet.att.net Net listing: http://www.a-comm.com

CAPACITOR DECADE: General Radio 1419M $125; Wavetek 1423A $500. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

WANTED: MEASURING & Test equipment, microwave components, RF connectors, etc. **Top price paid!** Write or FAX you list to: **Steigerwald GmbH**, Ungererstrasse 180, D-80805 Munich, Germany. FAX 011-49-8441-804881.

AMATEUR ROBOTICS

by Karl Lunt

I receive several requests each month for help getting started in robot-building. The plea usually takes the form of " ... my (son or daughter) wants to build a robot for (science fair, Scouts, fun); how do I get started?" Often, the parent has seen a copy of my column or found my name on the Internet. And some of the requests for help get pretty desperate, citing deadlines a week or so away.

I figure this would be a good time to condense some of the information from my previous 54 *Nuts & Volts* columns. After all, I've covered a lot of ground in the last 4+ years, and a review of the tools and techniques available in this hobby should be of interest both to beginners and to long-time readers.

How do I get started?

People who've never built a 'bot before usually approach the task from one of two directions. One group simply jumps in and starts. Grab some DC motors (these old windshield wiper motors look strong enough), a hurking power source (Bob doesn't need this motorcycle battery anymore), and some type of base material (I'll take a sheet of that 3/4" plywood). Saw, hammer, glue, and bolt for a while, then step back and see what you've got.

Don't get me wrong; I'm all for this kind of experimentation. Of course, you might well end up with a 100-pound juggernaut that (hopefully) won't move too fast or too far, and you will probably learn a lot in the meantime. But you're just as likely to create a large wood and metal sculpture, and the frustration of not getting your first R2D2 to move at all might stop you altogether. If this happens, you will miss out on a fascinating hobby and a lot of fun.

The other group of beginners takes the time to sit down and think out the whole effort. They are quickly paralyzed by the sheer complexity of the task; the questions seem endless. Where do I find motors? How do I make the robot back up? Should I use AA batteries? How will I control the thing?

Some who start down this path do build a machine. Of course, the motors aren't held onto the base all that well, it only does right-hand turns, and the spare bedroom is filling up with used alkalines, but it does roll around under its own power. Others in this group end up like the old Star Trek trick of shutting down a rogue computer by giving it an infinite problem to solve; they get so mired down in the complexity that they finally give up in frustration.

The solution for both groups lies with the single most important resource in robot-building; information. The more sources of information you can tap, the greater your field of options and the more tools you can bring to bear on your project. And, in the last four years, the amount of useful information for the novice robot-builder has exploded, thanks largely to the Internet.

When I started this column, Internet access was pretty much limited to colleges and universities, and to a few enlightened companies that provided their employees with net access in the form of E-Mail and news. In those days, there was no Web, and few individuals had built even one 'bot, let alone a herd of them.

How things have changed in such a short time! Today, Internet access is cheap and easily available, and the Web plays a major role in helping hobbyists pool their information. In just one afternoon of Web-surfing, you can visit dozens of sites filled with plans, information, pictures, and tools for helping you build your 'bot. If you are starting out in this hobby, the best help you can give yourself is to sign up with a reliable and supportive Internet service provider (ISP), hook up to the net, and get familiar with this new medium.

And since the Internet is so complex, it only makes sense that you need a tool to help you use the tool. This means a search engine, and my favorite is AltaVista (www.altavista.digital.com). Once you've reached the AltaVista Web page, you simply type a keyword or phrase in the search box, click the Submit button, and the search engine will examine millions of entries in its database, looking for web pags that contain your keywords. Spend some time getting used to the Web and AltaVista (or whatever search engine you choose); it will be time well spent, and the information you dig up will save you plenty of frustrating trial and error later.

My web page can serve as a good starting point. Just aim your Web browser at www.seanet.com/~karllunt to see a collection of tools and information I've set up for robot builders. From my page, you can reach the Seattle Robotics Society page (www.hhhh.org/srs) which, in turn, will take you to pages for other clubs and individuals interested in robotics.

You'll also want to visit and/or subscribe to some of the Internet list servers. A list server is a cross between a bulletin board system and E-Mail. Each subscriber receives a copy of any E-Mail any other subscriber sends to the list. So if someone finds a cool surplus store selling motors, she can send a single E-Mail to the list server, and all 200 subscribers get a copy of the note. I'm subscribed to the 68hc11 list server and find it an invaluable source of information. For information on subscribing, send E-Mail to majordomo@xx with the word HELP in the body of the message.

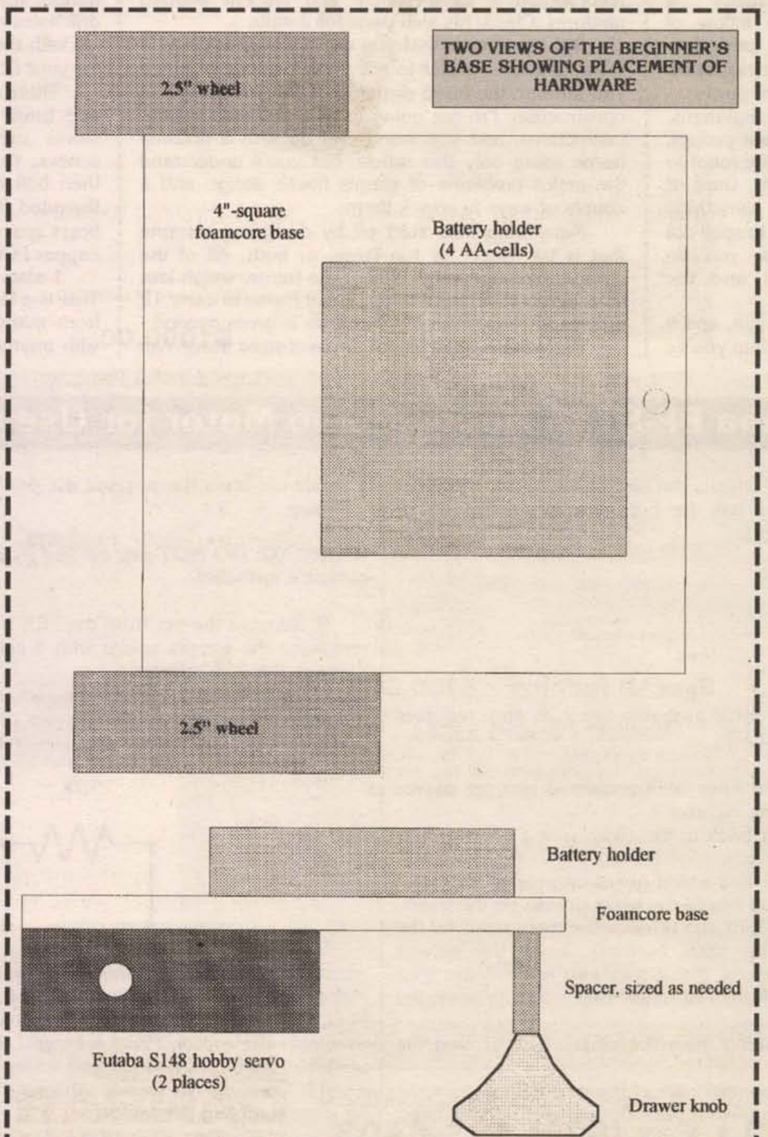
More traditional media also provides a wealth of valuable information. Tops on my list of books for robot builders is *Mobile Robots*, by Joe Jones and Anita Flynn (ISBN 1-56881-011-3). This superb book, published by A. K. Peters, Ltd., covers many of the design elements needed to build small robots in general. It also contains detailed plans for building two small robot platforms for experimentation.

To find any weird or unusual technical books, check out Powell's Books (www.powells.portland.or.us) and try their search system. Ideally, visit Portland, OR, and check them out in person. You gotta love Powell's City of Books, a bookstore that covers an entire city block. And a couple of blocks away, you'll find Powell's Technical Books, a normal-sized store filled with nothing but technical books of all types.

When you get to the low-level parts of your design, such as the electronic circuitry, be sure to contact the various manufacturers. In the last few years, more and more electronics firms have made it easier for the hobbyists to get up-to-date technical information. For example, National Semiconductor (www.natsemi.com) and Maxim (www.maxim-ic.com), among others, let you order free samples directly from their web pages.

And many companies, including Motorola (www.mcu.motsps.com) and Atmel (www.atmel.com), provide top-quality technical info in the form of .pdf files. You can view these files with a free Adobe Acrobat viewer, available on most web pages, and print them out on your laser printer. You end up with a full-size,

TWO VIEWS OF THE BEGINNER'S BASE SHOWING PLACEMENT OF HARDWARE



high-resolution technical summary, many include timing graphs, schematics, and application notes.

And remember to visit all the technical and surplus stores on the web. One of my favorites is Mondotronics (www.robotstore.com), a great source for everything from kits for small robots to parts and books. Also check out Marvin Green's web site (www.rdrop.agora.com/marvin) and take a look at his small BOTBoard circuit boards for building 68hc11 and PIC computers. And, if all of the above isn't enough incentive to hit the Internet, I'll add one more item. You can send E-Mail to me directly at my E-Mail address (karllunt@seanet.com).

But getting onto the Internet remains the single greatest step you can make to ensure your successful start at robot building. I consider it so important that I use it as a benchmark for how serious a person really is in pursuing this hobby. If someone asks me for help in building robots, and then tells me they aren't now and don't intend to be hooked to the net, I assume they aren't all that interested in amateur robotics.

Getting physical

Right. Now you have all the information you need, or at least you know where to find it. Time to get down to the tangible stuff. You can break down just about any robot design into four parts. The *sensors* collect information about the robot's internal and external environments. The *actuators* provide the physical interaction needed with the external environment. The *controller*, usually a microcontroller (MCU), coordinates the inflow of sensor data with the robot's program, and then controls the actuators to create the proper response. Finally, the *power source* provides the power — usually electricity — to drive the whole arrangement.

Whenever you want to start on a robot project, always begin by deciding what you want the robot to do. Whether you're aiming for the Holy Grail of robotics (a vacuum-cleaner robot), or something more modest like a robopet, take the time to spell out all of the robot's top-level goals. From here, you can determine the behaviors it will need and the information it must collect.

This phase can actually be the most fun, and it can shed light on how tough a design problem you've set for yourself. Start with something pretty outlandish, such as fetching a beer from the kitchen to the living room sofa. Then begin breaking this task down into its component parts. The robot must find the kitchen (don't laugh, that can be non-trivial, at least in my house), then find the refrigerator, then get the door open, find the beer, grab the beer, stash it somewhere safe, close the door, find its way out of the kitchen, find the living room (see above), find the sofa, move to (but not into) the sofa, and finally announce that the beer is served.

But a beer-fetcher is beyond the scope of a beginner article; sorry about that. Instead, I'll content myself to taking you through the design and construction phases of a small robot patterned after Arnold. Arnold is a robopet that wanders around my living room. It has fairly reliable object detection (in the form of bumper switches and an IR reflector system) so it almost never gets trapped in a corner. It uses two small hobby servo motors, modified to spin continuously, for its drive system; power is provided by four AA alkaline batteries. Finally, its brain, built around a small 68hc11 computer board, executes a program written in a Basic dialect to coordinate all its functions. Refer to the accompanying table of Arnold's design.

My original Arnold robot used a plastic frame designed and sold by Marvin Green. Dubbed the "BBot Frame," this circular plastic platform sports a clear plastic dome and a one-inch high bumper skirt that hangs around the frame's mid-point. Marvin may well still be selling the BBot frames; if so, I highly recommend it as a simple and elegant starting platform. Check his web page for details.

But I'll assume that you don't have access to a BBot frame, or prefer to roll your own, so I'll guide you through the basic elements of frame design and construction. I'm not going to give you step-by-step instructions, and you won't end up with a finished frame using only this article, but you'll understand the major problems of simple frame design and a couple of ways to attack them.

Many beginners start off by designing a frame that is too heavy or too large, or both. All of the components in Arnold, except the frame, weigh less than a pound. Using a three-pound frame to carry 12 ounces of electronics and batteries is gross overkill.

Besides being inelegant, an over-sized frame can prevent your robot from even working at all. Remember that your motors must provide motive power to carry the robot's full weight. Extra frame weight means larger motors and heavier wheels and drive system. This, in turn, means you need a beefier battery to get the same amount of running time, which adds still more weight. This vicious spiral, if left unchecked, can lead to a 100-pound robohog that gets 12 minutes of running time from a fully charged car battery.

Before you start your first robot design, resolve to build the lightest frame you can. If you build a light frame and experimentation shows it's too light, fine. You can always use the light platform as a template for making a sturdier second frame. But building the first version too heavy can prove very frustrating, and has ended more than one robot project.

There are many light frame materials available. The lightest by far is brass rod, available from the local hobby or hardware store. I use pliers to bend the rod to the desired shape, heavy nippers or horseshoe nail clippers to cut it to size, and a heavy-duty soldering gun and rosin-core solder to weld the pieces together. If you need to buy a soldering gun for this material, pick up a Weller gun rated at 100 watts or better. Note that you will NOT use this gun for soldering delicate electronics; it is only for welding brass and copper material.

Speaking of copper material, the blank copper printed circuit board (PCB) stock, available from many mail order houses, makes a terrific frame material also. Very light for its weight, you can cut the thinner stock with sheet metal shears or a hacksaw, drill holes in it easily, and weld brass rod directly to it. Go with the thinner material, say 0.062 inches thick, for your first robot.

There are other advantages to using copper-clad and brass rod as frame material. Many hardware stores carry brass hardware, such as nuts and screws. You can weld these onto the PCB material, then bolt other hardware to the frame using these threaded fasteners. And many surplus shops carry brass spacers, which weld easily to the brass rod and copper PCB.

I also use foamcore for making robot frames. This is a laminate of paper and rigid foam, available from many art supply stores. You can cut it easily with anything from a razor saw to a sharp knife. It

Modifying a Futaba FP-S148 Hobby Servo Motor for Use as a Robot Motor

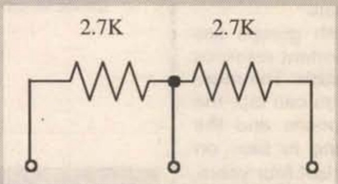
In the following instructions, "front" means the part of the motor case that encloses the motor's output shaft (and has the Futaba label on it); "back" means the opposite side of the motor case.

You will need:
Jeweler's screwdrivers (Phillips)
Small solder iron
Solder sucker
Needlenose pliers
Diagonal cutters
Two 2.7K ohm, 1/4-watt resistors (you could probably use 2.2K ohm resistors in a pinch; those are Radio Shack 271-1325)

1. If your motor already has some form of mechanical coupler device screwed onto the end of the output shaft, remove it.
2. Remove the four screws from the back of the case.
3. Remove the front and back covers.
4. Remove nylon center (top) gear and nylon gears on output shaft and motor shaft. Try not to disturb or wipe off any of the white grease on the gears.
5. Using diagonal cutters, carefully trim and remove the nylon spur on the surface of the large output gear. This spur normally limits the servo's movement to an arc of about 270 degrees. Make sure you remove the spur completely. You must not leave any chunks of nylon that might prevent the output gear from rotating freely.
6. Pry off the bronze sintered bushing from the plastic hub around the potentiometer (pot) shaft.
7. Remove the two small screws on either side of the motor shaft.
8. Firmly press on the pot's shaft to push it back through the servo's case. This should push the pot and the printed circuit board (PCB) out the back of the case.

WARNING: DO NOT pry on the PCB at all! DO NOT push on the motor's spindle!

9. Remove the pot from the PCB by carefully heating its connections, then removing the excess solder with a solder sucker. Work carefully and do not damage the PCB's traces.
10. Install two 2.7K resistors, wired in series, in place of the pot. The two resistors will appear to the servo's circuit as a 5K pot rotated to its center position. Refer to the following schematic:



where the Os represent the solder pads that previously held the pot's leads. Make sure you install the junction of the two resistors in the center pad on the PCB. Trim the leads so the resistors will fit inside the case when you later re-assemble the motor. Make sure you don't accidently short any traces on the underside of the PCB when you solder the resistors in place.
11. Carefully re-assemble the servo motor. Simply reverse the above steps for disassembling the motor.

ARNOLD, a small robopet

Sensors	Bumper skirt, 360-degree coverage Reflective 40 KHz IR object detection system, 150-degree coverage
Actuators	Two R/C hobby servos, modified for full rotation
Controller	68hc811e2 MCU (2048 bytes EEPROM, 256 bytes RAM) Programmed in 68hc11 SBasic
Power	Four AA alkaline batteries

weighs next to nothing, yet provides amazing strength. You can draw on it with a pencil, poke holes into it with an awl or a nail, and hot-glue odds and ends to it easily.

The big brother to foamcore is Gator-board. Also available at industrial art supply stores, Gator-board looks just like foamcore and weighs about the same, but it sports a tough plastic skin rather than paper. You will need a coping saw or a jigsaw to do a good job of cutting Gator-board, but you will like the end results. The material wears very well, is light but very strong, and hot-glue sticks to it well.

Your first robot shouldn't require anything more substantial than Gator-board or copper-clad as a frame material. If you need a heftier base material for a later robot, check out Sintra plastic. This is an opaque foam-based plastic, available in sheets of 1/4" thickness in various colors. It cuts with a saw, jigsaw, or even a tile knife, drills easily, and takes hot-glue well. It offers excellent strength for its weight, and you can usually find good-sized pieces in the scrap bin of your local plastics shop.

After choosing your frame material, you need to look into fasteners. My fastener of choice for small robots is hot-glue. You can pick up a suitable hot-glue gun from nearly any hardware store, and most stores sell a variety of glue sticks for different surfaces.

While you're out, pick up a roll of double-sided foam tape. You can find this invaluable tool at most hobby stores, and a few bucks worth will last you for several robots. To use the tape, simply cut a piece to length with an X-acto® knife, peel the tape of the roll, stick it to one surface, peel the paper off the other side of the tape, and stick the second surface to it. I use foam tape for mounting everything from battery holders to servo motors. It holds light objects very well, though you need to ensure both surfaces are clean and free of grease.

My next fastener of choice is nylon cable ties. You can find cable and wire ties at any Radio Shack and most large hardware stores. Get a variety of lengths, including 4" and 6". A bag of 40 ties will last you through several 'bots, and you can sometimes get the ties in wild colors, which can add a little pizzazz to your design.

In some cases, I can't avoid using threaded hardware of some type. If my frame design uses copper-clad, I'll go to brass spacers and bolts if necessary. In nearly all other instances, I'll turn to nylon or fiber spacers. You can hot-glue these spacers in place, and the threaded spacers make it easy to mount circuit boards to nearly any surface. Often, you can find nylon spacers and bolts at the larger hardware or hobby stores, and sometimes the mail-order houses will stock a few.

As you can see from the above list, all of my frame materials and all of my fasteners have one element in common; they are lightweight. It doesn't take many pieces of aluminum or steel hardware to boost the weight of your robot to an unacceptable level. Stay with the lighter materials and you'll build a lighter, faster, longer-running robot.

Next up is batteries. Small, light robots don't need a lot of juice, and most of my small machines run just fine on four AA alkaline batteries. I don't use NiCd batteries for a few reasons. First, a NiCd cell only puts out 1.25 VDC, not the 1.5 VDC available from alkaline cells. This difference may seem small, but it means that four NiCds only yield 5 VDC when fully charged, compared to the 6 VDC available from fresh alkalines. This one-volt delta translates into longer running time for both the motors and the electronics. And NiCd cells can exhibit what many people term a "memory effect," wherein the cells seem to go flat after shorter and shorter periods of use. The newer Renewal alkaline batteries, which I prefer, can be recharged up to 25 times and don't show this irritating behavior. Note that you MUST use a Renewal charger to recharge Renewal batteries; don't try to use a NiCd or other charger on these cells. Also, do not run a Renewal battery all the way down; this will effectively kill it. I've used the same Renewals for over three years now, and only had to throw away about eight. Four of those fatalities occurred because I accidentally drained a set down to zero.

To hold the batteries in your robot, you need a battery holder. Radio Shack sells a good assortment of holders made of nylon or similar light material. You'll likely only use the four-cell AA holders for your first robots, but it wouldn't hurt to pick up some two-cell holders and even some of the long, skinny four-cell units. These varieties give you greater flexibility in designing your robot frame, since you can build around the different holder shapes.

WARNING!

The BOTBoard was designed to use a servo other than the Futaba S148 used here. The power wiring for the servo motor is reversed from that needed by the Futaba. If you plug a Futaba S148 into the BOTBoard without changing the servo's wiring connector, you will burn up the servo!

The servo wiring connector is originally in white-red-black order. To modify the wiring connector, simply reverse the power (red) and ground (black) leads in the connector shell. You can do this by CAREFULLY prying up the black plastic finger that holds the red lead in place, then pulling the red lead out of the shell. Do the same for the black lead. Now swap the leads and push each back into the connector shell. Properly done, the connector wires should now be in white-black-red order.

Let's move on to motors. For beginners, nothing beats the Futaba S148.00 hobby R/C servo motors. These go for about $16.00 each from Tower Hobbies (1-800-637-6050) and using them in your robot offers some real advantages. First off, they are compact, rugged, and fitted into a sturdy, cool-looking case. Next, the hobby world carries plenty of gadgets and doodads already designed for use with hobby servos, so attaching devices to your servo motors will be cheap and easy to do. Finally, these motors offer 42 oz/inches of torque in a small, 6 VDC package. The rotational speed isn't all that great, but you can't beat the convenience and flexibility.

Unfortunately, hobby servos are designed to go back and forth, since they normally control flaps and other such airplane things. For robots, they need to go round and round. The conversion from back and forth to round and round isn't tough to do, but you need to work carefully. I've reprinted instructions for one type of conversion here. Other methods exist, such as grinding down the shaft of the servo potentiometer, but these require more care than the technique I've outlined here.

After you've modified two motors, you are ready to cut the platform material to shape. For your first robot, start with a square base roughly four inches on a side. Cut a piece of foamcore or Gator-board to size and smooth the edges if necessary. Place the motors at one end, aligning them so the shafts protrude far enough beyond the edges of the base to give good clearance for the servo control horn. When you are happy with the motor's alignment, cut two pieces of foam tape for each motor, apply the tape to one surface of each motor, then press the motors back onto the foamcore in the previous positions.

Next, flip the platform over so the motors are on the base's underside, then position the battery holder on the top of the base, slightly forward of center. Fasten the holder to the base's surface using foam tape.

Now you need to add some wheels to the motors. Most hobby stores carry suitable wheels; I've always been happy with Dave Brown's LiteFlite wheels. These are a foam wheel, available in several different diameters. Choose a pair of wheels 2.5" or so in diameter for this first machine.

To mount a wheel onto a servo control horn, remove the control horn from the servo, then put the mounting screw back into the larger circular control horn that came with your Futaba servo kit. Trim a couple of pieces of foam tape to about 1/4" wide, then stick them onto the outer surface of the control horn. These pieces of tape act as a shim, leaving enough gap between the control horn's surface and the wheel so later you can tighten or loosen the mounting screw.

Working carefully, align a wheel against a control horn and press the wheel into place. Make sure the wheel is centered exactly on the control horn, with the wheel's bore exactly over the center of the mounting screw. If your first try doesn't match up perfectly, pry the wheel off the control horn, replace the tape if necessary, and give it another shot. When properly mounted, you should be able to slip a small Phillip's screwdriver through the wheel's bore and tighten the mounting screw onto the servo's output shaft. If the screwdriver reaches the screw, but the screw won't turn easily, you may have to remove the wheel and slightly countersink the wheel's hub around the bore next to the control horn. Re-assemble the wheel and control horn.

After you've mounted the wheel to the control horn, run a bead of hot glue around the edge of the control horn where it meets the hub of the wheel. Perform the same operation for the second wheel, then mount the two wheels onto the robot's servo motors.

You have several options for the robot's front end. I usually stick a small caster onto the front underside of the frame, using foam tape to hold it in place. If you use such a caster, you will probably need to shim it out from the platform, so the platform sits level. You can also make a skid out of a large, colorful drawer knob. You'll find these at nearly any large hardware store, and the knob kit, which usually sells for less than a buck, includes a long mounting screw. To mount such a skid, just find or cut a piece of plastic tubing or spacer to the proper length, poke a hole in the platform at the proper location, and use the screw to bolt the whole assembly in place. Alternatively, you can mount the skid onto a separate piece of foamcore, about one inch square, and stick this foamcore to the underside of the platform where needed.

Now you have most of the base finished. Take a moment to check its weight. This base is suitable for many robopet projects, but weighs very little. Next month, I'll take you through the electronics involved. You can use nearly any small computer board to drive this machine. I usually stick one of Marvin Green's BOTBoards on my robopets; check his web page for distributors, or stop by Mondotronics. **NV**

As always, you can reach me at:
Karl Lunt
116 173rd St. S.W.
Bothell, WA 98012
E-Mail: karllunt@seanet.com
Web: http://www.seanet.com/~karllunt

DO YOU have a TEK 7D15? Get the special RF input cables SMB to BNC female 2 for $24.95 ppd. Four Designs 360-887-1555.

NTSC VECTOR SCOPE SALE: Tektronix 520A $400. AST Global Marketing, Meadville, PA 16335. Phone: 814-336-2138; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

SUCTION DESOLDERING stations: (pump built-in) Weller DS1000 digital readout $450; Pace MBT200 $400; Pace rework $300; Hakko 483 Ace with Pace pencil $200; (air powered): Ungar 2000 $150; Weller DS500 $200. Hart 200A SMD rework $1,000. Soldering stations: Hexacon $45; Weller WTCP $45; EC2000ESD $100; EC2001ESD $150; EC4000 18 watt digital $100; GC Xytronic $45. Lindstrom dyke, needle-nose $10. Jim 310-515-2058.

HP 400EL AC voltmeter $95. Also misc. PD & HP power supplies. Ed Matsuda 619-479-0225 E-Mail: ematsuda@themall.net

FOR SALE: HP 86235A sweeper plug-in 1.7-4.3 GHz, $400; Sorenson SRL-40-25, $500; HP 628A sig. gen. 15-21 Ghz, $300; Tektronix P6046 probe, $400; HP 3575A, phase gain, $750; Tektronix 575 curve tracer, $450; HP 415E, $150; Fluke 8810A, $200. A-Comm Electronics 303-290-8012. Fax 303-290-8133. E-Mail: ACOMM@worldnet.att.net Visit our web site at http://www.a-comm.com

TEKTRONIX 576 curve tracer $1,500, 4041 computer controller with all instructions new in box $1,000, also other Tektronix, Hewlett Packard, Fluke, Bell, Leeds and Northrup test equipment. Plus Electro Voice and Astatic microphones. Ed Davis, Box 203, West Baden, IN 47469. 812-936-9611.

FREQUENCY METERS: AN/USM-159A 125KC-1.0GHz $149. General Microwave N604 1.9-4.0 GHz $139. HP 5210A $99. P532A 12.4-18 GHz $129. Precision variable attenuator X382A 8.2-12.4 GHz $99. HP 3581A wave analyzer 15Hz-50KHz $379. Struthers Electronics 1219D-001-G1 thruline wattmeter 2MHz-1.0GHz $850. Scott's Electronic Surplus. 562-491-3181.

EIP 451/P1/P2/P5 automatic CW/pulse 18.5 GHz counter $800. Psitech Plus 707-745-4804, Fax 707-747-5277.

FEITEK PROVIDES repair, calibration and certification on many makes of test equipment. We also have a large selection of used equipment. Send large SASE envelope for list. VISA and MasterCard accepted. Feitek Inc., 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

WANTED! TEST equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. 1-800-432-3424.

NIGHT VISION kits. See our classified ad in Plans/Kits/Schematics. NENVIS 508-347-7238.

HIGH VOLTAGE equipment, misc. precision test equipment, rubidium oscillators. http://www.vigilante-electronics.com or 212-243-7964.

CABLE TV converter test equipment, Wavetek 1405 and 1402 generators, Wavetek 1901C display scopes and many other items. Ph. 561-747-3647, FAX 561-575-4635.

PROGRAMMABLE FREQUENCY GENERATOR PFG100 10Hz-10KHz squarewaves sequenced at selectable rates. $320. Actioncraft, 714-998-7117.

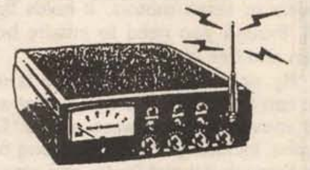
SECURITY

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

PAGER OWNER! Use your pager as a security monitor to monitor your burglar alarm and telephone answering machine using Pageout automatic paging system $99.99. Other systems available. Call 410-483-6211. http://www.worldprofit.com/maateez.htm

ICOM COMMERCIAL equipment bought, sold, and repaired by factory authorized distributor. GSA, export, warranty service, fleet maintenance. Two way, new R8500 and R10 receivers. Dealer prices to all. No amateur. SWS Security 410-879-4035, Sales@swssec.com

SECURITY CAMERAS: CCTV equipment Panasonic, Pelco, Vicon, Videolarm, AMD. **CAMERAS:** B&W + color from $50. Over 200 available. **LENSES:** From $20. **ZOOM LENSES:** $75 up. **CAMERA HOUSINGS** and **DOMES:** $40. Quads, **Switchers, multipliers**, pan + tilts, **IR Lites**, mini-systems. All equipment new in boxes. **SAVE 50% WHOLESALE** prices. Rick 617-933-0827.



COUNTERSURVEILLANCE = $250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTERSURVEILLANCE! For free catalog call: **1-800-732-5000.**

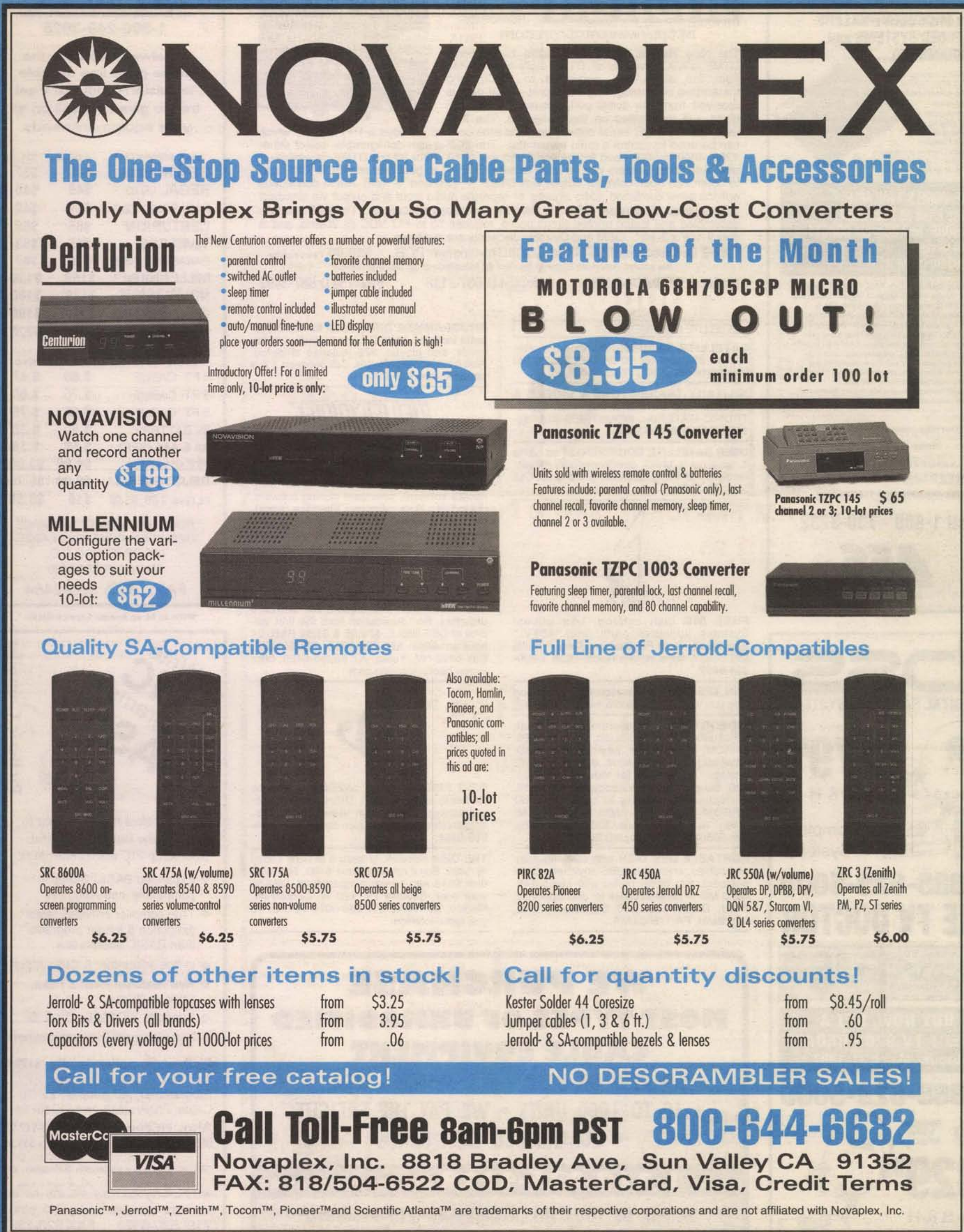
PROFESSIONAL ALARM control panels and all equipment. For a free catalog: voice or fax: 908-840-1390.

CSD-18, SBD-5 countersurveillance equipment from Great Southern Security with case + extras! Trade for sweep function generator. Send specs: 2162 Leghorn St., Mountain View, CA 94043; 415-237-4926, weekdays.

SATELLITE EQUIPMENT

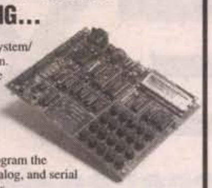
DSS HACKING: How to construct and program smart cards, w/PIC16C84, software. Complete DSS system schematics. $16.95. CABLETRONICS, Box 30502N, Bethesda, MD 20824.

SATELLITE RADIO BOOK AND GUIDE. New book covers all Audio Services, SCPC, Subcarriers, FM Squared, Facsimile, Press Services, Weather Services. Simple how-to-receive instructions. $16.95 plus $3 Priority Mail. UNIVERSAL ELECTRONICS, 4555 GROVES ROAD, #12, COLUMBUS, OH 43232. 614-866-4605.



Write in 103 on Reader Service Card.

Learn MICROCONTROLLERS EMBEDDED SYSTEMS and PROGRAMMING...



with the AES learning system/ embedded control system. Extensive manuals guide you through your development project. All programming and hardware details explained. Complete schematics. Learn to program the LCD, keypad digital, analog, and serial I/O, for your applications.

THREE MODELS AVAILABLE. Choose from an Intel 8051, Intel 8088, or Motorola 68HC11 based system. All models come with:

•32K Byte ROM, 32K Byte RAM • 2 by 16 Liquid Crystal Display • 4 by 5 Keypad • Digital, Analog, and Serial I/O • Interrupts,timers, chip-selects • 26 pin expansion connector • Built-in Logic Probe • Power Supply (can also be battery operated) • Powerful ROM MONITOR to help you program • Connects to your PC for programming or data logging (cable included) • Assembly,BASIC, and C programming(varies with model) • Program disks with Cross Assembler and many, well documented, program examples • User's Manuals: cover all details(over 500 pages) • Completely assembled and ready to use • Source code for all drivers and MONITOR • Optional Text Book

Everything you need. From $279
Money Back Guarantee
Call for Free Info Pack, or see
WEB at http://www.aesmicro.com
714-550-8094,FAX 714-550-9941

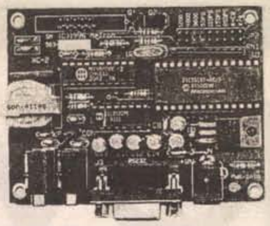
Call 1-800 - 730-3232

AES Advanced Educational Systems

AES 970 W. 17TH STREET, SANTA ANA, CA 92706, USA

MoTron **XC-2** DTMF To ASCII Transceiver

http://www.motron.com



The New **MoTron XC-2** is a versatile bi-directional DTMF to ASCII transceiver. DTMF digits are decoded from the audio line, converted to ASCII, and transmitted out through the serial port. ASCII data is received from the serial port, converted to DTMF digits and transmitted on the audio line. The **XC-2** uses the RS-232C serial communications protocol and includes a PTT output, which can be used to control a radio transmitter. The **XC-2** is user-configurable--select either 1200, 4800 or 9600 baud for the serial port and 5, 10, 15 or 20 cps DTMF transmission rate. Additional jumpers can be used to set DTMF "#" to generate an ASCII "CR", and to control an open-collector output with DTMF "*" (on) and "#" (off). Audio connection options allow combined audio signals, or separate audio input and output via standard 3.5mm jacks. A standard DE-9S is used for serial communications. The **XC-2** is a fully assembled and tested printed circuit board, requires +8 to +17 VDC @ 200ma, and is only 2-1/2" x 3-1/2". OEM and Quantity discounts are available.

XC-2 Bi-Directional DTMF to ASCII Transceiver PCB **$99.00** Plus Shipping

We accept American Express & Visa & MasterCard & Discover/Novus

Orders: (800) 338-9058 Info: (541) 687-2118 Fax: (541) 687-2492

SATELLITE EQUIPMENT *cont.*

SATELLITE EQUIPMENT available: Receivers $35 and up; 20-25 LNB $35; C-KU feed horns $65. Call 757-599-4408.

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

USED SATELLITE EQUIPMENT. You name it, we have it. LNAs, downconverters, drives, receivers. Working condition guaranteed. Call 317-385-2305.

FREE BIG dish catalog. Low prices! Systems, upgrades, parts...and **"4DTV." Skyvision**, 1016 Frontier Dr., Fergus Falls, MN 56537. www.skyvision.com **Call 1-800-334-6455.**

DSS TEST card information and everything else you want. Call Boxcom 1-800-345-7800.

VIDEOCYPHER II descrambling manual, schematics, video, and audio. Explains DES, EPROM, CloneMaster, pay-per-view (HBO, Cinemax, Showtime, Adult, etc.) $16.95, $2 postage. Schematics for Videocypher Plus, $20. Schematics for Videocypher 032, $15. Collection of software to copy and alter EPROM codes, $25. VCII Plus EPROM, binary, and source code, $30. Cabletronics, Box 30502N, Bethesda, MD 20824.

PORTABLE DBS DISH with carrying case and cables, enjoy your DBS anywhere. $185 postpaid. Sat finder meter with audio $45. Send MO or certified check to: J&B Specialty, Prod. Dept. 160, 590 Centerville Rd., Lancaster, PA 17603 USA.

PROGRAMMER DIAGRAMS for DSS systems includes parts list, for L-cards, battery cards, and plastic. $75 includes shipping. Also have some software. Call between 7 & 9 pm EST. 304-776-6717.

TELECODE™

DSS BIBLE II (Volume 2) new book & software. Release date 2-10-97. Covers: U161 EEPROM memory map, smartcard emulator plans, smartcard reader plans, receiver diagnostics software, smartcard cloning software, diagnostics data computer interface, smartcard traffic monitor, 2nd generation receiver service information, IBM Java smartcard Applet source code, ISO 7816 full protocol & specifications, Videocrypt system overview, connecting PC to 7816 smartcard, encryption, problems, security, 24C16 EEPROM specifications, EEPROM "modification" & much more! Over 200 pages & 267 files on 6 diskettes. **No** duplication from the first volume of DSS BIBLE. **$79.95 & $5.50 P&H.** 24 hour orderline: 520-726-2833. **TELECODE,** Box 6426-NV, Yuma, AZ 85366-6426. http: //www.hackerscatalog.com

BEST PRICING on 18" satellite TV systems for home and RV. DSS, DISH Network programming, multi-room viewing options, accessories. www.skyvision.com **Call 1-800-500-9264.**

THE DISH Network. U seen it in USA Today @ $499. Buy it now and save $100. The minidish $399 with 1 year programming. UPS to your door. Satellite TV, 120 W. Centennial, Muncie, IN 47303. 317-288-0074 11-5 E. 15 yrs. same location.

QB VIDEO

1-800-249-3025

As always we carry the same great line of cable television products. Feel free to give us a call on all your equipment needs.

BASIC CONVERTERS	SINGLE	10 LOT
GEMINI AD6000	$45	$37
REGAL CR-83	$49	$40
PANASONIC 100-3	$59	$49
CENTURION	$65	$58
TIMELESS	$65	$58
PANASONIC 145-3	$75	$67
MILLENNIUM 3	$159	$130
NOVAVISION	$189	$160
PANASONIC 175-3	$229	$190
MAESTRO	$279	$225

ACCESSORIES	SINGLE	20 LOT
1 FT. CABLE	$.60	$.47
3 FT. CABLE	$.75	$.60
6 FT. CABLE	$.90	$.75
9V BATTERY	$.50	$.38
AA & AAA (2PK)	$.50	$.38
18V AC ADAPTER	$4.00	$3.00
REMOTES FROM	$8.00	$5.75
FILTERS 2-28, 95-99	$10	$8.50

PRICES ARE SUBJECT TO CHANGE
SHIPPING/HANDLING WILL BE ADDED
UPS OR FEDEX C.O.D.
MINIMUM ORDER $80
FAX: (800) 568-2464

Write In 84 on Reader Service Card.

DSS™ DIGITAL SATELLITE SYSTEM

$279.95 + S & H
Complete System

1-888-629-5000

THE TV DOCTOR

VHS INSTALLATION TAPE $6.95

BUY NOW, GET A DIRECT TV $200 REBATE
Expires March 31, 1997

1-888-629-5000

$329.95 + S & H
Complete System

WE PURCHASE

MOST TYPES OF UNMODIFIED CABLE EQUIPMENT

• NEW OR USED • U.S. SYSTEM - NTSC
• 10 TO 1000 UNITS • WE PAY THE FREIGHT
• GUARANTEED CASH FUNDS

PHONE **1-219-935-4128** ASK FOR PURCHASING

OR FAX US YOUR INVENTORIES AT: 219-935-0010

NATIONAL CABLE SERVICES

Write PIC programs in BASIC! $99.95

PicBasic Compiler

BASIC makes it easy for you to program the fast and powerful Microchip PIC microcontrollers.

- Expanded BASIC Stamp 1 compatible instruction set
- True compiler provides faster execution & longer programs than BASIC interpreters
- In-line assembler & Call support
- *New Features!* Peek & Poke, I2Cin & I2Cout
- Supports PIC16C6x, 7x & 8x
- Use with most PIC programmers

PicBasic Compiler Bundle - $179.95
Includes: PicBasic Compiler, EPIC Programmer, AC Adapter, 25 Pin Cable, PICProto18 and PIC16F84

Also: PICProto Boards - $8.95-$17.95
EPIC Pocket PIC Programmer - $59.95

*BASIC Stamp is a trademark of Parallax, Inc.

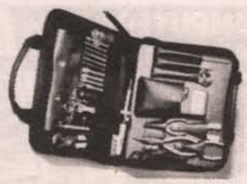
microEngineering Labs, Inc.
Box 7532 Colorado Springs CO 80933
(719) 520-5323 FAX 520-1867
www.melabs.com

Write In 158 on Reader Service Card.

Write In 164 on Reader Service Card.

FOR THE BEST PRICES ON PROFESSIONAL TOOLS, CALL ELECTRO-TOOL

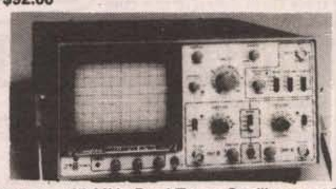
platt – Case – Deluxe Polypropylene. Chemical Resistant. Tools by CooperTools and others. 800T Case, complete with tools . . . **$389.99**
800T Case Only. . . **$114.80**



platt – Case – Cordura Exterior. Two exterior pockets & one literature pocket. 660ZT Case, complete with tools . . . **$208.00**
660ZT Case Only. . . **$57.40**
Optional Sperry meter #DM6510 as shown . . . **$63.95**

Weller WCC100- Electronically controlled station, temperature adjustable from 350°F-850°F, Zero voltage circuit-safe for sensitive components, 40 Watt pencil . . . **$92.00**

OptiVISOR – Superior magnification, Optical Glass Prismatic lenses, (not plastic) Select any one of (6) magnifications . . . **$22.50**



GoldStar – 20 MHz Dual Trace Oscilloscope OS-9020A-Large 6" rectangular, high sensitivity: 1mV/div, high accuracy: ±3%, stable, low-drift design, 8 divisions of displayed dynamic range and accurate, distortion-free waveform measurements . . . **$370.80**

Electro Tool, Inc.

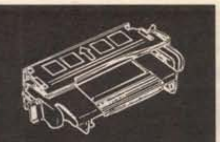
9103 Gillman, Livonia, MI 48150
Customer Service: (313) 422-1221
ORDERS ONLY: 1 (800) 772-3455
"Tools American Made."

VISA MasterCard

Write in 42 on Reader Service Card.

Toner Cartridge Recharge

& Laser Printer Supplies



Three Ways to Earn Cash

You Do It Dealer Program 1

You do the recycling work, and we'll supply all the materials, training, and technical support.

- Supplies cost from $6 each
- Free Directions
- 1 Free Video Training Tape
- Starter Kit-approx. $500 supplies for 36 recharges
- For complete information, see Fax document# 2040*

We Do It For You Dealer Program 2

You ship us your customer's toner cartridges and OPC cartridges, and we'll recycle them at a reduced price for you.

- Attractive Marketing Flyers with your name available
- Fast Turnaround
- Generic Packaging
- See Fax document# 2092*

We Do It For Your Customer Dealer Program 3

You recommend us and give literature with our name to your customer. We'll deal direct with your customer. You have your code on our prepaid shipping label.

- You earn commission
- You recommend us
- Prepaid UPS shipping labels
- For complete information, see Fax document# 2090*

*To obtain Fax documents, use our Fax-On-Demand system. Call 516-467-0772 from any Fax machine equipped with a touch-tone phone, 24 hrs/day, 7days/week. Dial document# 4633 for an index.

CP CHENESKO PRODUCTS
Chenesko Products Inc.
2221 5th Ave., Suite 4, Ronkonkoma, NY 11779
Phone: 516-467-3205 E-mail: chenesko@aol.com
Fax: 516-467-3223 Fax-On-Demand: 516-467-0772
800-221-3516

Write in 81 on Reader Service Card.

Learn by Example!

The PRIMER 8085 Based Microprocessor Training and Control System shows you how to program by example. Program examples take you from writing simple programs to controlling motors. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade ($49.95). The Upgrade includes: an RS232 serial port, a serial cable, 32K of battery backed RAM and Assembler/Terminal software.

EXPERIMENTS USING THE PRIMER INCLUDE:

- Measuring Temperature
- Using a Photocell to Detect Light Levels
- Making a Waveform Generator
- Constructing a Capacitance Meter
- Motor Speed Control Using Back EMF
- Interfacing and Controlling Stepper Motors
- Scanning Keypads and Writing to LCD/LED Displays
- Using the Primer as an EPROM Programmer

The PRIMER is only $119.95 in kit form. The PRIMER Assembled & Tested is $169.95. Please add $5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad ($29.95) installed.

EMAC, inc.
1985 - 1996 OVER 10 YEARS OF SERVICE
P.O. BOX 2042, CARBONDALE, IL 62902
618-529-4525 Fax 457-0110 BBS 529-5708

Write in 120 on Reader Service Card.

NIGHT VISION kits. See our classified ad in Plans/Kits/Schematics. NENVIS 508-347-7238.

PROJECTION BULBS: For overhead, slide, movie projectors; spotlights. Hundreds in stock at huge discount. 510-569-3619 voice/fax.

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

INSTRUCTIONAL HOW-TO VIDEOS/CD-ROMs. 7,000 on-line product catalog for preschoolers to graduate students. Something for everyone. Internet at: **http://www.totalmarketing.com/alcar1ml**

WANTED: PRO video equipment, VTRs, switchers, cameras, etc. Advanced Media 702-727-0498.

ARGON LASER, Spectra-Physics mod. 161B w/PS. 488 NM 16 MW $500 + frt. or int. trade. 210-774-1699 after 5pm CT.

PRO AUDIO, video & projection equipment for sale!! Microphones, mixers, switchers, cameras, monitors, TBCs, tubes, slide & film projectors & lenses. Great buys for the smart shopper. Call Tom for a detailed list. Tel 609-222-0636 Fax 609-222-0638.

LIGHTED OUTSIDE sign/electronic message center for advertising made by McKay Data Systems. Programmable. Has time, temp., your message. Fabulous advertising, very reliable. Includes lots of spare bulbs, program, all docs. Two units. $2,000 together. Bob 318-448-3206.

NVG, INC. offers a complete line of OEM laser modules, including all NM bands, low & high MW, as well as the world's smallest 6.4 module. Most are stock items, eliminating long lead times and providing fast delivery. Also available are laser diodes and module components. 912-379-9000 x2.

BROADCAST VIDEO equipment wanted: all types, new or old. Please call, Jon with info. 317-539-2859.

LASER RANGEFINDER measures distances up to 1000 meters: 1 yard/meter accuracy. Built into binoculars, 9V battery operated w/LCD display: **$300**. Laser Sensor Technology, 3873 Easy circle, Marietta, GA 30066-2031. 770-928-2867 fax & phone. E-Mail: JClark3873@aol.com

PANASONIC D-5100HS single chip color cameras, with lens and PSU $475. NOVA SYNC 2F full-frame TBCs with digital EFX, $585/offer. ISI cable demod. T-1 thru superband $275. 703-319-1431.

CABLE TV

DESCRAMBLING, NEW secret manual. Build your own descramblers for cable and subscription TV. Instructions, schematics for SSAVI, gated sync., sinewave (HBO, Cinemax, Showtime, UHF, adult) $12.95, $2 postage. Cabletronics, Box 30502N, Bethesda, MD 20824.

CABLE DESCRAMBLER ANYONE can build in **SEVEN EASY STEPS** with **RADIO SHACK** parts. **PLANS/KIT FROM $5 PLUS FREE BONUS. 1-800-818-9103.**

GENUINE UNMODIFIED S/A 8590 $150 ea. 1-800-804-8655. Minimum 5 units.

NEW! VIDEO cassette storage cases now available $1.25 each, plus shipping and COD, 100 piece minimum order black grain finish with interior hubs, call Ken Erny Electronics 24 hour order and information hot line 516-389-3536.

DEALERS! WELCOME. All makes & models available. Call Marco for best deal. 718-358-6237.

TAMPER LABELS: Permanent, tamper proof, "void" & tamper "seals." Protect your sales and repairs. Small or large quantities. Send $1 for sample sheets. D&R Electronics, 10 Park St., Thomaston, CT 06787.

SATELLITE EQUIPMENT *cont.*

SYNC-A-LINK UNIVERSAL VIDEO SYNC GENERATOR restores all horizontal & vertical sync lines, DC level, compensates for inverted video, color phase, from standard or distorted analogue video-type formats. Comes complete with operations manual & 90-day warranty. $160. 918-479-6451 or write to Sync-A-link Communications, PO Box 4, Locust Grove, OK 74352.

OBTAINING SOUND for your **VCII** and **VCII** Plus is easy! No codes needed. Also **DSS TEST CARD** information. **FREE DETAILS** 1-800-211-5635.

Closing Date
For Next Issue – April 10th

MILITARY SURPLUS ELECTRONICS

SG-85/URM-25D $45. TV-7B/U $195. TS1487/ALM23 $195. SG606A $49. AN/URM127 $29. USM281/OS-189 $149. AN/USM117A w/2 plugs $129. USM310/OS-201P $179. AN/USM281A $59. AN/URM-101B $29. TTU229/AE $75. AN/USM206 $21. SG376/U $79. TS1736/AWM-8 $65. TS-382C/U $99. TS-413C/U $79. AN/URM-26A $99, as-is. HP 5245L w/5253B $79. Spare plug-ins $35. Scott's Electronic Surplus. 562-491-3181. FAX: 562-491-3182.

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

DEFENSE TECHNICAL Supply Data CDs. NSNs, CAGE codes, suppliers, precious metal content, part numbers, cross-references, medical, & more. Strategic Technology, 334-889-4637.

AUDIO/VIDEO/LASER

LASERS 3MW all types $25 and up. Laser power supply, brick type output 1450 VDC, 4.0 mA $35. We have lots of robot stuff and stepper motors. 860-267-8763.

VIDEO PROJECTORS: Sony VPH-1031Q 250" multi-scan $2,900. Sony VPH-1030Q 100" multi-scan $2,600. Sony VPH-1020Q 100" video/RGB $2,300. 916-354-1990.

THE AC VOLT

by Ron Tipton

In the US, the DC volt is legally defined by the Josephson array — a super conducting quantum device with a highly repeatable output voltage. (The DC Volt, *Nuts & Volts,* Jan. '97.) Banks of standard cells and temperature-stabilized zener diode references are used by the National Institute of Science and Technology (NIST) to calibrate DC meters for scientific and industrial customers. So how is the AC volt defined?

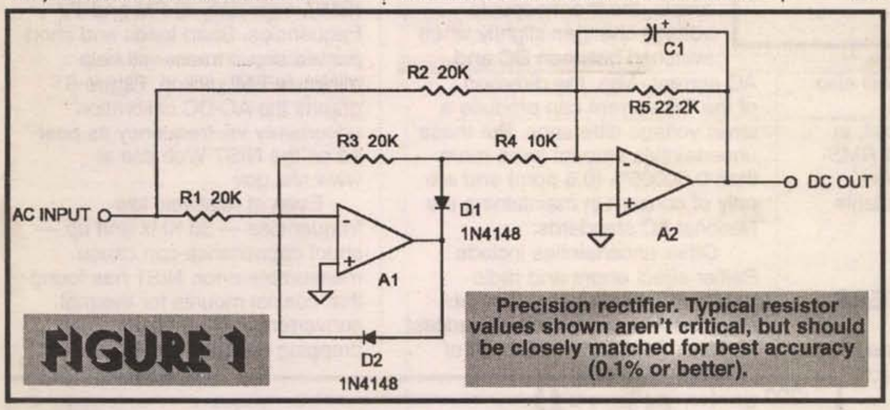
As it turns out, there is no "standard" AC volt in the same way there is a standard DC volt. Instead, the AC volt is defined by conversion to DC and comparison with a DC voltage standard.

The evolution of this conversion is another fascinating story in the quest for ever higher measurement accuracy. And, along the way, I'll give you some pointers on building low-cost AC calibration equipment for your own shop or lab.

PRECISION RECTIFIERS

Although not as accurate as the thermal converters we'll look at shortly, precision rectifiers are widely used. The circuits are inexpensive and quite good enough for "everyday" measurements. Many commercial AC meters are of this type.

The circuit in Figure 1 has been around for many years, but it can be made to perform very well. So how does it work? For positive input signals, diode D2 is off and D1 conducts. Thus, A1 is just a unity gain inverter. This signal is summed with the original input by A2, but because R4 is only 10K ohms, the A1 output is amplified by twice as much as the original input. When the input is negative, D1 is off and D2 conducts. This holds the inverting input of A1 at virtual ground and effectively removes A1 from the circuit. So A2 is an inverter producing a positive output of the same voltage as during the positive half-cycle input. R5 is chosen so that one-volt RMS at the input gives a one volt DC output. And this brings up the interesting subject of average, root mean square (RMS), and peak value measurements.



Precision rectifier. Typical resistor values shown aren't critical, but should be closely matched for best accuracy (0.1% or better).

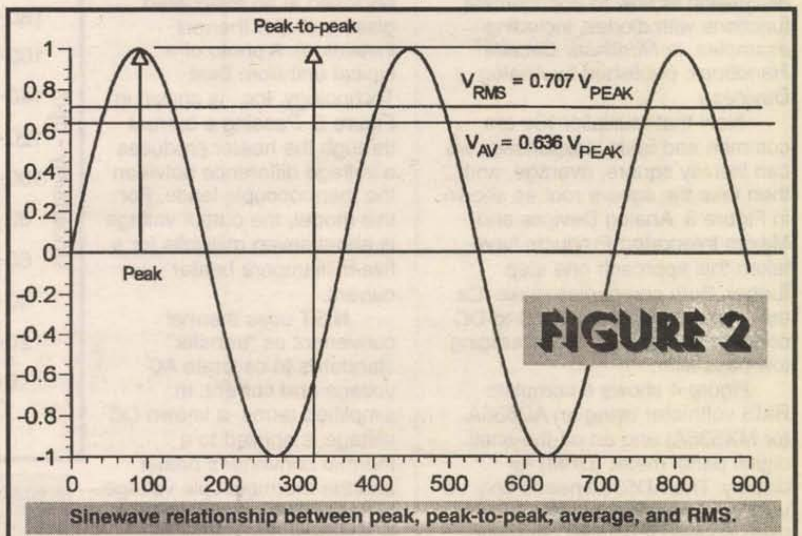
Figure 2 illustrates these relationships; the peak and peak-to-peak values are easy to see and understand.

If all the instantaneous values are averaged over a half-cycle, the result is the average voltage. For a sinewave, $V_{AV} = 0.636\ V_{PEAK}$. With R5 in Figure 1 equal to 20K ohms, the DC output would be the average value. But we usually find the RMS value to be more useful because it is a measure of the energy in the signal. Virtually all AC voltmeters read RMS volts although many are actually average responding (those that use rectifiers).

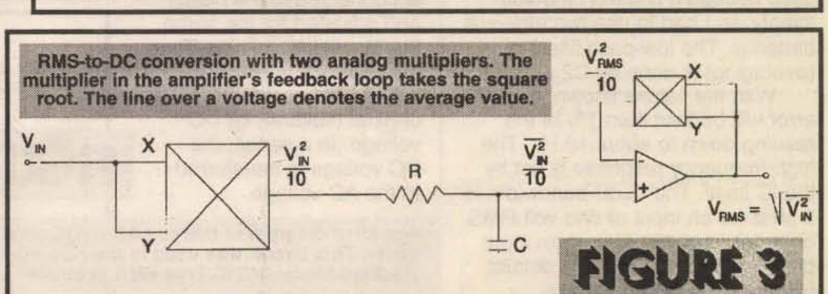
An AC RMS ampere flowing through a resistance produces the same amount of heat as a DC ampere, so this becomes the basis for defining an RMS volt. $V_{RMS} = 0.707\ V_{PEAK}$. By taking the ratio of $V_{RMS}/V_{AV} = 0.707/0.636 = 1.1116$, we get a value of 22.2K ohms for R5 to make the Figure 1 circuit RMS responding (for sinewaves).

Crest factor is the ratio of peak-to-RMS values. This is 1.414 for sinewave inputs (1/0.707), but can be as high as five or more for random noise. Average responding voltmeters are calibrated for sinewave inputs, but loose accuracy when used for other input wave forms (including distorted sinewaves).

There are many other precision rectifier circuits; some use opamps only and no diodes. One or two new designs or variations are published each year, and this is an indication of just how useful and widespread this function has become. Good places to look for new circuits are the "Design Ideas" section in *EDN* magazine and "Ideas for Design" in *Electronic Design*.



Sinewave relationship between peak, peak-to-peak, average, and RMS.



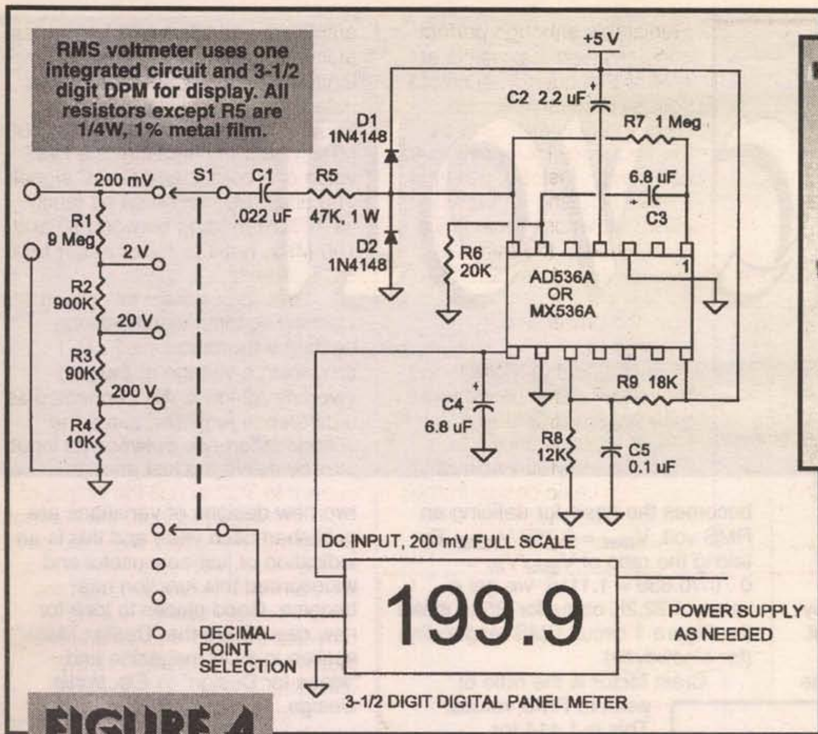
RMS-to-DC conversion with two analog multipliers. The multiplier in the amplifier's feedback loop takes the square root. The line over a voltage denotes the average value.

RMS CONVERTERS

An ideal RMS converter computes the average of the squared input over some averaging time interval and then takes the square root. That is:

$$E_{RMS} = \sqrt{\frac{1}{T}\int_0^T V_{in}^2\,dt} = \sqrt{\overline{V_{in}^2}}$$

This looks worse than it really is because we can perform this



RMS voltmeter uses one integrated circuit and 3-1/2 digit DPM for display. All resistors except R5 are 1/4W, 1% metal film.

FIGURE 4

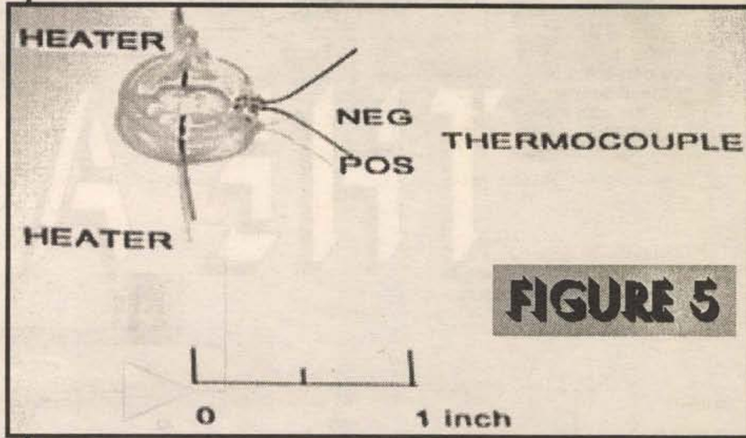


FIGURE 5

Model U.1 vacuum thermal converter from Best Technologies, Inc.; 5 mA through the 90-ohm heater generates a thermocouple output of about 7 mV.

operation electronically in a number of ways.

Many years ago, Ballantine Laboratories designed their model 320 True RMS Voltmeter. It used a series of biased diodes to approximate the "square" relationship between average and RMS. This worked well, but meter calibration was probably too labor-intensive for today's market, so it has been replaced by other techniques. (There is an excellent discussion of how to approximate functions with diodes, including examples, in *Nonlinear Circuits Handbook*, published by Analog Devices.)

Now that multiplier ICs are common and fairly inexpensive, we can literally square, average, and then take the square root as shown in Figure 3. Analog Devices and Maxim Integrated Products have taken this approach one step further. Both companies make ICs that contain the whole RMS-to-DC converter, except for the averaging low-pass filter.

Figure 4 shows a complete RMS voltmeter using an AD536A (or MX536A) and an off-the-shelf digital panel meter (DPM) for display. The AD536A needs only +5 volts for operation, but the DPM I used needed a floating nine-volt supply, so I had to use two nine-volt batteries. The low-pass filtering (averaging) is done by C2 and C4.

With the values shown, the DC error will be less than 1% of the reading down to about 10 Hz. The high-frequency response is set by the IC itself. The -3 dB bandwidth is 2 MHz for an input of one-volt RMS or larger, and 450 KHz at an input of 100 millivolts. For more details, ask the manufacturers for a complete spec sheet. You will also find a wealth of information, including this voltmeter circuit, in the Analog Devices booklet *RMS-to-DC Conversion Application Guide*. (The AD536A is available from Jameco Electronic Components.)

THERMAL CONVERTERS

A thermal converter consists of a resistance heater in contact with a thermocouple enclosed in an evacuated glass bulb (for thermal insulation). A photo of a typical unit from Best Technology, Inc., is shown in Figure 5. Passing a current through the heater produces a voltage difference between the thermocouple leads. For this model, the output voltage is about seven millivolts for a five-milliampere heater current.

NIST uses thermal converters as "transfer" standards to calibrate AC voltage and current. In simplified terms, a known DC voltage is applied to a thermal converter's heater and the thermocouple voltage is read. Then, an AC voltage is connected to the heater and adjusted for the same thermocouple voltage. Thus, the RMS value of the AC voltage is equal to the original (calibrating) DC voltage. In a sense, the DC voltage is transferred to the AC voltage.

Of course, in practice, there are many pitfalls and NIST is continually studying the various uncertainties and new converter designs. For example, the thermocouple voltage changes slightly when switched between DC and AC current. Also, the direction of the DC current can produce a small voltage difference. But these uncertainties amount to no more than 0.00005% (0.5 ppm) and are only of concern in maintaining the National AC standards.

Other uncertainties include Peltier effect errors and radio frequency pickup from other lab equipment or commercial broadcast stations. About one microwatt of heater power can produce 0.1% of rated output voltage in a typical five-milliampere thermal converter. They are rather sensitive to electromagnetic interference (EMI), especially at FM and TV frequencies. Short leads and short printed circuit traces will help minimize EMI pickup. Figure 6 graphs the AC-DC calibration uncertainty vs. frequency as posted on the NIST Web site at www.nist.gov

Even at relatively low frequencies — 50 KHz and up — shunt capacitance can cause measurable error. NIST has found that coaxial mounts for thermal converters and series voltage-dropping resistors are stable and

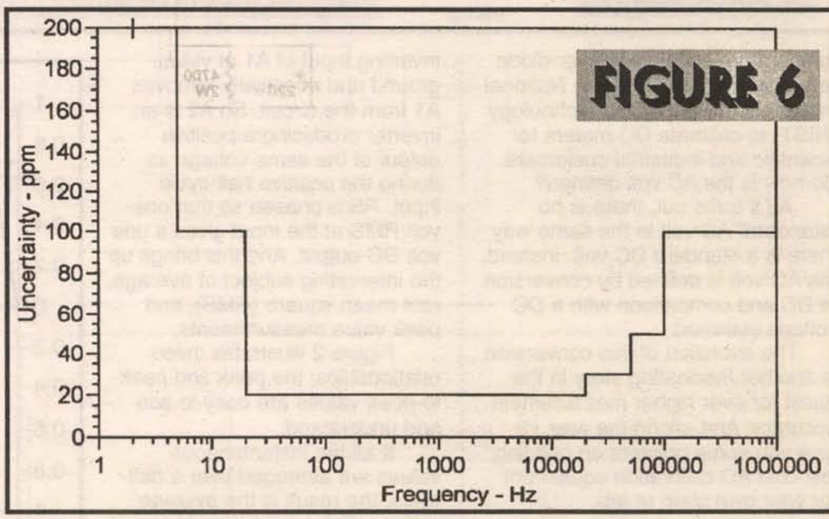


FIGURE 6

NIST AC-DC Calibration Uncertainty for voltages less than or equal to 100 volts, 1ppm = 0.00001%.

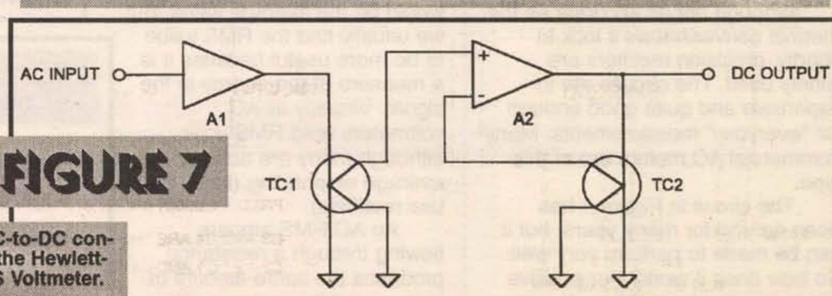
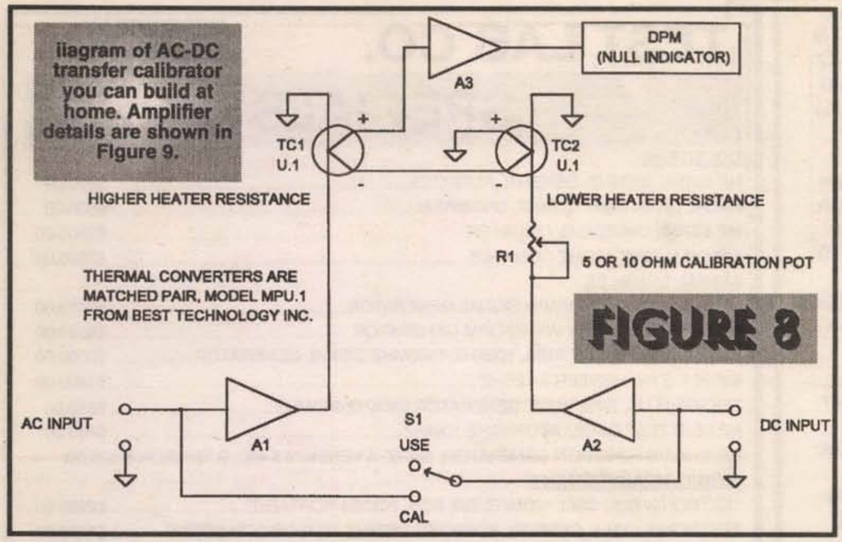


FIGURE 7

Simplified diagram of thermal AC-to-DC converter. This circuit was used in the Hewlett-Packard Model 3403C True RMS Voltmeter.



iiagram of AC-DC transfer calibrator you can build at home. Amplifier details are shown in Figure 9.

predictable although perfect compensation is possible at only one frequency. Accurate voltage measurement becomes very challenging as the frequency increases to 40 or 50 MHz. Instead, power is measured using a thermal converter whose impedance is matched to the transmission line. If needed, the voltage can be calculated from the power and impedance.

Instrument manufacturers also use thermal converters in their RMS voltmeters. A typical circuit is shown in Figure 7. Hewlett-Packard used this basic design in their model 3403C with the converters and associated amplifiers and filters in a heavy cast aluminum enclosure. Although no longer in production, the 3403C is noteworthy because it has a frequency response from DC to 100 MHz, and it will measure the RMS value of a combined AC, DC signal. The accuracy can be off as much as 10% of reading between 50 and 100 MHz, but it is 1% or better from DC to 1 MHz.

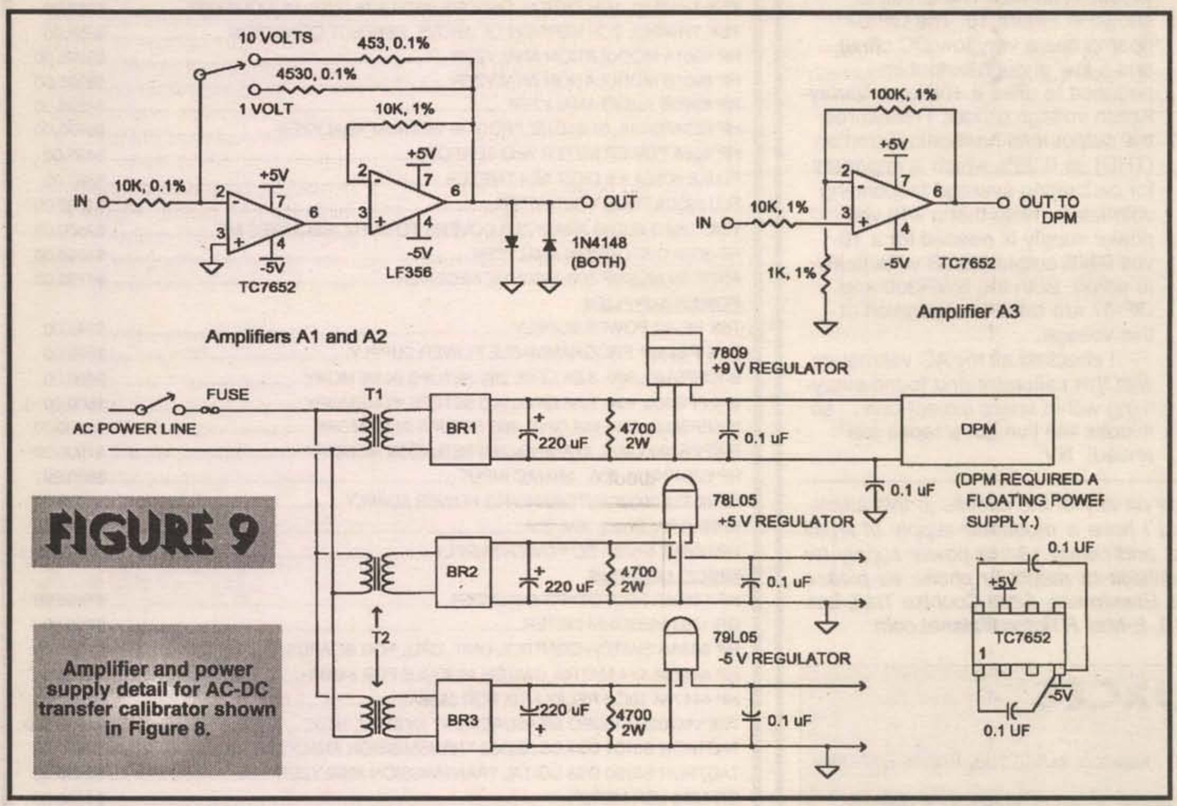
Let's look at how this circuit works. The input signal voltage heats the thermocouple in TC1 producing a voltage at the non-inverting A2 input. A2, connected as a difference amplifier, zeros the voltage difference between its input pins by delivering just enough current to TC2 to null the output of TC1. In this application, the thermal converters must be a matched pair so they track with each other over the zero-to-full scale range of the meter. The aluminum housing provides thermal stability (long thermal time constant) and EMI shielding.

Figure 8 shows an AC-DC transfer calibrator you can build for home or lab use. It is based on a moderate-cost pair of matched thermal converters from Best Technology, Inc. Let's take a look at how it works.

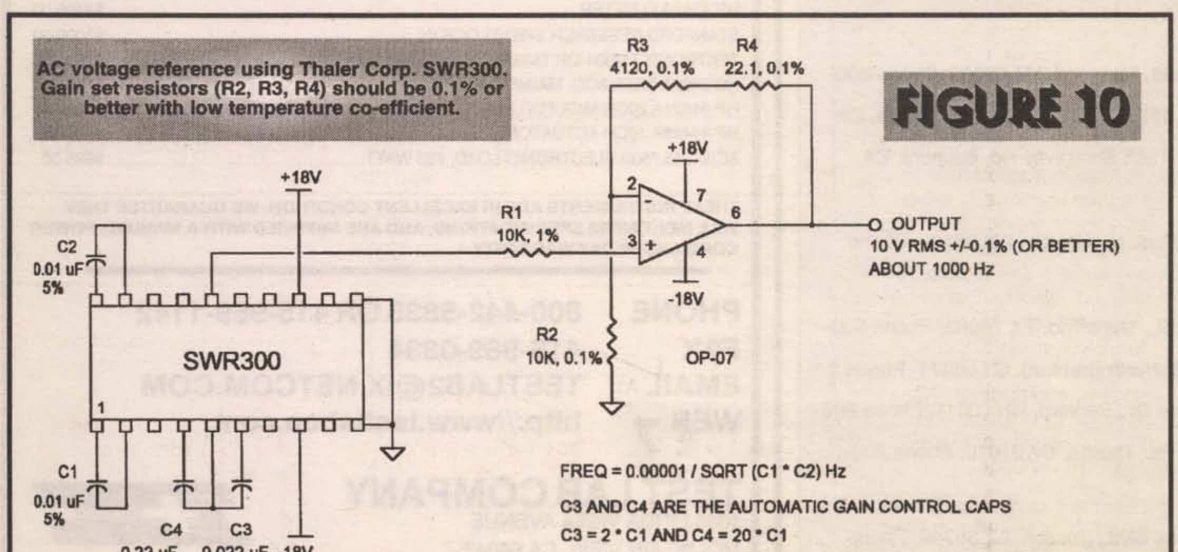
With S1 in the CAL position, the input DC reference voltage is applied to both thermal converters through amplifiers A1 and A2, and R1 is adjusted for a null (zero voltage) on the DPM. The thermal converters are matched for equal output voltages for a five-milliampere heater current, but the heater resistance can vary 10% from its 90-ohm nominal value. I measured a pair at 87.8 and 91.9 ohms for a 4.1 ohm difference. R1 is a five-ohm pot in series with the thermal converter with the lower heater resistance. (You may need a 10-ohm pot depending on the heater resistance difference.)

Now S1 is flipped to the USE position and the AC voltage to be measured is connected to the AC input terminals. Vary the AC voltage until the DPM again reads zero. The RMS value of the AC voltage now equals the DC calibration voltage to within ±0.1% or better. (Overall accuracy depends on your DC reference.) This is an audio frequency instrument and should be precise up to 10 KHz or so, depending on your circuit layout.

A1 and A2 are identical composite amplifiers as shown in Figure 9. The input opamp is chopper-stabilized for low DC offset and good drift performance, but it won't deliver five milliamperes to drive the thermal converter. Including a higher output current opamp in the feedback loop gives us the best of both worlds. A3 is also a chopper-stabilized opamp to give good null resolution on the ±200 millivolt scale of the 3-1/2 digit DPM.



Amplifier and power supply detail for AC-DC transfer calibrator shown in Figure 8.



AC voltage reference using Thaler Corp. SWR300. Gain set resistors (R2, R3, R4) should be 0.1% or better with low temperature co-efficient.

This is a straightforward circuit, but I need to mention some precautions. A printed circuit board is essential; we're dealing with microvolt differences from the thermal converters. For the same reason, solder the ICs and don't use sockets. Each chopper opamp needs a pair of external capacitors to store the offset voltage correction. These should be good quality metalized polyester or polypropylene units. One side of each cap goes to the negative supply voltage and the printed circuit traces should go directly to pin 4. Chopper opamps are subject to lockup, but this won't be a problem if you turn on the power supplies before applying a signal to either input. The diodes to common at the A1 and A2 outputs protect the thermal converters by limiting the heater voltage to about ±0.7 volt peak. The voltage-range switch should be a make-before-break type, and the A1 and A2 gain set resistors should be 0.1% or better. (Mouser Electronics stocks 0.1% metal film resistors with a temperature coefficient of 25 ppm at about a buck apiece in small quantities. And I've included a couple of precision resistor manufacturers in the Resources list.)

AN AC CALIBRATION SOURCE

If the AC-DC transfer calibrator is more than you need, you can still build a pretty simple AC voltage calibration source. The SWR300 is a precision sinewave reference IC from Thaler Corporation. It has an output of 7.071 volts RMS (±0.1%) over a programmable frequency range of 10 Hz to 100 KHz.

This output voltage is perhaps not too useful for meter calibration, but adding one opamp and a few precision resistors will give you 10 volts RMS which is a whole lot better. The frequency is set with two floating capacitors, so a four-pole switch is needed to change frequency. Also, below 1500 Hz, two external AGC (automatic gain control) capacitors are required which change value along with the frequency control caps.

For these reasons, I chose to build a fixed frequency reference (about 1000 Hz). The circuit is shown in Figure 10. The OP-07 opamp has a very low DC offset and a low enough output impedance to drive a 10K ohm Varley-Kelvin voltage divider. I measured the output total harmonic distortion (THD) as 0.35% which is important for calibrating average responding voltmeters. Note that a ±18 volt power supply is needed for a 10-volt RMS output (28.28 volts peak-to-peak). Both the SWR300 and OP-07 are rated for operation at this voltage.

I checked all my AC voltmeters with this calibrator and found everything within specs except one ... so it looks like I've got a repair job ahead! **NV**

I am available to answer questions on any of the circuits in this article. Printed circuit artwork is available and I have a moderate supply of small power transformers suitable for a plus and minus 18-volt power supply for the SWR300 reference. I'm usually difficult to reach by phone so please write, FAX, or E-Mail. Ron Tipton, TDL Electronics, 5260 Cochise Trail, Las Cruces, NM 88012. FAX 505-382-8810, E-Mail RTipton@zianet.com

RESOURCES

Precision Rectifier Circuits
EDN Magazine, 275 Washington St., Newton, MA 02158; Phone 617-964-3030.
Electronic Design Magazine, 611 Route 46 West, Hasbrouck Heights, NJ 07604; Reprints Phone 216-696-7000.

RMS-to-DC Converter ICs
Analog Devices, Inc., P.O. Box 9106, Norwood, MA 02062; Phone 800-262-5643.
Maxim Integrated Products, Inc., 120 San Gabriel Dr., Sunnyvale, CA 94086; Phone 408-737-7600.
Jameco Electronic Components, 1355 Shoreway Rd, Belmont, CA 94002; 800-831-5252.

Thermal Converters
Best Technology, Inc., 400 Boren Ave. N., Seattle, WA 98109; Phone 206-623-6135.

Precision Resistors
Mouser Electronics, 958 N. Main St., Mansfield, TX 76063; Phone 800-346-6873.
General Resistance, P.O. Box 185, North Branford, CT 06471; Phone 203-481-8937.
JBM Electronics, Inc., 1 Commerce Dr., Bedford, NH 03111; Phone 603-623-0446.
Micro-Ohm Corp., 1088 Hamilton Rd., Duarte, CA 91010; Phone 800-845-5167.

SWR300 AC Reference IC
Thaler Corporation, 2015 N. Forbes Blvd., Tucson, AZ 85745; Phone 520-882-4000.

Top Quality Reconditioned Electronic Test Equipment

Hewlett-Packard • Tektronix • Fluke • Wiltron

BOUGHT & SOLD

Test Equipment Wanted

Looking for Test Equipment Manuals?
Contact: Manuals Plus (801)882-7188•Fax (801)882-7195

Corporate Offices
P.O. Box 1762
San Mateo, CA 94401

Seattle, WA 206-251-6653
285 S.W. 41st St.
Renton, WA 98055

415-579-1711 • Fax 415-579-5777
http://www.bellelect.com

BELL Electronics

Write in 45 on Reader Service Card.

CABLE TV *cont.*

TOCOM 5503 VIP genuine unmodified, guaranteed to lite up and pass video $60/10 lot. A units available $18. Zenith 1082, 1000 field pulls, genuine unmodified $22, 6 lot. Jerrold DP5 genuine unmodified $50. Jerrold DRZP3, 3A ID IN, genuine unmodified, $22. Visa, MasterCard. 1-800-500-9825. Oak RTC 56 genuine unmodified $25. Apex Electronics, 1543A Sheridan Rd., Kenosha, WI 53140.

CABLE CONVERTERS. The best quality equipment w/warranty + money back guarantee. We have low overhead, so we sell for less. Houston, TX. 713-691-4610.

PC BOARDS REPAIRED. Prices start at $5. Minimum 25 of one type. Network Sales, 616-683-0500.

SOFTWARE FOR all your needs. New MULTIMODE kits and educational boards for all models. 0068, 0958, 0858, 0758, 0558, xxx2 to xx22, xxx5 to xxx6, 0001 to 0061 or even mm2500, T3055, T7055, low price. Educational purposes only. 909-941-4858.

GENUINE UNMODIFIED Pioneer, SA, Jerrold converters for sale. Also the new Panasonic multivision box. 40-pin $35. QBD for all boxes $25. New multivision BDS with inversion $75 ea. All products are sold for educational purposes only. Call for other products, services, and prices. Call BTW 7pm-9pm EST 617-389-5155.

SIGMA 3D/2000 converter kit. Gets all channels. $175. Fax name, address, city, state, zip, phone to 808-955-3959. Fully guaranteed.

CABLE CONVERTERS. We have the best quality equipment to fill your cable needs & the lowest prices around. Guaranteed w/warr. Houston, TX 713-691-4610.

UNMODIFIED CABLE box pulls Zenith ST 1000, 1086. Regal CR-83 plain converter. Oak RKDM-400 $20. Other brands available. Call 405-631-1856.

HAMLIN, PIONEER, ZENITH, AS and other manufacturer converters, various models including 6600, 6000 and 5000, 90s, 80s 29s, 28s 25s, and 100s, 5130, 5135, 4135 and 9310s, ST-1000 288 and 165 MP, 1086 and 1600, plus other models, **LARGE QUANTITIES, CALL for PRICING. 1-800-380-9530.**

FOR SALE: Genuine unmodified SA 8600, Tocom 5503 genuine unmodified. Best prices 717-788-8934.

UNBELIEVABLE PRICES. We carry a full line of cable tools and equipment for all your cable needs. Also a wide variety of electronic parts & accessories, tools, diagrams, converters, step-by-step instructions, and **full technical support**. 9am-7:30pm EST **1-800-562-8442**.

Upgrade your own 386 or 486 Computer

PDC Pentium Upgrade Kit* $499

VISA MasterCard

Do-It-Yourself Kit includes:

- ***Fast*** 120 MHz Intel Pentium® processor with ball bearing fan
- ***Fast*** motherboard uses reliable Intel VX chipset and supports an Intel Pentium® processor up to 200 MHz
- 16 MB ***Fast*** EDO ram and ***Fast*** 512K Pipeline Burst cache
- ***Fast*** 1 MB accelerated PCI SVGA video card
- Detailed step by step, easy to follow installation instructions
- PDC Pentium System sticker for your computer case
- Free technical support
- All components are tested and guaranteed compatible with Windows 95, Windows NT, DOS, Windows 3.1X and UNIX

Options:

- Add: $40 for kit with P133, $90 with P150, $200 with P166 CPU
- Add: $100 for kit with 32MB ram, $15 for kit with 2MB Video ram
- Add: $100 for installation of kit in your computer (call for details)

* Call for details and compatibility with your system. All components are warranted for 1 year. Contact MicroAge at 1-800-800-8906 for terms and conditions. Prices are subject to change. Call for current pricing. Shipping and Michigan 6% tax are extra.

MicroAge®

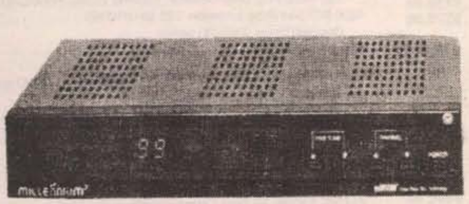
2025 US 41, Marquette, MI 49855 • 906-228-2626 • Fax 906-228-7774

Orders and technical support:
1-800-800-8906
Mon.-Fri. 8:30AM-5:30PM, Sat. 10AM-3PM EST

Write in 37 on Reader Service Card.

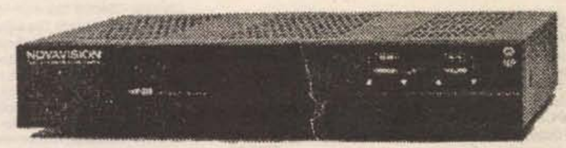
CALL 1-888-426-9787

ONE STOP SUPPLIER



MILLENIUM CONVERTER
$69.00

NO FLORIDA SALES



NOVAVISION CONVERTER
$199.00 CALL FOR QUANTITY

**WE STOCK A FULL LINE OF CABLE EQUIPMENT
CALL US FOR QUOTES**

DOZENS OF OTHER CONVERTERS AVAILABLE
CALL FOR QUANTITY PRICING

WE SHIP THE SAME DAY
90 DAY LIMITED WARRANTY

OPEN MONDAY - SATURDAY FROM 9:00AM TO 5:00PM

CALL 1-888-426-9787

Write in 157 on Reader Service Card.

WESTERN TEST SYSTEMS

WE BUY AND SELL

Inquiries 303-438-9662 • Fax 303-438-9685

Orders only 800-538-1493

530 Compton St., Unit #C, Broomfield, Colorado 80020

OSCILLOSCOPES & ACCESSORES

TO 100 MHz

TEK 7A18 75 MHz Dual Trace Amplifier ... $100.00
TEK 7A22 1 MHz High CMRR Differential Amplifier ... $300.00
TEK 7B53A 100 MHz Dual Time Base ... $175.00
TEK SC502 15 MHz Dual Trace Oscilloscope, TM500 series ... $375.00
TEK SC504 80 MHz Dual Trace Oscilloscope, TM500 series ... $475.00

ABOVE 100 MHz

TEK 475A 250 MHz Dual Trace Oscilloscope ... $1,000.00
TEK 7104 1 GHz Oscilloscope, with 7A29, 7A29-04, 7B10, 7B15 ... $4,500.00
TEK 7844 400 MHz Dual Beam Oscilloscope frame ... $750.00
TEK 7844 400 MHz Dual Beam ... $1,250.00
Oscilloscope with 7A24,7A26,7B80,7B85
TEK 7854 400 MHz Waveform Processing Oscilloscope frame ... $1,250.00
TEK 7904A 500 MHz System, with 7A24, 7A26, 7B92A ... $1,250.00
TEK 7904A 500 MHz System, with 7A24, 7A26, 7B80, 7B85 ... $1,250.00
TEK 7A13 105 MHz Differential Comparator ... $300.00
TEK 7A19 600 MHz Single Trace Amplifier ... $175.00
TEK 7A19-opt.4 600 MHz Single ... $200.00
Trace Amplifier, variable delay line
TEK 7A24 400 MHz Dual Trace Amplifier ... $350.00
TEK 7A26 200 MHz Dual Trace Amplifier ... $175.00
TEK 7A29 1 GHz Single Trace Amplifier ... $550.00
TEK 7B15 1 GHz Delaying Time Base ... $450.00
TEK 7B80 400 MHz Delayed Time Base ... $175.00
TEK 7B85 400 MHz Delta Delaying Time Base ... $200.00

STORAGE

TEK 7633 100 MHz Storage Oscilloscope frame ... $650.00
TEK 7633 100 MHz Storage Oscilloscope ... $1,000.00
with (2) 7A26, (1) 7B92A

PROBES

TEK 1101 Accessory Power Supply, for FET probes ... $250.00
TEK P6046 100 MHz Differential Probe ... $750.00
TEK P6101A 34 MHz 1X Modular Probe, 2m length *NEW* ... $25.00
TEK P6108A 100 MHz 10X Modular Probe, 2m length *NEW* ... $50.00
TEK P6201 900 MHz 1X/10X/100X FET Probe ... $450.00
TEK P6202A 500 MHz 10X FET Probe ... $300.00
TEK P6203 10X 1 GHz Active Probe, for 11000 series ... $450.00
TEK P6701-opt.02 O/E Converter, ... $675.00
450-1050 nm/0-1 mW: DC-700 MHz, ST conn

CALIBRATION

TEK CG5001-opt.01/TM5006 Programmable ... $7,000.00
Oscilloscope Calibrator, with power module
TEK CG551AP/TM506A Oscilloscope ... $3,500.00
Calibrator, with pulse head & power module

WAVEFORM GENERATORS

FUNCTION

HP 3310A 5 MHz Function Generator ... $325.00
HP 3310B 5 MHz Function Generator, ... $425.00
monocycle & var.phase trigger
HP 3312A 13 MHz Function Generator, sweep, AM, FM ... $850.00
TEK DD501 Digital Delay & Burst Gen., ... $375.00
for function & pulse gen's
TEK FG501 1 MHz Function Generator, TM500 series ... $250.00
TEK FG502 11 MHz Function Generator, TM500 series ... $325.00
TEK FG503 3 MHz Function Generator, TM500 series ... $275.00
TEK RG501 Ramp Generator, TM500 series ... $225.00
WAVETEK 23 12 MHz Synthesized Function Generator ... $1,100.00

PULSE

HP 214B 10 MHz Pulse Generator, ... $1,650.00
50 V/50 Ohms, auto duty cycle
HP 214B-001 10 MHz Pulse Generator, ... $2,000.00
50 V/50 ohms, counted burst opt
HP 8005B 20 MHz Dual Output Pulse Generator ... $450.00
HP 8007B 100 MHz Pulse Generator ... $650.00
HP 8012B 50 MHz Pulse Generator, variable transition time ... $600.00
HP 8013B 50 MHz Dual Output Pulse Generator, 3.5 nS fixed Tr ... $600.00
HP 8015A 50 MHz Dual Output Pulse Generator ... $700.00
HP 8080A/81A/82A/83A 300 MHz Word Generator ... $600.00
HP 8080A/91A/92A/93A 1 GHz Single ... $950.00
Channel Pulse Generator
HP 8080A/91A/93A 1 GHz Clock Generator ... $600.00
HP 8082A 250 MHz Dual Output Pulse Generator ... $1,400.00
HP 8111A-001 20 MHz Pulse/Function ... $1,650.00
Generator, burst mode option
TEK PG501 50 MHz Pulse Generator, TM500 series ... $250.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series ... $700.00

PROGRAMMABLE

HP 8160A 50 MHz Programmable Pulse Generator, HPIB ... $2,500.00
HP 8165A-002,003 Prog. Signal Source, ... $2,000.00
1 mHz-50 MHz, log sweep, rear out
TEK AWG5102 Arb.Waveform Gen.,20 MS/s, ... $1,400.00
12 bits,50ppm synthesis <1MHz
TEK AWG5105-opt.02 Arbitrary Waveform ... $2,200.00
Generator, dual channel option
TEK FG5010 Programmable 20 MHz Function ... $1,200.00
Generator, TM5000 series
WAVETEK 288 20 MHz Synthesized ... $1,500.00
Function Generator, GPIB

VOLTAGE & CURRENT

VOLTMETERS

HP 3456A 6-1/2 Digit Voltmeter ... $850.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, ... $1,500.00
10 nV sensitivity, GPIB
SOLARTRON 7081 8-1/2 digit Voltmeter ... $3,900.00

CALIBRATION

FLUKE 332B/AF DC Voltage Calibrator, ... $675.00
0-1111 V, 0-50 mA, 7 decades
FLUKE 343A DC Voltage Calibrator, ... $1,375.00
0-1100 V, 7 decades, 20 ppm acc.
FLUKE 510A AC Reference Standard, ... $450.00
10 VRMS, 0-10 mA
FLUKE 515A Portable Calibrator, ... $1,250.00
DC/AC/Ohms, line & battery power
FLUKE 5220A Transconductance Amplifier, ... $3,750.00
DC-5 kHz, 0-20 A
FLUKE 720A Kelvin-Varley Voltage Divider, 7 decade ... $2,250.00
FLUKE 731B DC Reference Standard ... $400.00
FLUKE A55-series AC Thermal Converters ... $300.00
VALHALLA 2703 AC Volt.Std., ... $2,500.00
0-120V/10 Hz-100 kHz;120-1200V/10 Hz-1 kHz

VOLTAGE SOURCES

HP 6115A Precision Dual Range ... $875.00
Power Supply, 50V 0.8A / 100V 0.4A

CURRENT METERS & SOURCES

DRANETZ 656A /(3)TR2019A Current ... $5,000.00
Demand Analyzer, w/(3) current probes 300A max.
HP 4140B Picoammeter / DCV Source ... $4,000.00
HP 6177C DC Current Source, to 50V, 500mA ... $600.00
HP 6181C DC Current Source, to 100 V, 250 mA ... $675.00
HP 6186C DC Current Source, to 300V, 100mA ... $750.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA ... $325.00
KEITHLEY 486 Picoammeter ... $1,500.00
KEITHLEY 614 Electrometer ... $1,000.00
KEITHLEY 642 Electrometer ... $2,900.00
TEK 7A14 Current Probe Amplifier, for P6021, P6022 ... $125.00
TEK CT-5 -opt.05 High Current Transformer ... $500.00
for P6021/A6302, to 1000A
VALHALLA 2301 Programmable Single Phase Power Analyzer ... $1,250.00
VALHALLA 2575A AC/DC Active Current Shunt, ... $1,000.00
20 mA-100 A, DC-10 kHz

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH ... $550.00
HP 4261A 3-1/2 digit LCR Meter, 120 Hz/1 kHz ... $1,000.00
HP 4262A-101 4-1/2 digit LCR Meter, ... $2,200.00
120 Hz/1 kHz/10 kHz, HPIB
HP 4275A-001 5-1/2 digit LCR Meter, ... $6,000.00
10 kHz-10 MHz, 0-35 V int. bias
HP 4332A Analog LCR Meter, ... $600.00
3 uH-1 H/ 3 pF-1 uF/ 3 ohm-1 Megohm

STANDARDS

E.S.I. SR1010 Resistance Transfer ... $700.00
Standards, 1 ohm-100 K/step
E.S.I. SR1050-10M Resistance Transfer ... $2,500.00
Standard, 10 Megohms/step
GR 1403-SERIES Standard Air Capacitors, 0.1% accuracy ... $150.00
GR 1406 Standard Air Capacitors, ... $375.00
GR900 connector, 0.1% acc.
GR 1409-SERIES Standard Mica Capacitors, 0.05% accuracy ... $150.00
GR 1412-BC Decade Capacitor, 50 pF - 1.11115 uF ... $350.00
GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res. ... $175.00
GR 1432-U 4-Decade Resistor, ... $125.00
0-111.10 ohms, 0.01 ohm resolution
GR 1433-J 4-Decade Resistor, ... $350.00
0-1,110 ohms, 1 ohm resolution
GR 1433-L 4-Decade Resistor, ... $350.00
0-11,110 ohms, 10 ohm resolution
GR 1433-N 5-Decade Resistor, ... $400.00
0-11,111 ohms, 0.1 ohm resolution
GR 1433-Q 4-Decade Resistor, ... $350.00
0-1,111,000 ohm, 100 ohm resolution
GR 1433-U 4-Decade Resistor, ... $350.00
0-111.0 ohms, 0.01 ohm resolution
GR 1433-W 6-Decade Resistor, ... $450.00
0-11,111.1 ohms, 0.01 ohm resolution
GR 1433-X 6-Decade Resistor, ... $450.00
to 111,111.0 ohms, 0.1 ohm res.
GR 1434-G 7-Decade Resistor, ... $300.00
0-1,111,111.0 ohms, 0.1 ohm res.
VALHALLA 2724A Programmable ... $1,675.00
Resistance Standard, 0-11 Gigaohms, GPIB

HI & LO RESISTANCE

HP 4329A High Resistance Meter, ... $1,350.00
5E5-2E16 Ohms, 10-1000 V test
VALHALLA 4150-ATC 4-1/2 digit ... $1,000.00
Ohmmeter, 20 milliohms-2 kilohms, 4-wire

CURVETRACERS

TEK 577D1/177 Storage Curve Tracer, ... $2,250.00
with standard test fixture

T.D.R.

TEK 1503-opt.04 Time Domain Reflectometer, ... $1,600.00
0-50,000 feet,chart recorder

POWER SUPPLIES

SINGLE OUTPUT

HP 6200B Dual Range Power Supply, ... $250.00
20 V 1.5 A / 40 V 0.75 A CV/CC
HP 6201B 20 V at 1.5A CV/CC Power Supply ... $200.00
HP 6206B Dual Range 0-60 V 0.5 A / 0-30 V 1 A CV/CL Supply ... $250.00
HP 6207B 160 V at 200 mA CV/CC Power Supply ... $300.00
HP 6209B 320 V at 100 mA CV/CC Power Supply ... $300.00
HP 6260B-027 10V at 100A CV/CC Power Supply ... $675.00
HP 6261B-027 20 V at 50 A CV/CC Power Supply ... $675.00
HP 6263B 20 V at 10 A CV/CC Power Supply ... $400.00
HP 6266B 40 V at 5 A CV/CC Power Supply ... $400.00
HP 6268B-027 40 V at 30 A CV/CC Power Supply ... $850.00
HP 6299A 100 V at 750 mA CV/CC Power Supply ... $250.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply ... $175.00
HP/HARRISON 6443B 120 V at 2.5 A CV/CC Power Supply ... $400.00
SORENSON DCR 110-45T 110 V ... $2,200.00
at 45 A CV/CC Power Supply
SORENSON DCR 300-6B 300 V at ... $950.00
6 A CV/CC Power Supply, 120 VAC 30 A line
SORENSON DCR 300-8A 300 V at 8 A CV/CC ... $950.00
Power Supply, 208/230 VAC line
SORENSON SRL 20-12 20 V at ... $550.00
12 A CV/CC Power Supply, low noise
SORENSON SRL 60-8 60 V at ... $950.00
8 A CV/CC Power Supply, low noise
TEK PS501-1 Power Supply, ... $175.00
0-20 V, 2 mV res., 400 mA, TM500 series

MULTIPLE OUPUT

HP 6227B Dual 25 V at 2 A CV/CC Power Supply, tracking ... $550.00
HP 6253A Dual Output 20 V 3 A CV/CC Power Supply ... $500.00
TEK PS5010 Programmable Triple ... $800.00
Power Supply, TM5000 series

MISCELLANEOUS

HP 59501A HPIB Isolated DAC/Power Supply Programmer ... $175.00
HP 6827A Bipolar Power Supply/Amplifier, to 100 V, 500 mA ... $800.00
KEPCO BOP 100-4M Bipolar Supply / Amplifier, 0-100 V, 0-4 A ... $1,000.00
TRANSISTOR DEVICES DAL-50-15-100 ... $200.00
Programmable Load, 0-50 V, 0-15 A, 100 Watts max.

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP 5315A-001 100 MHz/100 nS ... $650.00
Universal Counter, TCXO reference
HP 5315A-001,003 100 MHz/100 nS ... $800.00
Universal Counter, TCXO, 1 GHz C-channel
HP 5315A-002,003 100 MHz/100 nS Univ. ... $800.00
Counter, battery power, 1 GHz C-ch
HP 5316A 100 MHz/100 nS Universal Counter, HPIB ... $750.00
HP 5316A-003,006 100 MHz/100 nS ... $1,100.00
Counter, 1 GHz C-ch., offset/normalize
HP 5334A 100 MHz Universal Counter, HPIB ... $875.00
HP 5334B-010,060 100 MHz Universal Counter, HPIB, OCXO ... $1,000.00
HP 5335A 200 MHz Universal / Statistical Counter ... $1,500.00
RACAL-DANA 1992-04,55 ... $850.00
100 MHz/1 nS Univ. Counter, 1.3 GHz C-channel,OCXO,GPIB
TEK DC5004 Programmable 100 MHz/100nS ... $350.00
Counter/Timer, TM5000 series
TEK DC5009 Programmable 135 MHz Univ. ... $600.00
Counter/Timer, TM5000 series
TEK DC503A 125 MHz Universal Counter/Timer, TM500 series ... $450.00

FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB ... $3,250.00
EIP 578A-opt.06 26.5 GHz Source Locking ... $8,000.00
Counter, millimeter wave ext.
EIP 590-opt.92 WR19 Mixer Kit, 40-60 GHz, ... $875.00
for EIP option 06 counters
FLUKE 7220A 1.3 GHz Communications Counter ... $550.00
HP 5340A-011 18 GHz Frequency Counter, HPIB ... $1,600.00
HP 5342A 18 GHz Frequency Counter ... $2,400.00
HP 5342A-003,011 18 GHz Freq. ... $2,750.00
Counter, +22 dBm,-20 dBm dynamic range,HPIB
HP 5342A-01,04,05,11 24 GHz Frequency ... $3,900.00
Counter, OCXO, DAC, and HPIB
HP 5345A/5355A/5356B 26.5 GHz ... $4,000.00
CW/Pulse Frequency Counter
HP 5382A 225 MHz Frequency Counter ... $200.00

STANDARDS

AUSTRON 1250A Crystal Frequency ... $600.00
Standard, 0.1/ 1.0/ 5.0 MHz
HP 105A Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz ... $750.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP 8556A LF Section, 20 Hz-300 kHz ... $450.00
TEK 7L5-opt.025/L3-1 Spectrum Analyzer, ... $2,250.00
20 Hz-5 MHz, 75 / 600 / 1M ohms

Write in 38 on Reader Service Card.

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION

TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

VISA · MasterCard

DISTORTION ANALYZERS

HP 334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling ... $550.00
HP 339A Distortion Analyzer, built-in low distortion osc. ... $1,800.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz ... $700.00
FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz ... $700.00

OSCILLATORS

HP 204C Oscillator, 5 Hz-1.2 MHz, 5 VRMS ... $150.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator ... $200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max. ... $225.00
HP 239A Low Distortion Oscillator, 10 Hz-100 kHz ... $450.00
HP 652A Test Oscillator, 10 Hz-10 MHz ... $300.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 ... $200.00

MISCELLANEOUS

HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display ... $900.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal. ... $200.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave ... $500.00
KROHN-HITE 3202 Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct ... $600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave ... $1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct. ... $700.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz ... $1,000.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series ... $475.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer, 12.4-40 GHz, w/adapters, for 8555A, 8565A, etc. ... $675.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz ... $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz ... $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz ... $1,400.00
HP 11970V WR15 Harmonic Mixer, 50-75 GHz ... $1,600.00
HP 11971A WR28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B ... $1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B ... $1,100.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz ... $450.00
HP 8444A-059 Tracking Generator, **0.5-1500 MHz, for 8554,8568,etc.** ... $1,500.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A ... $650.00
HP 8557A/182T Spectrum Analyzer, 0.01-350 kHz, 1 kHz res., w/display ... $1,650.00
HP 8565A Spectrum Analyzer, 0.01-22 GHz, 1 kHz min. res. BW ... $5,000.00
HP 8565A-100 Spectrum Analyzer, 0.01-22 GHz, 100 Hz min. res. BW ... $5,500.00
HP 8569B Spectrum Analyzer, 0.01-22 GHz, 100 Hz min. res. BW ... $9,000.00
TEK 7L13/7633 Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz min.res.,w/frame ... $2,250.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6 ... $1,375.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz ... $2,000.00

NETWORK ANALYZERS

HP 11589A Bias Network, 0.1-3.0 GHz, N(f/f) ... $350.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... $450.00
HP 11664C Detector Adapter, for 8755/6/7 ... $200.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7 ... $375.00
HP 11666A Reflectometer Bridge, 0.04-18 GHz, for 8755/8756 ... $1,200.00
HP 3577A Network Analyzer, 5 Hz-200 MHz ... $15,000.00
HP 8505A-005/8503A Network An., 0.5-1300 MHz, w/S-Parameter & phase lock ... $5,000.00
HP 8755C/(3)11664A/182T Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame ... $1,750.00
HP 8756A/(3)11664A Scalar Network Analyzer, w/(3) detectors, 0.01-18 GHz ... $3,750.00
WAVETEK 1038D14A/H12/V13x2 Scalar Network An,w/(3)15882 WR28 detectors,26.5-40 GHz ... $2,200.00

SIGNAL GENERATORS

FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res,GPIB ... $2,000.00
GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 MHz res., GPIB ... $2,600.00
GIGATRONICS 605/10-18 Synthesized Source, 10-18 GHz, 1 kHz res., GPIB ... $3,000.00
GIGATRONICS 840-01 Freq. Doubler, 26.5-40 GHz (WR28) out, 13-20 GHz in ... $2,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm ... $3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs ... $5,000.00
GIGATRONICS 910/12-18,opt6,14,16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO ... $3,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm ... $4,250.00
HP 8640B-001,002,003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc. ... $2,500.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM ... $550.00
HP 8656A Signal Generator, 0.1-990 MHz, 100 Hz res, AM, FM, HPIB ... $2,900.00
HP 8660C/86602B/86632A Synthesized Signal Gen., 1-1300 MHz, 1 Hz res., AM, FM ... $2,750.00
HP 8660D/86603A/86632B Synthesized Signal Generator, 1-2600 MHz ... $7,000.00
HP 8671A-005 Synthesized CW Generator, 2.0-6.2 GHz, 1 kHz res., HPIB ... $6,000.00
WILTRON 6742A Synth. Signal/Sweep Gen., 18.0-26.5 & 26.5-40.0 GHz ... $8,750.00

SWEEP GENERATORS

HP 11869A Plug-in Adapter ... $450.00
HP 8600A Digital Marker, for HP 8601A ... $400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled ... $400.00
HP 8620C Sweep Oscillator Frame ... $550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable ... $675.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled ... $675.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled ... $1,000.00
HP 86240A-002 RF Plug-in, 2.0-8.4 GHz, +14 dBm lvld., 70 dB step att. ... $1,200.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled ... $500.00
HP 86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled ... $500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled ... $1,100.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled ... $675.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled ... $800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled ... $800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled ... $1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled ... $2,250.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled ... $2,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. ... $2,000.00

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm ... $2,500.00
ANRITSU MP-82B/ML-83A Power Meter, 90-140 GHz (WR8), -20 to +20 dBm ... $3,250.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor ... $375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor ... $500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm ... $375.00
HP 11683A Range Calibrator, for 435/6/7/8 power meters ... $750.00
HP 432C Autoranging Digital Power Meter, 10 uW-10 mW f.s. ... $425.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm ... $1,000.00
HP 435A/8482A Power Meter, 100 kHz-4.2 GHz, -30 to +20 dBm ... $1,000.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm ... $1,150.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series ... $350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ... $1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series ... $350.00

RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB ... $875.00

AMPLIFIERS, MISCELLANEOUS

BOONTON 82AD FM/AM Modulation Meter, 10-1200 MHz ... $800.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz ... $450.00
HP 8901A-002,010 Modulation Analyzer, 150 kHz-1300 MHz, OCXO, int. cal. ... $5,500.00
HP 8901B-001 Modulation Analyzer, 150 kHz-1300 MHz, rear panel input ... $8,500.00
HUGHES 1177H01F000 TWT Amplifier, 20 Watts output, 1.4-2.4 GHz ... $1,750.00
KALMUS 502LC Amplifier, 35 dB, 10 kHz-525 MHz, 2 Watts ... $900.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts ... $800.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts ... $800.00
MARCONI TF2304 AM/FM Modulation Meter, 18-1000 MHz, FM dev.1.5-150 kHz ... $500.00
MICROWAVE SEMI.CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC ... $325.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* ... $95.00
CONTINENTAL MW.&TOOL PLPT42 WR42 Low Power Termination, 18-26.5 GHz, 1 Watt ... $90.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f) ... $90.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz ... $450.00
GR 900-Q GR900 14mm Interseries Adapters ... $125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz ... $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... $800.00
HP 33330B Crystal Detector, 0.01-18 GHz, neg. pol., SMA(m)/SMC(f) ... $135.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz ... $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz ... $275.00
HP 8470B-012 Crystal Detector, 10 MHz-18 GHz, neg. pol., N(m) ... $250.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz ... $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... $500.00
HP K752 A/C/D WR42 Directional Couplers, 3/10/20 dB, 18.0-26.5 GHz ... $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz ... $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $425.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz ... $375.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz ... $400.00
HP R532A WR28 Frequency Meter, 26.5-40.0 GHz ... $500.00
HP R914B WR28 Moving Load, 26.5-40 GHz ... $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz ... $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz ... $650.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz ... $450.00
HUGHES 45113H-1000 WR19 Isolator, 25 dB, 40-60 GHz ... $650.00
HUGHES 45514H-1001 WR15 Stepper Motor Driven 4-Port Switch, with driver ... $1,675.00
HUGHES 45521H-2000 WR28 Manual 4-Position Switch ... $750.00
HUGHES 45711H-2000 WR28 Frequency Meter, 26.5-40 GHz ... $600.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz ... $900.00
HUGHES 45713H-1000 WR19 Frequency Meter, 40-60 GHz ... $900.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity ... $750.00
HUGHES 47323H-1211 WR19 Flat Broadband Detector, negative, 40-60 GHz ... $650.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response ... $375.00
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC ... $100.00
KRYTAR 1818 Directional Coupler, 16 dB, 2-18 GHz, SMA(f) ... $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz ... $450.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) ... $25.00
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f) ... $100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) ... $200.00
NARDA 3000-SERIES Directional Couplers ... $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz ... $300.00
NARDA 3090-SERIES Precision High Directivity Couplers ... $225.00
NARDA 368NM Coaxial High Power Load, 500 Watts, 2.0-12.4 GHz, N(m) ... $400.00
NARDA 369BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f) ... $325.00
NARDA 3753B Coaxial Phase Shifter, 0-60 deg./GHz, 3.5-12.4 GHz ... $1,250.00
NARDA 4000-SERIES SMA Miniature Directional Couplers ... $75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f) ... $225.00
NARDA 4245-10 Directional Coupler, 10 dB, 4-12 GHz, SMA(f) ... $100.00
NARDA 4246B-20 Directional Coupler, 20 dB, 6-18 GHz, SMA(f) ... $100.00
NARDA 4317-2 Power Divider, 18.0-26.5 GHz, 3.5mm ... $175.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f) ... $135.00
NARDA 5070-SERIES Precision Reflectometer Couplers ... $300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) ... $135.00
NARDA 766-10 10 dB Attenuator, 20 Watts, DC-4 GHz, N(m/f) ... $100.00
NARDA 768-20 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f) ... $125.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz ... $375.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz ... $250.00
SIERRA 662A-20 20 dB Attenuator, 100 Watts, N(f/f) ... $150.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz ... $125.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz ... $550.00
TELONIC TTF-2250-5-5EE Tunable Bandpass Filter, 1.5-3.0 GHz, 5% 3 dB BW, N(f) ... $350.00
TRG V510 WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz ... $1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz ... $600.00
TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz ... $400.00
TRG W510 WR10 Precision Rotary Vane Atten., 0-50 dB, 75-110 GHz ... $1,000.00
WAVELINE 822 WR42 Precision Rotary Vane Atten., 0-50 dB, 18-26.5 GHz ... $1,250.00
WAVELINE 898-DR WR42 Frequency Meter, 18.0-26.5 GHz ... $350.00
WEINSCHEL 1515 Power Divider, 2-Way, DC-18 GHz, SMA(m/f/f) ... $125.00
WILTRON 26N50 Precision Termination, N(m), DC-18 GHz ... $250.00
WILTRON 4612K Programmable Step Attenuator, 0-70 dB, DC-40 GHz ... $800.00
WILTRON 4622K Programmable Step Attenuator, 0-110 dB, DC-40 GHz ... $1,000.00
WILTRON 60N50-opt.1 SWR Bridge, 5-2000 MHz, 46 dB directivity, N(m/f/f) ... $500.00
WILTRON 87A50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port ... $600.00
WILTRON SP2369 SWR Autotester, 2-12 GHz, APC7 test port ... $400.00

LOGIC

FLUKE 9000A-series Microprocessor Pods: 6800; 6809; 8080; 8085; Z80 ... $375.00
HP 5005A Signature Multimeter ... $350.00
HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option ... $1,200.00
TEK 1240 Logic Analyzer, w/(36) 50 MHz channels ... $1,500.00

COMMUNICATIONS

HP 59401A HPIB Bus Analyzer ... $700.00
TEK 1411R-opt.04 PAL Test Gen. w/ SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ... $2,750.00
TEK 147A NTSC Test Signal Generator, with noise test signal ... $800.00
TEK 1750 NTSC Waveform / Vector Monitor ... $2,750.00
TEK 520A NTSC Vectorscope ... $1,200.00

MISCELLANEOUS

P.A.R. 5205-94,95,96,98 Lock-In Amp, 20 Hz-20 kHz, int. osc., lin/log, GPIB ... $2,750.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz ... $2,500.00
P.A.R. 5208-92,94,97,98 Two Phase Lock-In Amp., 5 Hz-20 kHz or 200 kHz, GPIB ... $3,250.00
TEK TM5006 5000-series 6-slot Programmable Power Module ... $600.00
TEK TM503 500-series 3-slot Power Module ... $175.00
TEK TM504 500-series 4-slot Power Module ... $175.00
TEK TM506 500-series 6-slot Power Module ... $250.00
TEK TM515 500-series 5-slot Traveller Power Module ... $275.00

ATTENTION DEALERS

BUY DIRECT FROM THE WHOLESALER

GET THE BEST PRICES AND SERVICE

ALL UNITS ARE IN STOCK FOR IMMEDIATE SHIPMENT

NOVAVISIONS

	QTY 10	QTY 20	QTY 50
NV-5600 (PIO)	$199	$185	$170
NV-5700	$199	$185	$170
NV-5800	$199	$185	$170
NV-5750 (JBB)	$275	$260	$245

NEW CONVERTERS

	QTY 10	QTY 20	QTY 50
CENTURY CT-3000	$65	$60	$55
PANASONIC 145	$79	$74	$69

ALL TYPES OF CABLE EQUIPMENT AVAILABLE. CALL FOR DETAILS.

CALL FOR THIS MONTH'S SPECIALS

1-800-808-3356

DIRECT CABLE SUPPLY

Mr. NiCd **E.H. Yost & Co.-YOUR SOURCE FOR** Mr. NiCd

★ BATTERIES! ★

★ AMATEUR / COMMERCIAL / AVIATION RADIO ★
★ LAPTOP COMPUTERS ★ VIDEO CAMCORDERS ★
★ CELLULAR & CORDLESS TELEPHONES ★
★ SEALED LEAD ACID ★ PHOTOGRAPHY ★
★ MEDICAL EQUIPMENT ★ TESTING EQUIPMENT ★

CALL OR WRITE TODAY FOR OUR FREE CATALOG!

Phone (608) 831-3443 / Fax (608) 831-1082

E.H. Yost & Company 2211-D Parview Rd., Middleton, WI 53562

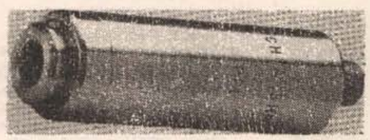
CABLE TV *cont.*

NEW! CABLE converter electronic service equipment and supplies for most cable converter boxes. Highest service, lowest prices. Call Ken Erny Electronics. 24 hr. order and information hot line 516-389-3536.

$ WANTED $: Cash for genuine, unmodified PV5, PV7, R2/V5, and DBB converters. 512-854-8989 evenings.

CABLE CONVERTERS. We should have the equipment you need. Warranty. Houston, TX. 713-691-4610.

FOR SALE: genuine unmodified Tocom 5503 VIP, Panasonic TZPC 160 volume control converters. Genuine unmodified SA 8600 ZNN. New SA 8600 remotes. Pioneer 5135, Pioneer 4130 converters. NSC 550MHz Ch 4 converters. 61-72 channel converters $15. Remotes from $1.50 to $6. Prices negotiable based on quantities purchased. Call Mon-Fri. 11am to 6pm. 718-262-0900 or Fax 718-657-4015, ask for Stan.



NOTCH FILTERS 110, 108.5, 106.5, 97.5 75dB deep notch. $19.95 ea., 1-5 qty. $14.95 ea., 6-10 qty. $10.95 ea., 11-20 qty. $8.95 ea., 21 or more qty. Call 24 hr. order and information hot line 516-389-3536.

FREE CABLE DESCRAMBLER PLANS! For details write: Sierra Publishing, 909 E. Yorba Linda Blvd., Suite H-181, Dept. NVP, Placentia, CA 92870.

WANTED: TEKNIKA 6510 cable converter boxes/parts. 415-221-5940.

CONVERTERS: HAMLIN CR83, Oak Sigma 500, Panasonic 145. Other brands available sale at any quantity. Call for prices 561-486-3695.

EVERYTHING YOU NEED FOR CABLE! 1-800-663-8530. FORMERLY 1-800-MODULE-0.

WANTED: GENUINE unmodified CFT and SA 86xx wanted. TOP cash paid for. Call 702-386-2659.

WANTED: DEALER & DEALERS! AUTOMATIC MULTIMODE 2200s. RFT-2 MULTIMATE 2200 SELLS! CONCEPT ENGINEERING 602-309-0367.

CABLE PARTS! Computer parts. Call for great prices or visit us on the Web: HTTP://WWW.CB-Electronics.com or call 1-800-436-8630.

ATTN. DEALERS: All makes and models of CATV equipment available. Call for pricing and information. 619-929-0585 or 1-800-871-7875 VM.

NEW AND used cable converters and related items. 419-385-3100.

REVOLUTIONARY TECHNOLOGY: ALL MAKES AND MODELS OF CABLE CONVERTERS. CALL US AT 561-340-7978.

WANTED!

WE PURCHASE SURPLUS LASERS, LASER RELATED EQUIPMENT AND OPTICAL EQUIPMENT

We also sell LASER's for researchers, industrial applications, educational purposes, entertainment and hobbyists.

MWK INDUSTRIES

e-mail mkenny1989@aol.com
FAX (909) 278-4887

1269 W. Pomona, Corona, California 91720

CALL FOR FREE CATALOG!

(909) 278-0563

See our catalog on the internet!
http://www.mwkindustries.com

Write in 119 on Reader Service Card.

Write in 80 on Reader Service Card.

A Do-It-Yourself Sound Blaster 16

by
Thomas Henry

This article describes a simple, but high-quality circuit, which when attached to your computer's Sound Blaster 16 card permits a whole new world of MIDI operations. Featuring one input and three outputs — unlike any commercial version — it also doubles as a stand-alone THRU box. If these terms are new to you, then read on, for we'll explain what they mean, as well as how to construct this useful project.

ABOUT SOUND BLASTERS AND MIDI

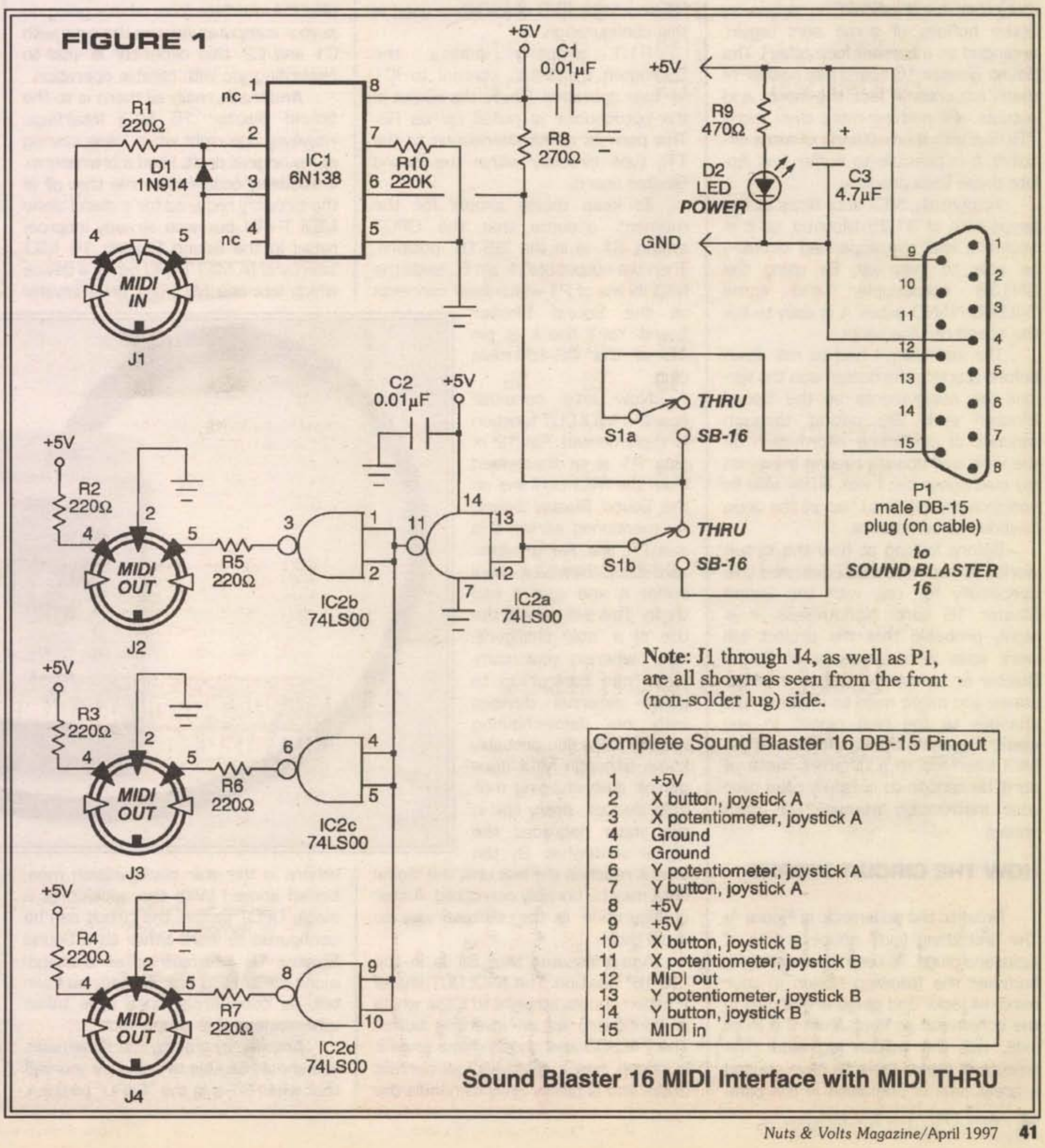
Nowadays, most personal computers are shipped with a sound card already installed. And thanks to recent price decreases, retrofitting older equipment is within reach of most everybody. For IBM compatibles, the Sound Blaster series has been an especially popular one. Besides all of the neat speech, voice, and CD applications it makes possible, it also provides a great way to get started in electronic music synthesis. Best of all, Sound Blaster cards come fitted with MIDI (Musical Instrument Digital Interface) which opens up new avenues for doing music at home, in the studio, or on stage. Instruments such as keyboards, sequencers, drum machines, etc., can be interconnected via the MIDI interface, and controlled by your computer using suitable software.

Unfortunately, things aren't quite as simple as merely patching in some connecting cables. For whatever reason (economic, I suppose), most Sound Blaster or compatible cards skimp on the MIDI port. Neither the electrical nor physical interface of such a card hits the MIDI standard on the button. However, as this article shows, for several dollars and a pleasant night's work in the shop, it is possible to bring the Sound Blaster MIDI port up to spec. A multitude of exciting musical applications are then available to you!

A WEALTH OF MISINFORMATION AT YOUR FINGERTIPS

When I was contemplating spiffing up my Sound Blaster 16 board to permit true MIDI operation, I started by scanning what was available on the World Wide Web. I wasn't too surprised to find all sorts of FAQ files (Frequently Asked Questions), archived schematics, and discussions on the Newsgroups concerning how to build such a circuit. After all, the Web has exploded lately, and is one of the greatest research resources available. However, you wouldn't believe what I also found: misinformation and loads of it!

Virtually every schematic I looked at was riddled with errors, or the circuits were so poorly designed it was doubtful they would ever work at all.



Note: J1 through J4, as well as P1, are all shown as seen from the front (non-solder lug) side.

Complete Sound Blaster 16 DB-15 Pinout

1	+5V
2	X button, joystick A
3	X potentiometer, joystick A
4	Ground
5	Ground
6	Y potentiometer, joystick A
7	Y button, joystick A
8	+5V
9	+5V
10	X button, joystick B
11	X potentiometer, joystick B
12	MIDI out
13	Y potentiometer, joystick B
14	Y button, joystick B
15	MIDI in

Sound Blaster 16 MIDI Interface with MIDI THRU

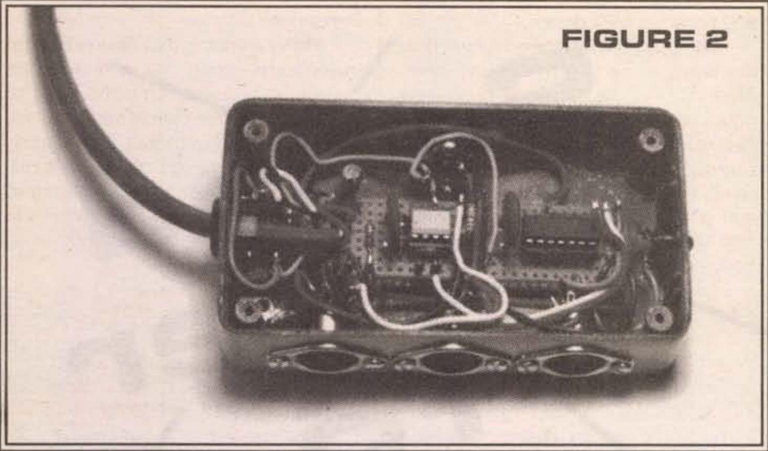


FIGURE 2

Incorrect pin assignments, reversed diodes, backwards plugs and jacks, unbuffered outputs, you name it; it was clear I was going to have to start this project from scratch.

The place to begin, of course, was with the MIDI 1.0 specification itself. According to this document, any MIDI inputs should be isolated by a current loop fed optocoupler. MIDI outputs, on the other hand, should be driven by active buffers of some sort (again, arranged as a current loop affair). The Sound Blaster 16 board has neither of these features. In fact, the inputs and outputs are nothing more than mere TTL. But with a smattering of extra circuitry, it is possible to buffer and isolate these lines properly.

Incidentally, MIDI data flows at the peppy rate of 31.25 kilobaud, so it is essential that the appended circuitry be able to keep up. By using the 6N138 optocoupler and some 74LS00 NAND gates, it is easy to lick the speed requirements.

The last thing I had to nail down before starting the design was the various pin assignments on the Sound Blaster jack. By sifting through mounds of conflicting information on the Web and actually testing things on my own computer, I was finally able to convince myself that I had all the dope I needed to commence.

Before looking at how the circuit works, please note that I designed this specifically for use with the Sound Blaster 16 card. Nonetheless, it is highly probable that the project will work as-is with a variety of Sound Blaster or compatible cards. In other cases, you might need to make simple changes to the plug pinout. In any event, if applying the Sound Blaster 16 MIDI Interface to a different make of card, be certain to carefully read over your instruction manuals or data sheets.

HOW THE CIRCUIT WORKS

Refer to the schematic in Figure 1. The first thing you'll notice is lots of jacks and plugs. To keep these straight, hammer the following notion in your mind: all jacks and plugs are shown in the schematic as seen from the front side, not the solder lug side. The pinouts of these seem to have caused a great deal of confusion in the past, so take a moment to be certain you understand how the pins are numbered.

Let's start with the MIDI IN at jack J1. This is a current loop input feeding optocoupler IC1. D1 is strapped across the unit to prevent any unexpected reverse voltage conditions which might harm the chip. And, by the way, the MIDI spec itself specifies that R1 should be 220 ohms when used in this configuration.

R10 properly biases the Darlington transistor internal to IC1 for best operation. Finally, the output of the optocoupler is pulled up via R8. This permits direct connection to the TTL type circuitry within the Sound Blaster board.

To keep things simple for the moment, assume that the DPDT switch, S1, is in the "SB-16" position. Then the output of IC1, pin 6, feeds the MIDI IN line of P1 which itself connects to the Sound Blaster board. You'll find it at pin 15 of the DB-15 male plug.

Now let's consider how the MIDI OUT function is implemented. Pin 12 of plug P1 is a direct feed from the MIDI OUT line on the Sound Blaster board. As mentioned earlier, this is a TTL line. For greatest versatility, however, we'll buffer it and split it into three. This will permit the use of a "star configuration," wherein your computer can control up to three external devices with no daisy-chaining required. (As you probably know, although MIDI does permit daisy-chaining multiple devices, every link in the chain degrades the signal somewhat. By the time it reaches the last unit, the digital data may be horribly corrupted. A star configuration is the slickest way to avoid this.)

Again, assume that S1 is in the "SB-16" position. The MIDI OUT line of P1 then shoots straight to IC2a, which is configured as an inverting buffer. The 74LS00 was chosen here since it is cheap, has a relatively low current drain, and is plenty zippy to handle the 31.25 kilobaud communication rate. The output of IC2a then splits off to three additional inverters, IC2b, IC2c, and IC2d. Each of these drives a 220-ohm resistor, which attaches to pin 5 of the respective MIDI OUT jacks. Pin 4 of each of these jacks is also fed by a 220-ohm resistor, and the net effect is the current loop affair dictated by the MIDI Specification 1.0.

But remember, there's an awful lot of digital switching going on here. So, 0.01 mfd bypass capacitors are tacked on to the power pins of both IC1 and IC2. Don't neglect these; it really is important to keep any spikes from hitching a ride on the power supply lines!

Conveniently, power for the circuit is provided by the Sound Blaster board itself (and ultimately, your computer). This is possible since the current drain is a minuscule amount, less than 10 mA. Looking at plug P1, +5V is derived from pin 9, while ground (GND) is found at pin 4. To provide positive indication that the circuit is on, LED D2 shines whenever the unit is fired up. Finally, electrolytic capacitor C3 decouples the interface from what's going on in your computer. As was the case with C1 and C2, this capacitor is vital to rewarding you with reliable operation.

And that's really all there is to the Sound Blaster 16 MIDI Interface. However, one night when I was staring at my original draft, I had a brainstorm. It suddenly occurred to me that all of the circuitry required for a stand-alone MIDI THRU box was already incorporated in the Sound Blaster 16 MIDI Interface! (A MIDI THRU box is a device which lets one MIDI unit drive several others in the star configuration mentioned above.) With the addition of a single DPDT switch, the circuit can be configured to work either as a Sound Blaster 16 Interface or as a stand-alone MIDI THRU box. As near as I can tell, no commercial units have taken advantage of this simple fact.

Anyway, by tracing the schematic, you should be able to convince yourself that when S1 is in the "THRU" position, plug P1 (and hence the sound card) is isolated from the jacks. Instead, whatever is connected to the MIDI IN drives jacks J2 through J4. And all of the MIDI spec requirements are met, too!

HOW TO BUILD IT

The Sound Blaster 16 MIDI Interface is a simple circuit, and fairly easy to build. However, there are a few fine points to keep in mind. This section will guide you along. As usual, your first step will be to gather together all of the parts. Fortunately, nothing exotic is used here, so you will have no trouble locating the components from mail order houses. The optocoupler is a common (but very high quality) one and costs less than a buck. The 74LS00 quad NAND gate is another cheapie; you probably have some sitting in your junk box right now. All of the caps and resistors are about as garden variety as they come. Finally, even the jacks and plugs are easily obtainable from various electronics or computer supply mail order companies. Notice that the MIDI spec requires J1 through J4 to be five-pin DIN jacks, arranged on a 180-degree arc.

Since this is a small circuit, I hand wired it using perfboard construction techniques. Flea clips hold most of the parts in place, while wire wrap was used to complete the connections. A piece of double-stick foam tape secures the board within the enclosure. Refer to Figure 2 to see how this looks.

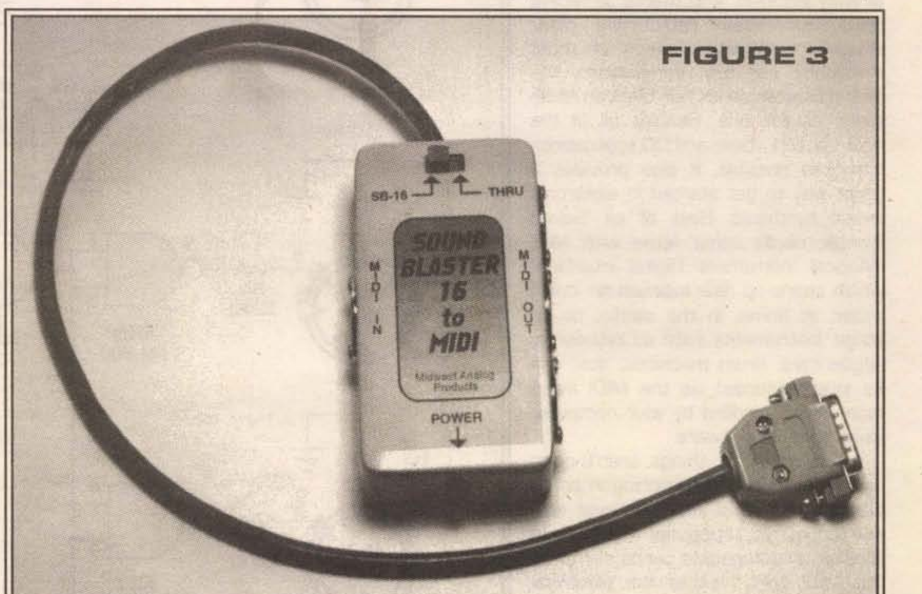


FIGURE 3

I utilized a plastic enclosure, sprayed with epoxy paint for durability. Using my laser printer and a simple art program, I directly printed a legend decal on a sheet of clear sticky back material. You can find this stuff at most any stationery store. One final layer of clear sticky back is on top of the decal itself, just to protect the printing from scratches and scrapes.

You can drill starter holes for jacks J1 through J4, then enlarge them with a rat tail file. Similarly, the slide switch opening can be fabricated as required using a flat file. Plug P1 is on a length of cable; to prevent damaging it, the cable should exit the box through a rubber grommet.

Please note that the cable is carrying TTL type signals directly to and from the computer. For this reason, the length should be kept as short as practical. And strictly speaking, the cable should be shielded, with three internal conductors. I'll confess, though, that I used a twisted quadruple, 19 inches long, and have noticed no ill effects whatsoever. I made the twisted quadruple myself. I simply cut four 22 gauge stranded hook-up wires to length, and gripped them by a vise, and an electric drill. A quick spin of the drill, and I had a neat bundle! For durability, I slipped the twisted quadruple through a sheath of plastic.

Now here's something you might not have noticed when looking at the schematic. Jack J1 has no connection to ground whatsoever; this is important. But jacks J2 through J4 all have a ground connection to their respective number 2 pins. The reason for this apparent asymmetrical arrangement is to prevent insidious ground loops. Anyway, this requirement is dictated by the MIDI Specification 1.0 mentioned earlier, so be sure to obey it.

Figure 3 shows what my unit looks like after closing it up. When you've completed yours, double-check the wiring once more. Remember, you're hooking this device up to your expensive computer, so please be careful. Even though my prototype has proven to be very reliable, neither I nor the publisher can be responsible for how you use or misuse the information in this article. Triple-check your work! If satisfied, then away you go.

HOW TO USE YOUR SOUND BLASTER 16 MIDI INTERFACE

Well, this is easy. Simply plug P1 into the Sound Blaster MIDI/Joystick jack. Connect any desired equipment to the MIDI IN or OUT jacks, and fasten your seatbelts. To get confidence that your interface works, you'll probably want to test it out first. The simplest way is to find some easy-to-use software that runs on your computer, then see if the interface properly sends and receives MIDI data.

For example, a sequencer program could be a great boon here. After running the software, play some notes on a MIDI keyboard which is connected to J1. Confirm that the sequencer (in record mode) reliably reads the data. If so, then turn around and put the sequencer in play mode, and see if any synthesizer gear connected to jacks J2 through J4 properly reproduces the pattern you just recorded.

To help you out, the World Wide Web site of Midwest Analog Products has a large variety of links to free or inexpensive MIDI software you can use to test your Sound Blaster 16 MIDI Interface. You'll also find hints, tips, and updates on how to best use your new circuit. The details are described in the Parts List.

I have a feeling that Sound Blaster boards are sitting idle in many computers, or at least not being used to their full potential. I know mine was for over a year. But with just a tiny outlay of time and cash, you can bring it reliably into the modern age of electronic music. Unlock the miracle of MIDI and you'll wonder how you ever got along without it! **NV**

ACKNOWLEDGMENT

I want to thank fellow author Jack Orman for suggesting a great way to handle the optocoupler in this circuit.

PARTS LIST

All resistors are 1/8-watt, 5% values.

R1 - R7	220 ohms
R8	270 ohms
R9	470 ohms
R10	220K

All capacitors are rated at 10V or better.

C1, C2	0.01 mfd disc
C3	4.7 mfd electrolytic

Semiconductors

D1	1N914 diode
D2	LED
IC1	6N138 optocoupler
IC2	74LS00 quad NAND gate

Other components

J1 - J4	Five-pin DIN jack, 180 degrees
P1	DB-15 male plug with hood
S1	DPDT switch

Miscellaneous: IC sockets, LED holder, shielded cable, rubber grommet, enclosure, perfboard, flea clips, wire, solder, etc.

A USEFUL WWW SOURCE

Updates, tips, and hints for this project are available at the following World Wide Web site maintained by Midwest Analog Products. You'll also find links to free or inexpensive software useful for testing and using your Sound Blaster 16 MIDI Interface.
WWW URL: http://prairie.lakes.com/~map

CABLE TV *cont.*

CABLE TV EQUIPMENT: All major makes and models of original equipment and accessories. Quantity discounts and dealer pricing available. Call CABLE CONNECTION toll free at **1-888-83-CABLE** (8am to 6pm CST) or E-Mail info to **cable@midusa.net**

SECRET! BUILD CABLE DESCRAMBLERS in 7 steps using **RADIO SHACK** parts. $5. GES Video, Box 72-N, Perryopolis, PA 15473.

WE HAVE what you want. #1 cable distributors. Dealers welcome. For your best price, call 1-800-640-9948.

CABLE CONVERTERS. Highest quality equipment. Money back guarantee. Houston, TX. 713-691-4610.

PICS, GALS READ if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

CABLE EQUIPMENT. We have converters. Much to choose from. Satisfaction guaranteed. Houston, TX 713-691-4610.

CABLE STUFF. Call for flyer. Jake 313-384-3949.

CATV EQUIPMENT starting at just **$11**. Call for information. 619-929-0585.

CABLE PRODUCTS & MORE! BEST PRICES! 1-800-663-8530. FORMERLY 1-800-MODULE-0.

AAA CABLE PRODUCTS. CALL US FOR ALL YOUR NEEDS! AUTOMATIC MULTI-MODE SELLS. CONCEPT ENGINEERING 602-309-0367.

GENUINE UNMODIFIED BBPD 7 $150 ea. 1-800-804-8655.

PANASONIC TZ-PC175 baseband volume control converter. Ideal for Boss 1, 3, 3, or 4. 10 in case, ran, $65 each. Call 1-888-561-4796.

Synthesized FM Stereo Transmitter

Microprocessor controlled for easy freq programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit........$129.95

Tunable FM Stereo Transmitter

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit...........$34.95
CFM, Matching Case and Antenna Set................$14.95

RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional matching case set.

LPA-1, Power Booster Amplifier Kit....................$39.95
CLPA, Matching Case Set for LPA-1 Kit................$14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95

Micro FM Wireless Mike

World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit......................$19.95

Crystal Controlled Wireless Mike

Super stable, drift free, not affected by temperature, metal or your body! Frequency is set by a crystal in the 2 meter Ham band of 146.535 MHz, easily picked up on any scanner radio or 2 meter rig. Changing the crystal to put frequency anywhere in the 140 to 160 MHz range-crystals cost only five or six dollars. Sensitive electret condensor mike picks up whispers anywhere in a room and transmit up to 1/4 mile. Powered by 3 volt Lithium or pair of watch batteries which are included. Uses the latest in SMT surface mount parts and we even include a few extras in case you sneeze and loose a part!

FM-6, Crystal Controlled FM Wireless Mike Kit..........$39.95
FM-6WT Fully Wired FM-6 ....$69.95

Call for our Free Catalog !

RAMSEY

Super Pro FM Stereo Radio Transmitter

A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes sharp looking metal cabinet, whip antenna and 120 volt AC adapter. Also runs on 12 volts DC.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit.......$299.95
FM-100WT, Fully Wired High Power FM-100...........$429.95

Speech Descrambler Scrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. The technology used is known as speech inversion which is compatible with most cordless phones and many police department systems, hook it up to scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC, RCA phono type jacks. Our matching case set adds a super nice professional look to your kit.

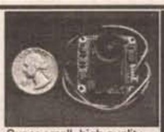
SS-70A, Speech Descrambler/Scrambler Kit...........$39.95
CSS, Custom Matching Case and Knob Set $14.95
SS-70AWT, Fully Wired SS-70A with Case.............$79.95
AC12-5, 12 Volt DC Wall Plug Adapter..................$9.95

Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit...............................$99.95
CTG, Matching Case Set for TG-1 Kit...................$14.95
TG-1WT, Fully Wired Tone Grabber with Case..........$149.95
AC12-5, 12 Volt DC Wall Plug Adapter..................$9.95

Mini-Peeper Micro Video Camera



Super small, high quality fully assembled B & W CCD TV camera the size of an ice cube! Provides excellent pictures in low light (2 lux), or use our IR-1 Infra-Red light source to invisibly illuminate an entire room on a pitch black night! Imagine the possibilities... build it into a smoke detector, wall clock, lamp, book, radio. Exact same camera that's in big buck detective catalogues and stores. Kit includes: fully assembled CCD camera module, connectors, interface PC board kit with proper voltage regulation and filtering, hook-up details, even a mini microphone for sensitive sound! Two models available: Wide Angle Lens 3.6mm/f2, adjustable focus lens, 92 degree view; Pinhole Lens 5.5mm/f4.5, 60 degree view. The Pinhole Lens is physically much flatter and provides even greater depth of focus. The camera itself is 1.2" square. The Wide Angle Lens is about 1" long, Pinhole Lens about 1/2", interface PC board is 1" x 2" and uses RCA jacks for easy hook-up to VCRs, TVs or cable runs. Power required is 9 to 14 VDC @ 150 mA. Resolution: 380 x 350 lines. Instruction manual contains ideas on mounting and disguising the Mini-Peeper along with info on adding one of our TV Transmitter kits (such as the MTV-7 unit below) for wireless transmission!

MP-1, Wide Angle Lens CCD TV Camera Outfit........$169.95
MP-1PH, Pin-Hole Lens CCD TV Camera Outfit........$189.95

MicroStation Synthesized UHF TV Transmitter

Now you can be in the same league as James Bond. This transmitter is so small that it can fit into a pack of cigarettes - even including a CCD TV camera and battery! Model airplane enthusiasts put the MTV-7A into airplanes for a dynamite view from the cockpit, and the MTV-7A is the transmitter of choice for balloon launches. Transmitter features synthesized, crystal controlled operation for drift-free transmission of both audio and video on your choice of frequencies: Standard UHF TV Channel 52 (which should only be used outside of the USA to avoid violating FCC rules), and 439.25 MHz or 911.25 MHz which are in the amateur ham bands. The 439.25 MHz unit has the nifty advantage of being able to be received on a regular 'cable-ready' TV set tuned to Cable channel 68, or use our ATV-74 converter and receive it on regular TV channel 3. The 911.25 MHz unit is suited for applications where reception on a regular TV is not desired, an ATV-79 must be used for operation. The MTV-7A's output power is almost 100 mW, so transmitting range is pretty much 'line-of-sight' which can mean many miles! The MTV-7A accepts standard black and white or color video and has its own, on-board, sensitive electret micorphone. The MTV-7A is available in kit form or fully wired and tested. Since the latest in SMT (Surface Mount Technology) is used to provide for the smallest possible size, the kit version is recommended for experienced builders only. Runs on 12 VDC @ 150 mA and includes a regulated power source for a CCD camera.

MTV-7A, UHF TV Channel 52 Transmitter Kit..........$159.95
MTV-7AWT, Fully Wired Channel 52 Transmitter $249.95
MTV-7A4, 439.25 MHz TV Transmitter Kit..............$159.95
MTV-7A4WT, Fully Wired 439.25 MHz Transmitter $249.95
MTV-7A9, 911.25 MHz TV Transmitter Kit..............$179.95
MTV-7A9WT, Fully Wired 911.25 MHz Transmitter $269.95
ATV-74, 439.25 MHz Converter Kit $159.95
ATV-74WT, Fully Wired 439.25 MHz Converter..........$249.95
ATV-79, 911.25 MHz Converter Kit $179.95
ATV-79WT, Fully Wired 911.25 MHz Converter..........$269.95

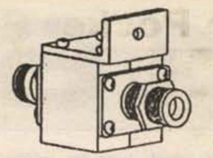
RAMSEY ELECTRONICS, INC.
793 Canning Parkway
Victor, NY 14564

Order Toll-free: 1-800-446-2295
Sorry, no tech info or order status at this number

Technical Info, Order Status
Call Factory direct: (716) 924-4560

VISA MasterCard DISCOVER

ORDERING INFO: Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add $4.95 for shipping, handling and insurance. Orders under $20, add $3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.



EXPLOSIVE CABLE TV GRAB! BRINKER ZAPPER/SNOOPER STOPPER combo module all in one! Buy wholesale factory-direct, no middleman. Let others get fined + zapped instead. Protect your cable box now! 100% COMPATIBLE. We supply over 80 advertisers weekly! Your order shipped fast, within hours! Why pay $39 when you can buy direct! LIFETIME GUARANTEE! We accept VISA/MC/COD/MO/CHECKS. ONLY $10 (SPECIAL: 3/$20 plus FREE DESCRAMBLER PLANS!). SUPER ZAPPER MODULES ONLY $16! FREE SHIPPING, ALWAYS! Call/fax us anytime 904-234-8302 ext. 5, BRINKER ENGINEERING LABS. (RIP-OFF ALERT: Advertisers now selling empty cans as cable protection. BEWARE!)

TELEPHONE/FAX

ESN READER connects between AR3000 or PRO-2006 scanner and personal computer, reads and logs to disk. Scanner and computer not included. $995 US postal money order to Keith Perry, PO Box 816, Leander, Texas (78641). SASE for info. 512-259-4770.

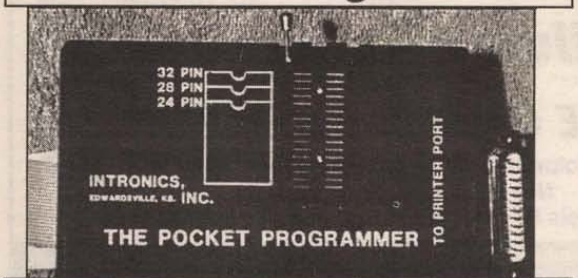
BLUE BOOK PHONE REPAIR. Fix 500+ models; American Oak to Western Electric: answer machines, cordless, wired phones. $25. KEN'S, 2825 Lake, Kalamazoo, MI 49001. 616-345-4609.

$89-$389 SALE, EXTENSION CELLULAR PHONES. MOTOROLA, REFURBISHED WITH ACCESSORIES, IDEAL FOR BACK-UP EMERGENCY USE. PHONE IS ACTIVATED TO ACT AS EXTENSION PHONE OF YOUR PRESENT CONTRACTED TELEPHONE NUMBER (NAM AND YOUR PERSONAL ESN NUMBER). REFURBISHED PHONES PRICE INCLUDES ACTIVATION AS EXTENSION, NEW ACCESSORIES: EXTENDED LIFE BATTERY, LEATHER CARRY CASE, AC BATTERY CHARGER AND BONUS DC CAR CHARGER! MODEL 8000 BRICK PHONE $89, ULTRA CLASSIC SLIM $129, ULTRA CLASSIC II, WITH MEMO/3 PRIORITY HOT KEYS $149, MOTOROLA FLIP $159, LITE FLIP $269, ELITE FLIP WITH ANSWERING MACHINE $399. BAG PHONE ATTACHE LOW PROFILE SERIES III, 3 WATT CAR PHONE, PLUGS INTO CAR CIGARETTE LIGHTER JACK, INCLUDES INTEGRAL BATTERY & AC CHARGER NOW $139. 90-DAY DEFECTIVE EXCHANGE WARRANTY, TO ORDER: ACTIVATED-EXTENSION CELLULAR PHONE, REQUIRES MAILED OR FAXED COPY OF YOUR CELLULAR CARRIER'S ACTIVATION SERVICE CONTRACT. **CATALOG/INFORMATION TELEPHONE OR FAX 702-642-3558 OR http://www.lessbusters.com** S&H CHARGES FEDEX AIR COD $19.95 PER ORDER, USA POSTAL MONEY ORDER OR CASHIERS CHECK ONLY. SORRY NO NEVADA SALES. TELEPHONE/FAX ORDERS ONLY. **(OUR 4TH YEAR OF SALES NUTS & VOLTS MAGAZINE, 99.5% SATISFIED CUSTOMERS) LESS BUSTER'S ELECTRONICS,** 2039 CIVIC CENTER DRIVE #176 N. LAS VEGAS, NV 89030.

MOTOROLA COPYCATS to version 951C w/elite, $900, **EE3/961C** w/elite and Startac ESN clip, $700, both $1,500. **GE-ERICSSON** (95W40) ESN clip, does most silverbacks, $250. **OKI 900 5 NAM** phone $450, chip for mod, $150, blank chips $35 (original Toshiba). **CTEK** interface w/software $150. **ASK FOR PRICES ON READERS. CALL FOR COMPLETE INFO 1-800-607-1745 9-5 PST.**

Write in 203 on Reader Service Card.

The Pocket Programmer



The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs E(E)prom, Flash & Dallas Ram. 27(C)/28(C)/28F/ 29F/29CXXXX & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, MCU's 874X, 875X, 40-Pin X 16 & Serial Eprom's, PLCC, 5-Gang and Eprom Emulator to 32K X 8. **Only $129.95**

Same Name, Address & Phone Number for 13 Years...... Now isn't that Amazing ?

Intronics, Inc.
Box 13723 / 612 Newton St.
Edwardsville, KS 66113 — **Add $4.75 COD**
Tel. (913) 422-2094 — **Add $4.00 Shipping**
Fax (913) 441-1623 — **Visa / Master Charge**

Write in 79 on Reader Service Card.

ACP's 79th GIANT COMPUTER SWAP★MEET

Orange County's Original!

Sunday, 8am-2pm
May 18th

Be a Seller! ...for space call Mary...

FREE Admission & Parking
Shop 100's of Sellers

in ACP's Giant Parking Lot

Advanced Computer Products, Inc.

ACP SUPER★STORE
Since 1976

1310 E.Edinger
Santa Ana, CA
714-558-8813

ALL PHASE VIDEO SECURITY

3-1/2 Digit Auto/Off DMM *w/ Transistor Battery & Diode Test*
- DC Volts to 500V
- AC Volts 500V
- Res. to 2 Meg Ohm
- DC Current 200MA

model #ST1500
17.95

Elenco Digital Capacitance Meter
- .1PF to 20,000 UF
- Banana jack and special insertion jack included

model #CM-1555
49.95

Sale!

Pinhole Camera
- Requires 1/16" opening size
- 1-1/4" x 1-1/4" x 5/8"
- Power 7.5-14VDC n • .8 lux
- 3.8mm lens included
- 380 lines resolution

DC Power Supply 7.50
model #CVC50PH 119.00
w/audio & plugs

Sanyo Realtime Recorder
• 8-24-40hr • 4 head • 350 lines

model #SRT600 1 year warranty 799.95
model #TLS972 3 day time lapse 825.00

Data Acquisition by... Sperry

Cutting Edge
The model DM 9100 meter has a RS 232C serial inerface. Measured value pre tranmitted to the computer via an interface cable and supplied software WINDOWS and MS-DOS. DCV 1000V ACV 1000V AC/DC Current 20A. Res. 40 meg. Ωfreq. 10MHz temperature & more.
REG. $209.95
model #DM9100...**169.95**

Call For FREE Catalog & Technical Assistance
Add $8.95 Shipping/Handling
NYS Add Tax
Visa/MC/Discover/Amex

ALL PHASE VIDEO-SECURITY INC.
WHOLESALE VIDEO WAREHOUSE

MAIL ORDERS TO : 70 CAIN DR. BRENTWOOD, NY 11717

1-800-945-0909
FAX: 516-435-7494

Write in 118 on Reader Service Card.

PHONE SYSTEMS WANTED!!! We buy AT&T MERLIN, SYSTEM 25/75/85 and other AT&T phone systems. Please call for a quote or fax us your equipment list. **KEYWAYS, INC.**, 513-847-2300 or FAX 513-847-2350.

PANASONIC, SOUTHWESTERN Bell, BBS Telecom, telephones, jacks, and systems. Free catalog: voice or fax: 908-840-1390.

TELECODE™

CELLULAR PROGRAMMERS PACKAGE OFFER! Volumes 1 & 2 Cellular Hackers Bibles, Cellular Programmers Bible, Bagphone Video Bible, and Cloning Cellular Telephones Videos. Software for Motorola bag, flip, & brick, NEC, Panasonic, Nokia, & ESN loader chip. Also includes: OKI-900 package of software and documents! Complete package $199. Postpaid USA. 520-726-2833. **TELECODE**, PO Box 6426-NV, Yuma, AZ 85366-6426. http://www.hackerscatalog.com

OKI 900/1150 experimenters cables for sale, connects your phone to any PC via serial port. Allows you to experiment with many of the OKI's hidden features. Software not included but available off the Internet. $149 plus shipping. For more information, E-Mail us at Capcon@shore.net or FAX your order to 508-977-0122.

CONNECT THE RADIO SYSTEM TO THE TELEPHONE SYSTEM. All you need is a dual band radio at home and in your car. You can make phone calls when you're away from home. (It is not a toy.) Plans $10, kit/plans $89 plus $5 shipping. Send check or money order to: Pham, PO Box 51675, San Jose, CA 95151-5675. Call 408-270-1995.

UNIQUE ELECTRONICS. Call us for all your electronic needs. Programmable OKI 900 $490, chip only $125; GE, Ericsson $600 modified. (Modification OKI = $300, GE = $450.) We also carry a number of cable converters. Send check or money order to: PO Box 675615, Marietta, GA 30006. 770-220-1300.

NORTHERN TELECOMM #2960 telephone network interfaces (RID/MTU). Easily converted into extension phone lockout. $1.50 each, $9.90 for ten, $59 per hundred. Full docs available. SYNERGETICS SURPLUS, Box 809, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

WHOLESALE: TELEPHONE distinctive ring decoders. Great for fax, computer, children's line. $54.95 + $4.95 S&H. MC/Visa. Fabtronics, 5714 W. Wautoma Beach, Hilton, NY 14468. 716-392-1231 Fax 716-392-1234.

CELLULAR EXTENSIONS $60 plus shipping. Motorola loader phones $200. Loader phone kits $100. Quality used phones programmed on your number $150 (includes phone and programming). Call or E-Mail Stuart for details. 601-831-8708 ccomco@aol.com

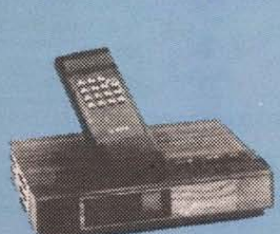
BEEPER, TWO-WAY radio repairs, modifications, duplications, all models, test equipment. Call TJ 718-341-1849, Fax 718-978-4616.

CONVERTERS • CONVERTERS • CONVERTERS

CONVERTERS, LTD.
34 East Main St.
Smithtown, NY 11787
1-800-322-9690

BRAND NEW! Factory Fresh

ALL PRODUCTS 1 yr. Warranty



JERROLD DRX-3-105
61 Channel, Fine Tuning
Factory Refurbished
Single: **$45.00**
5+: **$39.00**
10+: **$35.00**

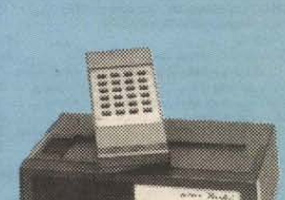
PANASONIC 550MHz

Single	**$69.00**
5+	**$65**
10+	**$62**
20+	**$59**

BRAND NEW Model 100.3

Call Re: Models 145 & 175

UNIVERSAL REMOTES!
REPLACEMENT REMOTES!
$5.00 & up



REGAL CR-83
83 Channel • Parental Lock–Out
More! Factory Refurbished
Single: **$55.00**
5+: **$49.00**
10+: **$45.00**

JERROLD STARCOM DQN-7 — CALL $$

Remote, Batteries & Coax Cable Always Included

WE STOCK EQUIPMENT COMPATIBLE WITH EVERY MANUFACTURER IN THE CABLE INDUSTRY.

CALL NOW!
1-800-322-9690

Write in 196 on Reader Service Card.

ELECTRONIC TEST EQUIPMENT BOUGHT & SOLD

Ailtech 360D11, Frequency Syn. .01-2GHz	$1,000
Anritsu ME645A, Microwave Radio Test Set	$1,000
Argosystems AS210, Frequency Calibration System	$3,500
Bafco 911A, Frequency Response Analyzer (unused)	$400
Ballantine 1627A, Scope Calib., with/acc. heads	$1,000
Boonton 25A, Power Meter Calibrator	$350
Boonton 4200, Power Meter, w/Detector, 100KHz-18GHz	$800
Boonton 42BD, Microwattmeter .2MHz-7GHz	$300
Boonton 518-A4, Q Standard	$250
Boonton 82AD, Modulation Meter	$650
Boonton 92A, RF Millivoltmeter w/Probe	$300
Bruel & Kjaer 1612, Bandpass Filter	$250
Cushman CE24B, Frequency Selective Voltmeter	$800
Datron 1062, Digital Multimeter	$650
DDC SR-400, Syncro Resolver Simulator	$400
Dolch COLT300, Logic Analyzer w/Ext. Chassis & Pods	$300
DR Thiedig MILLI-TO2, Ohmmeter, 1 Milliohm-2 Terraohms	$400
Eaton 380K11, Synthesizer, 1-2000MHz Opt. 01, 03, 183	$2,500
EIP 371, Source Locking Microwave Counter, .18GHz	$1,500
EIP 548A/05/06/08, Microwave Freq. Counter, 110GHz	$4,000
EIP 578, Source Locking Microwave Counter, Opt. 06	$4,000
ESI 296, Auto LCR Meter	$650
Fluke 3330B, DC Voltage, Current Calibrator	$400
Fluke 335A, DC Voltage Standard, 0-1100VDC	$600
Fluke 5200A, Programmable AC Voltage Standard HPIB	$1,600
Fluke 540B, Thermal Transfer Standard	$700
Fluke 8502A, Digital Multimeter, AC, DC, Ohms	$300
Fluke 8505A, Digital Multimeter, AC, DC, Ohms	$400
Fluke 8921A/03, True RMS Voltmeter	$450
Fluke 9010A, Micro-System Troubleshooter Opt. 001	$450
Fluke A55, Thermal Converter	$200
General Microwave 478A, Peak Power Meter	$1,000
General Radio 1422-CB, Standard Cap.	$300
General Radio 1482Q, Standard Inductor, 2 Henry	$100
General Radio 1538-P4, High Intensity Flash Capacitor	$100
General Radio 1650A, Impedance Bridge	$200
Gigatronics 600/6-12, Synthesized Source	$1,500
Goldstar OS-7040A, Scope, 40MHz, Dual Trace	$300
Gould 4500, Digital Storage Scope, 35MHz	$450
Guildline 9154C, Transvolt Standard Cell	$400
Hitachi V-212, Scope, 20MHz, Dual Trace	$250
HP 105A, Quartz Frequency Standard	$600
HP 1124A, 100MHz Active Divider Probe, Unused	$100
HP 11971K, Waveguide Mixer, 18-26MHz, 8569B	$800
HP 141T, Spectrum Analyzer Mainframe	$500
HP 1725A, Scope, 275MHz, Dual Trace	$500
HP 1741A, Scope, Storage, 100MHz	$450
HP 1742A, Scope, 100MHz Dual Trace, DMM	$400
HP 1744A, Scope, Storage, 100MHz, Dual Trace	$500
HP 1815A/1816A, TDR/Sampler, DC-4GHz	$400
HP 3300A, Function Gen. with 3302A Phase Lock	$150
HP 3320A, Frequency Synthesizer	$250
HP 3320B, Frequency Synthesizer	$350
HP 3325A, Synthesized Function Generator	$1,800
HP 3456A, Digital Multimeter, 6.5 Digits	$800
HP 3581C, Selective Level Meter	$600
HP 3582A, Spectrum Analyzer, .02Hz-25.5KHz	$2,500
HP 394A, Attenuator, 1-2GHz, 200 Watts	$125
HP 4270A, Automatic Capacitance Bridge	$600
HP 432A/478A, Power Mtr., Cable, Mount, 10MHz/10GHz	$250
HP 432B, Power Meter, Digital Display	$250
HP 436A/022, Power Mtr., w/8481A, HPIB	$1700
HP 4800A, Vector Impedance Meter	$600
HP 4815A, Vector Impedance Meter	$1,000
HP 5004A, Signature Analyzer	$100
HP 5334A, 100MHz Universal Counter, HPIB	$1,200
HP 5335A, Frequency Counter, 11 Digit, Opt. 010.040	$1,000
HP 5340A, Frequency Counter, 18GHz	$800
HP 5340A, Frequency Counter, 18GHz, LEDs	$1,200
HP 5341A, Counter, 10Hz-4.5GHz LEDs & HPIB	$700
HP 5342A, Frequency Counter, 10Hz-18GHz, Opt. 001	$1,800
HP 5345A, Universal Counter	$450
HP 54100A, Scope, 1GHz Digital, 100 GS/s	$3,000
HP 54112D, Digitizing Scope, 4 Chnl. Color	$3,000
HP 54200A, Digital Storage Scope, Dual Trace, 200/MG/S	$1,000
HP 6177C, DC Current Source 0-50V, 0-500mA	$300
HP 6920A, Meter Calibrator	$300
HP 779D, Directional Coupler, 1.7-12.4 GHz	$200
HP 8002A, Pulse Generator, .3HZ-10MHz	$250
HP 8015A, Pulse Generator, .1Hz-50MHz, 30V	$500
HP 8165A, Programmable Signal Source, .0001-50MHz	$1,800
HP 8350A/86290C, Sweep Gen. 2-18GHz HPIB	$4,800
HP 8410B/8412A/8411A, Network Analyzer, .11-12.4GHz	$600
HP 8443A, Tracking Gen., 100K-110MHz LED Display	$400
HP 8445B, Spectrum Anyz., Automatic Pre-Selector	$400
HP 8482A, Power Sensor	$400
HP 8484A, Power Sensor, w/11708A Attenuator, Unused	$500
HP 8553B, Spectrum Anyz., RF Plug-in, 1KC-110MHz	$200
HP 8553B/8552B, Spect. Anyz. 141T System, 1KC-110MHz	$1,000
HP 8554L/8552B, Spectrum Anyz., 141T System, 1250MHz	$1,400
HP 8556A, Plug-In, Spectrum Analyzer, 20Hz-300KHz	$300
HP 8557A/180TR, Spectrum Analyzer, .01-350MHz	$1,000
HP 8558B/180TR, Spectrum Analyzer, .1-1500MHz	$2,000
HP 8565A/100, Spectrum Anyz., .01-22GHz, Opt. 100	$4,400
HP 8565A, Spectrum Analyzer, .01-22GHz	$4,000
HP 8569B, Spectrum Analyzer, .01-22GHz	$7,500
HP 8620C, Sweeper Mainframe	$400
HP 8621B, RF Draw, with 86350A, 8-12.4GHz, 8620C	$400
HP 86222B/H69, RF Plug-in, .01-4GHz	$1,600
HP 86241A, RF Plug-in, 3.2-6.5GHz	$400
HP 86260A, RF Plug-in, 12.4-18GHz	$400
HP 8640B/01/02/03, Signal Gen., .5-1024MHz	$2,000
HP 8656A, Signal Gen., .1-990MHz, AM/FM, HPIB	$2,000
HP 8660A/100, Synth. Freq. Gen. Mainframe	$650
HP 8660C/100, Synth. Freq. Gen. Mainframe	$1,200
HP 8660C/86603A/86632B, Freq. Syn., 2.6GHz, AM/FM, HPIB	$3,000
HP 86601A, RF Plug-in, 110MHz	$250
HP 86602B, RF Plug-in, 1300MHz	$600
HP 86603A, RF Plug-in, 1-2600MHz, Opt. 02	$1,500
HP 86632B, Modulation Plug-in	$400
HP 8683A, Signal Gen. 2.3-6.5GHz, Opt 1, 2	$1,500
HP 8821A, Medium Gain Bank Amp	$150
HP 8901A, Modulation Analyzer	$4,600
HP 8903A, Audio Analyzer	$2,700
Huntron 2000, Tracker, Component Tester	$1,000
Huntron HSR410, Switcher, IC Tester	$150
IWATSU DS-6121, Digital Storage Scope, 100MHz	$1,000
Keithley 192, Programmable DMM, 6.5 Digits, HPIB	$600
Keithley 261, Pilo Amp. Source (unused)	$300
Keithley 614, Electrometer	$700
Keithley 619, Electrometer, 5.5 Digit	$800
Kepco ATE-100-1M, Power Supply, 0-100V, 0-1 amp (new)	$200
Krohn-Hite 3202, Filter, LP, HP, BP, 20Hz-2MHz, Unused	$450
Leeds & North 1091, Capacitor Decade, .001uF-1uF	$150
Marconi 2019A, Signal Gen., 80KHz-1040MHz, AM, FM	$2,400
Marconi 2955, Radio Comm. Test Set, OCXO	$4,500
Maury Micro LT105, Thermal Converter	$100
Micro-Tel SG800, Swept Signal Generator .1-18GHz	$1,000
North Atl 540/10, Resolver Synchro Bridge	$600
PMI 1018B, Peak Power Meter	$350
PMI 1038, Network Anyz., 1MHz-26.5GHz, w/detectors	$800
Polarad 1105 E-L, Sig. Gen., 1020A Mod., .8-2.4GHz	$300
Polarad 1207, Signal Source 3.8-8.2GHz	$200
Polarad 640, Spectrum Anyz., 18GHz, Dig. Storage	$1,000
Polarad SPNH, Generator 20Hz 20KHz	$450
Racal Dana 1515, Delay Pulse Generator	$500
Racal Dana 9082P, Signal Gen. 1.5-520MHz AM, FM	$800
Racal Dana 9303, True RMS RF Level Meter	$650
Racal Dana 9515, Universal Counter, HPIB, Opt. 41	$200
Sanders 5440C, Noise Figure Mtr., 10KHz-40GHz	$1,000
Sencore TF30, Super Cricket Transistor Tester	$200
T.B.E. 208, C, L Meter, 1fF-10uF, 1nH-10H	$300
Tek 11302, Scope, 500MHz w/(2) 11A71 Plug-ins	$2,000
Tek 1401/324, Spectrum Analyzer, .1-500MHz	$650
Tek 1502/04, TDR with Chart Recorder	$1,400
Tek 1503/04, TDR, Option 03, 04	$1,400
Tek 178, Linear IC Test Fixture, For 577	$300
Tek 213, Scope, 1MHz Mini with Battery & DMM	$400
Tek 2246, Scope, 100MHz, 4 Ch. Cursors	$1,400
Tek 2336, Scope, 100MHz, Dual Trace	$1,000
Tek 284, Pulse Generator	$350
Tek 318, Logic Analyzer, with Pods	$600
Tek 464, Scope/100MHz Dual Trace, Storage	$500
Tek 466, Scope, 100MHz Dual Trace, Storage	$600
Tek 466/DM44, Scope, 100MHz, Storage, DMM	$650
Tek 475A, Scope, 250MHz, Dual Trace	$650
Tek 624, XY Monitor	$200
Tek 7CTIN, Curve Tracer Plug-In	$350
Tek 7D20, Programmable Digitizer PI	$600
Tek 7L13/7603, Spectrum Anyz., .1KHz-1.8GHz	$1,800
Tek 7L18/7603, Spectrum Anyz. 1.5-18GHz Dig. Storage	$2,500
Tek 7L5/25, Spectrum Anyz., 20Hz-5MHz, Opt. 25	$2,000
Tek 7S12/S6/S52/S53, TDR Sampler	$2,000
Tek AM501, Operational Amp Plug-In	$150
Tek AM503, Current Probe Amp	$400
Tek CG551AP, Programmable Scope Calibrator	$2,500
Tek DC503, Universal Counter Timer TM500	$150
Tek DC504, Counter/Timer TM500	$100
Tek DC505A, Frequency Counter, DC-225MHz	$300
Tek DM502, Multimeter TM500 Modular System	$100
Tek FG502, Function Generator, .1-11MHz	$300
Tek MR501, XY Monitor Scope	$200
Tek P6020, Current Probe, Amp, Kit	$250
Tek P6021, Current Probe, 6MHz (new)	$250
Tek P6045, FET Active Probe	$100
Tek P6046, Differential Probe Kit	$350
Tek P6202A, FET Probe Kit, 500MHz, Unused	$400
Tek P6452, Data Acquisition Probe	$25
Tek P6464, Pattern Generator Probe, New In Box	$25
Tek P6465, Pattern Generator Probe, New in Box	$25
Tek PS503A, Dual Tracking Power Supply, TM500	$200
Tek S-52, Pulse Generator Head	$500
Tek S-53, Trigger Recognizer	$500
Tek SC502, Scope, 15MHz, Dual Trace	$250
Tek SC504, Scope, 80MHz, Dual Trace (unused)	$500
Tek SG502, Sig. Gen. 5Hz-50KHz TM500 Sys.	$200
Tek SG503, Sig. Gen. 250KHz-250MHz	$600
Tek T202, Scope, LCD Handheld	$500
Tek TG501, Time Mark Generator	$400
Tek TM503, Mainframe 3 Slot, TM500	$100
Texscan SSG2000, Freq. Syn., 100KHz-2GHz, AM, FM	$1,800
Vu-Data 5110, Semiconductor Tester, In/out Circuit	$250
Wavetek 1002, Sweep/Sig. Gen. 0-500MHz w/Markers	$350
Wavetek 1045/14139, Power Meter 1MHz-18GHz Opt. 01, 05	$800
Wavetek 144, HF Sweep Gen. .0005Hz/10MHz	$200
Wavetek 154, Programmable Waveform Gen. .001Hz-10MHz	$350
Wavetek 180, Sweep Function Gen. .1Hz-2MHz	$300
Wavetek 185, Sweep Function Gen. .0001-5MHz	$400
Wavetek 2002A, Signal Gen. Sweeper, 1-2500MHz	$1,000
Wavetek 3000, Signal Gen., 1-520MHz, AM, FM	$800
Wavetek 452, Filter, Dual Hi/Lo, 1Hz-10KHz	$450
Wavetek 750, Phase Meter	$300
Wavetek 7530A, FFT Spectrum Analyzer 0-100KHz	$1,000
Wavetek 859, Programmable Waveform Gen.	$1,000
Wavetek 907, 7-11GHz Signal Generator	$650
Wavetek, Signal Gen., 1KHz-520MHz, AM, FM	$800
Wiltron 560A, Network Analyzer, HPIB	$850
Wiltron 610D/6237D, Sweep Generator, 2-18GHz	$750

PHELPS INSTRUMENTS
2631 Hillside Ave., Norco, CA 91760 • 909-279-7347

MasterCard VISA AMERICAN EXPRESS

Cellular Extensions
from
"THE CELLULAR EXPERTS"

Motorola 3 Watt Bag Phone from $199
Nec P120 12oz. Portable $299
Motorola PT 550 10oz. "Flip" Phone from $299

Others available, buy new from us, or send us your phone.
Get a second or third phone with no additional monthly charges!
Motorola, NEC, Panasonic, Audiovox and many others.

Fax Back Hotline For 24hr info. call from your FAX (714) 581-7460 or call 1-800-457-4556 9 to 5 PST CA Grapevine. Worldwide inquiries welcome.

Write in 69 on Reader Service Card.

$249! COMBO (A) SALE, UJ'S OLD FAITHFUL EMULATOR (3rd year) A LOW COST, PROVEN, GET STARTED ESN PROGRAMMING SYSTEM. (USE WITH YOUR PC) PROGRAMS. ALL **MOTOROLA CELLULAR PHONES** TO FIRMWARE 9525. **COMBO (A)** INCLUDES L/R: EMULATOR, PROGRAMMING CONTROL BOX, SOFTWARE PROGRAMS INCLUDING MAMPS-1E-EMULATOR & G2E ETC., REGULATED AC TO DC POWER SUPPLY & 100 PAGE CELLULAR PROGRAMMING MANUAL (LATEST UNPUBLISHED DATA) $249. **COMBO (B) SALE $298**; INCLUDES ALL ITEMS COMBO (A), WITH YOUR CHOICE OF 1 EACH INTERFACE CABLE HARDWARE SET. **COMBO (C) SALE $348** INCLUDES COMBO (A) WITH YOUR CHOICE OF 2 EACH INTERFACE CABLE HARDWARE SETS. **SEPARATELY INTERFACE CABLE HARDWARE SETS** WITH AC/DC REGULATED POWER SUPPLY **$99 EACH, MODELS AVAILABLE L/R:** FLIP/POCKET F/P 8PD/P, BAG/MOBILE 2 & 3, UC-II 12PD/P, ELITE 10PD/P & BRICK/UC-PIGGY BACK. 100 PAGE CELLULAR PROGRAMMING MANUAL, FREE WITH $90 OR MORE ORDER. FREE TECHNICAL BACK-UP WITH WARRANTY. **NEW! WHOLESALE/ RETAIL CELLULAR ACCESSORIES CATALOG, DETAILS/FREE CATALOG ALL PRODUCTS, CALL 702-642-0325 OR OUR WEB SITE: http://www.lessbusters.com LESS BUSTERS ELECTRONICS** (OUR 4TH YEAR SALES N&V MAGAZINE, 99.6% SATISFIED CUSTOMERS!), 2039 CIVIC CENTER DRIVE #176, N. LAS VEGAS, NV 89030.

ESN READER, no scanner needed, only a PC needed and my S/W. Call 770-887-1475. $1,200.

POCSAG DECODER interface connects to your existing scanner via ear phone jack and your PC. Decodes text and numeric data in real time! Assembled and tested interface with shareware copy of software $49.95 plus shipping. $99.95 for interface and licensed software. For more information, E-Mail us at Capcon@shore.net or FAX your order to 508-977-0122.

NOKIA 100 handheld $50. AT&T 3610 handheld $50. Technophone EZ 400 handheld $50. 1-800-804-8655.

FIVE ESN/NAM modification installed in your OKI 900 for $250. Chip only $150. Phone with chip $600. Call Keith at 512-259-4770.

CELL PHONE cloning for the guy who has (two of) everything. Must have current service contract. Motorola, Tandy. For more info, call Keith, 512-259-4770.

MOTOROLA PT 550 flip cellular phones $120 ea. 1-800-804-8655.

Subscribe to Nuts & Volts Today! Call 1-800-783-4624 and Use Your Visa or MasterCard.

MOTOROLA® UHF DATA TRANSCEIVERS

$39.95 ea. Plus S&H
$69.00 pr.

Limited Quantity Offer!

NEW! **$74.95** ea. Plus S&H

MODEL PI-10 INTERFACE MODULE FOR UHF Data Transceiver

Motorola (P-10) HLE9018 - 1 watt crystal controlled UHF 450-470 mhz. transceiver (presently on 467.850 or 467.925) . Removed from data service in metal housing shown. 2 freq capable. Dim. 3"x 2 3/8" x 5/8". Wt 4.25 oz. Requires 7.5 vdc. Direct FM. Excellent for packet data, radio control, etc. With documentation. **Pair for $69.00** (NOTE: Motorola is the registered tradename of Motorola, Inc.)

SPECIAL PACKAGE DEAL!
One data transceiver with PI-10 interface for $99.00

A newly designed interface for the UHF data transceiver provides a simple straightforward circuit which interfaces most popular functions directly.
• Built-in voltage regulation... a 12 vdc power source will run the transceiver and interface board. • 2 adjustable audio inputs: one for direct transmit modulation and another for PL or other input. • Receiver audio out and speaker output with squelch action. • Carrier detect for C.O.S. operation as well as unfiltered receiver detector output. • Push-To Talk transmitter control.
• Compact size: 1.62 X 1.75 plug-in board (see photo directly above). Plug it in, connect it up, and it works!

RS232 INTERFACE NOW AVAILABLE!
Provides TTL level data. Only $94.95 ea.

email = mdmradio@earthlink.net
MDM Radio, Ltd.
1629-B N. 31st St.
Melrose Park, Il. 60160
VISA MasterCard
(708)848-4210
(708)848-0230 FAX

Write in 108 on Reader Service Card.

Write in 193 on Reader Service Card.

CD DUPE-IT!

INSTANTLY COPY CD-ROMS NO COMPUTER NEEDED!

COMPLETE STAND ALONE DUPLICATION SYSTEM

- *Totally self contained - no additional hardware or software is required.*
- *Automatically decodes and copies virtually any CD format, including CD-ROM, audio, CD-DA, CD-XA, Mac HFS, Mixed Mode and ISO 9660.*
- *Internal A/V hard drive stores bit-by-bit disk image for instant duplication.*
- *External SCSI port works like a fast CD writer. Connect to your PC or Mac and design custom CDs with the FREE included CD software.*
- *Only $1495 with Free software.*

Not for export to China.

NEW!! Rack Mount Systems! Call Today

INTENDED FOR BACKUP & IN-HOUSE DUPLICATION PURPOSES ONLY

Instantly duplicate CD-ROM disks for software distribution. Make spare backup copies of your valuable software. Produce disks quickly and economically. No CD design or multimedia production experience is required.

Insert your original disk and push "enter". The onboard fast multimedia processor decodes the CD format and copies it to the internal A/V hard drive. Insert blank recordable disks and make as many exact copies as you like. You'll easily and quickly produce identical bit-for-bit duplicates.

The *CD-Dupe-It!* system is totally self contained - absolutely no connection to a PC or Mac is required to copy disks. Just turn it on and press "enter" to start copying.

With the included CD design software, *CD Dupe-It!* also works over-time as your custom CD design system. Just attach a SCSI cable to your PC or Mac and you're ready to master your own custom CD-ROMs and audio CDs.

CORPORATE SYSTEMS CENTER
1294 Hammerwood Avenue
Sunnyvale, CA 94089
www.corpsys.com

Tel. (408) 743-8739

DEALERS AND RESELLERS-CALL FOR QUANTITY DISCOUNT PRICE STRUCTURE

We gladly accept Discover, Visa/Mastercard, COD or prepaid orders. No surcharge for credit cards.

SCSI PERIPHERAL EXPERTS • HARD DRIVES • CD-ROMS • TAPE DRIVES • M/O DRIVES

Write in 68 on Reader Service Card.

2.4 GHZ VIDEO/AUDIO TRANSMITTER/RECEIVER
4 Channels, 300 Foot Range, Cables and AC Adapter Included

$160

2.4 GHz Video/Audio Transmitter/Receiver w/Remote & IR Control Option $225
2.4 GHz Spread Spectrum Radio Modem Available

DBS 14" Antenna and Downconverter $175
Color CCD Camera $175

ALJON TECHNOLOGIES, INC.
3892 Del Amo Blvd. #703, Torrance, CA 90503
Tel (800) 600-4974
Web page: http:/aljontech.com
Major Credit Cards Accepted

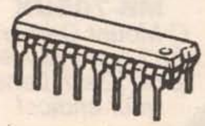
Write in 187 on Reader Service Card.

I WANT it and I want it now. I want all of your SIMM memory. IBM, Mac, new, used, even defective. I want it all. Highest $ paid. Now selling memory. We can beat any printed price in Nuts & Volts. Call 1-800-4-MEMORY now! Voice/FAX.

MILLIONS IN scrap gold are about to hit the market in the form of old computer junk. I'm making a bundle recycling this material and you can join me. Call 24-hour message: 603-645-4776.

RESISTORS 20 FOR $1. Catalog $1. Foreign add $1. ZIPFAST, Box 12238, Lexington, KY 40581-2238.

CRTs CHEAP. Buy direct from the manufacturer. Save money. Mfg. all CRT types since 1950. **3 year warranty.** Reg-Res 19" tubes $75; 25" $100; hi-res 13" tubes from $80. We specialize in **hi-resolution** video/computer CRTs. **T.M.C.** 215-226-0749/215-223-0388.



WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 310-494-4851 OR FAX 310-494-4913.

T-BAR EXPLORER DM-1 digital data line monitor for central site and field service use in isolating protocol and code related problems in data communications networks. Programmed BISYNC/ASCII. 5" CRT. Compact 14 pounds. New $150 w/manual. Louis Gold, Box 3636, Woodbridge, CT 06525.

DISTRIBUTOR: COMPUTER hardware: motherboards, memory, CPUs, mice, CD-ROMs, video controllers, refurbished systems, and other parts. Call **NAMETECHS:** Phone/Fax: 630-789-8393.

ELECTRONIC PARTS catalog two stamps. Dan's Small Parts, Box 3634, Missoula, MT 59806. Ph/Fax 406-258-2782. Online catalog http://www.fix.net/dans.html

MINIATURE TOGGLES 1/4" PANEL HOLE: SPDT on-on 35¢. SPDT on-off-on 35¢. SPDT (mom)-off-on 35¢. DPDT on-on 40¢. DPDT on-off-on 40¢. DPDT (mom)-off-on 40¢. **MICRO-MINIATURE 3/16" HOLE:** SPDT on-on 30¢. DPDT on-on 40¢. Brand new switches. Rated 6A/125V. Hardware included. $20 minimum order. Add $5 freight. Gateway Products Corporation, PO Box 936397, Margate, FL 33093, 954-974-6864, Fax: 954-974-6818. VISA/MC. Free catalog.

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

NIGHT VISION kits. See our classified ad in Plans/Kits/Schematics. NENVIS 508-347-7238.

DON LANCASTER'S ACTIVE FILTER COOKBOOK is back in print. Autographed copies of the seventeenth(!) classic printing $28.50. **SYNERGETICS PRESS**, Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

FILTERS · CONVERTERS · FILTERS · CONVERTERS · FILTERS · CONVERTERS

Converters, All Pro-Filters
All Cable Equipment, Good Prices
Shipped Same Day COD

Just Call: 1-800-A-WIRE 4U
(1-800-294-7348) or 1-888-219-3111

Plazac Sales, Inc.

Sorry, no New Jersey sales.

FILTERS · CONVERTERS · FILTERS · CONVERTERS · FILTERS · CONVERTERS

Write in 41 on Reader Service Card.

by TJ Byers

THE NUTS & VOLTS SOLAR WORKSHOP

Welcome to The N&V Solar Workshop ...

Two DIY Charge Controllers and A Solar CD-ROM Review

Hello, fellow solar enthusiasts, and welcome to another installment of the Nuts & Volts Solar Workshop. Now that we have the bulk of the heavy work behind us (i.e., the installation of outlets and wires), we can take time to focus in on the finer points of the 50-watt solar workshop project we started back in February. This month, I'll show you how to build a companion 50-watt charge controller, with built-in battery monitor.

There's also an update of the two-stage, series charge controller I described in the Dec. '96 Solar Workshop. I've added some sensitivity to the design, and will solve the mystery of the missing Q2 transistor. Building either of these charge controllers can save you several bucks over a commercial equivalent.

Finally, I have some room to open up the classroom for a short session. I'm sure most readers know about or have read *Home Power Magazine*. What you may not know is that issues 1 through 37 — along with a plethora of related information — are now available on CD-ROM. I'll be looking at that CD-ROM in the Classroom, with comments on how to put its vast resources to work for you.

Well, this is certainly a full plate, so let's get started.

The Workshop

Charge Controllers and More

Despite recent advances in NiCd and lithium battery technologies, it's still the venerable lead-acid battery that gets most of the work done. Whether you need the battery to start your car, protect your computer data from power blackouts, or power a cordless drill, chances are good that there's a lead-acid battery on the job.

Which is why it should come as no surprise that the prime mover behind alternative energy sources like photovoltaics is the energy stored in lead-acid batteries. Unlike the battery in your car, though, the batteries in a solar-powered system need special care and maintenance — beginning with the battery charger itself.

A DIY Charge Controller/Battery Monitor

Back in Dec. '96, I described a two-stage charge controller built around an LM339 voltage comparator. Although I've updated this controller (see "Two Charge Controllers In One: An Update"), it's still a simple design that doesn't include the features and safeguards you want in a 50-watt photovoltaic installation. This workshop session describes a photovoltaic battery charger specifically tailored for the needs of our 50-watt solar shack. The controller includes a battery monitor "gas gauge" with a low-voltage disconnect, which prevents damage to the battery array in the event of a solar drought.

About the Circuit

Better described as a charge controller — because it does more than just charge a battery — this "black box" has three functions. First and foremost, it acts as a battery charger that prevents overcharging the battery, which would shorten battery life and could lead to a potentially explosive situation (literally) if left unchecked.

Second, the controller has a built-in fuel gauge (essentially a voltmeter) that monitors the battery's state of charge and displays it in terms of full to empty.

Finally, there's a low-battery disconnect circuit that prevents you from taking too much charge out of the battery; a situation that can also shorten battery life. The schematic diagram of the charge controller is shown in Figure 1.

Battery Monitor

At the heart of the charge controller is an LM3914 dot/bar display driver. This IC senses analog voltages and drives 10 LEDs or incandescent lamps to provide a linear display of the measured voltage. Because each LED driver is an individual circuit, it's unaffected by the status of the other LEDs, making the LM3914 suitable for use as a programmer or sequencer, too. Our design incorporates traits of both features.

First there's the voltmeter. The LM3914 contains a precision voltage reference that's adjustable from 1.2 volts to 12 volts. By placing the voltage reference above ground, we can create what's called an expanded voltmeter. Unlike conventional voltmeters — which read from zero volts up to full scale — an expanded voltmeter doesn't display a reading until a certain threshold voltage is reached. This allows us to more accurately display voltages that are in a narrow range of interest.

Take the AC line voltage, for example. The line voltage typically fluctuates between 110 VAC and 125 VAC over the course of the day as consumer demands increase and decrease. If the voltage goes lower or higher than these levels, equipment and appliances plugged into the line can be damaged, which is why it's desirable to keep an eye on it.

A conventional voltmeter would typically cover this range with a 150-volt scale, which has a resolution of three volts per division. Consequently, our range of interest (90 VAC to 130 VAC) spans a short one-fourth (26 percent) of the full scale. If, however, we disregard all voltages under 90 VAC and don't start taking readings until this threshold is passed, a more sensitive 50-volt voltmeter could be used to monitor voltages between 90 VAC and 140 VAC. Our area of interest now occupies 80 percent of the full scale and resolution

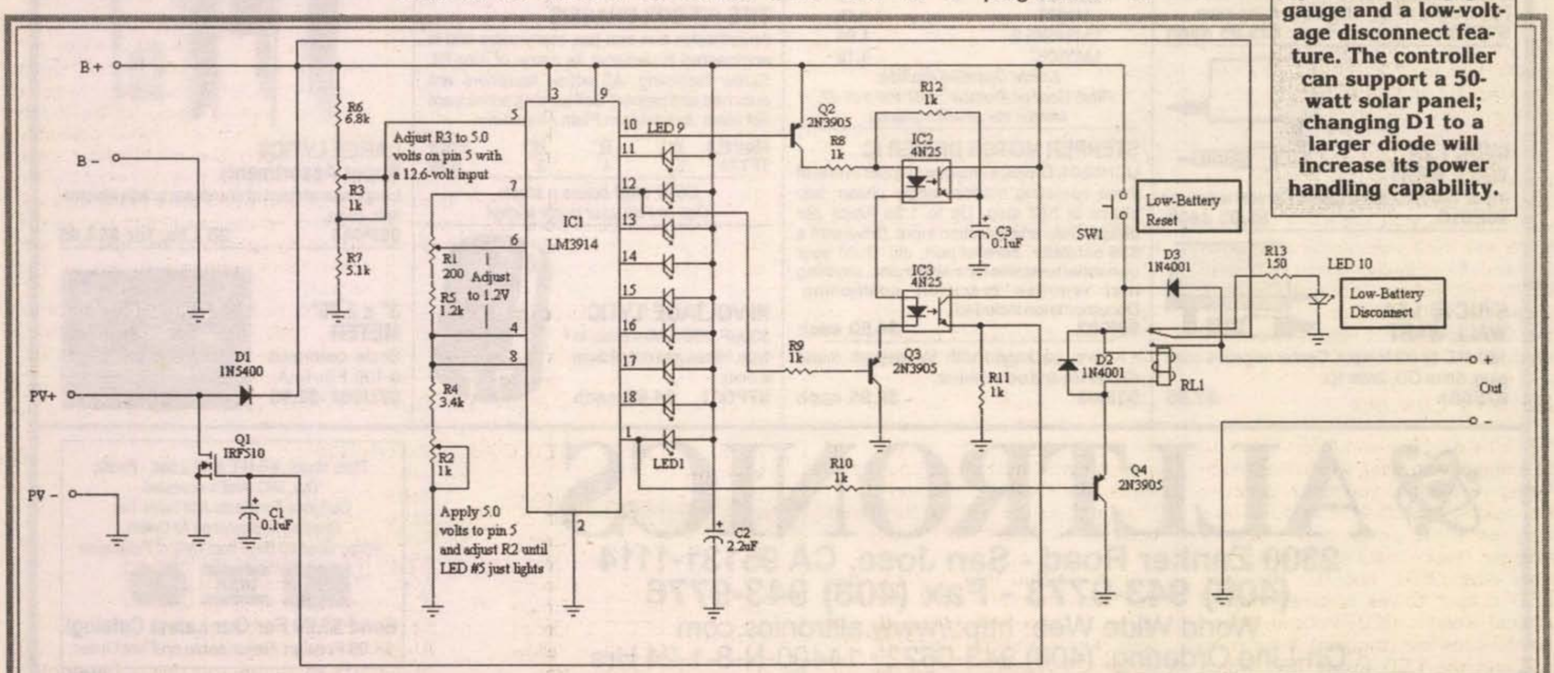


FIGURE 1. The charge controller sports a battery gas gauge and a low-voltage disconnect feature. The controller can support a 50-watt solar panel; changing D1 to a larger diode will increase its power handling capability.

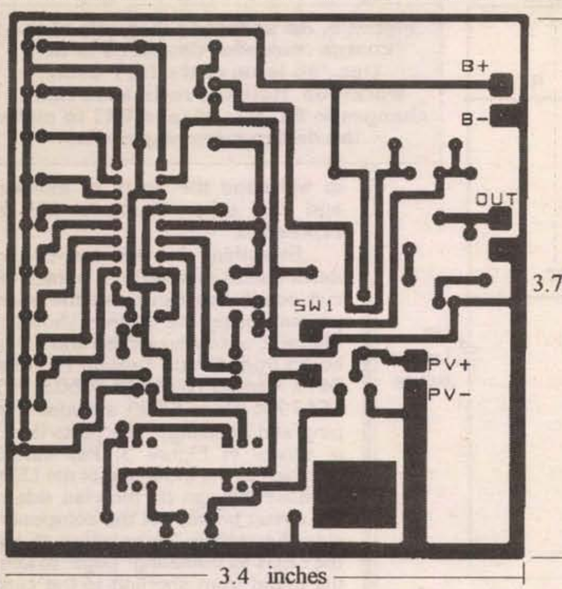


Figure 2. This is the foil pattern of the charge controller/battery monitor's printed circuit board, which measures 3.4 by 3.75 inches.

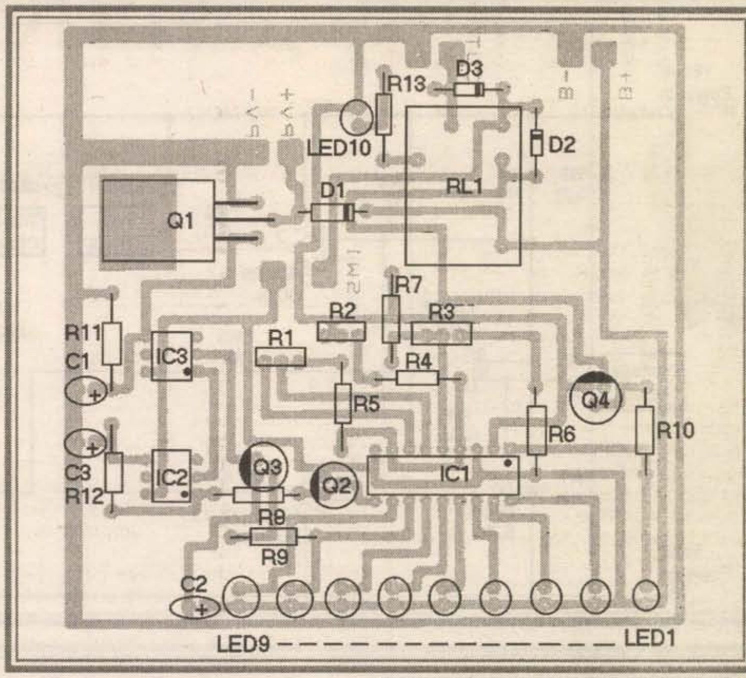


Figure 3. Here is the parts layout for the charge controller/battery monitor.

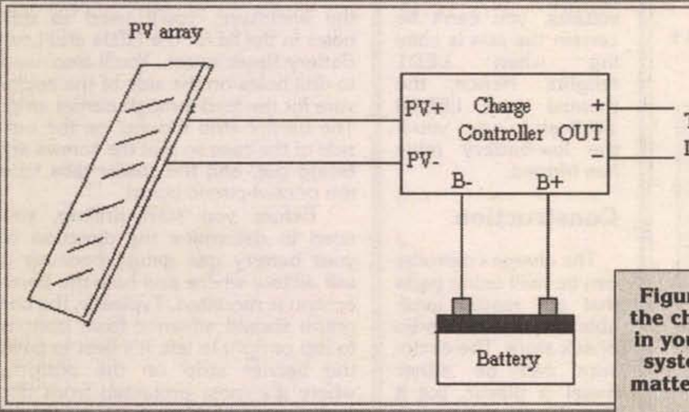


Figure 4. Installing the charge controller in your photovoltaic system is a simple matter of connecting six wires.

has increased to one volt per division.

In our charge controller design, the threshold voltage is 11.4 volts, and the top voltage is 14.1 volts for a full-scale range of 2.7 volts and a resolution of 0.27 volts per division. Resistors R2 and R4 (Figure 1, again) set the threshold voltage limit, and R3 sets the range.

To calibrate the fuel-gauge voltmeter, first adjust R1 so that the voltage across pins 4 and 6 measures 1.2 volts. Next, adjust R3 for 5 volts on pin 5 with 12.6 volts applied between B+ and B-. Finally, adjust R2 until LED5 just lights. That's it. Table 1 shows the voltage value of the respective LED and how it relates to battery charge.

Battery Charger

Why did I use an LM3914 instead of a digital voltmeter, which has much better resolution, you ask? Because I'm asking the LM3914 to do double duty as a gas gauge and a battery charger. Notice that the voltmeter has only nine LEDs, not 10. The 10th LED output drives a cross-coupled optical isolator (IC2) instead. When pin 10 goes low (triggers), it turns on Q2 and the LED inside IC2, which causes the internal transistor to conduct current. Look carefully, and you'll see that the internal transistor is wired to drive the internal LED when it's conducting. This creates a feedback loop, which causes the LED to remain lighted even after the LM3914 output disappears.

In effect, we've created an optical latch. When LED8 turns off, drive to Q3 is lost which removes power to the latch and resets it. We must now wait for pin 10's output to fire again before the latch engages.

What this design does is control the charge to the battery using trip voltages. It's generally agreed that when the charging voltage reaches 14.1 volts, a lead-acid battery should be removed from the charger, and when the battery voltage drops below 13.5 volts, it can be put back on the charger. This dead band area is called hysteresis, and it prevents the battery charger from "hunting" as the voltage fluctuates between 14.09 and 14.10 volts.

(Before you start writing, telling me that your battery vendor recommends 14.2 or 14.3 volts, I know all about it. I've seen some gel-cell vendors prescribe 14.7 volts as the cut-off. But you have to remember that battery voltage varies with temperature, and you'll have a lot wider fluctuation than 0.1 volts as the weather warms and cools. That's why I say it's "generally agreed." Yes, a temperature sensor would be nice, but it's not necessary for most applications where the battery temperature is maintained between 50 and 80 degrees Fahrenheit.)

IC3 is used to control Q1, which is the actual regulating element. When the optical latch is locked, the transistor in IC3 ties Q1's gate to the B+ line, which turns Q1 on. This shorts out the photovoltaic module. This type of charge controller is called a shunt regulator, and it's commonly used for solar arrays up to 16 amps in size. No, shorting a photovoltaic module doesn't damage the solar module.

When the panel is shorted, it produces zero volts, which equals zero watts. Larger systems normally use a series regulator, like the one described in "Two Charge Controllers In One: An Update," which disconnects the solar panels rather than shorts them. This is done not to protect the panels, but to eliminate stress on the power wiring.

Low-Battery Disconnect

The last feature is a low-battery disconnect circuit. Like overcharging, completely depleting a lead-acid battery significantly shortens its life. This circuit won't let you take more power from the battery than it can safely deliver.

The disconnect voltage is determined by LED1's output. As long as LED1 remains lighted, Q4 holds relay RL1 engaged. Should the battery voltage drop below 11.4 volts, though, LED1 extinguishes and RL1 drops out, disconnecting the loads from the battery. Note, however, that only the loads are shed; the photovoltaics and battery are still connected, which allows the battery to recharge when the sun comes back up.

Once RL1 drops out, it stays out until you press the Low-Battery Reset button. Lead-acid batteries have a habit of coming back to life if left alone for a while. You've probably had it happen. You accidentally leave your car's headlights on, only to find the car now won't start. Many times, if you turn off the headlights and let the car sit for a while, the battery will come back enough to crank the engine.

This trait is desirable for automobiles, but not for photovoltaics because the instant the car starts, the

Table 1. How to read the charge controller's gas gauge

Battery Voltage	LED #	LED Color	Description
13.8	LED 9	Green	Battery charging
13.5	LED 8	Green	Battery charging
13.2	LED 7	Green	About 100% of charge remains
12.9	LED 6	Green	About 80% of charge remains
12.6	LED 5	Green	About 70% of charge remains
12.3	LED 4	Green	About 55% of charge remains
12.0	LED 3	Green	About 40% of charge remains
11.7	LED 2	Yellow	About 25% of charge remains
11.4	LED 1	Red	About 10% of charge remains — Caution!

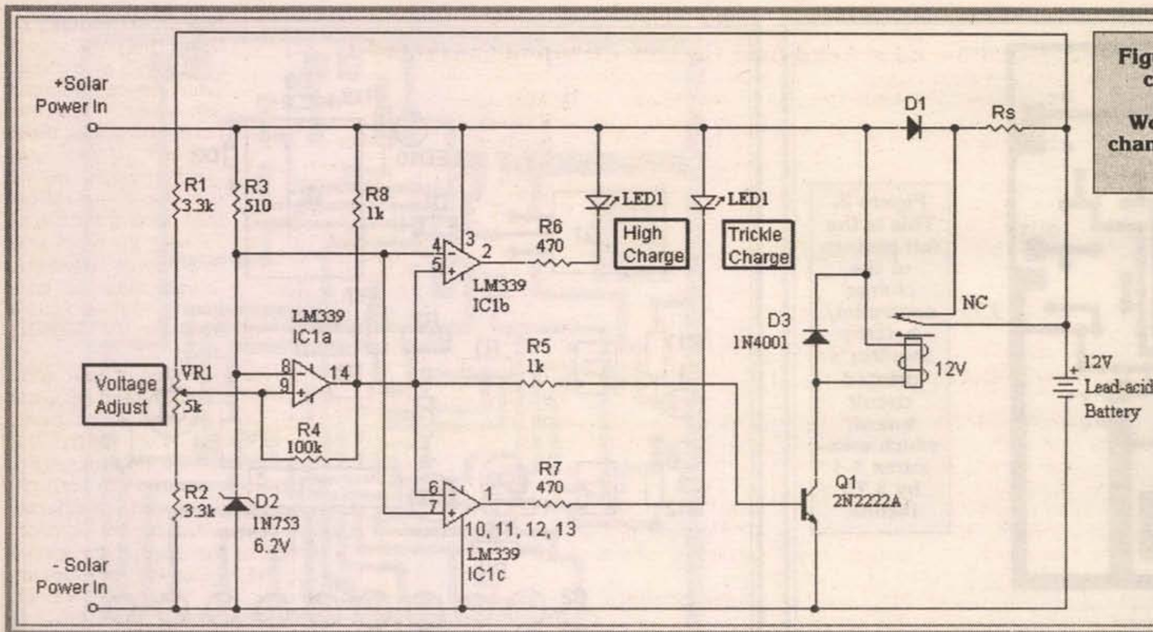


Figure 5. An updated schematic of the charge controller described in the Dec. '96 issue of the N&V Solar Workshop. Note the resistance value changes to R1, R2, R4, and VR1 to make the design more responsive.

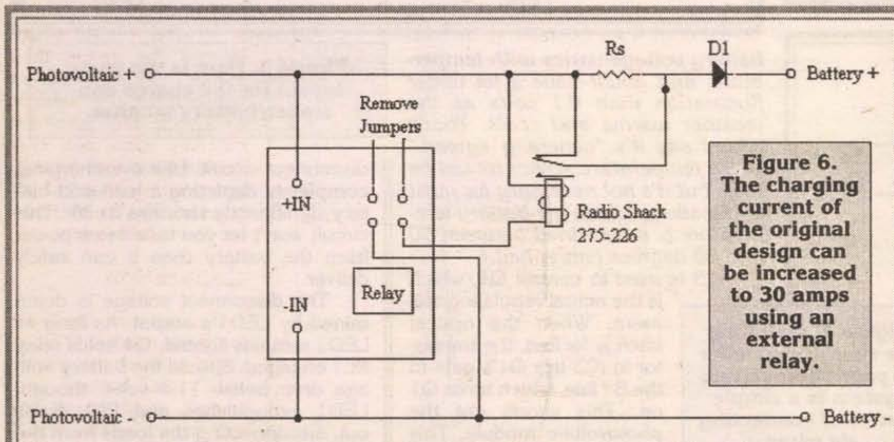


Figure 6. The charging current of the original design can be increased to 30 amps using an external relay.

battery begins to recharge. With photovoltaics, you can't be certain the sun is shining when LED1 relights. Hence, the manual reset. LED10 will flash to warn you if the low-battery relay has tripped.

Construction

The charge controller can be built using parts that are readily available from any Radio Shack store. The enclosure can be either metal or plastic, but it must be sturdy enough to withstand the rigors of moisture and the other elements it'll be exposed to.

Everything but the Low-Battery Reset button mounts on a printed circuit board. You can make the board yourself using the pattern shown in Figure 2, or buy an etched and drilled board from Circuit Design, P.O. Box 5415, Central Point, OR 97502; 541-664-7904 (Price: $7.95, includes shipping and handling). The parts layout is shown in Figure 3. Pay careful attention to the mounting of the LEDs because they go on the clad side of the circuit board, not the component side. Essentially, we're going to use the LEDs as insulating "pegs" to keep the board from shorting to the case, so you'll want them all the same height.

To fit the completed board into the enclosure, you'll need to drill holes in the lid for the LEDs and Low-Battery Reset switch. You'll also need to drill holes on the side of the enclosure for the feed-through barrier strip. The barrier strip mounts on the outside of the case so that the screws are facing out, and the solder tabs face the printed circuit board.

Before you start drilling, you need to determine the direction of your battery gas gauge because it will dictate where and how the barrier strip is mounted. Typically, the bar graph should advance from bottom to top or right to left. It's best to have the barrier strip on the bottom, where it's most protected from dirt and moisture. Now is the time to apply the labels — after drilling the holes and before the final assembly. Dry transfer decals from an art supply store work great.

Finally, mount the barrier strip and wire it to the circuit board before mounting the circuit board (it's easier that way) using 16 AWG, stranded automotive wire (not solid). Now mount the circuit board in the case using an aquarium-grade silicon sealant to anchor the LEDs.

Test and Installation

The charge controller is easily tested using a variable 0-15 volt power supply. Observing polarity, connect the power supply to the B+ and B- terminals and advance the output voltage to 12.6 volts. LED10 should be blinking at this point. Press the Reset button and check to see that LED1 through LED5 light. If the calibration is off, adjust R2 to bring it back in line.

Now vary the power supply voltage between 11.3 and 13.9 volts to verify the linearity of the gas gauge; R1 adjusts the linearity.

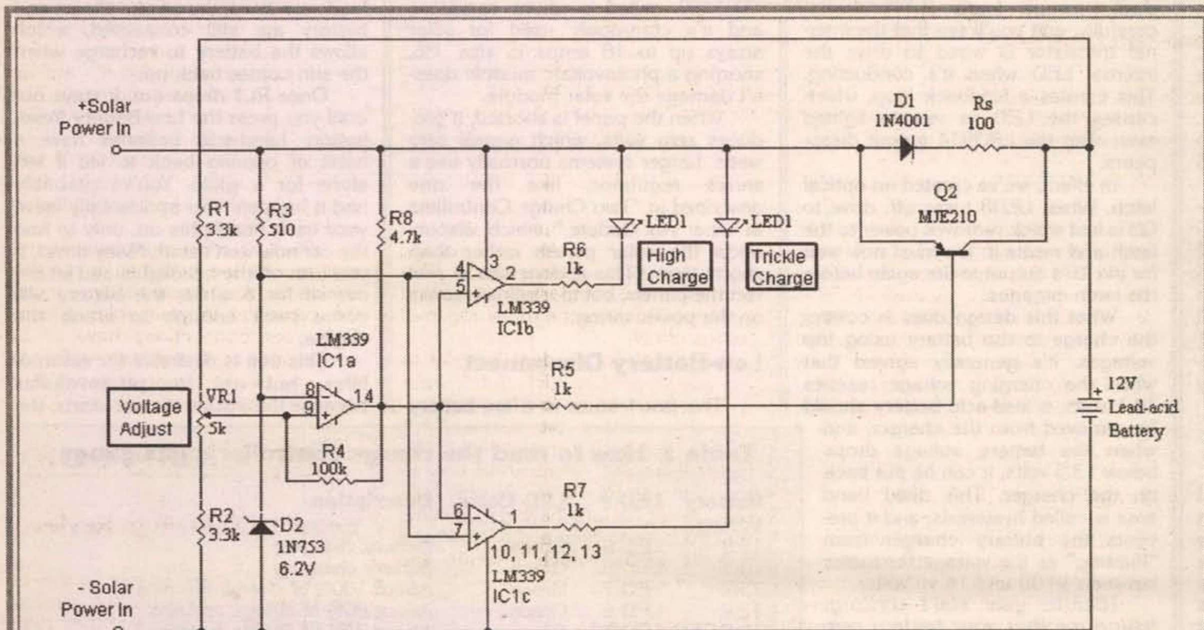


Figure 7. The low-power version of this design (not shown in the Dec. '96 issue) consumes less power than the relay version, and is designed for photovoltaic systems of 10 watts and less.

Decrease the voltage to 11.0 volts to verify that LED10 activates again. Remove the power supply and install the charge controller in the photovoltaic system according to the diagram in Figure 4. Now enjoy free power from the sun!

Table 2. Recommended Lead-Acid Battery Charging Currents

Battery Capacity (amp-hours)	Maximum Charge Rate (amps)	Trickle Charge Rate (amps)	Rs Value (ohms)	Rs Wattage Rating (watts)	D1 Blocking Diode
5	1.0	0.1	23	1/4	1N4001
10	2.0	0.2	12	1/2	1N5400
15	3.0	0.3	8.7	1	1N5400
25	5.0	0.5	4.6	1	GI750
50	10	1.0	2.3	3	MBR1045
75	15	1.5	1.5	5	MBR3045
100	20	2.0	1.2	5	MBR3045
150	30	3.0	0.7	10	MBR3045

Two Charge Controllers in One: An Update

For the second part of our Workshop, I'll more fully describe some features of a two-stage charge controller that I first described in the Dec. '96 installment of The N&V Solar Workshop. This is a no-frills, simple-to-install charge controller that's capable of delivering more than 30 amps on a shoestring budget. In fact, you can build this controller for just $17.00 using off-the-shelf Radio Shack parts, and you can do better if you shop around.

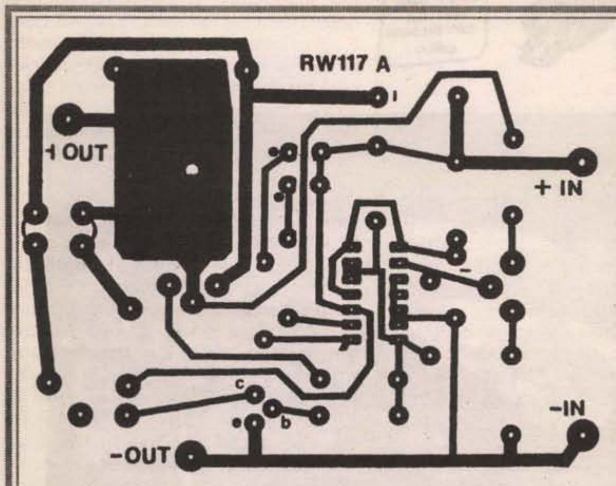


Figure 8. You can use this artwork to make the printed circuit board for the updated charge controller.

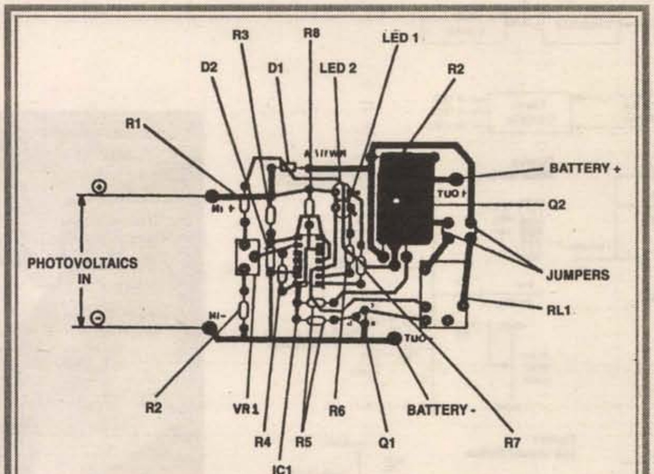


Figure 9. This parts layout shows the placement for both the high- and low-power designs. The high-power version uses RL1, with Q2 omitted; in the low-power version. Q1 and RL1 are omitted. The placement of R5 changes, too.

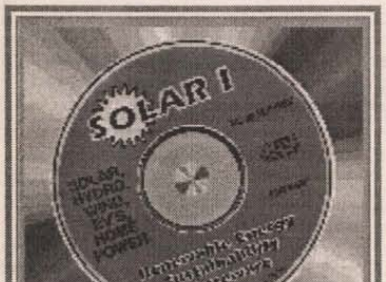


Figure 10. Solar 1 CD-ROM from the publishers of *Home Power Magazine.*

Unfortunately, a couple readers have pointed out that the printed circuit board layout is confusing, and that the circuit doesn't work as described. Hopefully, this update will clear the confusion.

High-Power Controller

To begin with, this is a two-part design that uses a common printed circuit board, e.g., the two circuits have enough parts in common that it was more economical to use one circuit board for both designs. Hence, the confusion as to why there are two R5 locations shown in the parts layout. (Had I anticipated this, I would have labeled one resistor R5 and the other R15 ... oh, well.)

The first design is the one published and shown in Figure 5 below. This circuit uses a relay to switch a current-limiting resistor (Rs) in and out of the charging path. The values of Rs and D1 depend on the size of the storage battery, as listed in Table 2. At maximum capacity, this design can deliver 10 amps of charging current. By using the on-board relay (RL1) to drive an external relay (Figure 6), the current-handling capacity can be increased to more than 30 amps.

Low-Power Controller

The second design, shown in Figure 7, is a low-power charge controller for smaller photovoltaic systems of 10 watts and less. To lower the charger's power usage, a transistor (Q2) is used in place of the relay to switch the control between the full charge and trickle modes.

The power consumed by this controller is less than a watt (450 mW in the trickle mode), as opposed to the 1.5 watts used by the relay version. The low-power version can handle charging currents up to 250 mA; 1 amp if you replace Q2 with a Zetex ZTX705 Darlington transistor (available from Digi-Key, 800-344-4539). The copper pad on the circuit board serves as a heatsink for Q2.

New Smarts

The brains behind both of these controllers is a comparator, IC1a. The function of a comparator is to compare an unknown voltage to a reference voltage, then make a decision about the two. The reference voltage is derived from a zener diode (D2) and fed to the comparator's inverting (-) input. This sets the triggering level for the circuit.

A couple of readers brought to my attention that VR1 didn't have quite enough range for their application, so I modified the values of R1, R2, R4, and VR1 to make the circuit more responsive. Please take note of the changes if you've already built this circuit, or are having problems making it work. IC1b and IC1c drive a pair of LEDs, which indicate the mode of charge.

Construction

The controller is constructed on a printed circuit board. In case you missed the Dec. '96 charge controller article, you'll find a foil pattern of the board in Figure 8. Using the parts layout in Figure 9 as a guide, insert the components into their respective holes and solder them in place. *Before you start, though, notice that the layout shows the parts placement for both the high- and low-power designs, which may be confusing at first. Here's how the two layouts differ:*

With the exception of four components (D3, Q1, Q2, and R5), the two designs share the same parts. This includes D1, D2, IC1, LED1, LED2, R1 through R4, R6 through R8, and VR1. R5 is common to both circuits, too, but it's located in a different position dependent on the version. It's closest to the edge of the circuit board in the high-power, relay-operated design. The high-power version uses D3, Q1, and RL1; Q2 is omitted. The low-power design uses Q2, with D3; Q1 and RL1 omitted.

Although all the resistors are labeled the same, their values are different between the two models, so check the parts list carefully. Also take care to orient the semiconductors properly to avoid pin reversal. The board is now ready for calibration.

Calibration

Calibration is the same for both models. This is done without the photovoltaics or battery connected. First, short the +IN input to the +OUT output, and turn VR1 fully counterclockwise. Observing polarity, connect a variable power supply to the +IN and -IN terminals and apply 12.6 volts to the controller. LED1 should light. Advance the output voltage to 14.1 volts. Now adjust VR1 until LED1 extinguishes and LED2 lights.

Finally, remove the power supply and mount the board in a suitable enclosure. You're now ready to install the controller in your solar system. Only four connections have to be made to the controller: two to the battery and two to the solar panel. And that's it. You're done!

The Classroom

Solar 1 CD-ROM in Review

Sorry it's taken so long to assemble another Classroom, but between the hands-on projects and their related theory, we've covered a lot of ground in the last couple months. In fact, I had a hard time squeezing in this abbreviated session, so let's not waste precious time or page space

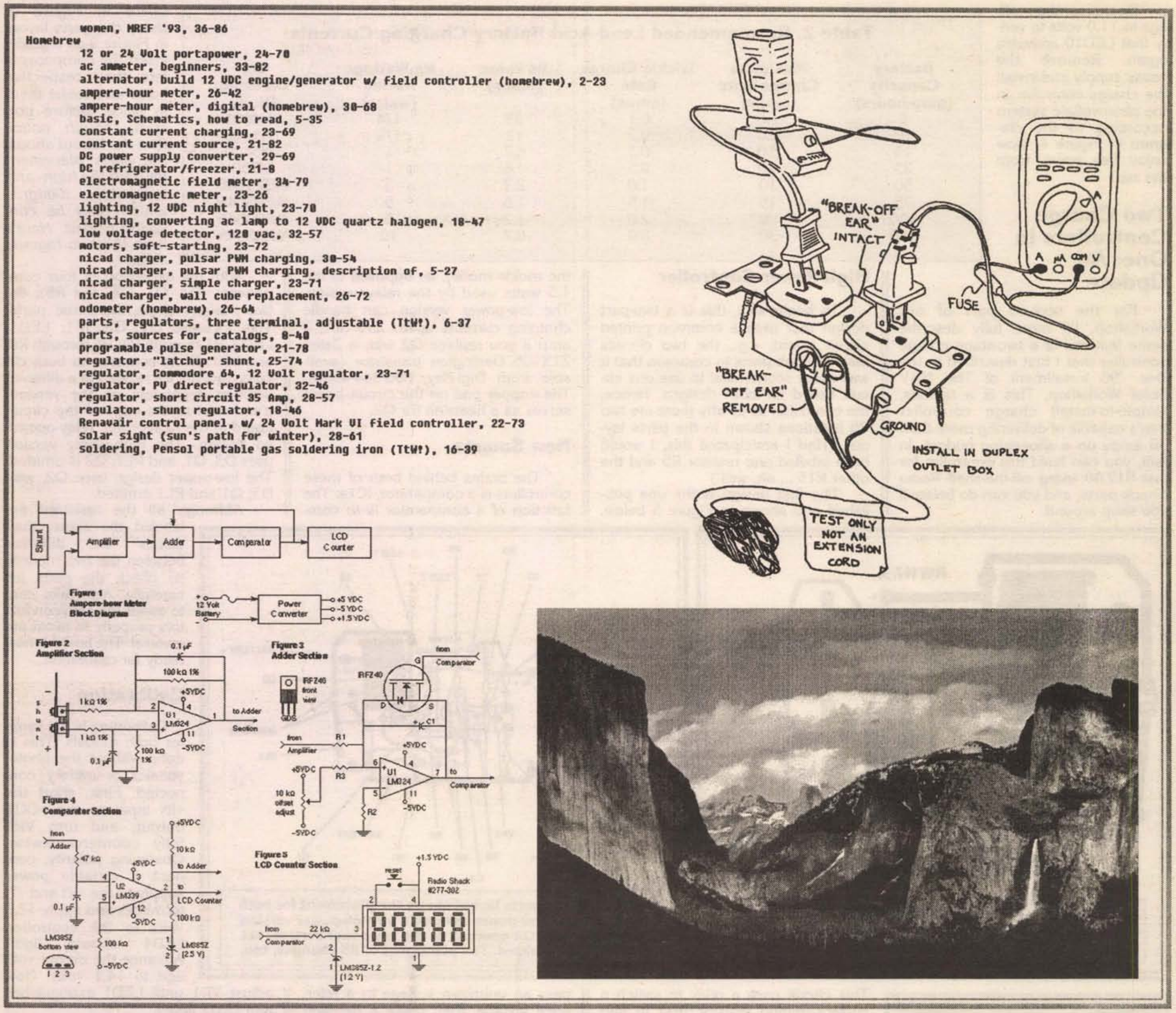


Figure 11. The Solar 1 CD-ROM contains a wealth of information that's useful for anybody interested in alternative energy and/or computers, as this collage of screen shots shows. Shown here are: a small portion of one of the many CD-ROM indexes; the schematic of a sophisticated watt-hour meter; a simple current-monitoring breakout cord for appliances; and a GIF slide of Yosemite Falls.

and get right to the subject matter.

While searching the Internet a couple of months back for appropriate solar sites, I ran across a unique product from *Home Power Magazine* (http://www.homepower.com) — a CD-ROM called Solar 1 (Figure 10). This CD-ROM contains copies of *Home Power Magazine* starting from the 11/87 issue up to Volume 10/93. The entire editorial contents of each issue, including the "Letters to HP" and Editorial columns, are presented as text and GIF-format graphics files.

The individual issues are put in their own file folder (subdirectory) for easy finding; a master index to the articles helps you find the specific information that you need. There's even a category called Homebrew (Figure 11) that lists all the DIY construction projects for the entire six-year period.

Despite this ambitious effort, the publishers discovered that they had an awful lot of empty disk space on their hands (600 MB, to be exact). They decided to fill this unused space with a selection of the best public domain and shareware software they could find. Of course, there's a section that contains energy-related professional publications ranging from thin-film photovoltaic theory to biofuel research to carbon emissions around the world.

Among the general-interest software included is a small selection of PC games, such as Doom and Duke Nukem, and several computer programs, including business, graphics, and telecommunication applications. There's even a good assortment of GIF graphics displaying video slides of everything from a 1963 Corvette to the clouds of Jupiter.

Unfortunately, the viewing and unzipping tools needed to use some of these programs aren't provided. The publisher correctly reasoned that the high cost of licensing this software would push the price of the CD-ROM beyond a reasonable amount. Instead, you'll find these tools embedded in the shareware areas, where you are responsible for the financial arrangements for its use.

Required is an unzipping program and a graphics viewer. I recommend PKunzip for the unzipping program and Paint Shop Pro for the GIF viewer, both of which you can find on our Web site (http://www.nutsvolts.com) under the file names PK250W16.EXE (Win 3.1 version) or PK250W32.EXE (Win 95 version) and PSP311.EXE (Win 3.1 version) or PSP32BIT.EXE (Win 95 version), respectively.

The Solar 1 CD-ROM is a non-interactive, cross-platform CD that runs on the PC, Mac, and Unix plat-

Parts List
Charge Controller/Battery Monitor

Resistors
R1 - 200-ohm trimmer
R2, R3 - 1K trimmer
R4 - 3.3K
R5 - 1.2K
R6 - 6.8K
R7 - 5.1K
R8, R9, R10, R11, R12 - 1K
R13 - 150 ohms

Capacitors
C1, C3 - 0.1 uF
C2 - 2.2 uF, 25V

Semiconductors
D1 - 1N5400
D2, D3 - 1N4001
Q1 - IRF510
Q2,Q3,Q4 - 2N3905
IC1 - LM3914
IC2, IC3 - 4N25
LED1 - Red LED
LED2 - Yellow LED
LED3 - LED9 - Green LED
LED10 - Blinking red LED; Radio Shack 276-036

Misc.
RL1 - 10A SPDT relay; Radio Shack 275-248
SW1 - SPST momentary pushbutton, Radio Shack 275-609 or equivalent
Enclosure - Radio Shack 270-224
Eight-position chassis-mount feed-through barrier - Radio Shack 274-653
Dry transfer decals
Printed circuit board - Circuit Design, P.O. Box 5415, Central Point, OR 97502; **541-664-7904** (Price: $7.95, includes shipping and handling)

forms. The CD conforms to the ISO 9660 standard, which means it acts like a hard disk, so installation isn't needed. Simply slip it into your CD-ROM drive and treat it like you would any other disk drive.

You can order Solar 1 CD-ROM at 800-707-6585, at 916-475-3179 outside the US, or from *Home Power Magazine* online. The price is $29.00, postpaid. Hot on its heels is Solar 2 CD-ROM, which will have the most recent issues of HP in Adobe Acrobat format that lets you view the magazine pages exactly as they appeared in the magazine, with mixed text and graphics.

That's all we have time for today. I know it's terse, but I hope it was helpful. 'Til next month. **NV**

Parts List

High-Power Controller

Resistors
R1, R2 - 3.3K
R3 - 510 ohms
R4 - 100K
R5, R8 - 1K
R6, R7 - 470 ohms
Rs - (see Table 2)
VR1 - 5K potentiometer

Semiconductors
D1 - (see Table 2)
D2 - 1N4735
IC1 - LM339
LED1 - Yellow LED
LED2 - Green LED
Q1 - 2N2222A

Misc.
RL1 - 10A SPDT relay; Radio Shack 275-248
Enclosure - Radio Shack 270-223
Four-position chassis-mount feed-through barrier - Radio Shack RSU 11673159
Dry transfer decals
Printed circuit board - Circuit Design, P.O. Box 5415, Central Point, OR 97502; **541-664-7904** (Price: $7.95, includes shipping and handling)

Low-Power Controller

Resistors
R1, R2 - 3.3K
R3 - 510 ohms
R4 - 100K
R5, R6, R7 - 1K
R8 - 4.7K
Rs - 100 ohms
VR1 - 5K potentiometer

Semiconductors
D1 - 1N4001
D2 - 1N4735
IC1 - LM339
LED1 - Yellow LED
LED2 - Green LED
Q2 - MJE210 (Radio Shack RSU 11370178)

Misc.
Enclosure - Radio Shack 270-223
Four-position chassis-mount feed-through barrier - Radio Shack RSU 11673159
Dry transfer decals
Printed circuit board - Circuit Design, P.O. Box 5415, Central Point, OR 97502; *541-664-7904* (Price: $7.95, includes shipping and handling)

COMPONENTS *cont.*

RF TRANSISTORS, tubes, electrolytics. MRF477, 2SC2879, 2SC1969, MC145106P, 2SC2075, MRF454, SRF numbers, tubes, 4CX250B, 6KG6A, 12D6Q, 6146W, 3-500 graphite, trimmers, all types. Westgate 1-800-213-4563.

ELECTRONIC COMPONENTS bought. All xsistors, diodes, resist, caps, ICs. Labb Assoc., Ph. 215-364-5414, Fax 215-364-5415.

WE BUY gold plated parts, transistors, hybrids, ICs, diodes, circuit boards, patch panels, military pins, tantalum capacitors, relays, old test equipment and all types of electronic material. **GOLD'N WEST SURPLUS** in Corona. Ph: 909-340-1501, FAX: 909-340-1504. ASK FOR MARK.

WHOLESALE: TONER AND PARTS, OEM and compatibles, for copy machines and laser printers. Call **NAMETECHS**: Phone/Fax: 630-789-8393.

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

MICROCONTROLLERS

HIGH SPEED MICROCONTROLLER DC80C320 (8051 compatible), 64K-128K RAM, 64K-128K ROM, RS232, RS485, I2C EEPROM, RTC, parallel I/O (8255), AT keyboard input, 2-8 bit ISA slots, expansion header, LCD interface. Minimum system $89, full system $149. Free monitor/debugger. CG Microsystems, PO BOX 1074, Redlands, CA 92373. Voice/Fax 909-793-3917. http://home.earthlink.net/~cgmicro/

ANTIQUE ELECTRONICS

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

ENTIRE STOREHOUSE FULL of classic Apple collectibles. II, II+, IIe, IIc, III computers, monitors, drives, cards, cables, docs, software, bunches more. Closeout at $590. Synergetics Surplus, 3860 West First Street, Box 809, Thatcher, AZ 85552. 520-428-4073. synergetics@tinaja.com VISA/MC.

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-231-6478/540-763-2321).

TUBES, PLUG-INS: thousands of vacuum tubes; tube equipment (VTVMs, plug-ins, etc.). Call/fax want list: Daniel Buchalter, 510-569-8008 (Northern California).

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

ANTIQUE RADIO CLASSIFIED. Free sample copy! Antique radio's largest-circulation monthly magazine. Old radios, TVs, ham equip., 40s & 50s radios, telegraph, books, & more. Ads & articles. Free 20-word ad monthly. Subscribe today. Six-month trial: $18.95. Yearly rates: $36.95 ($53.95 by 1st class). Foreign: Write. ARC, PO Box 802-G18, Carlisle, MA 01741. Phone: 508-371-0512; Fax: 508-371-7129; Web: www.antiqueradio.com

CRYSTAL SETS. Parts, plans, books, kits. Largest source in the world. Catalog $2. MIDCO, PO Box 2288, Hollywood, FL 33022.

TV TUBES, over 4,000 available. New old stock, $2 each plus UPS. For list send LSASE to: Mike Stacy, 705 Honey, Longview, TX 75605.

WESTERN ELECTRIC WANTED: 1920s-1960s. Amplifiers, mixers, pre-amps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

AVIATION ELECTRONICS

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

BUY, SELL, trade avionics equipment, IFR, Collins, TIC, Mil, HP, Linaire, King. Shop equipment, Kingsley, Eubanks wire stamp machines. Need Litton INU, type LTN-72. 941-575-0138, fax 24 hrs. 941-575-2361.

PUBLICATIONS

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

MILITARY MONITORING GUIDE. New book covers all phases of Military Monitoring. Military Frequencies All services, US Military bases, Military Black Projects. Major Air Force Installations, Monitoring Equipment and Systems, Navy/Coast Guard and more. $19.95 plus $4 Priority Mail. UNIVERSAL ELECTRONICS, 4555 GROVES ROAD, Suite12, COLUMBUS, OH 43232. 614-866-4605.

HACKERS AND EXPERIMENTERS BOOKS. Cable Hackers Bible Volumes 1 & 2 $45.45 each, DSS Bible $49.95 ppd, DSS SECRETS 3-volume set $69.95 ppd, Scanner Hackers Bible Volume 1 & 2, $35.45 each, Satellite Hackers Bible $55.45, 8.6 megabytes hacker software $29.95, Black Box Bible $35.45, Phone Phreakers Bible $35.45, Phone Box Bible $45.45, Superhackers Bible Volumes 1 & 2, $35.45 each. Add $2 per order for insurance. Many more plus videos! Ask for **new 40-page 1997** catalog. Only $1 in USA, $3 elsewhere. **TELECODE 520-726-2833.** http://www.hackerscatalog.com

THE CASE AGAINST PATENTS. Don Lancaster's tested and proven alternatives that work in the real world. $28.50, Synergetics Press, 3860 West First Street, Box 809, Thatcher, AZ 85552. 520-428-4073. synergetics@tinaja.com VISA/MC.

Write in 154 on Reader Service Card.

ELECTRONICS Q & A

With TJ Byers

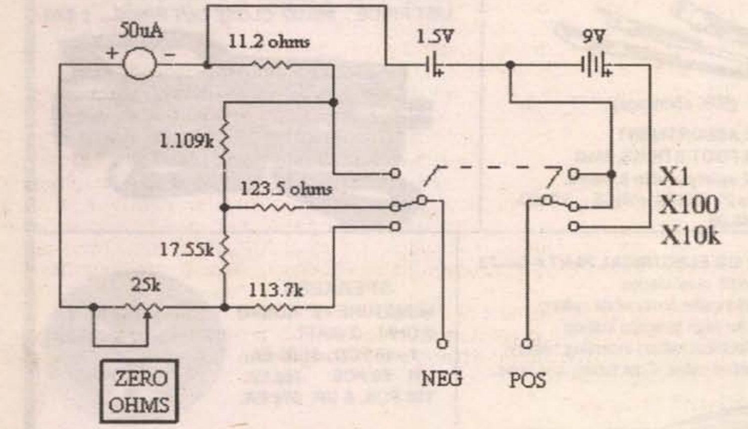
In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYERS, on the Internet at TJBYERS@aol.com, or by snail mail at *Nuts & Volts Magazine*, 430 Princeland Ct., Corona, CA 91719.

Serious Ohmmeter

Q. I need a circuit for a series ohmmeter that reads zero ohms at full scale when the leads are shorted. There are beautiful 50 uA, 1800-ohm d'Arsenval meters on the surplus market from places like Brigar Electronics (page 57) that also have 2.5-, 5-, 10-volt meter scales as well. The voltmeter portion is easy: Just add multiplier resistors. But it's not so easy for ohms.

Joe Kish
via Internet

***A.** Actually, it's exactly the same thing as measuring voltages – switching multiplier resistors in and out – except that this time you're dealing with different meter currents while the voltage remains stable. Here's a diagram of a typical VOM-type resistance measuring circuit. Basically, what we're doing is placing resistors of differing values across*



*the meter, shunting off some of the current from the batteries so that whatever range we select, full scale will always be 50 uA. The equations for calculating the resistor values aren't complex, but labor-intensive enough that we don't have time to go into it here. If you're interested, check out a good book on basic electronic theory, and look up Node analysis in the index. The values specified here are those used by Simpson Electric for their Model 260/6 Volt-Ohm-Multimeter. The reason I went with this network and odd resistance values is because the resistors are available from instrument calibration/repair centers, or from any number of advertisers listed under Test Equipment in the N & V classified ads. If you really can't locate these resistors, you can make your own using combinations of standard 1% values that you can buy from Digi-Key (**800-344-4539**) using the formula:*

$$R = \frac{R1 \times R2}{R1 + R2}$$

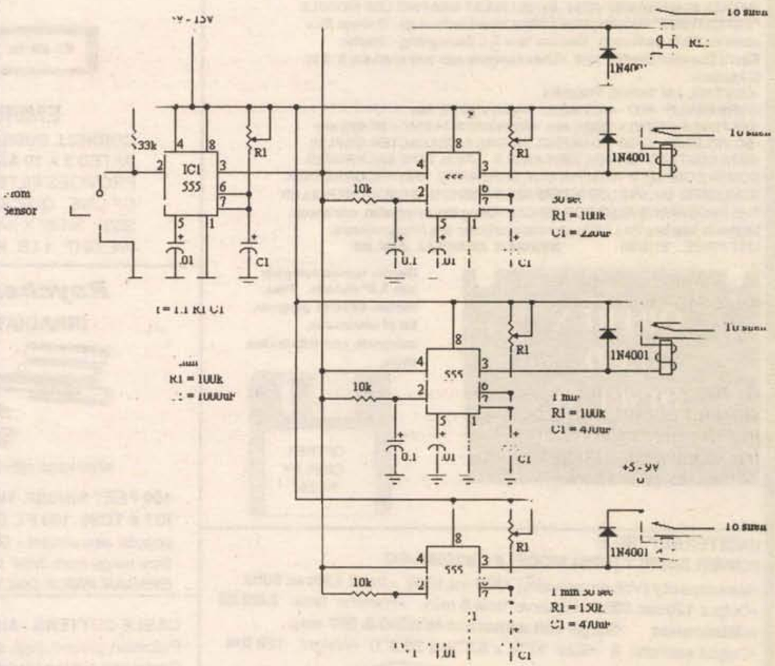
This formula is often called the MAD equation, because the sequence is Multiply, Add, then Divide. To create the equivalent of the 123.5-ohm resistor, for example, you can parallel a 124-ohm resistor with a 30.9K resistor, or parallel a 150-ohm resistor with a 698-ohm resistor. Other combinations are easier, like the 113.7K resistor, which can be made by stringing a 113K resistor in series with a 698-ohm resistor, for a total of 113.698K – close enough for government work. When making a resistance value from resistor combinations, parallel-generated resistor values are more accurate than resistors in series.

Screaming Sirens

Q. I would like to add a circuit to my motion detector, ultrasonic and other types, that would trigger at least two sirens (preferably three or four) in a sequence of one at a time at half-minute intervals; i.e., first one siren, then two sirens, three sirens, and so on. The whole circuit should then reset itself after two minutes if no further motion is detected. The trigger times between the sirens and the reset time should be adjustable.

Melvin Fisher
Lebanon, PA

***A.** Here's just what the doctor ordered.*



IC1, a one-shot multivibrator, is the master controller in this circuit. I'd use a pair of relay contacts driven by the motion detector to trigger IC1. When pin 2 goes low, the output, pin 3, goes high and stays high for up to two minutes. This activates RL1, the first siren, and resets the siren timers (pin 4), which now start timing out according to their R1/C1 values. As each timer expires, its corresponding relay pulls in, sounding another siren. When IC1 times out, its output goes low, which removes power to RL1 and the sequencer timers. Notice that each timer is independent of the others; each stands on its own, and will perform even if the other timers fail (except for IC1). The time delay for each timer is adjusted by R1. While this is only a three-stage sequencer, you can add as many timers as you wish by simply piling on more 555 circuits off IC1.

Monitor Mayhem

Q. Here's a strange one (if you chicken out, I'll understand). I have a monitor that – like most monitors – builds up a high-static charge on the screen. Like any charged plate, this charge has the annoying habit of attracting every fleck of dust in the room, but this isn't the problem. The strange part happens when I try to clean off the accumulated dirt while the monitor is running. When I attempt to touch the screen or actually come in contact with it, with a wet or dry rag, a spark jumps to my hand and I get a "Keyboard error" message complete with nagging beeps coming from the computer. This "error" won't stop until I unplug the keyboard or shut off the computer, after which the dust falls off on its own. I recently installed a ground strap to the monitor's screen through a 10-meg resistor, hoping it would alleviate the problem, and that created an even stranger phenomenon: the sound of the hard disk changed! It's quiet – way too quiet. The PC has always been grounded, so I don't get it. What gives? Other than these strange occurrences, the system works well, as it has done so for many years.

Chris
Bieber, CA

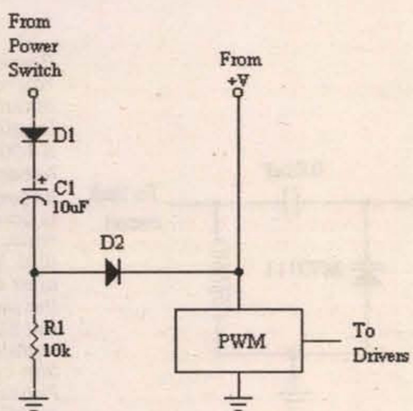
***A.** Like death and taxes, static build-up is an inescapable part of life. Lightning, for instance, is the result of static build-up between clouds and the earth. Like lightning, the spark that jumps from the screen to your finger emits large amounts of radio emissions – radiation that's being picked up through your keyboard's cable and causing the error. What* *you want to do is bleed off the charge as it develops. That way, you avoid lightning bolts – or sparks that corrupt the keyboard interface. Your 10-meg ground strap is definitely a step in the right direction, but you may wish to take it a step farther using ClearView, an anti-static spray from UltraStat (**800-460-7828**). This conductive liquid provides a low-resistance path from all corners of the screen to the grounding strap. About the change in sound, from your account of the events, I suspect that your monitor has a high level of radiation emissions in addition to static charge. Placing the ground strap on the face of the screen gives the radiation a path to follow. In other words, the radiation is shunted off before it invades your PC, where the hard disk was previously picking it up and making it audible. Overall, I would say you have a lot of EMI and RFI floating around in your computer room. What you might want to do is upgrade your monitor to one that meets today's lower emission standards, and perhaps move your motherboard and disk drives to a better-shielded cabinet.*

More Monitor Ills

Q. Thank you for all the help you gave me with my previous search (the "ear-mike" device, Oct. '96). It was just what I needed! Now I have a new problem – one that involves a SVGA monitor made by Princeton Graphic. It's an "Ultra 14," which recently started acting strangely. Several seconds after I turned on the power switch, the power LED would finally flicker to life, after which the screen would come up. This delay has since grown from seconds to minutes. It seems to me that this is a power supply problem, because about two years or so ago, I paid $75.00 to have the power supply replaced. Unfortunately, I didn't use the monitor myself before the repair, so I don't know if this is the same problem or not. Why bother with a seven-year-old monitor, some may ask? Well, could be my bit of Scotch blood, or maybe I've just grown accustomed to its face.

Johnnie Eskue
Richardson, TX

A. *You're right, it's a power supply problem. In fact, the problem is in the start-up circuit. But that's not your real problem; the real challenge is finding the defective part in this bootstrap circuit. Nonetheless, I'll give it a try. Basically, all start-up circuits rely on an RC time delay, like the circuit below, to give the high-voltage circuit a kick start.*



When power is first applied to the monitor, C1 begins to charge through R1. At this point, the voltage across R1 is sufficient to power the PWM controller, which drives the high-voltage switching transistors. If all is working well, this will generate a voltage at V+ which now provides power for the PWM. As time goes on, C1 accumulates more charge, and the voltage across R1 decreases. If the high voltage is working, this isn't a problem because the PWM now receives its power from V+; D2 isolates V+ from R1. If, however, the high voltage fails to start, V+ won't appear and the PWM will drop out as the voltage across R1 decreases to zero. From the way you describe your symptoms, I suspect C1 is defective. It's not charging properly, which means no current flows through R1 to generate the voltage needed to start the PWM. Of course, the PWM could be bad, or there may be a problem with the on/off switch. But at least you know where to start looking.

Preview PostScript Pictures

Q. In some fields – including the scientific field – a form or format commonly used for storing and printing data is called PostScript. These files have a extension of PS. Will you please discuss this format a bit, and the programs that create them. I get the idea that PS files are used for high-resolution graphic printing. Can I use my normal inkjet to print them, and do the PS fonts on some printers have anything to do with PS files? The reason I ask is because I downloaded a schematic that's in PS format and I don't know how to handle it.

Charles E. Heisler
K3VDB

A. *Introduced by Adobe in 1985, PostScript is a programming language optimized for printing graphics and text on paper, film, or the CRT. The purpose of PostScript is to provide a convenient language to describe images in a device independent manner without reference to any specific device features (e.g., printer resolution). The PostScript language, which somewhat resembles the computer language FORTH, is interpreted and stack-based in the same manner as an RPN calculator.*
Postscript files can be created using a text editor, if you know the language. Generally, though, PostScript programs are written with the help of a compiler like GhostScript. When the file is "played back" (run), it generates vector instructions that the printer or display device turns into shapes such as circles, lines, and polygons.
The easiest way to view a PostScript document is with a PostScript pre-

```
%%BeginProcSet:Adobe_Illustrator_1.2d1 0 0

/Adobe_Illustrator_1.2d1 dup 100 dict def load begin
% definition operators
/bdef {bind def} bind def
/ldef {load def} bdef
/xdef {exch def} bdef
% graphic state operators
/_K { 3 index add neg dup 0 lt {pop 0} if 3 1 roll } bdef
/_k /setcmybcolor where {
  /setcmybcolor get
} {
  { 1 sub 4 1 roll _K _K _K setrgbcolor pop } bind
} ifelse def
```

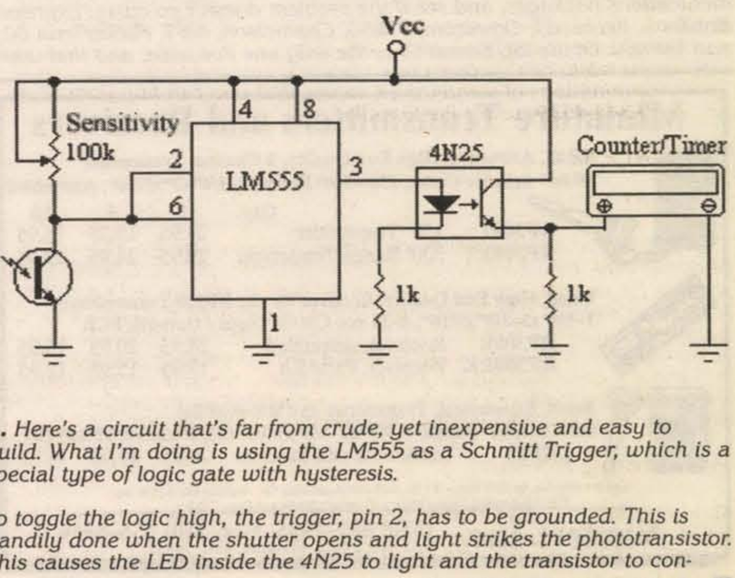
viewer. However, most previewers, such as Ghostview and GSPreview, operate on the UNIX platform. Fortunately, I located a program called Preview Lite from Liberty Systems that runs under Windows.
*You can find a demo of Preview Lite at **http://www.primenet.com/~liberty/pvl.htm** or download it from our Web site (**http://www.nutsvolts.com**) under the name pvl22.zip. The demo allows you to view, print, or export up to 10 PostScript files; paying $29.95 nets you a key that unlocks the demo for unlimited use. If you don't mind shuffling files over the Internet, Image Alchemy provides a file conversion service which converts between a large variety of image files, including PostScript, via a web page. What you do is first upload the file to be converted, then download the converted file in your selected format (GIF, PCX, etc.). They can be reached at **http://www.handmadesw.com/hsi/web_alchemy.html***

*Don Lancaster, helmsman of the N & V Resource Bin column and a PostScript pundit, has written much about this programming language. Check out his Web site at **http://www.tinaja.com***

Shutter Bug

Q. I need a circuit to measure the duration of a light striking a photo-sensitive device. All I need is duration, not intensity, because I plan to use the circuit to make a crude camera shutter speed tester. Consequently, I'll need to have some type of readout to display the time in the range of, say, 1 second to 1/1000 second.

DCM
White Plains, NY



A. *Here's a circuit that's far from crude, yet inexpensive and easy to build. What I'm doing is using the LM555 as a Schmitt Trigger, which is a special type of logic gate with hysteresis.*

To toggle the logic high, the trigger, pin 2, has to be grounded. This is handily done when the shutter opens and light strikes the phototransistor. This causes the LED inside the 4N25 to light and the transistor to con-

duct, which generates a voltage across the 1K resistor. When the light level drops below that needed to maintain the logic high (i.e., the shutter closes), the LM555 toggles off and the transistor ceases to conduct. A counter/timer is used to measure the amount of time the shutter is open. The value of Vcc can range between 5V and 15V, depending on the needs of your particular counter/timer.

When Dinosaurs Roamed The Earth

Q. I have an antique IBM PC/jr computer that I'd like to give to my nine-year-old daughter. However, the PC/jr has only 128K of RAM: 64K on the main board and 64K on a plug-in board. Most of the software that I have calls for at least 256K of RAM — so I replaced the 64K DRAM chips (eight ICs on the plug-in board), with 256K DRAM chips. Unfortunately, the machine doesn't recognize the added memory. After power up and self-check, the PC/jr still displays 128K of RAM. Is there anything I can do to fix this problem?

Chris Bartnik
Crescent City, CA

A. *Unlike the Atari or the Commodore C64, which have survived the ravages of time, the IBM PC/jr is an all-but-forgotten relic of the 80s. Because the RAM is permanently stuck at 128K (no, you can't make it any bigger), it used special software applications written specifically for the PC/jr, the likes of which I haven't seen in years. Besides its limited computing power, it has other problems, most notably the keyboard with its chicklet-sized keys. I wouldn't give this system to my daughter as her first PC. Check out the computer specials listed in our N & V Classifieds under Computer Hardware. Here's where I ran across an IBM PS/2 Model 30 for just $50.00 at **http://www.usedcomputer.com/** on the Web. Good luck.*

Drum-Style TV Tuners

Q. I have a TV that has a drum-type tuner which has become very loose and no longer makes contact unless the knob is nearly between nubs. Any answer as to why this happened and how to repair it?

Tater Schuld
via Internet

A. *Sure, the contacts are dirty. Back in the days of old we used to clean these button contacts using a pencil eraser. But we soon discovered that the eraser did more harm than good by removing the plating from the metal, leaving the base metal exposed to the weather. The correct way to clean the contacts is with a spray tuner cleaner, such as Radio Shack's 64-4320.*

Atariese As A Second Language?

Q. I recently tried to use an old Atari 800 computer with a 1030 modem. What happened was one-way communication: the Atari was able to understand what the IBM was saying, but the IBM couldn't understand what the Atari was saying. Could this problem caused by the fact that around this time modems weren't standardized and data transfer protocols were different even for text? Is there some communication program that can interpret the binary junk that the Atari is sending to the IBM?

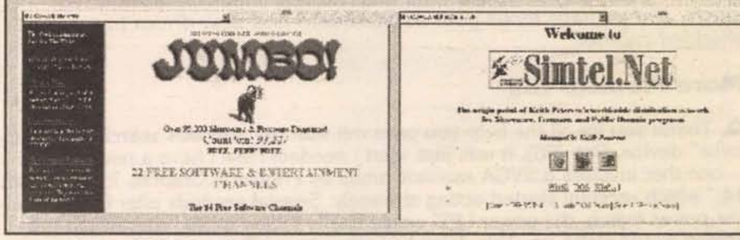
Charles Oblender
via Internet

A. *I don't think there's a language problem here. Most likely, the problem is in your communications software which isn't written for the Atari 800, but is close enough that it will run, somewhat. I'd try one of these communications packages, and see if the problem doesn't go away: Express!, BobTerm, Kermit-65, Omnicom, VT850, Chameleon, Ice-T, FlickerTerm 80, and Term80. Of the lot, Kermit-65 is the only one I've used, and that was on an Atari 1200XL a long time ago. If you want to learn more about Atari systems, surf over to **http://www.emulation.net/atari800/index.html** or **http://zippy.sonoma.edu/˜kendrick/nbs/whatisatari/***

Reader's Tip: Shareware Search

Two good sites where you can search for software are **http://www.simtel.net/simtel.net** which has its own archive, and **http://www.jumbo.com** which links to other sites (and is unfortunately, becoming badly infected with advertising). Using these sites may be more efficient than using a general-purpose search like Lycos. For instance, searching Simtel's MSDOS archive for "modem" will get a listing of programs with modem either in the name of the file, or in the description of the file. Try that search on Lycos and you get 20,328 various references.

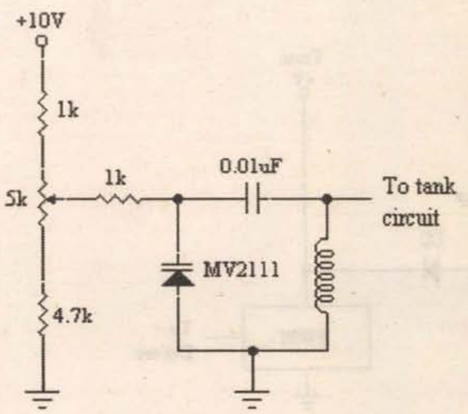
Stephen Parry
via Internet



Mailbag

I have a couple of (constructive, I hope) comments regarding "Varactor Replaces Variable Cap" in the Mar. '97 Electronics Q & A. First, the voltage divider is directly loading the tuned circuit, which will greatly reduce its Q. There should be a high-value resistor, e.g., 100K, between the slider of the 5K pot and the cathode of the var-cap diode to prevent this. Second, although the coupling capacitor should have a value that's high relative to the var-cap, 1 uF is overkill. It will be hard to find a cap of that value with good characteristics at the frequency of a circuit that's using a few tens of pF for tuning.

Stephen Parry
via Internet



Response: You're absolutely correct about the voltage divider loading the tuned circuit; a 100K series resistor is needed (see schematic above). The second point is good, too, in that this capacitor may be hard to find. What I had in mind after browsing through the parts catalogs was the ECWF(B) series of metallized polypropylene film capacitors from Panasonic. They have excellent high-frequency characteristics with high-current capability. But on reflection, a 0.01 uF capacitor is a better choice for this design.

TJ Byers
Q & A Editor

PUBLICATIONS *cont.*

"FORBIDDEN SECRETS Of The Legion of Doom Hackers." Big 224-page handbook. Condemned programs & techniques from the infamous LOD's shut down BBS. Hacking, phreaking, & more! Limited edition. $20.95 plus $5 S/H ($7 Canada). NYS add $2.14 tax. VISA/MC OK. CRB Research, Box 56-NNV, Commack, NY 11725. Phone orders: 516-543-9169.

MAKE PCBs for a fraction of the cost professionals charge! This valuable booklet explains the secrets of making your own printed circuit boards with readily available inexpensive materials. Most boards can be made for less than $6. It takes only minutes and anyone can do it! You'll wish you had this information years ago! Money back satisfaction guarantee. Send $10 check or money order to: MJS, PO Box 271571, Fort Collins, CO 80527.

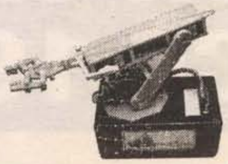
HOME AUTOMATOR: "The News-Magazine of Home Automation Ideas." Each issue contains technical articles, schematics, feature homes, how-tos, and product reviews. Subscription $19.95/year. **http://www.homeauto mator.com** Home Automator Newsletter, 2258 Sandy Lane, Mebane, NC 27302. 910-578-9519 (voice), 910-578-0012 (fax).

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

WORLD'S MOST UNUSUAL Communications Books! Large selection covering Scanners, "confidential" frequency (HF/VHF) registries, wireless history, bugging, wiretapping, electronic surveillance, monitoring, etc. Big free catalog! CRB Research, Box 56-NV, Commack, NY 11725.

"NEW ROBOTICS" magazine! $9.95 for 10 monthly issues. Writers and advertisers invited. Rose, POB 7589, Chula Vista, CA 91912.

ROBOTICS



ROBOTIC ARM KIT, five axis with gripper. Control with any serial port. Very accurate and repeatable. $195 includes all hardware, structural components, software, illustrated assembly manual, 6 Hitec servos and MiniSSC servo controller. Add S&H $7.50 USA and Canada, $25 International Airmail. IL residents add 6.25%. Credit cards welcome. TSS, 104 Partridge Road, Pekin, IL 61554-1403, 309-382-1816. www.lynxmo tion.com NEW mobile version $250.

Events Calendar now on the Web! **http://www.nutsvolts.com**

Celebrating our 14th Year Of Service !!

RECTANGLE LED - (.124" x .212")

- Forward Volt. - 1.7-2.2 V
- Forward Current - 50ma
- Diffused

STOCK#	COLOR	1-24	25-99	100+
SB1089	Bright Green	.24	.23	.21
SB1090	Yellow	.15	.14	.13
SB1091	Bright Yellow	.24	.23	.21

INFRA-RED COLLIMATOR PEN

A low power collimator pen containing a MOVPE grown gain GaAlAs laser diode. Pen delivers 2.5mW @ 820nm. Operating voltage of 2.2-2.5V @ 90-150mA is designed for lower power applications. Measures 11 mm x 27 mm.

STOCK#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

COMPUTER CARE KIT

A complete computer care kit containing:

- Cleaning diskette
- Head-cleaning fluid
- Cleaning swabs
- Anti-static cleaner
- Anti-static screen wipes

SB1099 - 3.5"
SB1100 - 5.25"

STOCK#	1-9	10-24	25+
SB1099	3.99	3.79	3.41
SB1100	3.99	3.79	3.41

LOW PROFILE IC SOCKETS

- Tin Plated Contacts
- .125" Lead Length
- .156" Body Height

STOCK#	PINS	1-24	25-99	100+
S08	8	.08	.07	.06
S014	14	.08	.07	.06
S016	16	.09	.08	.07
S020	20	.09	.08	.07
S024	24	.12	.11	.10
S028	28	.12	.11	.10
S032	32	.14	.13	.12
S040	40	.14	.13	.12

SINGLE TURN POTENTIOMETERS

- 1/2 Watt
- 10% Tolerance
- 3/8" Square
- TO-5 Grid
- Top Adjustment

STOCK#	VALUE	1-24	25-99	100+
PO150	50 Ω	.69	.66	.59
PO1100	100 Ω	.69	.66	.59
PO1500	500 Ω	.69	.66	.59
PO11K	1K Ω	.69	.66	.59
PO12K	2K Ω	.69	.66	.59
PO15K	5K Ω	.69	.66	.59
PO110K	10K Ω	.69	.66	.59
PO120K	20K Ω	.69	.66	.59
PO150K	50K Ω	.69	.66	.59
PO1100K	100K Ω	.69	.66	.59
PO1200K	200K Ω	.69	.66	.59
PO1500K	500K Ω	.69	.66	.59
PO11M	1 Meg Ω	.69	.66	.59

Switching Power Supply

- 115/230 V input
- 41 watt
- 5v @ 3.75 A
  12v @ 1.5 A
  -12v @ 0.4 A
- 7" L x 5.25" W x 2.5" H

STOCK#	1-9	10-24	25+
PS1003	17.99	17.09	15.38

What Do We Have ?

- I.C.'s
- Oscillators
- Crystals
- Diodes
- Tools
- Laser Diodes
- Vises
- Resistors
- Capacitors
- Connectors
- Trimpots
- Kits
- Vises
- LED's
- Transistors
- And more!

GADGETEER'S GOLDINE

This exciting collection of electronic projects features experiments ranging from magnetic levitation and lasers to high-tech surveillance and digital communications.

- By Gordon McComb

STOCK#	1-9	10-24	25+
TB3360	19.99	18.99	17.09

- Order Line — (800) 824-3432 • International — (412) 495-1230 • Fax Orders — (412) 495-7882
- Technical Support — (412) 495-1231 • No Minimum Order – (Orders under $15 subject to $ 5 charge)
- UPS 3 day, Blue, Red, & Fed. Ex. Shipping Available (Call for charges) • PA Res. Add 7 % Sales Tax
- Open Mon-Fri 9:00 AM - 5:00 PM (EST) • Corporate Accounts / Quantity Discounts Available
- We accept M/C, VISA with no surcharge • Call For FREE Catalog ($2.00 Outside U.S.)
- We Carry A Complete Line Of Electronic Components • Email - Unielect @ aol.com

FREE SHIPPING!!

on pre-paid orders

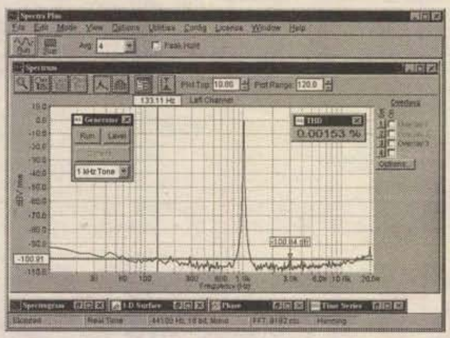
Unicorn Electronics
1142 State Route 18
Aliquippa, PA 15001

Write in 149 on Reader Service Card.

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

Features

- 20 kHz real-time bandwidth
- Fast 32 bit executable
- Dual channel analysis
- Up to 65,536 pt FFT
- Octave analysis (1/1 - 1/24)
- THD, IMD, SNR measurements
- Signal Generation
- Digital Filtering
- Triggering, Decimation
- Transfer Functions, Coherence
- Dynamic Data Exchange (DDE)
- Time Series, Spectrum Phase, Spectrgram 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

Real-Time FFT Analyzer (single channel) $299

Options:

Dual Channel Operation $99
Recording, Post-Processing Modes $99
Signal Generator $99

Professional Quality Sound Cards Available ....Call

DOWNLOAD FREE 30 DAY TRIAL!

www.telebyte.com/pioneer

PHS Pioneer Hill Software
24460 Mason Rd. N.W.
Poulsbo, WA 98370

Spectra Plus 4.0
Affordable Signal Processing Software

Sales: (360) 697-3472 *Fax: (360) 697-7717* *e-mail: pioneer@telebyte.com*

Write in 110 on Reader Service Card.

COMPLETE ON-LINE CATALOG & AUCTION. LIST YOUR OWN ITEMS .WWW.COMP-RECYCLE .COM

486 CPU's - 5volt
486DX-33 ----- $17
486DX2-66 ---- $32
486DX2-80 ---- $32

USED SPECIALS

EGA VIDEO CARDS ---------- $20
VGA VIDEO CARDS ---------- $18
16 BIT MEMORY CARDS ------ $30
386SX-33 MOTHERBDS ------ $20
ALL TYPES OF POWER SUPPLIES
PS2 1.44 FLOPPY DRV -------- $29
1.2 MEG FLOPPY DRV ---------- $10
MFM CONTROLLERS ---------- $15
SOUND CARDS ------------------ $29
386SX-25MHZ MBD ------------ $20
16/4 TOKEN RING CARDS ----- $10
16 BIT ETHERNET CARDS ----- $10
LOTS OF IBM PS2 PARTS
ALL TYPES COPROCESSORS
ALL TYPES MEMORY
ALL TYPES USED HARD DRIVES
ALL TYPES OF EPROMS ------- CHEAP
101 AT/XT KEYBOAARDS --------- $10
12V@2AMP WALL PLUG PWR SUP- $7
BOX OF 100 ASSORTED CABLES -- $9
MONOCHROME VIDEO CARDS ---- $5
40 MEG IDE HARD DRIVES ------ $20

REBUILT MONITORS
RGB COLOR ----------- $55
EGA COLOR ----------- $85
VGA COLOR -- FROM $99

FREE EMAIL ADDRESS – $5
HAVE YOUR OWN EMAIL ADDRESS.
NO INTERNET PROVIDER REQUIRED
MUST HAVE MODEM - NO DIALUP OR

UNLIMITED INTERNET
ACCESS. ONE TIME $59 SET-UP CHARGE. NEVER ANOTHER CHARGE. FREE NETSCAPE SOFTWARE.

COMP-RECYCLER
1035 I-35 SUITE 213
CARROLLTON , TX. 75006
PH: 972-245-3008
FX: 972-245-1331

Write in 155 on Reader Service Card.

REMOTES

Remote Control for Any Application

NEW NEW NEW NEW NEW

3.5" x 2.75"

- 3 Channel Receiver
- Channel 1 - 5 amp Relay, N/O, N/C
- Channel 2 and 3 Digital Outputs
- Compatible with 2 Button or 4 Button Remote
- Code Hopping Receiver at 434 Mhz
- Compatible with All Garage Doors and Some Car Alarms

$69.95

2.75" x 2.75"

- 6 Channel Receiver with Digital Outputs
- All Channels are Programmable for Momentary, Latched, Latched with Condition 30-60-90 Sec. Timed Outputs
- Code Hopping Receiver at 434 Hhz
- Compatible with 2 Button or 4 Button Remote
- Compatible with Some Car Alarms

$99.95

1.25" x 1.75"

- 2 Button - 3 Channel Remote
- Extra Long Range 434 Mhz with S.A.W. Resonator
- Push Both Buttons together for Channel 3
- Compatible with Three and Six Channel Receivers.

$29.95

1.25" x 1.75"

- 4 Button - 15 Channel
- Extra Long Range 434 Mhz S.A.W. Resonator
- Push Combination of Buttons together for Channel 5 through 15, *i.e.:Push Button 1 and 2 together for Channel 5*
- Compatible with Three and Six Channel Receivers.

$39.95

Street Smart Security • 1-800-908-4737
7147 University Avenue • La Mesa, CA 91941
Send, Fax or Call Order In - Use Credit Card or Check. Fax (619) 462-0652

Write in 195 on Reader Service Card.

ROBOTICS *cont.*

ROBOTS WANTED: Dead or alive, whole or parts. HeathKit (HERO JR, HERO 1, HERO 2000, or Arm Trainer), Androbots (Topo, Bob, Fred, and Androman), RB5X, Gemini, Omnibots, Rhino, Smart Rabbit, Robie Sr., MAXX STEELE, etc. Also looking for robot options, books, and literature. Will pay cash. Please E-Mail: rdoerr@bizserve.com Call 810-777-1313 or write to: Robert Doerr, 26308 Cubberness, St. Clair Shores, MI 48081.

STEPPER IC: new EDE1200 is ideal for 5/6 wire stepper motors. Download our data sheet or call E-Lab Digital Engineering, Inc. 712-944-5344. Visa/MC. http://www.net ins.net/showcase/elab

PLANS/KITS/SCHEMATICS

ULTRA HIGH energy electromagnetic radiation plasma generator. High frequency, wide bandwidth electromagnetic plasma directly capable of destroying semi-conductors throughout a system, house, etc. Will burn through most types of insulation, including glass. Includes plans for plasma antenna used for jamming signals and power sources. Plans/schematics $10, kit/plans $75. Order #uhplas (kit or plans). Send to: Unlimited Underground Electronics, 1839-D West Vista Way #515, Vista, CA 92083. Voicemail: 619-414-6631. Uue@usa.net

HOBBY CATALOG: Broadcast, ham, CB transmitters, amplifiers, antennas. TV addons, descramblers, bugging devices, science projects, start your own radio station books and more. PAN-COM International, Box 130-V, Paradise, CA 95967. www.panaxis.com

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

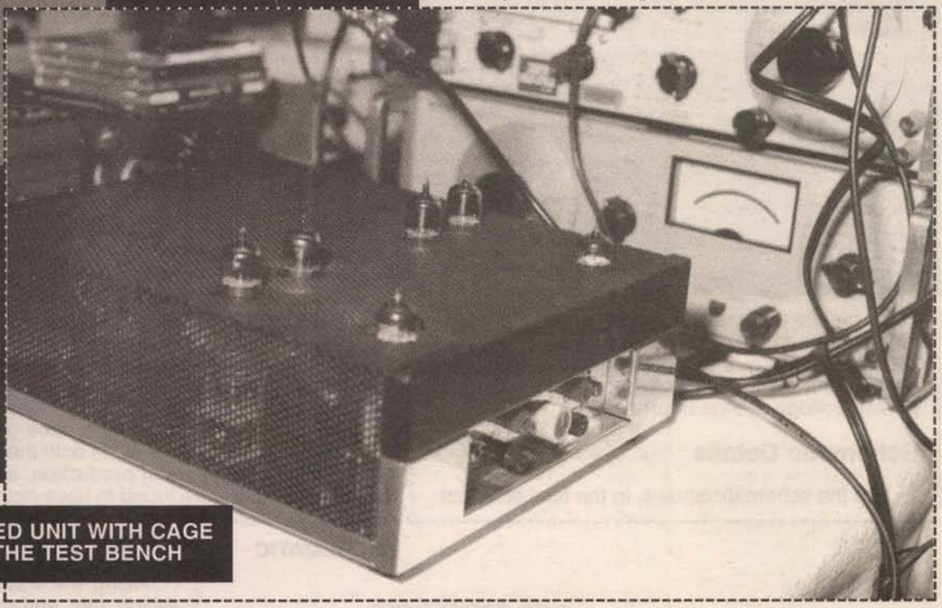
CALLER-ID phoneline simulator. Demonstrate telephone devices without phoneline! Six direct-dial extensions, Caller-ID, distinctive ringing. Authentic dial tone, busy signals, 20Hz ringing. "Party-Line" deluxe kit $199.95. Includes PCB, all electronic parts, microcontroller, documentation. Custom enclosure $32.95. Fully assembled $425. Shipping $8. Major credit cards accepted. Digital Products Company, 134 Windstar Cir., Folsom, CA 95630. 916-985-7219, Fax 916-985-8460, E-Mail: DigProd@aol.com

SCHEMATICS AND DOCUMENTATION for remote control miniature encoded RF and IR transmitter and receiver boards. $5 Inventive Solutions, PO Box 8, Stratford, NY 13470. E-Mail: **invent@klink.net**

The BENDER-2pp Tube Push-Pull Amplifier Rebuild Project

PART 3

by Steve Bender



FINISHED UNIT WITH CAGE ON THE TEST BENCH

In the prior two installments, the concept of rebuilding a 1960's transistor power amplifier using advanced tube technology was detailed in general terms. This month, the final details of the project are provided.

Test Equipment Problems

As in the time-frame from Part 1 to Part 2, there are more changes in Part 3. One minor correction in Part 2: I mentioned a crossover notch distortion that I noted; turns out that was an anomaly caused by the HP signal generator, and so the distortion numbers given were inflated by that generator being out of spec. Distortion numbers on the revised circuit are given later in the article (and mostly they are much better).

More Test Equipment Stuff

It had also been planned to use some Capacitor ESR (Equivalent Series Resistance) type meters to check the high-voltage caps being "recycled" from the disposable flash cameras. This is essentially a high-frequency/low-ohms resistance meter. An ESR reading provides a very different functional value than is provided in the "Cap Meter" function. Some of the current generation of multi-function DMMs — such as the Wavetek DM-27XT, DM-28XT, or Fluke Model 79 Series II — will accurately measure what is a very low frequency — near DC — capacitance value, which is only one way of measuring a capacitor. Tests of a few samples of some "recycled" caps are detailed later in this article.

More CAP Bank Details

As a true DIY project, another innovation is that this massive CAP Bank is assembled from parts in discarded throw-away flash cameras. These small flash cameras cost around $10.00 to $15.00; they are available from Kodak, Fuji Film, and other brands. They contain a small circuit board to which is attached a photoflash type capacitor, usually having a nominal rating of 160 uF @ 330 volts.

When the film is exposed, the developing facility pulls the film cartridge (a two-second process), then many toss the rest of the camera into the trash. I've collected about a hundred of these and removed the caps with minimal effort. I feel this is my way of helping the environment, and also saving some money. Similar photoflash caps can be purchased from suppliers, but often those are less space-efficient, and cost upwards of $8.00 each. For those who won't bother, a pair of 560 uF @ 400 volt caps (costing about $26.00 for the pair) can be substituted.

!BEWARE! If disassembling throw-away cameras, the caps in these cameras can be charged to high voltage, retaining that voltage for hours, even days later! I've been shocked four times by handling these small flash circuit boards (Yes, they can give off quite a charge.) Find the cap leads and be sure to discharge the cap using a 68- to 220-ohm one-half watt or larger resistor — while holding the plastic camera or by holding the circuit board by its edges. I found some Genovese Drug Stores and some 1 Hour Photo shops (the ones that have actual photo-finishing machines on the premises) will, for the most part, impart to you a handful or bag-full of these cameras for "recycling" into your project for nothing more than a polite smile.

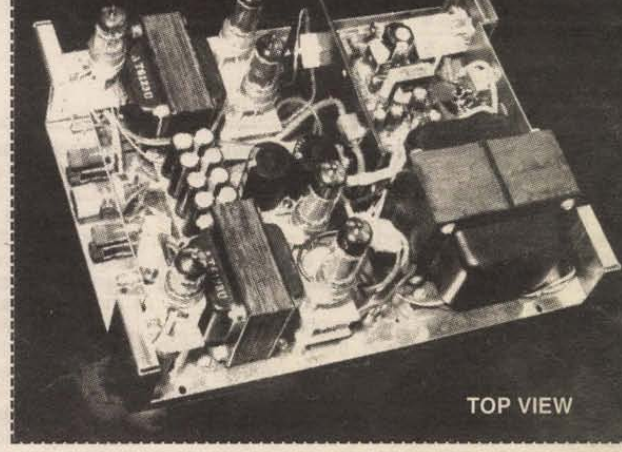
More on Free Parts

Statistically, you will find inside these disposable cameras, five or more variations of photoflash caps. Most of these caps have fairly long (>1/2") leads, and these can be cut or snipped off the circuit board. A very small minority of Kodak models have very short leads (<<1/4") and must be desoldered, or the leads end up being too short to reuse. The "Fun Saver" Kodak cameras mostly contain Rubycon photoflash caps showing a case rating of 160 uF @ 330 volts.

These Rubycons have a black body which is 9/16" in diameter, and most are "Type One" which is just a fraction over 1 9/16" long; occasional units are Rubycon "Type Two" where the cap is 1/8" shorter, but has identical case ratings.

Wavetek's DM28XT meter indicates that most of the Rubycon caps usually fall within about plus or minus 5 uF of their nominal rated capacitance. These caps have rubber end seals with a safety vent; a general indication of a quality cap.

About one-out-of-five Kodak cameras will have a SAMWHA or SAMHWA cap inside. These may be from two different companies, or if not, then they spell their name wrong on some of their products. Physically, the SAMWHA/SAMHWA



TOP VIEW

caps are just a fraction shorter than the Rubycon Type One caps, and are capacitance-rated at 160 uF @ 350sv (Surge volts "?"). The SAMHWA units are the only ones found to have actual date codes

CHART 1 — 2 Main Variations of 5CZ5 Beam Pentode Tubes

5CZ5 Short Tubes	5CZ5 Tall Tubes
CBS-HYTRON Made in USA	GE - Made in USA
GE - Made in USA	Philco - Made in USA
GE - Made in Canada	Raytheon - Made in USA
Rauland - Made in USA	RCA - Made in USA
Raytheon - Made in USA	Sylvania - Made in USA
RCA - Made in USA	Zenith - Made in USA
Sylvania - Made in USA	
Tung-Sol - Made in USA	
Wards Super - Made in USA	
Westinghouse - Canada	
Zenith - Made in USA	

(like 9411 or 9501 — YYMM) and noticeably thinner flexible leads; the SAMWHAs have thicker gauge leads like the Rubycon caps.

Both the SAMWHA/SAMHWAs are denoted as Photo 55 degrees C, and their construction is similar; like the Rubycons, they have rubber end seals with a safety vent and a polarity bar for the minus lead.

Fuji Film camera units contain an unmarked cap bearing no brand name or other ratings. They do state 4(2) or 5(2), and below that either two additional letters (N H) or a number and a letter (9 R), which is obviously a house number system/internal code.

In all cases, a polarity bar denotes the minus lead. The unmarked caps are 1-1/2" tall and 9/16" in diameter, and they lack the safety vent hole technology. Measurements show three distinct variations for the caps found in Fuji cameras. One type measures 140-145 uF and exhibits a "greenish" tingle to the polarity bar on the outer case. Similarly, the other two variations have an "off-white" polarity bar, with measured values around 160-165 uF.

Other variations seen caps with a brown or blue case insulation instead of the traditional black. Any of these caps should handle at least 330 volts, as they are probably rated at either 330 volts or 350 volts. You may need to collect a dozen or more cameras to get a matched set of eight caps for the CAP Bank.

In all cases, a polarity bar denotes the minus lead. On an early prototype, I did use a mixed set of eight dissimilar caps and did not encounter any problems, but to be conservative and on the safe side, I'd suggest using a matched set of eight caps.

As photoflash caps are designed for high-frequency (>10 KHz) operation, they are not known for their spectacular capabilities dealing with 60/120 Hz ripple which, if excessive, can cause them to overheat. These caps are carrying high voltage, and use of an ESR meter (if you have one) would be a good idea. However, most people don't own that type of cap measuring meter. In any event, the completed CAP Bank should be carefully checked using whatever type of meter is available — for caps showing excessive leakage to the outer foil, odd values, or backward installed caps, double-check your physical inspection.

On a cap meter, from the exposed top of the case to the minus lead should indicate not more than 5 uF, preferably 2 uF. Under such a test, a value approaching the rated capacitance value means a short to the outer case, and possible trouble down the line; replace that cap. Likewise, for any that appear to be bulging, or warm/hot under applied voltage, never exceed the printed voltage ratings (if present).

CHART 2 — 5 Main Variations of 10BQ5 Beam Pentode Tubes

Amperex - 2 Rib/Gray Plate - Made in USA
GE - 2 Rib/Gray Plate - Made in USA
Philco-Ford - 2 Rib/Gray Plate - Made in USA
Sylvania - 2 Rib/Gray Plate - Made in USA

RCA - Flat/Black Plate - Made in USA

Sylvania - 4 Rib/Gray Plate indented - Made in USA

Sylvania - 4 Rib/Black Plate indented - Made in USA
Tung-Sol - 4 Rib/Black Plate indented - Made in USA

IEC Mullard - 2 Rib/Crmp Gray Plate w/ctr key - Japan

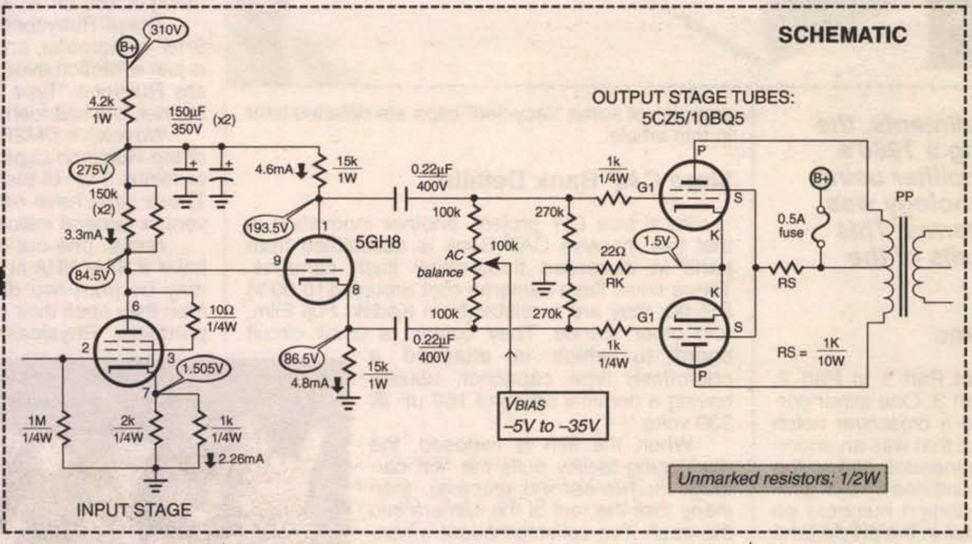
Schematic Details

As the schematic shows, in the final schematic each channel consists of a single voltage gain tube/phase splitter (5GH8) and a pair of pentodes (5CZ5, or other suitable pentodes) for current through the output transformer, which ends up as power into the speaker. In the earliest build stage, the tubes were mounted in bakelite tube sockets, and the output tube sockets reacted badly to the heat generated by the output tubes. That was why three fans were originally part of the design prototype. Objections to the fans lead to the use of military-type ceramic sockets.

In the infrastructure, nylon spacers can be used, which have the benefit of being non-conducting, and can be used in close proximity to high-voltage connection points. But nylon spacers are somewhat problematic, as they get loose or simply don't mate tightly with other parts and, as such, they should be avoided if possible.

PINS 10BQ5	PINS 5CZ5
P = 7	P = 9
S = 9	S = 1
K = 3	K = 7
G1 = 2	G1 = 3
H = 4	H = 4
H = 5	H = 5
10.6V/.450A	4.7V/.600A

Final Revision 3/1/97



Sturdy metal spacers are best attached to the chassis for physical stability, but should be used with care, as they can lead to a direct short to chassis ground. Some heat shrink can be used on tube socket connections in close proximity to metal spacers. Pay careful attention to soldering; spacing of connections should allow use of metal spacers in most areas, without problems.

The switching power supply details were discussed at length in Parts 1 and 2, and as the prototype is unusual, in using a five-volt set of output tubes in the left channel, and a 12-volt set in the right, the load just about maxed out the SPS used. The five-volt line is running at 15% over rated load, while the 12-volt line is around half of the rated load.

As SPS units are maximally efficient at rated loads, this is near the worst case scenario, with the heatsink running at over 63.0° Celsius, and the transformers almost as hot. But, no problems so far. The Dynaco power transformer runs at 40° Celsius after several hours of operation, which is fine.

The only real hot spots are about 1" diameter around the output tubes, whose glass bottles can reach 150° Celsius; and of course, that over-stressed SPS supply's heatsink — most likely a pair of SPS units in either the 4.7 volt or 10.6 volt only filament configurations.

5CZ5 Power Tubes

As the prototype is using different tube sets in each channel, I explored finding both 5CZ5 and 10BQ5 tubes. The price of 5CZ5 tubes tended to be 50% more, often double the price of 10BQ5s, which is still inexpensive. While both the 5CZ5 and the 10BQ5 are long out of production, at least half a dozen sources were found to have both tubes, at reasonable prices, so builders have the option of building using either one.

Along the way, an interesting fact surfaced about the 5CZ5 tubes. These were mainly designed for color TVs, with some showing date codes back into the late 1950s, with no known recent production for this type.

A few Canadian-made tubes were encountered in the 5CZ5 type designation among the 10 brands of the "short" tubes. Only six brands of the "tall" variety were noted among the almost 50 samples I examined. Due to the overall exactness of the internal physical structures, only two "real" 5CZ5 variations were found: these being short and tall tubes.

The short version has a glass bulb standing 2-1/4" tall (bottom to tip), while the tall version is 2-3/4" tall (bottom to tip) which is the same size as the 10BQ5s. It seems likely that only two places of production for the USA-made 5CZ5s, but who the actual manufacturers were, isn't currently known (I suspect RCA made the tall variety).

The advantage of this, is that within a given variation, the characteristics of either the short or tall tubes are likely to be more consistent from tube to tube. Of the few Canadian-made samples found, most were identical with the "short" USA versions, but some appeared to have the flat plate

The BENDER-2pp Tube Push-Pull Amplifier Rebuild Project

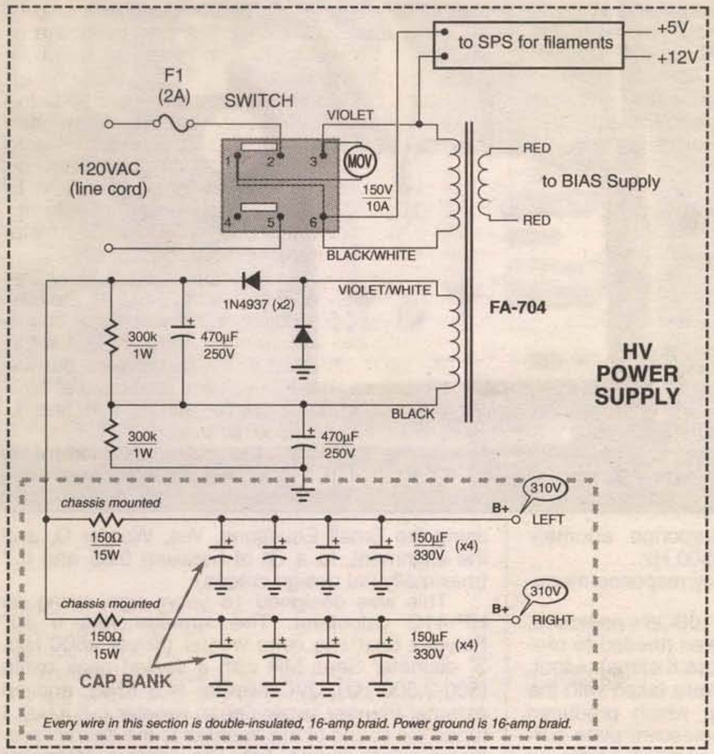


CHART 3 Final Distortion Measurements into 8-Ohm Test Loads

Tubes	Frequency	Voltage / Power Level	THD Level
5CZ5s	1.001 KHz	0.895 volt/0.1 watt	0.41% THD
5CZ5s	20.00 KHz	0.895 volt/0.1 watt	0.25% THD
5CZ5s	1.001 KHz	2.82 volt/1.0 watt	0.92% THD
5CZ5s	20.00 KHz	2.82 volt/1.0 watt	0.72% THD
5CZ5s	1.001 KHz	8.95 volt/10 watt	5.00% THD
5CZ5s	20.00 KHz	8.95 volt/10 watt	3.00% THD
5CZ5s	1.001 KHz	10.0 volt/12.5 watt	4.60% THD
5CZ5s	20.00 KHz	10.0 volt/12.5 watt	2.90% THD

structure of the USA "tall" units, only they were in the short bottle, otherwise, they were identical ...

The RCA tube manual lists the 5CZ5 beam power tube as a vertical deflection amplifier while Sylvania tube manual shows audio power amp or vertical deflection amplifier. All the "short" tubes had a flat black plate with a central "door" flap (for lack of a better term) on one side (some pointing east, some pointing west). On the other hand, "tall" tubes had a black flat plate with no ribs, no doors. Chart 1 shows the brand variations of 5CZ5 tubes found.

10BQ5 Power Tubes

The 10BQ5s, on the other hand, were found to be plentiful under numerous brand names. With at least five variations, and likely others that I didn't encounter, this tube may have been used in military equipment back in the late 1950s or 1960s. There is no known production for this type at present; only in the 6.3-volt filament variety. 6BQ5s/EL-84s/E84Ls, etc., are made in Russia, Slovakia, and maybe China, but their quality can't be counted on, like NOS (New Old Stock) production tubes.

More variations of 10BQ5 were encountered than the already discussed 5CZ5s, the net result being that divergent 10BQ5s would more likely have wider variations in their operating characteristics. However, tubes having identical plate structures would, in most cases, be closer, having been from similar or the same production run, regardless of the name printed on the bottle. See Chart 2.

Circuit Variations

Since the circuit has been revised, my measurements of Total Harmonic Distortion (THD) are now more detailed, and seemingly are circuit related; as changing values of RgridA&B changed both channel's distortion levels at low, intermediate, and high output levels, as well as changing the losses and therefore the overall circuit gain. More will be detailed on the distortion figured later in the article, for both 5CZ5 and 10BQ5 push-pull configurations.

Closing the feedback loop of an amplifier can be a troublesome situation for a number of reasons. This amplifier was no exception. The unknown electrical characteristics of the "junker" output transformers is most likely the cause of these last minute problems. That the original design combined high gain with high feedback, for 23 dB closed loop gain (resulting in about 20 dB of feedback) caused some fierce and nasty high-frequency oscillations in both the 5CZ5 and 10BQ5 channels with the original gain configuration.

As a result, the input stage was altered to run the input tube's voltage gain stage in triode mode instead of pentode mode. The reduced gain — and a somewhat higher current level — was achieved by decreasing the value of the plate resistor and also the value of the cathode resistor. In a precautionary move, since there is no circuit board with a massive groundplane, the input lead was shielded with a grounded wire.

The two benefits here are first, the input tube's plate voltage was increased slightly, which results in audible improvement and better dynamic headroom for the voltage gain stage; and second, the range of the voltage gain circuit is more linear. This revised gain configuration has an open-loop voltage gain of 26.0 dB, and requires no overall loop feedback. The gain is slightly high — around .50 volts for 12.5 watts output — which is around 3-4 dB higher than most typical amplifiers. Still, that is a reasonable value. As no crossover notch was found, there is little reason for an overall feedback loop and this configuration makes the resulting amplifier maximally stable.

Many people have come to expect ultra-low values of THD for specs because of certain advertising done over the years towards this hypothesis.

It would be implied that there was "vanishing low" levels of distortion, and that implied better sound. Right? Well, maybe not.

Negative feedback has had its proponents, and certainly over the past 20 years the "more is better" axiom has lost ground. Certainly that has been nullified when applied to feedback in transistor amps, though perhaps less so in tube amps. Negative feedback is in some ways a trade-off and, in most cases, it is difficult or impossible to quantify the real advantages, because these may not be counted in similar terms like THD figures or phase margin angles. The only real advantage of larger amounts of feedback in tube amps is — in the application of said feedback around the output transformer — a higher "damping factor" resulting in tighter bass response. The reduction in distortion figures may be trading off a steady-state distortion for a time-related one.

Perhaps Lynn Olsen, writing in *Positive Feedback* magazine, said it best: "All feedback systems introduce questions of stability ... in reality, all loudspeakers are feeding time-delayed, distorted, and highly resonant signals back to the amplifier ... the basic distortion signature of the amplifier should be invariant with load. This is very difficult with any kind of feedback amplifier, since altering the stability margin of a feedback system also alters the distortion-reducing properties significantly. ... To sum up, feedback amplifiers have a continuously varying distortion signature that is directly modulated by the delayed energy fed back from the speaker."

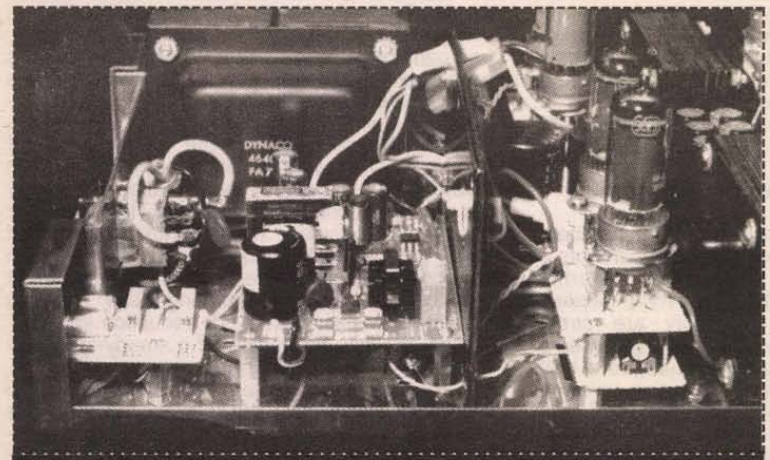
I respect the above assessments of the amplifier/speaker interaction, and I believe I have heard this effect in different tube amps using feedback (which tend to have a much lower damping factor than most transistor amps). Then again, since the tube's spectrum of distortions are so much more melodic to the ear, generally, the resulting sound is much more pleasant even when employing minimal feedback from the output. It has also been stated that since the music at the amplifier's input (unlike test signals) is always changing, NFB goes back to affect a later input, having been delayed by the group-delay transit time, causing a smear, in time, of the music, by being inappropriate, in time.

Circuitry influences aside, the now-limited gain in the revised circuit would provide minimal changes in the speaker damping factor for a closed-loop situation. As a result, this amp will sound best when plating through speakers having a maximum flat Qt of 0.65; the best example of this would be a closed box, e.g., acoustic suspension system, as invented by Edgar Villchur.

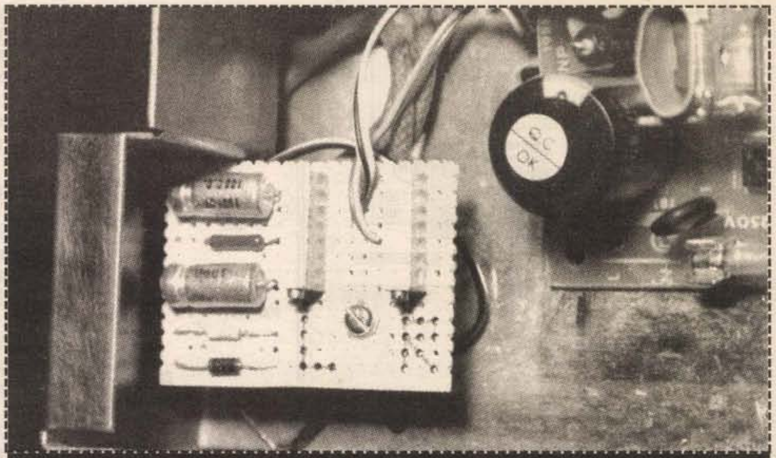
Since the push-pull circuit with the output transformer will effectively cancel some of the distortion products, the sound of a push-pull amplifier is most likely different from that of a Class A single-ended design, even one that uses the same tubes. A single-ended design would also tend to show higher level's second Harmonic as output

CHART 4

Frequency	Deviation	Frequency	Deviation
28 Hz	-3.0 dB	1000 Hz	0.0 dB
41 Hz	-1.0 dB	1307 Hz	+0.1 dB
42 Hz	-0.9 dB	1973 Hz	+0.2 dB
44 Hz	-0.8 dB	7687 Hz	+0.1 dB
46 Hz	-0.7 dB	9496 Hz	0.0 dB
48 Hz	-0.6 dB	12308 Hz	-0.1 dB
51 Hz	-0.5 dB	14315 Hz	-0.2 dB
56 Hz	-0.4 dB	16427 Hz	-0.3 dB
69 Hz	-0.3 dB	18193 Hz	-0.4 dB
104 Hz	-0.2 dB	20437 Hz	-0.5 dB
204 Hz	-0.1 dB	22273 Hz	-0.6 dB
1000 Hz	0.0 dB	24223 Hz	-0.7 dB
		26240 Hz	-0.8 dB
		28137 Hz	-0.9 dB
		30002 Hz	-1.0 dB
		61066 Hz	-3.0 dB



LEFT TO RIGHT: BIAS CIRCUIT, SPS SUPPLY, LEFT CHANNEL WITH AC BALANCE CONTROL



BIAS ASSEMBLY

levels rise.

Interestingly enough, some of the single-ended tubes (no feedback designs) have been the cleanest sounding amplifiers I've ever heard. So, not every aspect of the amplifier/speaker/ear interaction is taken into account by the numbers on a THD analyzer, or graphs, or scope photos, or even spectrum analyzers.

Final Functional Tests and Distortion Tests

Another small revision in a resistor value to the bias circuit reduces the series resistance on the diode end, increasing the bias output voltage capability to -35 volts, the rest remains the same — a resistive voltage divider (39K plus the 50K trimpot and its 10K resistor to ground) and a 1K resistor in series with the output. The resulting bias levels range from around -5 volts to -35 volts.

The following measurements were taken on the left channel, using 5CZ5s, the revised grid with drive resistor values RgridA and RgridB = 100K ohms. The bias level used -34.8 volts on the center pin of the AC balance pot, for 1.505 volts across Rk. This provides a quiescent Class A drive level on the output stage at 70 mA total current, or 35 mA per tube. At the measured nominal plate voltage of 310 volts, the 5CZ5 plate dissipation was 10.8 watts, or 90% of the rated maximum value.

Filament voltage was 4.57 volts (-2.8% of nominal). The power at the symmetrical clip point was 11.32 volts/8 ohms, or 16.0 watts output at 1 KHz at 7.0% THD. The PB (Power Bandwidth -3 dB) points were 28 Hz and 61,066 Hz. With the input shorted across 600 ohms, the channels residual hum and noise was 0.00135 or -77.4 dB below 12.5 watts. Stereo crosstalk (alternate channel signal leakage) was measured with the right channel producing 12.5 watts at 1 KHz and no signal in the left channel. Crosstalk to the left channel was -75 dB or better (that number decreases at higher frequencies). See Chart 3.

Some random noise appeared on the residual distortion products on lower level signals, and this may have been some RFI from the switching power supply. A better attempt to shield it (adding a steel plate to the heatsink?) might decrease the residual noise. So, the distortion levels of 1 watt/0.1 watt may actually be lower than what was measured. Some minor deviations from flat response were measured which may account for the sonic attributes of the unit's sound. At the one-watt level, with 1000 Hz equal to 0 dB, the response was linear, decreasing gradually to -1.0 dB at 43 Hz on the low end, and 22,375 Hz at the high end of the spectrum. At the higher 10-watt level, a slight frequency response anomaly appeared between 1000 and 9500 Hz.

Chart 4 shows the frequency response measurements at the 10-watt level.

On the right channel using 10BQ5's pentodes, an input signal of 0.361 volts was needed to produce 10.0 volts (12.5 watts across 8 ohms) output. The following measurements were taken with the bias at the -15.5-volt setting, which produced 1.505 volts on Rk for 70 mA quiescent plate current at no signal, the same operating points as was used in the left channel. Filament voltage was 10.41 volts on the filaments (-1.6% of nominal). The channel clipped at about 14.5 watts, the PB points (-3 dB) were 25 Hz and 58,810 Hz referenced to 12.5 watts. With the input shorted across 600 ohms, the channel's residual hum and noise was 0.00215 volts or -73.4 dB below 12.5 watts. With the left channel producing 12.5 watts at 1 KHz and no signal in the right channel, stereo crosstalk to the right channel was -73 dB or better (that number decreases at higher frequencies). See Chart 5.

The frequency response measurements at the 10-watt level are shown in Chart 6.

Due to time constraints, tests using the Hammond 1620 output transformers could not be performed. Perhaps that will have to wait for another time or project.

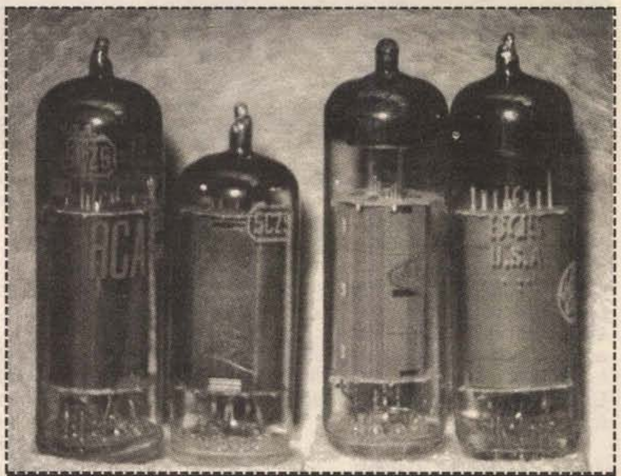
Speakers Used and Sound Impressions of the Completed Project

While an Ongaku or other high-end super amplifier was simply not available for comparison, I did compare the final finished amplifier to another similarly constructed 6-watt-per-channel (SE) single-ended paralleled triode amplifier, which uses 10BQ5s, and was also a no-feedback design. I was curious as to the comparison of the two. The SE design uses a rather expensive output transformer costing over $100.00 each and, probably as a result, its overall sound was better. The BENDER-2pp sounded louder sometimes, but never quite as effortless. It almost sounded as clear and clean as the SE triode unit, it was actually a fairly close comparison. The Bender-2pp was capable of going louder, but was more distorted when it did.

Two sets of speakers were used to sound-test the BENDER-2pp. My primary speakers — the BENRGUN-1 — are a four-way custom closed-box design in a heavily reinforced 25.5" x 14.25" x 11.5" (~1.50 cu.ft. internal volume) box, designed using the Small Equations, Vas, Woofer Q, and the alignment, to a Qt of between 0.65 and 0.7 (maximally flat design criteria).

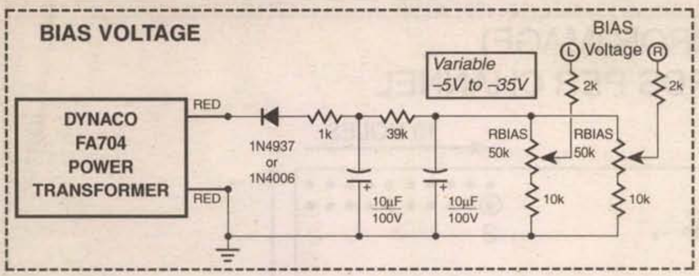
This was designed 15 years ago, using an HP-41C calculator. The speaker has a 10" Polydax Bextrene cone woofer (Xover <500 Hz), 3" diameter Seas MR with a sealed back baffle (500-2,500 Hz), JVC tweeter (1.5 KHz), and an external Pioneer super-ribbon tweeter (>5 KHz). I tuned the sound of this speaker to the sound I preferred, which is very flat. The passive crossover network was designed in an external box, making this task reasonably easy. The sound is similar to the AR-3a in the bass, but smoother in the mid-bass and mid-range, with lots of clean, crisp treble. This speaker, unchanged for almost 15 years, shows no obvious peaks or problems. It closely fits the 8-ohm designation.

The second pair of speakers is a 27-year-old, two-way non-closed box of Danish design, using Seas drivers — the Dynaco A-25. This older, and smaller 10" speaker, as it turns out, is more efficient, by about 5-6 dB when compared to my own design. This added efficiency really allowed the BENDER-2pp to "rock" on some CDs. The A-25 was a decent sounding speaker in its day and, surprisingly, it still is very revealing of "amplifiers." Most transistor amplifiers sound metallic, with a mid-range honk and harsh slurred treble. Tube amplifiers come through sounding much smoother, lacking many of the sonic faults inherent in many transistor amps.



LEFT: TALL 5CZ5/SHORT 5CZ5
RIGHT: 10BQ5s AMPEREX/GE

On both the BENGRUN Reference speaker



and the Dyna A-25s, the BENDER-2pp amplifier had a slight glassy sound — for lack of a better description — noted on many recordings. This kind of effect is sort of like that obtained when cupping your hands behind your ears (but the amp effect was at a much reduced level). This is perhaps due to a slight enhancement in the upper mid-range that was noted, and if we assume that the test equipment is maximally flat, this deviation measure is some +0.1 dB to +0.2 dB deviation from flat, in the upper mid-range, and maybe this is audible on music? Anyway, the A-25s added 5-6 dB of efficiency and changed the sonic perspective. Its lack of closed-box design changed the bass, too, sounding powerful or thin, depending on the recording; generally sounding thinner than the closed-box design.

Grado SR-60 headphones were also used during the design and testing phases, and the sound was clear, detailed, and clean (by the way, this unit makes a great headphone amp). Clearly, there is the question: Which channel sounded better — the 5CZ5s or the 10BQ5s? The definitive answer is difficult to state here ...

Both circuits were tried using 330-Kohm grid biasing resistors and also values of 100 Kohms. There was a loss of about 3 to 4 dB overall system gain, using the 100-Kohm resistors in the schematic shown, and this was considered the final version. While the distortion numbers seemed best for the 100-Kohm revision (which also allowed a much greater range for the AC balance control), there were more losses in the loading of that circuit. Whether this value was indeed optimum for both the 5CZ5s and 10BQ5s isn't as easily determined.

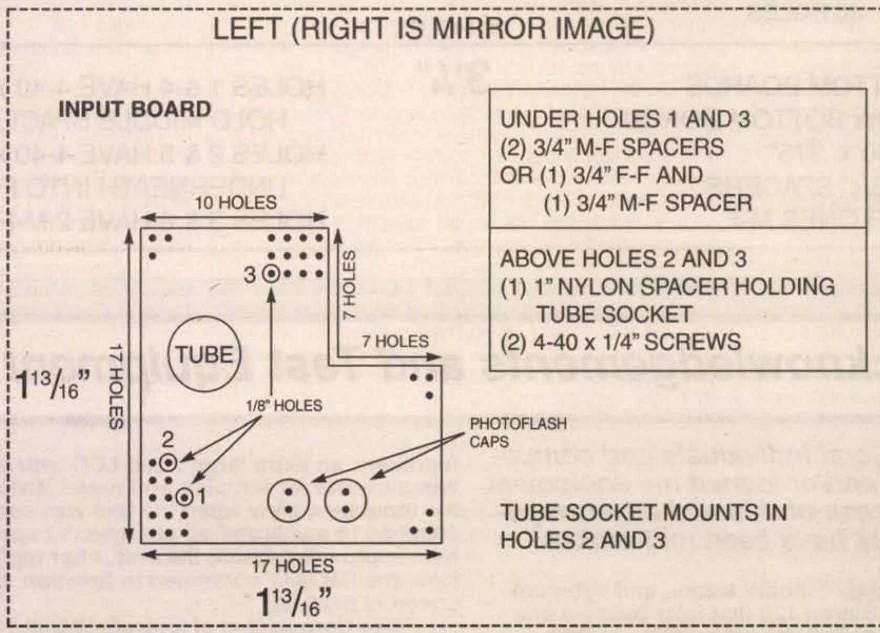
Still, overall, I tend to think the 10BQ5's channel sounded a little better, but this isn't a sure thing; often a minor deviation — like +0.2 dB in net gain — can throw one's sonic perception off in that direction. As the two 5GH8 input tubes on the left and right channels were not identical units, or even the same brand, some sonic differences, signal-to-noise differences and microphonic differences, could be attributed there.

Obviously, a 12-watt per channel amp is moderate for modern day speakers (except in the case of a horn-loaded speaker system). Yet, 12 watts per channel, is enough for speakers rated in the 80 to 90 dB watt range. Great sound, just not "that" loud. Subjectively again, the amp sometimes seemed a bit bass heavy, on "Mussorgsky's: Pictures at an Exhibition" (Dorian Sampler), but on many rock recordings, the bass seemed just right (Dire Straits, Don Williams, Linda Ronstadt, George Strait). On a few recordings, it sounded more subdued in the bass (Cowboy Junkies, Donald Fagen, The Nightfly) than some other amps. Perhaps this anomalous behavior is a "junker" transformer artifact, or the presence of significant amounts of bass in the sub-30 Hz region.

But unlike lower power amps of yesteryear, the BENDER-2pp rebuild tube amplifier has a well-defined low end (which would probably be better using a better quality output transformer). It does have that tube clarity in the mid-range, especially detailed on female voices and solo instruments. It gives a wire-with-gain aspect to the overall top to bottom range of sound, that I thought was a very good characteristic.

Beyond the basic channel topology differences, the prototype was constructed using a stereo — two-pole, three-position switch mounted between the output terminals — allowing instantaneous switching between the 4/8/16 ohm taps. Perceptually, there was about a 3 dB change between adjacent taps using 8-ohm resistive loads and the Grado SR-60 headphones. The 16-ohm tap had slightly less gain, and its treble seemed somewhat subdued — compared with the 8-ohm tape, with the 4-ohm tap being still louder. The 4-ohm setting seemed to be more distorted than the others, or, maybe it was the 6 dB of extra gain. Very hard to tell.

Subjectively, the bass seemed tightest at the 16-ohm setting. It was extremely difficult to make some decisions as these effects were very, very minor when the small gain differences were simultaneously adjusted for.



The BENDER-2pp transmits a clear detailed sense of the music, while not quite as clear and effortless sounding as the single-ended triode amplifier, but the bass end seems well controlled, almost as in a higher damping-factor transistor amplifier. Its performance is both fast and controlled, more like a well behaved and detailed modern day amp than tube amps of yesteryear. The circuit's 2,500+ micro-farads of capacitance in the high-voltage power supply circuit likely accounts for that performance characteristic. That value is more than 20 times as much capacitance as was typically found in the HV power supply of a tube power amp built in the 1960s.

Lastly, I'm still not sure which output tap is better sounding, but you can try whatever taps are available on your transformer, on your speaker system. You make the decision, as you are the ultimate judge. **NV**

Continued on next page

For inquiries or details, send a SASE to Bender Consulting, P.O. Box 260402, Bellerose, NY 11426; E-Mail: exqw41d@prodigy.com — parts kits for a stereo BENDER-2pp are not yet available. Continue checking the web site; http://pages.prodigy.com/sbender/index.html should be operational in April 1997.

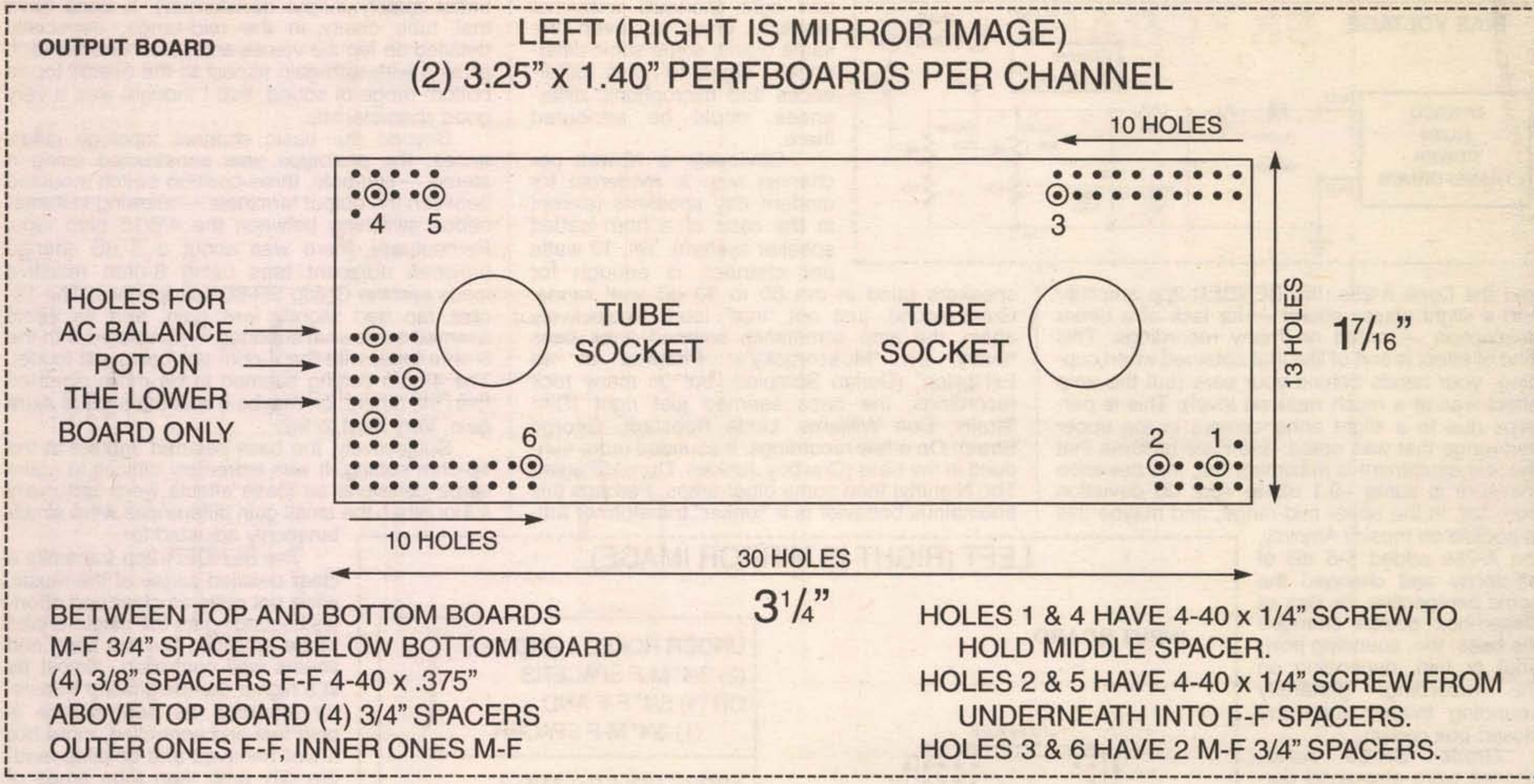
CHART 5 Final Distortion Measurements into 8-Ohm Test Loads

Tubes	Frequency	Voltage/Power Level	THD Level
10BQ5s	1.001 KHz	0.895 volt/0.1 watt	0.45% THD
10BQ5s	20.00 KHz	0.895 volt/0.1 watt	0.36% THD
10BQ5s	1.001 KHz	2.82 volt/1.0 watt	0.97% THD
10BQ5s	20.00 KHz	2.82 volt/1.0 watt	0.91% THD
10BQ5s	1.001 KHz	8.95 volt/10 watt	6.10% THD
10BQ5s	20.00 KHz	8.95 volt/10 watt	4.40% THD
10BQ5s	1.001 KHz	10.0 volt/12.5 watt	7.50% THD
10BQ5s	20.00 KHz	10.0 volt/12.5 watt	5.70% THD

CHART 6

Frequency	Deviation	Frequency	Deviation
28 Hz	-3.0 dB	1000 Hz	0.0 dB
40 Hz	-1.0 dB	1175 Hz	+0.1 dB
41 Hz	-0.9 dB	1470 Hz	+0.2 dB
42 Hz	-0.8 dB	3316 Hz	+0.25dB
44 Hz	-0.7 dB	6217 Hz	+0.2 dB
46 Hz	-0.6 dB	7938 Hz	+0.1 dB
48 Hz	-0.5 dB	10920 Hz	0.0 dB
54 Hz	-0.4 dB	12561 Hz	-0.1 dB
63 Hz	-0.3 dB	13988 Hz	-0.2 dB
95 Hz	-0.2 dB	15670 Hz	-0.3 dB
130 Hz	-0.1 dB	17525 Hz	-0.4 dB
1000 Hz	0.0 dB	19005 Hz	-0.5 dB
		20634 Hz	-0.6 dB
		22537 Hz	-0.7 dB
		24175 Hz	-0.8 dB
		25791 Hz	-0.9 dB
		27375 Hz	-1.0 dB
		56332 Hz	-3.0 dB

The BENDER-2pp Tube Push-Pull Amplifier Rebuild Project



MAX

Acknowledgements and Test Equipment

I must acknowledge several individuals and companies who have helped and/or loaned me equipment during the design process of this and other amplifier rebuild projects that have been undertaken:

Mr. Roberto Dias, writer/Prodigy™ board leader, and cybercollecting guru, donated a Dynaco Stereo 120 that later became one of my prototype amps. Also deserving special mention is Dick Bergeron of Electron Tube Enterprises, in Essex, VT, who donated some tubes to the project, and who is a likely source of low-priced tubes for the needy DIY builder. Mr. John Grado, of Grado labs in Brooklyn, NY (they are known for cartridges and headphones) who graciously donated a pair of the SR-60 open-aire dynamic headphones to this project. Also, NYC professional photographer, David Slagle managed to get me another usable Dynaco Stereo 120 that someone else, one sunny morning, retrieved from a Manhattan garbage can.

Also instrumental were comments, suggestions, and info from Jay Vazquez, in The Bronx, NY, Chris Withers of Woodbridge, CT; Greg Sorvino, in Westchester, NY; Eric Barbour of Svetlana in California, all of whom provided grand technical repartees that allowed me the insight to solve some of the difficult design problems encountered during the project's early prototype and testing phase. Thanks again, guys.

The Wavetek Corporation of San Diego, CA, donated their DM28XT 3.5 digit multifunction DMM meter for use in this design project. The "28XT" measures more than just its five AC/DC voltage/five AC/DC current ranges (up to 20 amps for 30 seconds). It measures resistance in six ranges from 200 ohms to 20 megohms/diode forward voltage test; eight capacitance ranges to 20,000 uF temperature in Fahrenheit and Celsius with 0.1 degree resolution (it comes with a point temperature probe); and audio frequencies to 199.9 Hz or 19. 99 KHz. It also features HOLD and functions, an extra large sized LCD with all those visual symbol annunciators for function and range. Twice, during routine testing, the input fuse blew when the unit was connected up wrong, or attached to a charged up photoflash capacitor. One spare small fuse is provided inside the unit. After replacing the small internal fuse, the DM28XT continued to function. It's quite remarkably priced at $120.00.

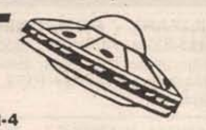
Fluke Corporation of Everett, WA, provided their Model 79 Series II multifunction DMM. This made-in-the-USA, holster encased, autoranging (or manually range set) DMM with four digits of resolution (mostly 4,000 count readout), is calibrated to NIST accurate references, which is essentially MIL spec. It has half-inch high digits, and one of those 63 segment analog bargraph annunciators, and all those nice function and range display symbols on the LCD display. It measures AC/DC volts, current to 10 amps continuous (fused at 20 amps for 30 seconds), and resistance to 40 megohms. It uses an extended 9999 count display on the frequency range to beyond 100 KHz, capacitance to 9999 uF, and lo-ohms ranges. The lo-ohm has an auto-calibrate function to null test leads values; simply great stuff for those sub-10-ohm readings, down to 0.01 ohm.

The four-digit resolution is dynamite, and the autoranging feature is a true pleasure. Autoranging units need hefty input protection, and when attached to a charged cap, it recognized that, and went into DISCHARGE mode, so this meter never flinched. Its calibration is traceable to NIST standards: $199.00. While the Model 79 Series II DMM lacks temperature reading capabilities, Fluke's Model 52 meter is a dual-digital thermometer with Fahrenheit/ Celsius readout and dual probes, to allow inspection of two temperature points at the flick of a rubber switch, also priced at $199.00.

Motorola Semiconductor of Phoenix, AZ, generously provided samples of numerous types of semiconductors, some of which made it into this project.

When Visiting Disney World And Sea World. Come To The World Of Electronic Surplus!

SKYCRAFT



PARTS & SURPLUS, INC.
ORLANDO, FLORIDA

Located At The Intersection Of I-4 And Fairbanks Avenue.

A Self-Service Retail Outlet Featuring Commercial And Government Electronic Surplus Including:

★ WIRE	★ COAX
★ SWITCHES	★ RELAYS
★ RESISTORS	★ HARDWARE
★ TRANSISTORS	★ CAPACITORS
★ TRANSFORMERS	★ PANEL METERS
★ TEST EQUIPMENT	★ CIRCUIT BOARDS
★ NI-CAD BATTERIES	★ INTEGRATED CIRCUITS

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

We Buy Surplus Electronic Parts —
FAX your list.

HOURS:
Monday - Friday 8:30-6:00
Saturday 8:30-5:00

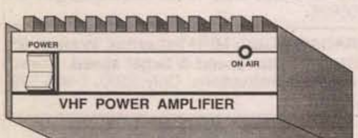
FAX 407/647-4831
PH 407/628-5634
P.O. BOX 536186
ORLANDO, FLA. 32853-6186

PLANS – KITS – SCHEMATICS *cont.*

BUILD A radar jammer out of your old radar detector. No electronic knowledge needed. Call 24 hr. for easy step-by-step plans. "GUARANTEED." New from "Image Master Publishing" 1-800-295-0953. Only $9.95, $2.50 S&H.

CABLE! SATELLITE! If you repair these type items, we have 300+ reverse engineered schematics that might help. Latest draws: **8600STZN, CFT2254, DPBB7-312/V5S8.** We also have prints on two of the **DSS** systems. Send $5 (refundable with order), ask for **TELEVISION** catalog. **BOMARC SERVICES**, P.O. Box 1113, Casper, WY 82602. 307-234-3488 rollo@trib.com

200+ ELECTRONIC PLANS & KITS. Build for pleasure or resale. Make 100% profits reselling printed plans. LSASE for list & dealer info. MATCO-A3, POB 509, ROSEVILLE, MI 48066-0509.



BROADCAST FARTHER! 75-110MHz amplifier connects to stereo transmitters. Produces 2-15 watts. Requires 50-150mW drive. Complete plans with part source and antenna information only $14 + $2 S&H. **Progressive Concepts**, PO Box 586, Streamwood, IL 60107. 630-736-9822.

TUNABLE WAVE master weapon. Build a 1500W master beam weapon with the same power potential as a laser, yet capable of passing through walls. Design can be built for under $150. Send $10 for complete plans/schematics. We have kits/parts for this item, $1 for catalog. Unlimited Underground Electronics, 1839-D West Vista Way #515, Vista, CA 92083. Voicemail: 619-414-6631. Uue@usa.net

SPECTRUM ANALYZER KITS. MODEL 810B as seen in 1991 Radio Electronics $300 ea. Limited offer. Call for details. DKD INSTRUMENTS 805-929-2285. E-Mail: dkdinst@lightspeed.net WEB: http://www.dkdinst.com

GENERATOR FOR COLLOIDAL SILVER. Build your own generator and save. Generate your own otherwise expensive electrolytic: your own colloidals. Check or MO. Kit $49, assembled $59. Information only LSASE. P&A, Box 565, Adair, OK 74330-0565.

AWESOME KITS: Voice changers, levitators, lasers, gas sensors, and more! Catalog $1. **LNS Technologies**, 20993 Foothill Blvd., Suite 307R, Hayward, CA 94541 www.ccnet.com/~lnstech

SMART CARD READER/PROGRAMMER

- Capable of reading ISO7816 Cards
- Send single or multiple bytes to Card - response is displayed on screen
- Send External Datafiles to Card - write to the card and log answers to disk.
- On board Pic16C84 Programmer - Program these chips 'in-circuit'.
- 'Proto' card Programmer - 1, 2 & 3 IC Cards.
- Supplied with Interesting Data on various subjects relating to Smart Cards
- Comes with software, connection data and full instructions.

ONLY..............£79.00

SMART CARD INTERROGATION SYSTEM

- Smart Card Reader/Writer
- Smart Card Interrogation System, to identify commands accepted by any valid Smart Card and log them to disk for evaluation. Will allow the user to 're-send' known commands and monitor the result.
- Passive Interface to allow the user to monitor the data flow between Card and host system.
- 244 page Hard Back reference book, covering all aspects of Smart Card design and programming.
- Sample program to read memory type Phone cards.
- Data on NEW Visa Smart Cards.

ONLY..............£195.00

PROFESSIONAL READER/WRITER

Serial PC Interface, technical documentation giving command protocols and .lib files for all cards listed below. This intelligent Reader/Writer allows communication between a PC and cards that have different communication protocols. By taking care of the card specific particulars, it allows control of the cards without the user getting involved with the technical details of the card operation.
INTRODUCTORY PRICE...................£225.00

US3		SGS Thomson	Gemplus	Siemens	Amtel
USF015	USD032	ST1305	GPM103	SLE4406	AT88SCOG
USM202	USD033	ST14C02XC	GFM1K	SLE4436	AT24C01
USM204	USL101	ST14C04C	GFM2K	SLE4404	AT24C02
USM216	USL102		GFM4K	SLE4418	AT24C04
USM264	USL404		GPM416	SLE4428	AT24C08
USD019	USD304			SLE4432	AT24C16
				SLE4442	AT88SC101
					AT88SC102

MOTOROLA MC68HC705 DEVELOPMENT PACK
Professional development package produced by MOTOROLA, ideal for the developer working on HC05 based Smart Cards.
Inc. In Circuit Emulator, Programmer, MC68HC705J1A demo 'C' Compiler, Assembler, Editor and DATA Books with Application Notes.
PSU and cables included for use with IBM compatible PC.
FREE CD ROM inc MOTOROLA WEB SITE
£100.00

BASIC SMART CARD EVALUATION PACKAGE

- Smart Card Reader/Writer (Programming Interface).
- Evaluation applications, for use with Smart Cards provided in the package. Basic ID Card, Basic Electronic Purse, Basic Loyalty Card.
- 'C' Library & Command descriptions. For the user to design their own Smart Card applications using the cards provided.
- Programmer's Development Suite. Text Editor Assembler, Simulator for programming the Cards provided.

INTRODUCTORY PRICE.......................... £135.00

CROWNHILL ASSOCIATES LIMITED
THE OLD BAKERY
54, NEW BARNS ROAD
ELY
CAMBRIDGESHIRE
CB7 4PW U.K.
Tel: +44 (0) 1353 66 67 09
Fax: +44 (0) 1353 66 67 10
Email:sales@bannold.demon.co.U.K

MASTERCARD
VISA
accepted
PRICES ARE POUNDS STERLING
CARRIAGE EXTRA

NEW CD-ROM
Our Current Catalogue in full colour. Including Smart Card related Data Sheets and Software. Smart IC Development tools and DEMO's and much more **£10.00**

Write in 132 on Reader Service Card.

Robot Kits

✓ Academic-Level Books
✓ Build it Yourself
✓ Action Packed

EASY TO BUILD You do ALL electronic & mechanical assembly using 2-color Instruction Books with step-by-step, well-illustrated directions for assembly, experiments and testing. Each Robot Kit applies different electronic & robotic principles. Learn how Robots work and have fun at the same time!

606A *"Scrambler"* **All Terrain Robot** This 6-legged Robot walks over rough terrain. Uses high-tech infrared beam to sense and avoid avoid objects in its path. 32 page Book. **$37.95**

603A *"Copycat"* **Programmable Robot** Program direction, light and sound using detachable keypad (included) or optional PC. Learn digital logic basics. 44 page Book. **$57.35**

602A *"Blinky"* **Pathfinder Robot** Follows path made with a marker pen or tape. Red/green LEDs react to steering changes, adding fun and interest. 28 page Book. Infrared emitter/detectors. **$36.95**

601A *"Scooter"* **Sound Controlled Robot** Backs up, changes direction, goes forward when it hears loud noise or hits an object. Florescent red. 24 page Book. Fast-paced excitement! **$18.95**

DEPENDABLE PRODUCTS Since 1963, Graymark's ONLY business has been producing educational electronic kits. We do one thing and we do it right. That's why Graymark has the largest selection of electronic kits. And, our ***"It works or we fix it"*** policy guarantees success for YOU!

ORDER TODAY! ***Phone:*** *VISA/MasterCard/Discover/AMEX*
Mail: *Check/Money Order, Credit Cards*
Add: *$4.00 Shipping*

CALL FOR ***FREE***
40 PAGE CATALOG

Graymark P.O. Box 2015, Tustin, CA 92681

800-854-7393

Write in 78 on Reader Service Card.

QUALITY KITS. Electronic project kits for assembly. Please call for free catalog **1-888-GO-4-KITS**, or check out **www.qkits.com**

ATTENTION HACKERS and PHREAKERS. For a catalog of plans, kits and assembled electronic **"TOOLS"** including the **RED BOX, RADAR JAMMER, SURVEILLANCE, COUNTERSURVEILLANCE, CABLE DESCRAMBLERS** and many other **HARD-TO-FIND** equipment at **LOW PRICES.** Send $1 to M. Smith-01, PO Box 371, Cedar Grove, NJ 07009

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

VOICE CHANGER board! Fully assembled and tested! Not a kit! 16 levels of change, many applications! $39.95 + $4 (S&H) US funds! **PARSEC Electronics**, PO Box 34594, Phoenix, AZ 85067.

NIGHT VISION kits. US military intensifiers. Kits as low as $119. US generation 2 from $399. Why spend more for inferior quality? Easy assembly, 4 years experience building & repairing night vision. Credit cards, etc. Mike @ NENVIS, 10-5 Eastern 508-347-7238.

HEATH COMPANY is selling photocopies of most Heathkit manuals. Only authorized source for copyright manuals. Phone: 616-925-5899, 8-4 ET.

MANUALS/SCHEMATICS WANTED

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

MANUAL WANTED for the Epson FX-100 printer. 1-800-804-8655.

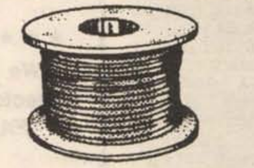
WANTED: DIAGRAMS for radio frequency heating equipment. Induction, dielectric, plastic, microwave. YOUNGSON's, INC., 6701 Melrose Ave., Louisville, KY 40216. 502-448-6228.

WANTED: TEST EQUIPMENT SERVICE MANUALS! And catalogs, for HP, Tektronix, Fluke, etc. Pepper Systems, 214-353-0257; 214-902-9511 FAX.

MISC. ELECTRONICS FOR SALE

ELECTRO SCIENTIFIC Industries: MD#296 digital LRC meter. Performs high speed: L, R, C, & G measurements. Calculated D & Q. 4" digital readouts (used). Only $750. Credit cards accepted! ISE: 210-350-5555, FAX: 210-350-5574.

SURFACE MOUNT system. Multi-reel and loose parts wheel/carousal. Vacuum placement by X-Y mechanism, requires factory; two-stage hot plate for reflow, requires 220VAC 60Hz, $1,000 plus $100 crating charge plus UPS. Original cost $9,000. Call Frank M-TH 10-4 PT 702-565-3400.



ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors. If interested, please call **1-800-626-7540**, FAX: 714-771-5043. Visa/MC/Amex. SEE US ON THE INTERNET: http://www.anaheimwire.com OR E-Mail: info@anaheimwire.com

CLOSEOUT ITEMS from BNF. Blinking LEDs. Stop lite kit blinking, red, yellow, green LEDs, reqs 6VDC, $3, $10/4. Ni-cad battery charger/rejuvenator kit $7.77, $20/3. Alarm indicator kit, 2 LEDs, steady, blinking $2, $10/6. letter sign kit, 1" letters, 40 LEDs, some blinking, $15, $40/3. Wind speed indicator kit $5, $13/3. Jacobs Ladder 25K voltage kit $19, $55/3. Fan/motor speed control $3, $10/4. 2-1/2"ID 1-1/2"D solder pot $3, $13/3. Voice/sound activated switch modu. $1. Components by the foot, assorted, $1/10', 500 pts. 2 speed sw. motor/lamp control $1/2, 12/$5. Mallory Sonalert SC628 $3.50, $16/5. Security keylock switch, w/2 keys $3/2. All working units. On the web, WWW.BNFE. COM BNFE, Rte. 1S, Peabody, MA 01960. V508-536-2000, F508-536-7400. In our 33rd year.

DO PRINTED circuits! 11x14 process camera with rail, lights, lens & copy holder. Nu-Ark arc light, $350 plus shipping. 810-989-4600.

T-BAR EXPLORER DM-1 digital data line monitor for central site and field service use in isolating protocol and code related problems in data communications networks. Programmed BISYNC/ASCII. 5" CRT. Compact 14 pounds. New $150 w/manual. Louis Gold, Box 3636, Woodbridge, CT 06525.

RADAR GUNS: MPH Industries, model K-55. Displays your speed & target speed. Comes w/case & instructions. Only $300. 1-800-539-2859.

SOLAR-POWERED FAN HAT. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

PNEUMATIC TIE wrap gun for high production. Like new with balancer, regulator, $550. 810-989-4600.

RADIO CABLE SPECIAL PURCHASE!!!

PJ-068 CABLE!!!
Hard to find, but Gateway's Got 'em! These are the connectors like the ones used on Collins and aircraft radios. PJ-068 plug on a 3 conductor shielded coiled cord (2 ft coiled, 5ft extended.) $9.50ea.

AMPHENOL 4-PIN MIC PLUG CABLE
This cable is a 3-conductor (1 shielded) coiled cord with a 4-pin amphenol microphone plug (91-MC4M) on one end. Extended, it measures about 4 ft, and coiled 2ft. As used on older microphones and radio equipment. $9.50ea.

127 THERMOCOUPLES
PELTIER JUNCTIONS

The peltier junction is a solid-state thermovoltaic device. Current applied to the device will produce heat on one side of the device and a cold surface on the other side. Water placed on the surface will freeze or boil depending on polarity of applied voltage. Ideal for applications from 3-12 VDC -- grab a battery and let your imagination run wild!
DOCUMENTATION INCLUDED!!!
Small Peltier Junction $20.00
(approximately 1.17"x1.17"x.12")
Large Peltier Junction $29.50
(approximately 1.56"x1.56"x.15")

SILLY SOUND KITS
SOUND EFFECTS KITS ARE GREAT FUN AND EASY TO BUILD! CHOSE THE CHOO-CHOO 4 TRAIN SOUND KIT ($7.95), THE COPS 'N' ROBBERS KIT, (SIRENS AND GUN SOUNDS, $7.95), THE RINGY DINGY TELEPHONE SOUNDS KIT ($7.95), OR THE DING-DONG DOOR CHIME SOUNDS KIT ($7.95) *Powered by 2.5-5 VDC, these are great fun. Kits include parts and instructions -- 2 AA batteries not included.*

PHOTON MICROLIGHT

8 Candellas of bright red or yellow light, visible over a mile away! This super-bright LED is secured in a tough ABS case and runs on a 3V lithium battery (included!) It won't burn out because it is an LED! Incredible birght colors! Specify red, yellow, blue or green color when ordering. Battery has a 5 year shelf life and lasts up to 11 hours. (replacement battery $0.98).Great for home or office use, popular with fire and rescue professionals, pyrotechnicians, stage performers, and more.
red or yellow microlight $10.00
blue or green microlight $15.00

CAPACITOR CRAZY!
The capacitors you've been looking for have arrived...470 mfd 450 volt radial lead capacitors measure approximately 2"x1-3/8". Great for projects! $4.95 ea.

We've also got 800 mfd 450 volt Computer Grade capacitors for those who need something a little bigger. The dimensions are about 5"x2". $6.95ea. Ideal for all kinds of applications, you might grab an extra just to have on hand.

PAN & TILT COLOR CAMERA WITH NO MOVING PARTS?!?!?!
A compact on-board camera with the capability to telephoto pan & tilt, zoom, and more...without the mechanical complications of a moving mount! Can be computer controlled through the RS-232 port to utilize additional features like fade, exposure, and balance. (User programming is required.) Great quality picture, this camera is ideal for security, stealth surveillance, keeping an eye on the kids, and more. Operates on 12VDC. Approximate dimensions:
sp = 30mmX25mmX31mm
pc = 58mmX45mmX11mm
wt = 32g
Other useful specs:
exposure: electronic shutter auto iris
signal format: NTSC
lens: F2.4, f=4.7 (horiz. 45 degrees)
resolution: more than 300 TV lines
pixels: 510X492
$350.00
please allow upto 3 weeks for shipment

Passive Infra-red Talking Motion Detector !!!
$27.50

"Stay out of that refrigerator !", "Watch your step!", "Do your homework", "Don't touch that remote!" ... The possibilities are mind-boggling with this talking motion detector. You speak into it to record your message (upto 12 seconds long), turn the unit on, and instantly your voice (or your mother-in-laws) reminds anyone in the vicinity that you were expecting them. Message can be changed with the flip of a switch. Uses 4 AA batteries (not included), or an external power source (built-in jack). May be used independently (80 db output) or with an amplified speaker to blast your message throughout the house. Approx 4"x 3-1/2"x 1-1/2".

AMAZING MINI MICRO FM RADIO!
$7.50

Much lighter than a heavy jam box with really good sound! This tiny radio (1.5"x1.06"x0.38") has a seek button, reset control, and an on/off switch. Personal listening has never sounded better! Ideal for ballgames, studyhall, and workouts. Battery and nugget style earphones included.

0.8" NTSC miniature color LCD display
This nifty little device includes a backlight module and some documentation. We haven't tried 'em out yet, but it looks like a challenging endeavor for the technically adept and curious. According to the specs, the unit features include active matrix, high contrast, high resolution, limited documentation. Great price, $4.95

flexible solar cells!!!

High efficiency flexible solar panels are great for projects! Amorphous silicon alloy on a thin flexible sheet of stainless steel – now you can make that solar powered T-shirt you've been wishing for...or how about a solar powered RC car? Solar charge your HT battery! The ideas abound!
1.6v @ 350mA $5.95 ea
10 @ $4.95 ea.
approx. 1-3/4" x 6-1/4"

VIRTUAL REALITY COLOR VIDEO HEADSET WITH AUDIO AND MOTION SENSOR
$65.00
Watch late night TV without disturbing anyone! This video viewing system can be connected to your vcr and you can watch (and hear) your program on the headset! Of course, it is not like the picture on that 12 foot big screen at the local sports pub, but you can watch in your jammies and see who the guests are on your favorite late night talk show! ***Play your favorite video games arcade style!*** Designed for use with many Super NES and Sega Genesis games, the headset has both audio and motion sensing capabilities. Generally speaking, this is ideal for racing, flight, and tank simulators with a first person or rear view perspective, and games with an eye level perspective. System features volume control, sensitivity control, brightness control, tint control, as well as a reset button and mode switches to select your application. Composite video headset system includes headset, tracking tube (for motion sensing), AC adapter, Super NES cable assembly and Sega Genesis cable assembly. A pinout is also included for TV/VCR viewing.

DISCOVER VISA

THE FINE PRINT : PRICES SUBJECT TO CHANGE WITHOUT NOTICE • GATEWAY IS NOT RESPONSIBLE FOR PRINTING ERRORS • MASTERCARD, VISA AND DISCOVER ACCEPTED • YES, WE'LL TAKE YOUR CHECK – SORRY, NO C.O.D.s • $10 MERCHANDISE MINIMUM ON MAIL ORDERS • SUPPLY OF SOME ITEMS IS LIMITED • PRICES DO NOT INCLUDE SHIPPING • UPS GROUND SHIPPING/HANDLING WITHIN THE CONTINENTAL U.S. (ITEMS REQUIRING ADDITIONAL AMOUNTS ARE NOTED)...$4.25 FOR THE FIRST ITEM, $0.50 FOR EACH ADDITIONAL ITEM. RESTOCKING CHARGE MAY BE ASSESSED ON RETURNED ITEMS. My road to success is still under construction!

www.gatewayelex.com
gateway ELECTRONICS, INC
8123 PAGE BLVD • ST. LOUIS, MO 63130 **(314)427-6116**
9222 CHESAPEAKE DR. • SAN DIEGO, CA 92123 **(619)279-6802**
2525 FEDERAL BLVD. • DENVER, CO 80211 **(303)458-5444**
MAIL ORDERS CALL TOLL-FREE
1-800-669-5810
FAX ORDERS (314)427-3147

Write in 93 on Reader Service Card.

PCB Design software. Free unrestricted trial. Schematic, Autorouter, SMDs, Gerber, etc. Why pay more? http://www.bestproto.com/ftp site

ELECTRONIC ASSEMBLY MACHINERY. We buy and sell assembly machinery including solder machines and board cleaners, insertion machines and lead formers. Petlock Inc., Rialto, CA. 909-877-8900, FAX 909-877-8902.

LPKF MILL/DRILL Model 101, 9"x12" X-Y machine. Design your board on Apple II+ graphics tablet and run on X-Y mill/drill machine. Mill/drill machine, Apple II+, graphics tablet, software, all for $1,000 plus $100 crating charge plus UPS. Original cost $18,000. Call Frank M-TH 10-4 PT. 702-565-3400.

SOLAR KING'S many millions of dollars of solar panels in stock. Solar panels: Credit card solar panel, 6V 30mA, flexible plastic panel add more panels for other voltages & amps, $4.95 ea., $45/10, $210/50, $400/100. 12"x6" 15V @ .125A, 1.5W, $15.95, $140/10, $1,200/100, $9,000/1,000. 6"x6" 7.2V @ .065A, .75W $6.95, $59/10, $500/100, $3,990/1,000. Wholesale, retail, mail order. Material running low. New solar material coming in all the time. Many other solar items available. On the web, WWW.BNFE.COM BNFE, Rte. 1S, Peabody, MA 01960. V508-536-2000, F508-536-7400. In our 33rd year.

AMP MULTIMATE, misc. inventory: Flange/plug: 4, 9, 22, 23, 27, cable clamps, D-shells 35, AMP "D" connectors, transistors, diodes, capacitors, resistors, integrated circuits, inductors, thermal printer paper, Hammond boxes, 9V battery clips, fuses, and MUCH more. Help us clean our warehouse shelves! Will FAX or send list: 612-639-1800, or FAX 612-639-0146 requests. Ampria Surplus, 2666 Patton Road, Roseville, MN 55113.

HP SPECTRUM analyzer 8553B, 8552B, 141T display 0-110 MHz w/manuals $1,000. HP Model 461A/426A wideband amplifier $175. HP Model 467A power amplifier w/manual $150. Wavetek digital LCR meter LM22A capacitance $150. Global Specialties 4001 pulse generator $130, & digital multimeter $100. LF Engineering L600S VLF receiving system 300Hz-10KHz $150. L-400B VLF octave gain antenna 3KHz-530KHz $150. PCSM soil test meter $150. Dynatech Nevada ECG analyzer 432D $40. Amrel 37 autorange multimeter $70. Lodestar MV-3100 AC millivolt meter $230. Sangean ATS 818 radio $75. Realistic amplifier MPA-30 $50. Phase II demagnetizer 900-315 $40. Also metal detectors. 541-855-1590.

RELAYS DPDT 24V 190 ohm mercury wetted, 30 grams and 12 PDT 12V 550 and 900 ohm may be palladium contacts, 50 grams. I believe these are under 1 amp. These are used, on PC boards, in US $.40 ea. while they last. Please include postage. Dale Trynor, Box 18, St. George, New Brunswic E0G 2Y0. gadget@nbnet.nb.ca Call evenings 506-755-2612.

HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE. European and American screwdrivers, nutdrivers, pliers, hex keys, balldrivers, and much more! Wiha, Bondhus, and Knipex! Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 908-758-8388.

COMMODORE COMPUTERS $8, software $5. 541-839-4462. More electronics.

FOR SALE: Electronic components, etc. Carbide PC drills $0.30 ea. Mallory Quad Lytics $3.75 ea. 50A/50V MOS-FETs (1-9) $1.55 ea., (10+) $1.25 ea. 2A/800V MOS-FETs (1-9) $0.95 ea., (10+) $0.75 ea. Gold plated dual 5-way binding posts (1-4) $1.95 ea., (5+) $1.65 ea. 25A/400V bridge rectifiers (1-5) $1.95 ea., (5+) $1.65 ea. We have many other components in stock. Call/send for free flyer. Hoffman Industries, 853 Dundee Ave., Elgin, IL 60120. We accept: Check, MO, Visa, MC, Discover, AMex. Ph: 847-622-8201, FAX: 847-622-8202.

CANNON PLUGS, military cut-offs. Silver pins. All sizes. 8,000 lbs. 50¢ lb. all. FOB Texas. 601-236-4673. Fax 601-281-1110.

CALL FOR a free **electronics catalog** or visit our web page at www.bgmicro.com/ **B.G. Micro**, PO Box 280298, Dallas, TX 75228. Order lines 1-800-276-2206.

IBC INSTANT CIRCUIT BOARD maker! 8"x10" PCB X-Y machine; Gerber file compatible. Eagle computer included to run software. $1,500 plus $100 crating charge plus UPS. Call Frank M-TH 10-4 PT 702-565-3400.

COMPLETE ELECTRONICS shop equipment sale: two complete Sencore test bench set-ups for sale. I also have 100s of tubes (new and used), old consumer electronics. Send SASE to Equipment, 837 Hwy 334, Oxord, MS 38655 for list.

RECORDING PAPER 15W x 500L, 8 ch., 96 ea., $25 ea., or OBO for all. BSE, POB 09649, Bexley, OH 43209-0649. 614-239-5763, Fax 614-231-2224.

F/S: NIB Collins 455 mechanical filter. Wanted: 7JP1 CRT or substitute for Sylvania scope; Sams or service data for Yaesu FRG-7; case for Triplett 630-PL multimeter. George Hoskinson, 16900 Jacqueline Ave., Montague, CA 96064. 916-459-3688.

1 HP 3488A HPIB switch with: 2 44472A modules $1,500. 1 HP 3497A/HP 3498A with: 5 44429A dual DAC, 2 44428A 16 ch. interrupt, 2 44421A relay, 2 44421A relay $8,500. Credit cards accepted! ISE: 210-350-5555, FAX: 210-350-5574.

NEW, USED, and "as is" Radio Shack items. Software, printers, computers, books, parts for R/C cars, etc. Free list. B and B Enterprises, 208 S. Pulaski St., Baltimore, MD 21223. 410-566-5388.

GENRAD RLC 1658 digibridge, and Genrad LC 1688. 110VAC, 120Hz & 15KHz. Sell for $900 ea. Credit cards accepted! ISE: 210-350-5555, FAX: 210-350-5574.

NEW: PHANTOM, POLICE LASER/RADAR JAMMER & DETECTOR: No more tickets or manufacturer pays them! Guaranteed lowest prices. Free brochures. 30-day money back guarantee, 3-yr. warranty. Visa/MC/COD. Kortesis Marketing, order 303-548-3995, FAX or messages 303-699-6660.

Write in 55 on Reader Service Card.

Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

How can I generate a high rising pulse from the master pulse of a PWM or binary coded word? The master pulse is of the same amplitude, but three times as wide as the rest of the bits of the train. I want to externally trigger my analog scope from the output of an IR remote controller. A memory scope or a strip chart recorder is not available to me.

The IR word seems to be about 0.385 MS; the master pulse .1 MS. I'm using a simple IR receiver to view the word on my scope, but to read the binary to decimal value is too fast, what with the flash of the presentation.

4971 **Gabriel Silva**
t20sil@webtv.net

I would like to know how to convert one of the PS/2 type 1.44 meg floppy drives to use with a standard floppy controller/cable. This drive doesn't have a power connector and apparently gets voltage through the signal cable.

4972 **Mike Young**
Newville, AL

Some time ago, I purchased a SCSI board from a friend who promised to supply the jumper data. Unfortunately, I have never received this. Perhaps one of your readers or others could identify the board and the organization from whom I can get the necessary information to use the board.

It is identified as "FDC/SCSI Card, Assy 144N44" with a further stick-on label "Storage Research SCSI V2.1F S/N ASC10535." It has the following JP pins: JP1, 1,2; JP3, 1,2,3,4; JP7,1,2; JP8,1,2,3; J1 is an external 25-pin SCSI connection; J3 is a 34-pin HD connection; J2 is a 50-pin SCSI connection.

4973 **John du Gan**
Palm Beach, FL

I want to display a negative B/W composite video image. If the camera is looking at black objects on a white background, I want to be able to display white objects on a black background. The video signal is from a low-cost NTSC format board camera. I have the feeling that there should be a chip set or a simple circuit to allow me to do this. Any suggestions would be appreciated.

4974 **George Henry**
Mentor, OH

The answer to #1975 in the Feb. '97 issue caught my eye. I'm quite comfortable with digital electronics, but my analog and RF knowledge is zero. Could you give me an idea what the 60 KHz WWVB signal looks like on a scope?

I would also like to know how to put together a fairly good quality receiver to get the signal into the scope in the first place.

What's a good reading material to learn some RF basics?

4975 **Dusan Benko**
Brooklyn, NY

I'm looking for a good reference that tells me what types of capacitors (i.e., mylar vs. electrolytic vs. tantalum, etc.) are appropriate for a given application (i.e., reducing the effects of noise on a supply).

4976 **Thomas Ng**
San Jose, CA

ANSWERS

ANSWER TO #3976 - MARCH 1997

You are correct, the +12 VDC supply has insufficient voltage to directly light an emergency fluorescent lamp such as you described. It is accomplished through the use of a step-up voltage converter. One common method to do this is to have the DC supply power an oscillator which then drives a small step-up transformer. The oscillating waveform creates an alternating current which lights the lamp. Usually, a simple squarewave is enough to do this. The high-pitched whine — which can sometimes be heard from small portable lamps — is a harmonic of the oscillating frequency that falls in the audio range.

Jay Rabkin
Pasadena, CA

ANSWER TO #3975 - MARCH 1997

A simple way to have five LEDs flashing completely at random is to use the flashing T-1 3/4 LED (Digi-key 1-800-344-4539 part #LT042, red; #LT1043, green; and #LT1044, yellow.) Wire five of these in parallel to the 3-10 VDC power source. Since each LED has its own internal flashing circuit, the flashing rate of each LED is approximately twice per second and the sequence of the group will be completely random.

Howard Olsen
St. Augustine, FL

ANSWER TO #3974 - MARCH 1997

Lightwaves and microwaves act exactly in the same manner, with the frequency being the only difference between the two. Any reflective coating that is consistent with light will work with the wave lengths used in the satellite TV industry. Most of the coatings used with satellite TV dishes today are anodized black aluminum, powder coated, epoxy paint or common enamel paint. Any evenly applied coat of any paint, preferably epoxy or enamel because of its durability, should do just fine. The quality of the paint job and not the paint, will be more important than anything else.

Chris
Bieber, CA

ANSWER TO #3973 - MARCH 1997

I hope you have access to a modem. If not, your only option is to call HP sales and order disks. HP still maintains a BBS at **208-344-1691**. You really should consider getting Internet access, though. The following information and files are all available on the HP support web site at http://hpcc997.external.hp.com:80/cposupport/cpoindex1.html

On the BBS, search for an article numbered BPS01212 HP scanjet scanners installing Microsoft Windows 95 drivers. This will give you instructions and background information based on which interface card you have. Then search for and download "HP DeskScan II Software for Windows 3.1x and Windows 95." The file name is sj120en.exe. This self-extracting archive contains the drivers you will need. Follow the instructions given in the README file.

Tim Godfrey
tgodfrey@unicom.net

ANSWER TO #3972 - MARCH 1997

This is a simple audio modification I found a few years back when the Icom 02AT was very popular. It works on the 02AT and 04AT. It increases audio level output, as well as reducing some of the low frequencies (the muffled sound you mentioned) that don't sound good through a small speaker. The results are pretty good. The modification involves the circuit components around Q105. **1.** Replace C119 with a .01 uF capacitor (disc ceramic is fine). **2.** Parallel R131 with a 1 uF capacitor (use a tantalum cap). **3.** Parallel R132 with a .01 uF capacitor (disc ceramic is fine).

This modification is better than some others that involve C117, and is also better than some commercial units made to enhance audio performance. It is also quite inexpensive.

Steve Muldoon
Dearborn, MI

ANSWER TO #3971 - MARCH 1997

A couple of different POCSAG type of decoders are available in kit form. POCSAG is by and far the most common numeric and alphanumeric paging system in use today.

An article appeared in the Mar. '97 issue of *Popular Electronics* that describes a kit. The kit is available from Cylex, Inc., 2501 Afton Ct., League City, TX 77573-3438. They can be reached at **1-800-356-7047**.

Also, on page 75 of the Mar. '97 issue of *Nuts & Volts*, an ad appears for a paging decoder with software for $49.95, or $99.95 for the fully registered version. The ad lists Capcon@shore.net for more information, or fax to **508-977-0122**.

Also, a version that I have personally purchased is available from IEC for $19.95 for a kit or $29.95 for the assembled version. This decoder comes with shareware, and the fully registered software version is available for an additional $33.00. Contact: IEC at **423-584-8600**, P.O. Box 52347, Knoxville, TN 37950-2347.

The IEC decoder was developed by

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
- If you do not want your name, address, or phone number available to the reader please so indicate or it will be assumed that you have no objection.
- In the event that more than one person submits the same solution, the choice will be made at the discretion of the publisher.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.

QUESTION INFO
TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS
- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS
- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

Peter Baston, and he is the author of the software, which includes the plans for building the decoder with commonly available parts. Mr. Baston can be contacted at pete@bearnet.demon.co.uk

Kirk Ellis
Pikeville, NC

ANSWER TO #39717 - MARCH 1997

Twelve-volt fluorescent lamps are available from recreational vehicle dealers, but they are usually low wattage fixtures designed to keep battery drain to a minimum. If you need to run a heavy-duty light, you should consider using a 12- to 120-volt inverter connected to a standard fluorescent fixture. If you need something in between, check out the "DC ballasts" — available to replace the AC ballast in 120-volt fixtures — available from solar power dealers. Check out Thinlite at **805-987-5021** or www.thinlite.com TJ Byers' excellent two-part solar power article in *Nuts & Volts* (Feb. and Mar. '97) has some good references as well.

George Scott
Alexandria, VA

ANSWER TO #39716 - MARCH 1997

Heathkit is still around. You can contact their parts department at **616-925-5899** to check on availability of the certain parts you need for your weather station.

Kirk Ellis
Pikeville, NC

ANSWER TO #39714 - MARCH 1997

The GI AY-3-8500-1 video game IC is still available from Alltronics (http://www.alltronics.com or **(408) 943-9773**). It may be easier to find a complete video game based on this IC; they often turn up at thrift shops and flea markets. Or, Mike Cherven (catcher@buffnet.net) may have some complete games left.

Note that the AY-3-8500-1 does not have color or sound built-in, which makes for a very bare-bones game. You might want to try the National MM57100/MM53104 chipset instead (also available from Alltronics).

David DiGiacomo
San Francisco, CA

ANSWER TO #39712 - MARCH 1997

If you want to check the actual data transmitted, connect an oscilloscope across the remote control's LED output. To check the LED's light output, you can get a small card from several suppliers (like Radio Shack) which will glow when struck with an IR beam. If you need to analyze the data patterns in depth, contact Electronic Rainbow Kits at **317-291-7262** or www.rainbowkit.com and ask about their TIR1 IR decoder kit, which will show the data output of any IR remote control on a 80386 or better PC.

George Scott
Alexandria, VA

ANSWER TO #39713 - MARCH 1997

Blue LEDs are available from Alltronics (**408-943-9773** or www.alltronics.com) at the bargain price of 10 for $12.95. 10 mm bi-color LEDs will be more difficult to find — 10 mm LEDs are usually used in automotive brake lights where only red is needed. If they are available, Digi-Key (www.digikey.com) is the place to start your search. Miniature motors are easy to salvage from broken pagers. The motors are usually okay. Check with your local pager companies. I've picked up broken pagers for parts for as little as $1.00 each. For new motors, you can either strip a miniature radio control servo down and remove it's motor (about $30.00). If you don't mind using a stepper motor, try Mondotronics at **415-455-9330** or www.robotstore.com They have a mini-stepper that isn't much bigger than your little fingernail (surplus from an autofocus camera).

George Scott
Alexandria, VA

ANSWER TO #39710 - MARCH 1997

A frequency counter prescaler is the type of circuit that Mr. Dunn is looking for. Several older issues of *QST* and *73* magazine from the '70s carried such plans. However, some of the ICs now cost in excess of $25.00 each. Taking into account the other parts and time required to build a circuit good to 1000 MHz, the cheaper alternative would probably be to buy either a kit or an assembled version.

Ramsey Electronics sells an assembled prescaler (model PS-10B) for $89.99 that is good to 1500 MHz and uses a 1000:1 divide ratio so that 1500 MHz can be read even on a cheap 10 MHz counter as 1.5 MHz. Mr. Dunn may also want to consider buying a full-fledged counter for $129.95 from Ramsey that is good from 10 Hz-1300 MHz. Ramsey can be contacted at **1-800-446-2295**. Ask for their full catalog of kits and counters.

Kirk Ellis
Pikeville, NC

ANSWER TO #3977 - MARCH 1997

Linear tracking turntables typically use a motor with a speed reduction system (gears, belts) connected to a cable, which moves the arm carriage along a rod. The arm is allowed to pivot slightly on the carriage to account for small errors in the concentricity of the record, and to actuate sensors to tell the motor when to move the carriage. From your description of the problem, it can be either electronic or mechanical.

First, determine if the arm moves freely along its entire path, using the manual control buttons. If it has any problem with this step, check the drive mechanism. My Sony PS-FL7 had this problem due to a stretched belt. You probably should clean and lubricate the carriage rod and bearing (silicone).

If the mechanical part is functioning smoothly, but the arm refuses to track, the problem is in the control circuit. Usually, this is a broken wire to a sensor. The sensor may be optical or mechanical but, in either case, it is on the carriage assembly. You can check the cable with an ohmmeter.

You can check the tracking subsystem as a whole by removing your stylus and "playing" an opaque paper "record." Start in the middle and move the arm to the end of its pivot range. The carriage should move to keep up. If it does not, check that the motor is at least trying to move (this requires the bottom to be off). If the motor does not move, and the sensor cable checked out, the problem may be with the actual sensors. If the sensor is optical, the lamp or LED may be defective. Unless the system has had a bad power surge or static zap, the ICs are probably not the problem.

Mike Beaver
Los Altos, CA
mrbeaver@netcom.com

ANSWER TO #39722 - MARCH 1977

The AD590 temperature sensor IC is available from Alltronics (http://www.alltronics.com or **408-943-9773**). You may also be able to adapt the circuit to use the more common LM334.

David DiGiacomo
San Francisco, CA
dd@adobe.com

ANSWER TO #39719 - MARCH 1997

You want to read information from a standard consumer credit card from a distance of 8 or 10 inches; to the best of my knowledge that isn't possible. The information on credit cards is recorded on the magnetic strip on the back of the card. This is recorded in a digital format, somewhat like the magnetic recording on a floppy disk. There isn't any way to "play back" that recording from a distance. The digital domains on the strip are very small — thousandths of an inch. To play them back, you need to pass the strip over a magnetic playback head with a gap that is roughly the same size. As the strip moves past the head gap, the alternating direction of the magnetized domains on the strip will generate a corresponding voltage across the head winding. To do this, the head must be in contact with, or a microscopic distance from, the magnetic strip. (As you know, the smallest spec of dust — even airborne smoke particles — will cause data errors with floppy disks.) Eight to ten inches just won't work!

Optical bar codes, of course, CAN be read from a distance because of the optical property of reflection. The scanner projects a small diameter laser beam at the bar code. As the beam scans across the code from one end to the other, the alternating black and white stripes reflect back a light and dark pattern to the optical sensor in the scanner. The squarewave output from the sensor contains the coded information. But the magnetic code on a credit card cannot be read by any such means using reflection.

There IS a security system which can read information from a credit-card size device from a distance of a foot or more. I've seen it used in parking garages; maybe this is the type of system you've seen. This card is NOT magnetic like a normal credit card; this system uses RF to do the job. The card is actually two or three times as thick as a normal credit card and contains a small loop antenna and some sophisticated electronic circuitry. The reader transmits an RF signal, which is picked up by the card's antenna and rectified to provide DC to run the card's electronics (so there's no battery on the card). The card's electronics then transmit a digitally coded signal (on a different RF frequency) which is picked up by a receiver in the reader.

Continued on page 112

Events CALENDAR

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

APRIL 1997

APRIL 4-5

AL - ALBERTVILLE - Hamfest. Albertville Recreation Center. Fri: 5pm-9pm, Sat: 8am-3pm. Buddy Smith 205-593-2516

APRIL 5

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CO - LONGMONT - Hamfest. Longmont ARC. Jim Deeming 303-651-7764
CT - WATERFORD - Ham Radio Auction. Waterford Senior Center. Rte. 85. Tony 860-859-0162
FL - MIAMI - Tailgate Swap Meet. Parking lot Univ. of Miami, main campus. 8am-noon. Walt 305-895-0398
FL - WEST PALM BEACH - Computer Show & Sale. Palm Beach Airport Hilton, 150 Australian Ave. Narisaam 770-663-0983
IN - COLUMBUS - Hamfest. Bartholomew Co. 4-H Fairgrounds, Community Bldg. 8am-2pm. Marion Winterberg 812-342-4670
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center, 3655 E. Raymond St. 10am-4pm. 317-299-8827
MA - HYANNIS - Computer Show. Tara Hyannis Hotel, West-End Circle. 10am-3:30pm. Northern Computer Shows 508-744-8440
MA - WEST SPRINGFIELD - Computer Show. Eastern States Exposition. 9:30am-4pm. MarketPro 201-825-2229
MI - FLINT - Super Computer Sales. IMA Arena. 10am-3pm. Computers & You 313-283-1754
NH - TWIN MOUNTAIN - North Country ARC & LARK Fleamarket. Town Hall. 8am-3pm. Richard Force 603-788-4428
NJ - TRENTON - Computer Show. Trenton State College. MarketPro 301-984-0880
NY - SYRACUSE - Computer Show. On Center. 9:30am-4pm. MarketPro 201-825-2229
OK - LAWTON - ARRL Hamfest. Lawton Ft. Sill ARC. Bob Morford 405-353-8074
VA - MANASSAS - Computer Show. Manassas Fairgrounds. MarketPro 301-984-0880

APRIL 5-6

CA - VALLEJO - Computer Show & Sale. Solano Co. Fgrds. MarketPro 415-456-6730
FL - CLEARWATER - Computer Show. Harborview Center. MarketPro 301-984-0880
IN - FORT WAYNE - Computer Show. Memorial Coliseum (1/3 of Expo III). MarketPro 301-984-0880
MD - TIMONIUM - ARRL State Convention/Amateur, Computer and Electronic Flea Market, Show & Sale. Timonium Fairgrounds. Sat: 8am-5pm, Sun: 8am-4pm. 410-HAM-FEST
PA - GREENSBURG - Computer Show. Greengate Expo Center. MarketPro 301-984-0880

APRIL 6

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
DE - DOVER - Computer Show. DE State Univ. MarketPro 301-984-0880
FL - FORT LAUDERDALE - Computer Show & Sale. Holiday Inn West, 5100 N. State Rd. 7. Narisaam 770-663-0983
IN - FORT WAYNE - Computer Fair. Ramada Hotel, off I-69 Exit 105A. 10am-3pm. AGI 317-299-8827
MA - FRAMINGHAM - Ham Radio/Electronics Flea Market. Framingham High School off Rte. 126. 9am-1pm. Martin Bayes 508-435-0564
MA - TAUNTON - Computer Show. Taunton Holiday Inn. 10am-3:30pm. Northern Computer Shows 508-744-8440
MD - UPPER MARLBORO - Computer Show. The Show Place Arena. MarketPro 301-984-0880
MI - GRAND RAPIDS - Super Computer Sales. Crowne Plaza, 5700 28th St. SE. 10am-4pm. Computers & You 313-283-1754
NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229
NY - UTICA - Computer Show. Utica Memorial Aud. 9:30am-4pm. MarketPro 201-825-2229
RI - WEST WARWICK - Computer Show. Civic Center. 9:30am-4pm. MarketPro 201-825-2229

APRIL 11-12

MS - TUPELO - Hamfest & Computer Expo. MS Bldg., Tupelo Furniture Market Complex, Coley Rd. Fri: 6-9pm, Sat: 8am-5pm. Jack Ellis 601-842-7255

APRIL 12

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - SAN FRANCISCO - Robert Austin Computer Show. Cow Palace. 1-800-346-0100
KY - BOWLING GREEN - ARRL Hamfest. Leon Garrett 502-842-5307
MD - NEW CARROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880
ME - PORTLAND - Electronics Flea Market/Hamfest. Univ. of Southern ME, Sullivan Gym, Falmouth St. 8am-1pm. Marty Feeney 207-839-5072
MN - ROCHESTER - ARRL Hamfest. Rochester ARC. John Scott 507-732-5091
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
PA - FREDERICKSBURG - ARRL Hamfest. Mark Schropp 717-754-7700
UT - OGDEN - State Convention. Kathy Rudnicki 801-547-9218

APRIL 12-13

CA - VENTURA - Computer Show & Sale. Ventura Fairgrounds. MarketPro 415-456-6730
FL - FORT LAUDERDALE - Computer Show. War Memorial Auditorium. MarketPro 301-984-0880
GA - ATLANTA - Ham & Computer Festival. Tim Vogle 770-593-3962
GA - KENNESAW - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827
GA - NORCROSS - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880
KY - LOUISVILLE - Computer Show. Commonwealth Conv. Center, Hall B. MarketPro 301-984-0880
MI - DEARBORN - Super Computer Sales. Dearborn Civic Center, 15801 Michigan Ave. 10am-4pm. Computers & You 313-283-1754
NC - WINSTON-SALEM - Computer Show. Lawrence Joel Veterans Memorial. 9:30am-4pm. MarketPro 201-825-2229
NJ - SECAUCUS - Computer Show. Meadowlands Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
OH - CINCINNATI - Computer Show. Cincinnati Gardens. MarketPro 301-984-0880
PA - KING OF PRUSSIA - Computer Show. Valley Forge Conv. Center. MarketPro 301-984-0880
TN - NASHVILLE - Computer Fair. State Fairgrounds. Sat: 10am-5pm, Sun: 10am-3pm. Trade Show Productions 937-263-3378

APRIL 13

CA - SAN DIEGO - Computer Show & Sale. Scottish Rite Center. 10am-5pm. MarketPro 415-456-6730
CA - SANTA ROSA - Computer Show & Sale. Sonoma Co. Fairgrounds. 10am-5pm. MarketPro 415-456-6730
CT - SOUTHINGTON - Electronic Flea Market. Southington High School. 9am-1pm Chet 860-628-9346
IL - CHICAGO - Ham Auction. DeVry Inst. of Tech., 3300 N. Campbell Ave. 773-545-3622
NC - RALEIGH - NCARS 25th Hamfest & Computer Fair. Jim Graham Bldg., NCS Fairgrounds. 8am-4pm. Ronnie Reams 919-217-0263
NH - MANCHESTER - Computer Show. Center of NH Complex. 10am-3:30pm. Northern Computer Shows 508-744-8440
NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229
OH - CIRCLEVILLE - Hamfest/Computer Show. Pickaway Co. Fairgrounds Coliseum. Roy Ulko 614-477-8310
PA - BLOOMSBURG - ARRL Hamfest. Dave Schack 717-752-6851
VA - ANNANDALE - Computer Show. Northern Virginia Community College. MarketPro 301-984-0880
WI - MADISON - Swapfest. Dan Co. Expo Center Exhibition Hall. MARA 608-245-8890

APRIL 18-19-20

IL - QUAD CITY- Computer Show. QCCA Expo Center. Blue Star Productions 612-788-1901

APRIL 19

CANADA - ONTARIO - PICKERING - Hamfest. Ian Smith 905-427-4873
CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
GA - WARNER ROBINS - ARRL Hamfest. Charles Armstrong AE4VA, 912-328-0935
ID - LEWISTON - ARRL Hamfest. Doug Graham KB7RKY, 208-743-2163. E-Mail: yvette@clearwater.net
KS - COLBY - Swapfest. National Guard Armory. 8am-2pm. Jim Robison KG0PI, 913-462-6436
MI - LIVONIA - Super Computer Sales. Elks Lodge Hall, 31117 Plymouth Rd. 10am-3pm. Computers & You 313-283-1754
MN - FERGUS FALLS - Hamfest. Otter Tail Co. Fairgrounds, Hockey Arena, Hwy. 82 S. 8am-3pm. Stan Olson W0LUP, 218-736-4980
MO - JOPLIN - ARRL Hamfest. Joplin ARC. Andy Gabbert 417-673-8371
NC - GASTONIA - ARRL Hamfest. Joey Ferguson W4JF, 803-372-4373. E-Mail: kf4r@cetlink.net
NH - NASHUA - Electronic Fleamart. Res. Ctr. Church. 617-923-2665
NH - SEABROOK - Computer Show. Seabrook Greyhound Park. 10am-3:30pm. Northern Computer Shows 508-744-8440
PA - LEBANON - Computer Show. Lebanon Valley Expo Center. MarketPro 301-984-0880
TX - BELTON - Hamfest. Mike LeFan WA5EQQ, 817-773-3590. http://www.tarc.org
VA - GOOCHLAND - SMART Swapfest '97. County Fairgrounds, Rte. 522 & 632. 8am-3pm. Buddy Travis KA4NNN, 540-894-0406
VA - HAMPTON - Computer Show. Hampton Coliseum. MarketPro 301-984-0880

APRIL 19-20

AL - BIRMINGHAM - ARRL Hamfest. Ellis Dobbins K4LI, 205-798-3459. http://www.bro.net/barc
FL - TAMPA - Computer Show. State Fairgrounds. MarketPro 301-984-0880
IN - INDIANAPOLIS - Computer Show. State Fairgrounds. MarketPro 301-984-0880
KY - LOUISVILLE - Computer Fair. KY Fair & Expo Center. Sat: 10am-5pm, Sun: 10am-3pm. Trade Show Productions 937-263-3378
MD - GAITHERSBURG - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229
PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart, West Wing. MarketPro 301-984-0880

APRIL 20

CA - LANCASTER - Computer Show & Sale. Antelope Valley Fairgrounds. 10am-5pm. MarketPro 415-456-6730
CA - STOCKTON - Computer Show & Sale. Civic Auditorium. 10am-5pm. MarketPro 415-456-6730
CT - HARTFORD - Robotics Contest. Trinity College. Jake Mendelssohn 860-233-2379
DE - NEW CASTLE - State Convention & Hamfest. Nur Temple, Rte. 13. 9am-3pm. Hal Frantz 302-798-7270
MA - CAMBRIDGE - Hamfest. MIT RS & Harvard Wireless Club. Nick Alternburnd 617-253-3776
ME - PORTLAND - Computer Show. Verillo's Conv. Center, Howard Johnson's Motor Lodge. 10am-3:30pm. Northern Computer Shows 508-744-8440
MI - GROSSE POINTE WOODS - ARRL Hamfest. Steve Semrau KA8UHG, 810-296-5874. E-Mail: semara@amsat.org
MI - MADISON HEIGHTS - Super Computer Sales. UF&CW Hall, 876 Horace Brown Dr. 10am-4pm. Computers & You 313-283-1754
MI - ST. JOSEPH - ARRL Hamfest. Al Rea W8LRM, 616-983-6052
OH - CANFIELD - Hamfest. Canfield Fairgrounds, State Rte. 46. 8am-3pm. Don Stoddard 330-793-7072
PA - WILKES BARRE - Computer Show. Genetti's Best Western. MarketPro 301-984-0880
VA - RICHMOND - Computer Show. The Showplace, Showplace Bldg. MarketPro 301-984-0880

APRIL 25-26

AR - LITTLE ROCK - Hamfest. Little Rock Expo Center, Exit 126, I-30. Fri: 4pm-9pm, Sat: 8am-5pm. Jim Blackmon 501-246-7833
FL - GAINESVILLE - Hamfest & Computer Show. Alachua Co. Fairgrounds, SR-24 & SR-222. Larry Walker WB4VAU, 352-377-0683
NE - SOUTH SIOUX CITY - Iowa State Convention. Mike Nickolaus 402-494-6070

APRIL 25-26-27

MN - ST. PAUL - Computer Show. State Fair Grounds. Blue Star Productions 612-788-1901

APRIL 26

CANADA - ONTARIO - PICKERING - Hamfest. Ian Smith VE3ITG 905-427-4873 http://www.globalserve.net/~ismith
CA - BAKERSFIELD - Computer Show & Sale. Kern Co. Fairgrounds. MarketPro 415-456-6730
CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
CA - GLEN ELLEN - ARRL Hamfest. McDougal Hall, Sonoma Developmental Center, 15000 Arnold Dr. 8am-1pm. Darrel 707-996-4494
CO - DENVER - Metro Computer Show & Swap Meet. 2950 W. 72nd Ave., Westminster. Reputable Systems 303-444-2664
FL - ORLANDO - Computer Show. Orlando Centroplex. MarketPro 301-984-0880
MI - TAYLOR - Super Computer Sales. Democratic Club Hall, 23400 Wick Rd. 10am-3pm. Computers & You 313-283-1754
NJ - HARMONY - Cherryville Hamfest. Warren Co. Farmers Fairground. 8am-2pm. Charlie Kosman 908-788-4080
NM - ALBUQUERQUE - Hamfest. Chuck Opdyke KC5GA, 505-858-0306. E-Mail: n5oqj@juno.com
NY - WHITE PLAINS - Computer Show. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229
OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
OR - ROSEBURG - Hamfest & Computer Show. DC Fairgrounds. 9am-3pm. Ed Pahl 541-673-1310
RI - WEST GREENWICH - Hamfest. Bill May WA1WM, 401-822-0520
VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880
WA - VANCOUVER - Hamfest. Wayne Schuler AI9Q, 360-896-8909. E-Mail: waynes@pacifier.com
WV - FLATWOODS - ARRL Hamfest. Ed Messenger N8OYY, 304-462-5312. E-Mail: messengr@wvlc.wvnet.edu

APRIL 26-27

CA - SACRAMENTO - Computer Show & Sale. Cal Expo. MarketPro 415-456-6730
DE - NEWARK - Computer Show. Univ. of DE. MarketPro 301-984-0880
FL - SARASOTA - Computer Show. Municipal Auditorium. Frank Cox 941-954-0202

Events CALENDAR

IL - ELGIN - Chicago CoCoFEST. Holiday Inn, 345 W. River Rd. 10am-5pm. Tony Podraza 847-428-3576
NC - CHARLOTTE - Computer Show. Charlotte Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229
NJ - PARSIPPANY - Computer Show. Parsippany Hilton. 9:30am-4pm. MarketPro 201-825-2229
NJ - WEST WINDSOR - Trenton Computer Festival & Flea Market. Mercer Co. Community College. Sat: 9am-6pm, Sun: 9am-4pm. 609-409-0690. E-Mail general information: tcf.info@edit.com Web: http://www.dorsai.org/fair

APRIL 27

CA - OXNARD - Computer Show & Sale. Community Center. 10am-5pm. MarketPro 415-456-6730
FL - MELBOURNE - Computer Show. Melbourne Auditorium. MarketPro 301-984-0880
IL - ARTHUR - MARK Hamfest. Moultrie/Douglas Co. Fairgrounds. 8am-1pm. Ralph Zancha 217-873-5287
IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300
MA - WESTPORT - Computer Show. Whites of Westport. 10am-3:30pm. Northern Computer Shows 508-744-8440
MN - SHAKOPEE - Hobby Electronics Show. Canterbury Park. 8am-1pm. Tim 612-474-9232
NY - FISHKILL - Mt. Beacon Hamfest. John Jay High School. 8am-1pm. Ken Akasofu 914-485-9617
NY - OLD WESTBURY - Computer Show. SUNY Old Westbury. 9:30am-4pm. MarketPro 201-825-2229
NY - POUGHKEEPSIE - Eastern NY Section Convention. Ken Akasofu KL7JCQ, 914-485-9617. http://www1.mhv.net/~fritzing
OH - ATHENS - Hamfest. Athens Recreation Center, 733 E. State St. 8am-3pm. John Cornwell NC8V, 614-593-6474. E-Mail: ab075@seorf.ohiou.edu
OH - COLUMBUS - Computer Show. Ohio Expo Center. MarketPro 301-984-0880
OH - LANCASTER - Hamfest. Betty J. Reilly N8POZ, 513-574-1653
VA - FREDERICKSBURG - Computer Show. Fredericksburg Armory. MarketPro 301-984-0880
VA - HARRISONBURG - Computer Show. Rockingham Center. MarketPro 301-984-0880

MAY 1997

MAY 2-3

CA - FRESNO - ARRL Hamfest. John Pritchett WA6JWK, 209-222-6793
LA - BATON ROUGE - ARRL Hamfest. Herb Ramey KB5AQ, 504-654-6087 or 1-800-256-FEST

MAY 2-3-4

WI - WAUSAU - Computer Show. Wausau/Marathon Co. Park. Blue Star Productions 612-788-1901

MAY 3

AZ - SIERRA VISTA - Hamfest. Ron Slominski KC7QXJ, 520-378-3018. E-Mail: slominsk@Tron.Cochise.cc.az.us
CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
IN - SOUTH BEND - Computer Show. Century Center. MarketPro 301-984-0880
KY - OWENSBORO - ARRL Hamfest. George Stokes KD4CKT, 502-926-4451
MA - WEST SPRINGFIELD - Computer Show. Eastern States Exposition. 9:30am-4pm. MarketPro 201-825-2229
MD - NEW CARROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880
MI - CADILLAC - Hamfest. Cadillac Middle School. 8am-2pm. Dan KE8KU 616-775-0998
MO - KANSAS CITY - ARRL Hamfest. Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@juno.com
NY - OWEGO - ARRL Hamfest. Dick Wilson KB2LDY, 607-648-2748
OR - KLAMATH FALLS - ARRL Hamfest. Tom Hamilton WD6EAW, 541-883-2736. E-Mail: wjonesjr@cdsnet.net
WI - CEDARBURG - ARRL Hamfest. Gabe Chido N9QQA, 414-377-2784
WV - MIDDLEBOURNE - Hamfest. Ray Gorrell KA8GOH, 304-758-2832

MAY 3-4

CA - VALLEJO - Computer Show & Sale. Solano Co. Fgrds. MarketPro 415-456-6730
FL - MIAMI - Computer Show. Dade Co. Fairgrounds. MarketPro 301-984-0880
PA - HARRISBURG - Computer Show. Farm Show Complex, East Bldg. MarketPro 301-984-0880
TX - ABILENE - ARRL West TX Conv. & Hamfest. Abilene Civic Center. Sat: 8am-5pm, Sun: 9am-2pm. Peg Richard 915-672-8889
VA - NORFOLK - Computer Show. Norfolk Scope. MarketPro 301-984-0880

MAY 4

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
CA - SAN DIEGO - Computer Show & Sale. Scottish Rite Center. 10am-5pm. MarketPro 415-456-6730
IL - DECATUR - ARRL Hamfest. Doug Ellison N9ULL, 217-423-1013
IL - SANDWICH - Hamfest. Sandwich Fairgrounds. 8am-1pm. Bob Yurs 815-895-3219
IN - BLOOMINGTON - Hamfest. Monroe Co. Fairgrounds. 8am-3pm. John Anderson 812-332-3734 after 5pm
IN - FORT WAYNE - Computer Show. Memorial Coliseum, 1/2 of Exhibit Hall. MarketPro 301-984-0880
IN - NOBLESVILLE - AGI Computer Fair. Hamilton Co. 4-H Grounds (off Pleasant St. on SR-37).10am-3pm. 317-299-8827
MD - FREDERICK - Computer Show. Frederick Fairgrounds, MarketPro 301-984-0880
MD - HAGERSTOWN - Hamfest & Computer Show. Hagerstown Junior College, Athletic, Recreation, & Community Center. ARA 301-791-3010
NH - PORTSMOUTH - Computer Show. Yoken's Conference Center. 10am-3:30pm. Northern Computer Shows 508-744-8440
NJ - FAIRFIELD - Computer Show. Fairfield Radisson. 9:30am-4pm. MarketPro 201-825-2229
NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229
NY - YONKERS - Electronic Flea Market. Lincoln High School. Otto 914-969-1053
PA - WRIGHTSTOWN - Hamfest. Middletown Grange Fairgrounds, Penns Park Rd. John D'Onofrio 215-675-9165
VA - ROANOKE - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880
WV - RIPLEY - ARRL Hamfest. Joe Pickens N8UXE, 304-372-5648

MAY 9-10

NH - ROCHESTER - HOSSTRADERS Hamfest. Joe Demaso K1RQG, 207-469-3492. E-Mail: k1rqg@aol.com

MAY 9-10-11

IA - DES MOINES - Computer Show. State Fairgrounds. Blue Star Productions 612-788-1901

MAY 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
GA - STATESBORO - ARRL Hamfest. Ellie Waters WB4CJB, 912-653-4939. E-Mail: marshall@bulloch.com
ID - CALDWELL - ARRL Hamfest. Dan Gardner KB1WW, 208-893-4705. E-Mail: dgardner@micron.net
IL - PEOTONE - ARRL Hamfest. Willis Bowser K9IFO, 815-472-2079
MA - STURBRIDGE - Computer Show. Sturbridge Host Hotel. 10am-3:30pm. Northern Computer Shows 508-744-8440
OH - MEDINA - ARRL Hamfest. Clarence Miller WA8JLA, 330-725-4492
SC - GREENVILLE - ARRL Hamfest. Anderson Co. Fairgrounds, E. of Anderson on Hwy 29. 8am-5pm. Gene WB4ZBZ, 864-476-2609
SD - HURON - Amateur Electronics Swapfest. National Guard Armory, State Fairgrounds. 8am-3pm. Lloyd Timperley 605-352-7896 eves
WA - STANWOOD - ARRL Hamfest. Vic Henry N7KRE, 360-387-7705
WI - MANITOWOC - Hamfest & Computer Swapfest. County Expo Ctr., intersection of Hwys 42-151 & I-43 on Co. R. Red 414-684-9097 days, Glenn 414-684-7096 day or evening

MAY 10-11

FL - WEST PALM BEACH - Computer Show. South Florida Fairgrounds. MarketPro 301-984-0880
GA - KENNESAW - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827
MD - PIKESVILLE - Computer Show. Pikesville Armory. MarketPro 301-984-0880
NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229
OH - CINCINNATI - Computer Show. Cincinnati Gardens. MarketPro 301-984-0880
TN - NASHVILLE - Computer Show. State Fairgrounds, Exhibition Bldg. MarketPro 301-984-0880
VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880
VA - FLOYD - FAIRS Club Station N4USA, US5WE, BY1QH, 8R1WD & S21AM. Send QSL for certificate to FAIRS, POB 341, Floyd, VA 24091

MAY 15-16-17

CA - BAKERSFIELD - San Joaquin Valley Section Convention. Ed Harlander KO6DY, 805-589-4163. E-Mail: eharlander@aol.com

MAY 16

OH - DAYTON - Quarter Century Wireless Assoc. Banquet. Alex's Continental Restaurant. Robert Dingle, 1117 Big Hill Rd., Kettering, OH 45429-1201

MAY 16-17-18

OH - DAYTON - Hamvention '97. Hara Arena, Intersection, Shadow Springs Creek & Wolf Rd. Fri: 8am-6pm, Sat: 7am-5pm, Sun: 7am-4pm. 937-276-6930. E-Mail: info@hamvention.org

MAY 17

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CO - COLORADO SPRINGS - Hamfest. Dennis Major KB0SXC, 719-535-1160. E-Mail: dennis.major@mci.com
MA - TOPSFIELD - Computer Show. Topsfield Fairground. 10am-3:30pm. Northern Computer Shows 508-744-8440
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
PA - EPHRATA - ARRL Hamfest. William Kirkner N3PZA, 717-484-2102. E-Mail: N3PZA@ptd.net
PA - GREENGATE - Computer Show. Greensburg Mall Expo Center. MarketPro 301-984-0880
RI - FORESTDALE - Spring Auction & Flea Market. VFW Post 6342, Main St. (N. Smithfield). 8am-3pm. Rick Fairweather K1KYI, 401-725-7595 7-8pm
VA - ANNANDALE - Computer Show. Northern Virginia Community College. MarketPro 301-984-0880
VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0880

MAY 17-18

FL - ORLANDO - Computer Show. Central Florida Fairgrounds, Bldg. D & E. MarketPro 301-984-0880
GA - NORCROSS - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880
IN - INDIANAPOLIS - Computer Show. State Fairgrounds. MarketPro 301-984-0880
PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880
WA - SELAH - Washington State Convention. Dick Umberger N7HHU, 509-248-3580.

MAY 18

CA - CARMICHAEL - Hamfest. Bob Naylor AC6HF, 916-966-3654. http://www.ns.net/~NHRC
IA - MASON CITY - Hamfest. Douglas J. McMannes KB0JBF, 515-423-5064. E-Mail: mcmannes@willowtree.com
MA - CAMBRIDGE - Hamfest. MIT RS & Harvard Wireless Club. Nick Altenburnd 617-253-3776
MA - SWANSEA - Computer Show. Venus DeMilo. 10am-3:30pm. Northern Computer Shows 508-744-8440
MD - WEST FRIENDSHIP - Computer Show. Howard Co. Fairgrounds. MarketPro 301-984-0880
NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229
PA - ERIE - Computer Show. Erie Civic Center. MarketPro 301-984-0880

MAY 23-24

MS - PASCAGOULA - ARRL Hamfest. Pascagoula Civic Center, Jackson Co. Fairgrounds. Fri: 5pm-9pm, Sat: 8am-3pm. Charles F. Kimmerly 601-826-5811

MAY 24

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
NH - NASHUA - Computer Show. Sheraton Tara. Northern Computer Shows 508-744-8440

MAY 24-25

DE - NEWARK - Computer Show. Univ. of DE. MarketPro 301-984-0880
FL - TAMPA - Computer Show. State Fairgrounds. MarketPro 301-984-0880
KY - LOUISVILLE - Computer Show. Kentucky Fair & Expo Center. MarketPro 301-984-0880

Continued on page 86

MISC. ELECTRONICS FOR SALE *cont.*

NIGHT VISION kits. See our classified ad in Plans/Kits/Schematics. NENVIS 508-347-7238.

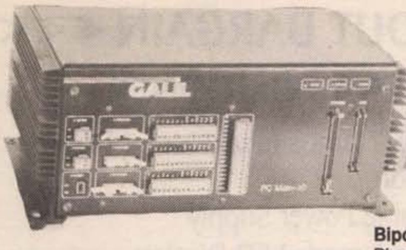
RAYMOND (SARATOGA) carousel basket conveyor: MD# GPHH/CD1028, used for order picking or assembly line. Has 20 10' carrier baskets, 11 shelves per basket (adjustable). 1,000 lb. capacity, manuals included. Used in good condition. Credit cards accepted! Pictures are available! ISE: 210-350-5555, FAX: 210-350-5574.

OPTICAL IMPULSE GENERATOR, TEK OIG-502. New, unused, complete documentation and accessories. 1996 cat. price $9,500, our price with warranty $1,750. 2 available. **SI-5010** programmable scanner as new $500. Psitech Plus 707-745-4804, Fax 707-747-5277.

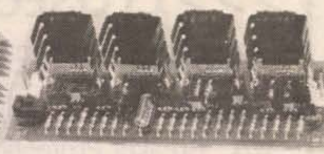
MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

MISC. ELECTRONICS WANTED

WANTED: TUBE HiFi, Tube theater/commercial amps, speakers etc. Corner speakers/coaxials/triaxials. Old guitars & guitar amps. Altec, McIntosh, Marantz, Western Electric, Scott, Fisher, Dynaco, Electrovoice, Jensen, Gibson, Fender, Vox etc. Sonny Goldson, 1413 Magnolia Ln., Midwest City, OK 73110. 405-737-3312. FAX 405-737-3355.



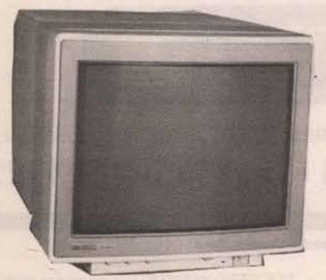
Galil 3-axis motion controller, DMC-600. Controls up to 500 oz.in. motors, receives feedback from incremental encoder controlled by your computer using your own parallel interface or a Galil controller........................**$300.00 postpaid**



Bipolar Swiching Amplifier Module. Bipolar refers to the fact that the output can be either positive or negative. This is a universal module that has just two inputs, on/off and +/-. Input voltage is 6-60 volts. Output is controlled by four power FETs in a bridge circuit, rated at 4 Amperes. Output is controlled by varying the "on" time. Use computer or analog circuit for control. Uses include: high power DC motor driver, Stepper driver (2 req'd), Audio amp, bipolar supply..............................**$14.75 Postpaid**

DC Motor with encoder. Japan Servo Co., Ltd. Gearhead DC Motor with HP encoder (HEDS-5600-C14). 24 VDC, 490 rpm at output shaft. Model DMEC60B6HF-112. 100 Watt output, much faster than steppers, Will drive lead screws on large machine like Bridgeport. See Stamp applications for how to use. ....**$35.00 postpaid**

Sony TV camera block. EVI-100. This is the camera block for Hi-Band camcorders, meaning the complete camera assembly, but no case. Some interconnection required, data supplied. 2/3 inch Vidicon with 420,000 picture elements, complementary mosaic filters. Includes 8:1 zoom lens, variable speed digital shutter to 1/10000 sec, TTL autofocus, auto white balance. Camera is controlled by its own 4-bit microprocessor.........**$249.00 Postpaid.**



Sony 17" Monitor. Originally used on HP workstation, it carries HP number 98789A. **For a Mac**, it can support 1024 x 832 if your Mac can, though most people prefer to use it at 832 x 624. Set up with a cable and Griffin Tech. Sync. Adapter...........**$225**
For an IBM. We recommend the combo with a Photon Torpedo graphics card & cable which will allow you to run many resolutions up to 1280 x 1024.............**$375**
Experimenters keep in mind that this is not a multisync monitor. Monitor only....... **$175**
20" Monitor.......................................**$500**

Dear Readers,

Just a reminder that if you are visiting Boston or live here, the MIT flea market begins in April, third Sunday of every month, at the Albany Street garage. Maybe your dream of finding an original Theremin or Nipkow disk TV will be fulfilled. We (my son Ronald has joined the firm) will be there with antiques and merchandise.

Dont forget, when you buy from V&M, no minimum order, no handling charge, most items postpaid. We don't use the credit card companies, so we don't have to increase prices to cover their take. To order, phone us on our toll free line, reserve it and send us a check or ship COD ($4.75 extra). Best wishes

Frank and Ron Fink.

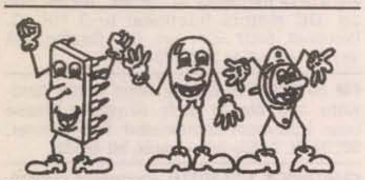
Vision and Motion Surplus
222 Pleasant Street
Marlboro, MA 01752

1-800-471-0747, 1-508-485-3561
GPS: 71 DEG. 33.82 MIN. WEST, 42 DEG. 20.87 MIN. NORTH
INTERNET SITE (STILL UNDER CONSTRUCTION):
www.shore.net/~vision/motion.html

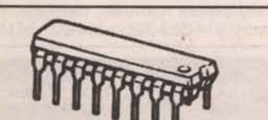
Color Matching Assembly. A wealth of Optical parts, any one of which is worth several times our price. Contains a bifurcated (Y shaped) clad fiber bundle, a Halogen lamp reflectorized light source in a machined heat dissipating housing, an infra-red rejecting filter, A 1 inch square EG&G silicon photodetector, 2 dichroic filters green and blue, lenses etc....................................**$65.00 postpaid**

Write in 170 on Reader Service Card.

I WANT it and I want it now. I want all of your SIMM memory. IBM, Mac, new, used, even defective. I want it all. Highest $ paid. Now selling memory. We can beat any printed price in Nuts & Volts. Call 1-800-4-MEMORY now! Voice/FAX.



WANTED: ELECTRONIC EXCESS "NEW" ICs, SEMICONDUCTORS, CAPACITORS, RELAYS, FANS, MOTORS. Late model TEST EQUIPMENT. Your NEW but excess electronics could be exactly what I'm buying. LYNN JOHNSON CONSULTING. 408-274-3559 V/FAX, lyntec@ccnet.com WEB http://www.angelfire.com/ca/ljehome/index.html



WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 310-494-4851 OR FAX 310-494-4913.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 513-847-2300 OR fax 513-847-2350.

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

WESTERN ELECTRIC WANTED: 1920s-1960s. Amplifiers, mixers, pre-amps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

WANTED: AVIONICS test equipment. IFR 1200Y3, 401L, 750B, 600A, Also Collins, King, Microline, Proline, Silver, Gold Crown Ground Power Units, Fox Carts. Avionics Plus, 28000 Airport Rd., Box A17, Hangar 97, Punta Gorda, FL 33982. 941-575-0138 P, 941-575-2361 F.

WANTED: SMALL quantities 10 to 20 ea. SK3054, SK3083, MJE6041, MJE6044. Daniel 707-468-5571.

WANTED: JENNINGS type J-1004 or J-1005 high voltage voltmeter. Equipment in all types of condition accepted. Youngson's, Inc., 6701 Melrose Ave., Louisville, KY 40216, 502-448-6228.

WANTED: OLD, new, used, Western Electric, RCA, Telefunken, GE, Jan, McIntosh, Marantz, Dyna, Fisher, JBL, EV, Tannoy, Jensen, EMT, Thorens, Fairchild, Altec, Westrex: **TUBES**, speakers, amps, etc. Maury Corb, 713-728-4343, FAX 713-723-1301.

WANTED: ELECTRICAL materials, Allen-Bradley, Agastat, Appleton, Crouse-hinds, T&B, Square D, Pyle National, Russel & Stoll, circuit breakers, fuses, connectors. Call Beiner Sales, 805-376-9044, FAX 805-376-8207.

EXCESS INVENTORY WANTED: Transistors, semiconductors, capacitors, PC boards, & diodes. We buy it all!! Contact: **SEMITECH, INC.**, 334 Cooper Road, Bldg. A., Berlin, NJ 08009. Phone 609-768-0030, FAX 609-768-5690.

WANTED: ELECTRON tubes, ICs, semiconductors. Astral, PO Box 707NV, Linden, NJ 07036. Call 1-800-666-8467.

Media-Tech
INTERNATIONAL

Your Source For All Your Cable TV Accessories!

And We Mean All!

DEALERS SPECIAL!
BUY A
MILLENIUM CONVERTER, ETC...

$89

Unassembled • Minimum order 50

FOR TECHNICAL SUPPORT CALL
(305) 234-9795

FOR ORDERS ONLY CALL... **1-800-673-6178**
SORRY...NO FLORIDA SALES

C.O.D. - MONEY ORDER ONLY

SAME DAY SHIPPING
90 DAY LIMITED WARRANTY
9am - 5 pm (Eastern) M-F

ATTENTION DEALERS

BUY DIRECT FROM THE WHOLESALER

GET THE BEST PRICES AND SERVICE

ALL UNITS ARE IN STOCK FOR IMMEDIATE SHIPMENT

CABLE CONVERTERS AND ACCESSORIES

CALL FOR PRICING ON ITEMS NOT LISTED

NEW CONVERTERS

	QTY 5	QTY 10	QTY 20	QTY 50+
CENTURY CT-3000	$68	$64	$60	CALL
COMMERCIAL-11	$75	$70	$65	CALL
PANASONIC-1003	$59	$55	$50	CALL
ZENTEK	$45	$40	$37	CALL

NOVAVISIONS

	QTY 5	QTY 10	QTY 20	QTY 50+
NV-5600	$205	$195	$185	CALL
NV-5700	$195	$185	$175	CALL
NV-5800	$195	$185	$175	CALL
NV-5750	$305	$295	$285	CALL

REFURBISHED CONVERTERS

REGAL • PANASONIC — *CALL FOR THIS MONTH'S SPECIALS*

1-800-800-0766

KIMTRONIX

30 day money back guarantee. All shipping and handling at customers expense. Anyone implying theft of cable service will be denied sale. NO FLORIDA SALES.

WE WILL MEET OR BEAT ALL COMPETITOR'S PRICES IN THIS MAGAZINE

KIM-8

Write in 116 on Reader Service Card.

>>> CLOSEOUT BARGAIN <<<

SAMSUNG ANTENNA POSITIONER

- 36 VDC, 3 Amps (typ)/7 Amps (peak) Motor Power w/C. Breaker Protection
- 110/220 VAC Switchable Power Supply
- Clear and Bright Alphanumeric LED Display
- Interface with Samsung Satellite Receiver and others

ONLY $20.00. We accept offers.

(Parts value of this unit is $57.00/3,500 pcs. available.)

Topp Inc., 8280 N.W. 27th St. #506, Miami, FL 33122 • Attn: Mr. Israel Perez, Jr.

Phone: (305) 477-1414 • Fax: (305) 477-1122

Write in 77 on Reader Service Card.

WANTED: BALANCING machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

HIGHEST PRICES PAID FOR WESTERN ELECTRIC TUBES, EQUIPMENT, AND LITERATURE. Other tubes wanted: 2A3, 5AR4/GZ34, 6CA7/EL34, 6L6GC, 10, 12AX7/ECC83, 45, 50, KT66, KT77, KT88, 211/VT-4C, 845, 5691, 5692, 6550, etc. Don Singerhouse, PO Box 321, New Richmond, WI 54017. Phone/Fax: 715-246-3899.

MICROABRASIVE BLASTERS (Comco, SS White, MPM, etc.), work chambers, airdryers, dust collectors and boom-stand stereo, zoom binocular microscopes wanted for resale. Please send details, descriptions or photos to Edward Hennessey, 2719 Tyler St., Long Beach, CA 90810.

TESTERS WANTED: Immediate offers made for Ultrasonic, Magnetic Particle, Eddy Current, X-Ray and Borescopes, 24hrs. Leave detailed message with make/model. 1-800-530-3371.

MICROWAVE MIKE, the RF Plumber, needs waveguide, fixed and transportable microwave radios, and related hardware. Fax your available inventory to 609-875-7577 or Call 609-875-1189.

WANTED: X-BAND radar & microwave equip., WWII-1960. Civilian, military. Working or not. Parts TMs etc. SHF, Box 10215, Pittsburgh, PA 15232.

WANTED: TUBES, radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Cranbury, NJ 08512-4212. Phone: 609-395-1116, FAX 609-395-1117.

WANT USED or surplus DC motor controls or adjustable frequency AC drives, 1/2 HP and up. DC motors fractional to 3 HP. C. Woodruff, 5507 55th Ave. So., Seattle, WA 98118. Voice/Fax 206-723-8487.

FM STOCK RECEIVER. Want to buy hardware, info, etc. to study. Anything! Please help. Info most appreciated. Bob Fenner, 30737 W. 7 Mile Rd., Livonia, MI 48152.

CHADWICK HELMUTH equipment wanted. Spectrum analyzers & peripherals. Also, ATI, Daniels, and Kearney cable gauge & test tools (for wire rope control cables). Contact Andrew Smith with model numbers, condition & best price. AMSL, Vermont. Ph. 802-254-9459, FAX 802-257-4862.

WANTED: LATE MODEL TEST EQUIPMENT (Tektronix, HP, Fluke). Also we buy test equipment manuals, catalogs. Pepper Systems, 214-353-0257; 214-902-9511 FAX.

CA1000 CELLULAR ANALYZER

- Easy to use AMPS reader
- Full ESN, SCM, and MIN display
- Dialed number display
- Auto tunes to control channel
- Internal DTMF decoder
- Reverse voice message decoding
- Stores up to 99 records internally
- Date and time stamp
- Continuous RSSI
- Compact handheld design
- Works with the local cell site
- NiCds with built-in charger
- Keypad adjustable gain
- Password access
- 1 year limited warranty
- Surveillance model available
- See the manual at our website

$1495

AZTEC RESEARCH

Sales:(909) 678-8357 www.aztecresearch.com

Fax:(909) 678-6232 email: aztec@ez2.net

Sales limited to cellular related businesses. FedEx C.O.D. certified check.

Write in 54 on Reader Service Card.

CUNARD ASSOCIATES

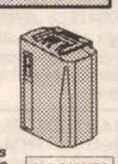
R D 6 Box 104, BEDFORD, PA 15522

TEL / FAX 814 623 7000

THE POWER PRO

IF YOU NEED NEW BATTERIES FOR YOUR ELECTRONIC EQUIPMENT DON'T PITCH EM' .... SEND THEM TO US FOR REBUILDING !

- WE INSTALL NEW NI-CAD BATTERIES INTO YOUR ORIGINAL CASE
- WE IMPROVE CAPACITY TO BETTER THAN ORIGINAL
- WE FIX WHAT CAN'T BE FOUND. (OR AFFORDED)
- WE PROVIDE QUICK SERVICE. / EXTENDED LIFE FOR OLDER EQUIPMENT
- WE PROVIDE FREE QUOTES. / FREE RETURN IF QUOTE IS REFUSED.
- WE PROPERLY DISPOSE OF YOUR OLD CELLS BY RECYCLING.
- WE GIVE YOU A 12 MONTH WARRANTY.
- WE WILL BE HERE WHEN YOU NEED US / 10 YEARS IN BUSINESS.
- WE SAVE YOU **** MONEY **** !!!!!
- NO JOB IS TOO LARGE OR TOO SMALL .... WE OFFER VOLUME DISCOUNTS TO LAW ENFORCEMENT / COMPANIES / FIRE DEPARTMENTS / UNIVERSITIES



ALL MAKES & MODELS

FOR MORE INFORMATION ABOUT YOUR PARTICULAR NEEDS, WE CAN BE CONTACTED VIA PHONE OR FAX AT (814) 623-7000 OR VIA E-MAIL TO: ZAPPEM @ AOL.COM OR SEND YOUR PACKS FOR QUOTATION VIA UPS OR PRIORITY MAIL TO ADDRESS ABOVE.

GENERAL ELECTRIC
MPD/PLS - MPR/MPS/MPX
19A704850P(1200mAH) $ 34.95
19A704860P(1800mAH) $ 39.95
PL19D429763(777)G1/3 $ 37.95

MAXON SA-1155 $ 39.95

MOTOROLA
P200/HT600/MT1000
NTN5521/4585/4824/5414 $ 37.95

MIDLAND
70-B32 / 70-B36 $ 39.95
70-B10 / B16 / B19 / B21 $ 39.95

STANDARD
CNB111/HWA110 $ 29.95
CNB120/HWA120 $ 34.95
CNB121/152/153 $ 39.95

UNIDEN
APX650 $ 34.95
APX1100/1200 $ 39.95
BP100/200/205 $ 19.95

ICOM
BP2 / BP3 /BP22 $ 18.95
BP5 / BP23 / 24 $ 24.95
BP7 / CM7/ BP8 $ 34.95

BENDIX KING
KR105/LAA125 $ 34.95

KENWOOD
PB2 / KNB3 $ 29.95
PB21/21H $ 14.95
PB25/H/26 $ 24.95

YAESU
FNB3/4//12/27 $ 32.95
FNB11/14/16/26$ 32.95
FNB17/25 $ 23.95

COMPUTERS
SEND PACK FOR QUOTE

BATTERY REBUILD SERVICE

MANY OTHERS AVAILABLE WRITE OR CALL

FREE CATALOG

ADD $ 4.50 SHIPPING & HANDLING PER ORDER

Master Card — VISA

Write in 166 on Reader Service Card.

BBS & ONLINE SERVICES

VISIT DON Lancaster's **GURU'S LAIR** website at **http://www.tinaja.com** PICs, pseudoscience, PostScript, patents, Tinaja quests, flutterwumpers, book-on-demand, magic sinewaves, money machines, Navicubes, tramways, wavelets, and Webmastering. Online reprints, consultants net, forums, annotated hot links, surplus bargains, great heaping bunches more.

SHARE REPAIR. E-Mail tech support for TV-VCR technicians. For information, E-Mail: rhett@dump.com

Closing Date
For Next Issue – April 10th

Dealing With 60 Hz Interference

Open Channel

by Joseph J. Carr
K4IPV

Over the past several decades, I've seen a lot of situations where 60 Hz interference disrupted all manner of circuits and instruments. It's basically a pain. The best solution, by far, is to prevent it from occurring. The usual methods involve shielding, or using a location that is free of 60 Hz fields. Lots of luck! Have you noticed those lights you are using to read this article? Unless you are on battery power, they are powered by 60 Hz alternating current (AC), or, if certain other countries than USA and Canada, 50 Hz AC.

A practical example arose when I was employed as an electronics technician (later as an engineer after I got my degree) at George Washington University Medical Center in Washington, DC. A physiologist was using a Wheatstone Bridge transducer to measure the contractions of some muscle or another.

The output of the sensor was very tiny. Its sensitivity factor was 5 µV/V/gram-force. With a six-volt battery, and gram-forces between 0.5 and 2, the output of the contraction pulses were from 15 µV to 60 µV. The bridge has a differential output (see last month's column), so it had to be processed in a differential amplifier.

Figure 1 shows the system used. The two sensor output wires were passed to a very long (about 12 feet) shielded two-wire cable, to a differential input on a strip-chart recorder (shown here as a differential amplifier). Unfortunately, the differential input was not truly differential. It was (like an oscilloscope) a two-channel device ("A" and "B" channels) that permitted an "A-B" input to function as pseudo-differential.

Even though the cable was shielded, the slight difference in the input amplifiers produced a common mode voltage that was seen as a valid input signal by the recorder. The 60 Hz fields radiated by the building power wiring induced 60 Hz signals into the sensor circuit. And with the tiny input signals, any 60 Hz at all was fatal. The scientist's tracings were corrupted with 60 Hz interference.

My first solution was to tell him to buy a differential amplifier plug-in for the recorder. Wrong answer! It seems that research grants for junior scientists are not all that generous. He simply didn't have the money to buy the correct amplifier. So I decided to build a differential amplifier at the sensor end of the cable. Figure 2 shows the resultant system. A gain-of-100 DC differential amplifier, using a CA-3240 operational amplifier, was built and installed right at the sensor. A single-conductor coaxial cable was run to one of the single-ended amplifier inputs of the recorder (eliminating the A-B pseudo-differential problem). The 60 Hz completely disappeared.

Figure 3 shows the actual device. The Grass FT-3 strain gauge sensor had a Cannon connector on it. I obtained the mate and mounted it on a Pomona box that contained the amplifier. A seven-pin Amphenol 126-series connector on the other end carried DC and grounds (one each for DC and signal) to the box, and carried signal back to the recorder. Cost? About $25.00 in 1975 bucks.

One humorous aside. I met the scientist a day or so later and he asked me for a written "technical description" of the project. Okay, so I sent him a couple paragraphs. He then said he had something on the order of 5 to 10 pages on the project. So I wrote a piece (about the length of a magazine article) that started with the theory of op-amps and ended in my two original paragraphs. About a year later he handed me 50 reprint copies of "our article." It seems that he had submitted my words along with about as many of his own to a physiology journal "tech notes" section. A bit shocked, I told him that any second semester electronics technology student at the local community college could do the same. He replied: "Yes, but a physiologist couldn't ... and would have to pay $975.00 for the correct plug-in amplifier."

Unfortunately, it's not always possible to prevent 60 Hz from occurring. In that event, we need to find a solution involving filtering out the 60 Hz stuff. If the input signal permits, then a high-pass or low-pass filter can be used. Any signal has harmonics, and these must fall within the bandpass of the filter. For very slow signals — with a maximum frequency content of 20 Hz or less — a low-pass filter will sufficiently attenuate the 60 Hz signals. Similarly, if the signal frequencies are much higher than 60 Hz, then a high-pass unit will be needed.

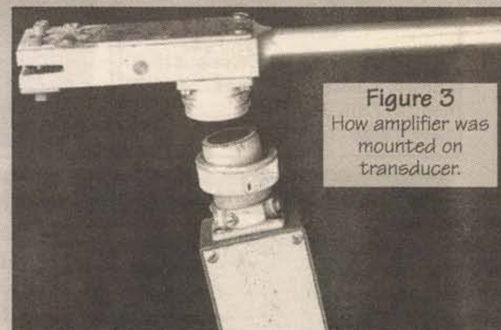


Figure 3
How amplifier was mounted on transducer.

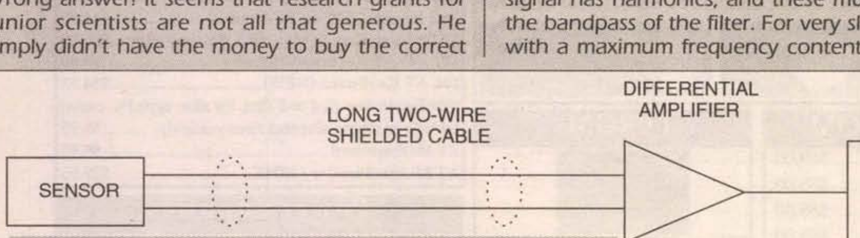


Figure 1
Original configuration of sensor and amplifier was sensitive to hum.

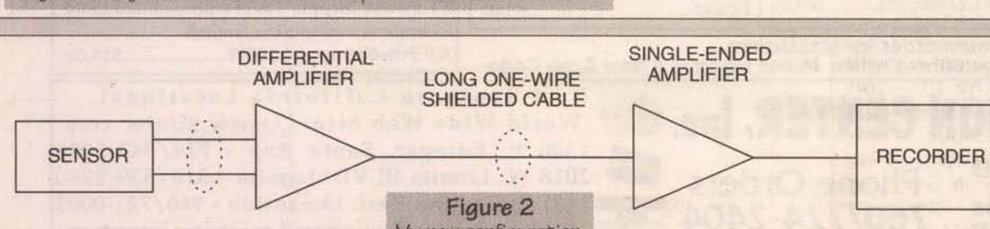


Figure 2
My new configuration.

Notch Filters

The usual solution to unwanted in-band frequencies is the notch filter. The frequency response of a notch filter is shown in Figure 4. These filters are similar to another class, i.e., bandstop filters, but the band of rejection is very narrow around the center frequency (F_C). The bandwidth (BW) of these filters is the difference between the frequencies at the two -6 dB points, when the out-of-notch response is the reference 0 dB point. These frequencies are F_L and F_H, so the bandwidth is $F_H - F_L$.

The "sharpness" of the notch filter is a measure of the narrowness of the bandwidth, and is specified by the "Q" of the filter. The Q is defined as the ratio of the center frequency F_C to bandwidth:

$$Q = \frac{F_c}{BW} \qquad (1)$$

For example, a notch filter that is centered on 60 Hz, and has -6 dB points of 58 and 62 Hz (4 Hz bandwidth) has a Q of 60/4 or 15.

The notch filter does not remove the entire offending signal, but rather suppresses it by a large amount. The notch depth (see again Figure 4) defines the degree of suppression, and is defined by the ratio of the gain of the circuit at an out-of-notch frequency (e.g., F_{ob}) to the gain at the notch frequency. Assuming equal input signal levels at both frequencies (which has to be checked, most signal generators have variable output levels with changes of frequency!), the notch depth can be calculated from the output voltages of the filter at the two different frequencies:

$$Notch\ Depth = 20\ \mathrm{LOG}\left(\frac{V_{fc}}{V_{ob}}\right) \qquad (2)$$

Twin-Tee Notch Filter Networks

One of the most popular forms of notch

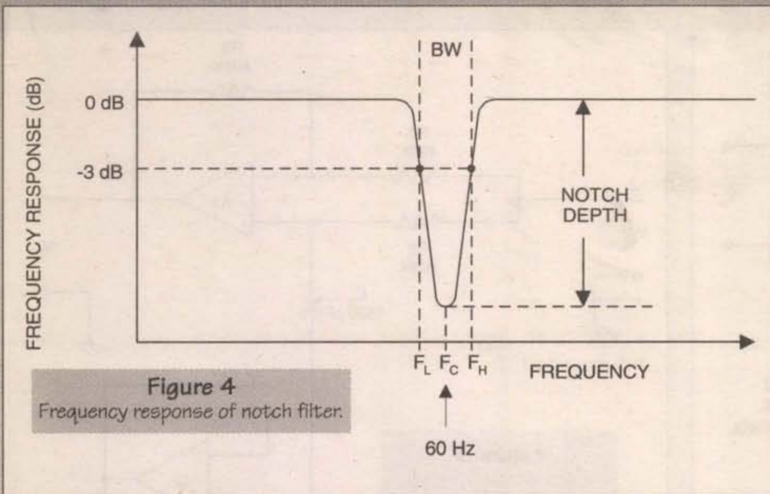


Figure 4
Frequency response of notch filter.

filter is the twin-tee filter network, shown in Figure 5. It consists of two T-networks, consisting of C1/C3/R2 and R1/R3/C2. Notch depths of -30 to -50 dB are relatively easy to obtain with the twin-tee, assuming proper circuit design and component selection. Very good matching and selection of parts makes it possible to achieve -60 dB suppression.

The center notch frequency of the network in the generic case is given by:

$$F_c = \frac{1}{2\pi}\sqrt{\frac{C1 + C3}{C1\,C2\,C3\,R1\,R3}} \qquad (3)$$

We can simplify the expression above by adopting a convention that calls for the following relationships:

C1 = C3 = C
R1 = R3 = R
C2 = 2C
R2 = R/2

If this convention is adopted, then we can reduce the frequency equation to:

$$F_c = \frac{1}{2\pi RC} \qquad (4)$$

In these expressions, F is in hertz (Hz), R is in ohms, and C is in farads. Be sure to use the right units when working these problems: "10 kohms" is 10,000 ohms, and "0.001 µF" is 1×10^{-9} farads. In calculating values, it is usually prudent to select a capacitor value, and then calculate the resistance needed. This is done for two reasons: one is that there are many more standard resistance values; and second, potentiometers can be easily used to trim the values of resistances, but it is more difficult to use trimmer capacitors. For 60 Hz filters, some common values for R and C are:

C	R
0.001 µF	2,652,582 Ω
0.01 µF	5,258 Ω
0.15 µF	17,684 Ω

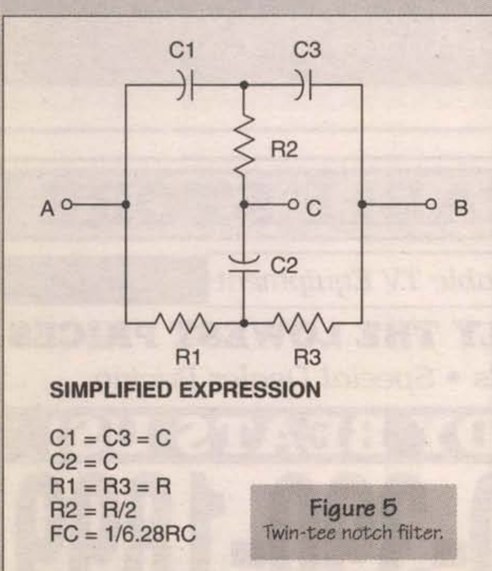


Figure 5
Twin-tee notch filter.

One of the problems of these filters is that the depth of the notch is a function of two factors involving these components: first, that they are very close to the calculated values; and second, that they be matched closely together. For example, a 60 Hz notch filter was built using the 0.15 µF and 17,684 Ω values from the table above, the 0.15 µF capacitors were selected at random from a group of a dozen or so "mine run" capacitors of good quality, while the resistors were 18 kohm, 5% metal film resistors. The notch depth at 60 Hz was only 10 dB, but at 58 Hz it was 48 dB. The mismatch caused a significant shift of notch frequency.

A second filter was built using the same values. In this case, the 0.15 µF capacitors were selected from about 20 on hand (precision components are difficult to obtain). In order to match them as close as possible, the capacitance of each was measured using the capacitance tester function on a low-cost (<$100.00) digital multimeter. The order of prior selection was to find those that closely matched each other, and only incidentally how close they come to the calculated value. Errors in the mean capacitance of the selected group can be trimmed out using a potentiometer in the resistor elements of the twin-tee network.

When selecting a frequency source, either select a well-calibrated source, or use a frequency counter to measure the frequency. Keep in mind the situation described above where only a 2 Hz shift produced a 38 dB difference in notch depth!

Alternatively, use a 6.3 volt or 12.6 volt AC filament transformer secondary as the signal source. (WARNING: The primary circuits of these transformers are at a potential of 115 volts AC, and can thus be lethal if mishandled!)

Adjustable frequency notch filters can be built using the twin-tee idea, but none of the usual solutions are really acceptable. One implementation requires three ganged matched potentiometers or three ganged capacitors. Unfortunately, in either case at least one of the variable sections must be of different value from the other two, causing a tracking problem. You might not notice a tracking problem in some circuits, but in a high-Q notch filter it can be disastrous.

Active Twin-Tee Notch Filters

Active frequency selective filters use an active device such as an operational amplifier to implement the filter. In the active filter circuits to follow, the "twin-tee" networks are shown as block diagrams for sake of simplicity, and are identical to those circuits shown earlier; the ports "A," "B," and "C" in the following circuit are the same as in the previous network.

The simplest case of a twin-tee filter is to simply use it "as is," i.e., use the filter circuits shown above. But the better solution is to include the twin-tee filter in conjunction with one or more operational amplifiers. There is one solution in which the twin-tee network is cascaded with an input buffer amplifier (optional) and an output buffer amplifier (required). These amplifiers tend to be non-inverting op-amps follower circuits. The purpose of buffer amplifiers is to isolate the network from the outside world. For low frequency applications, the op-amps can be 741, 1458, and other similar devices. For higher frequency applications (i.e., those with an upper cut-off frequency above 3 KHz), use a non-frequency compensated device such as the CA-3130 or CA-3140 devices.

A superior circuit is shown in Figure 6. In this circuit, port-C of the twin-tee network (the common point) is connected to the output terminal of the output buffer amplifier. There is also a feedback network consisting of two resistors (R_a) and a capacitor (C_a). The values of R and C in the twin-tee network are found from the equation above, while the values of R_a and C_a are found from:

$$R_a = 2RQ \qquad (5)$$

and,

$$C_a = \frac{C}{Q} \qquad (6)$$

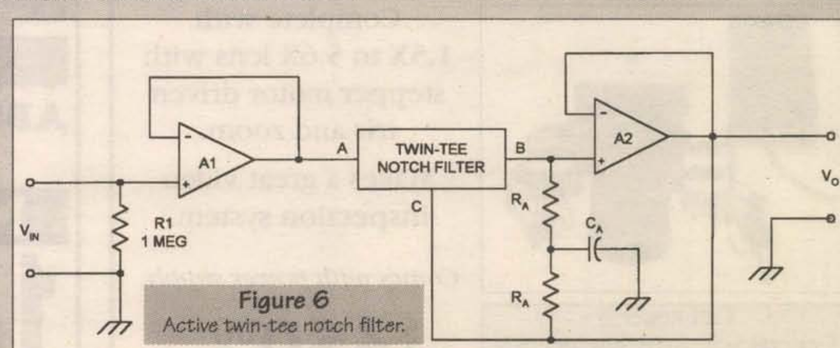


Figure 6
Active twin-tee notch filter.

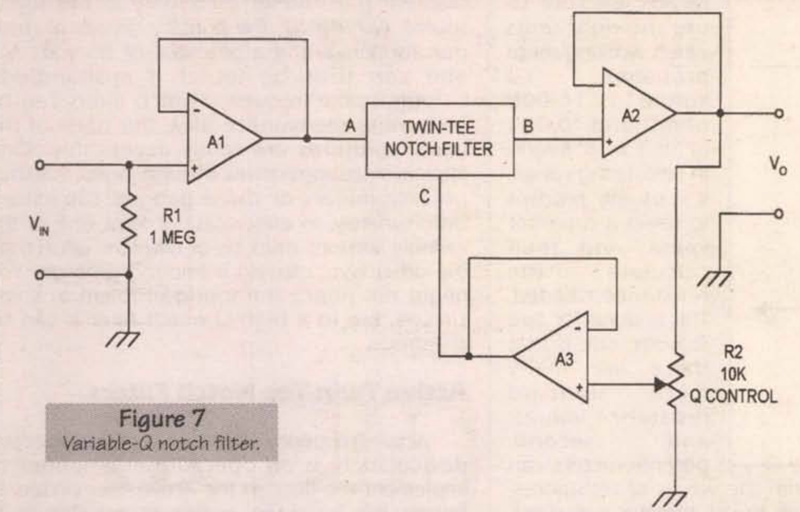


Figure 7
Variable-Q notch filter.

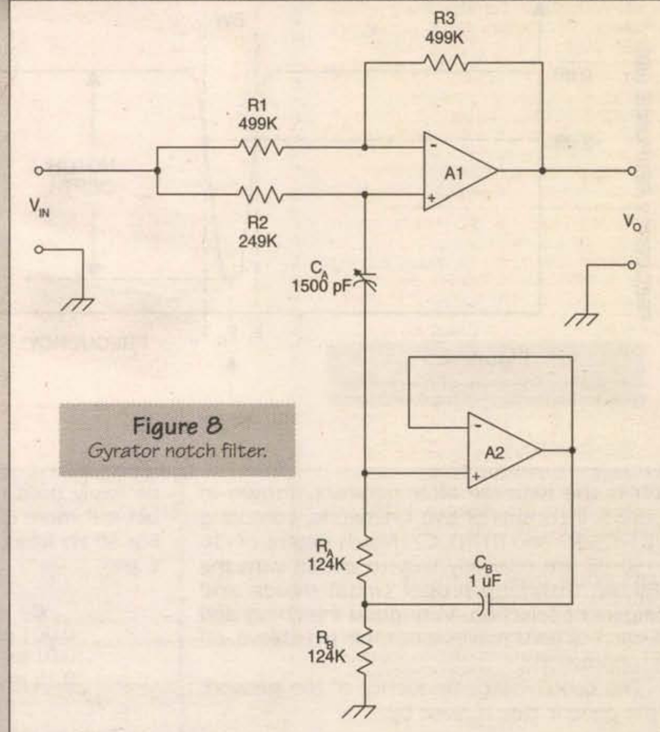


Figure 8
Gyrator notch filter.

Example

Design a 60 Hz notch filter with a Q of 8.

1. Select a trial value for C: 0.01 µF.
2. Calculate the value of R from the equation: 265,392 Ω
3. Calculate R/2: 265,392/2 = 132,696 Ω
4. C2 = 2C = (2)(0.01 (F) = 0.02 µF.
5. Select R_a: R_a = 2QR = (2)(8)(265,392 Ω) = 4.24 megΩ
6. Select C_a = C/Q = 0.01 µF /8 = 0.0013 µF.

When Figure 6 was built using these values in Joe's Basement Lab using the twin-tee network, the null was close to -48 dB deep using components at hand.

A variable Q control is shown in Figure 7. In this circuit, a non-inverting follower (A3) is connected in the feedback loop in place of R_a and C_a. The Q of the notch is set by the position of the 10 kohm potentiometer (R2). Values of Q from 1 to 50 are available from this circuit.

Another approach to notch filter circuits is shown in Figure 8. This circuit is sometimes called the gyrator or active inductor notch filter (it's also sometimes called the virtual inductor notch filter).

The notch frequency is set by:

$$F_c = \frac{1}{2\pi\sqrt{R_a R_b C_a C_b}} \qquad (7)$$

Equation 7 can be simplified to

$$F_c = \frac{1}{2\pi R\sqrt{C_a C_b}} \qquad (8)$$

If the following conditions are met:

$$\frac{R3}{R1} = \frac{R2}{R_a + R_b} = \frac{R2}{2R} \qquad (9)$$

It is possible to use any one of the elements, C_a, C_b, R_a, or R_b, to tune the filter. In most cases, C_a is made variable and C_b is a large value fixed capacitor. The 1,500 pF variable capacitor can be made by paralleling all sections of a three-section broadcast variable, with a single small fixed or trimmer capacitor. Alternatively, since most applications will require a trimmer rather than a big honkin' broadcast variable, it is also possible to parallel one or more small capacitors and a trimmer. For example, a 100 pF trimmer can be parallelled with a 1,000 pF and 470 pF to form the 1,500 pF capacitance required. Make sure that low drift, precision capacitors are used. Or you can match them using a digital capacitance meter.

Be careful when using any filter to remove components from a waveform. If the filter is not a high-Q type, then too much of the signal might be removed. In medical electrocardiograph (ECG) systems, the signal has components from 0.05 to 100 Hz, so 60 Hz is right in the center of the range! Oops. To make matters worse, the leads have to be connected to the human body, so are unshielded at their very ends. Interference from 60 Hz is almost guaranteed unless care is taken. But filtering can take out components that assist the physician in making diagnosis, so it is only used when it is unavoidable. On medical ECG amplifiers, the filter is usually switchable so it can be either in or out of the circuit. **NV**

Connections ...

I can be reached at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at carrjj@aol.com

EDUCATION

KNOWLEDGE CARDS. Facts and formulaes from math, English, science, and electronics. Fun and educational. For elementary school thru college. Set $3. Box 12238, Lexington, KY 40581-2238.

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

DON LANCASTER'S ACTIVE FILTER COOKBOOK is back in print. Autographed copies of the seventeenth(!) classic printing $28.50. **SYNERGETICS PRESS**, Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

LEARN PC ASSEMBLY LANGUAGE. Disk $5, book $15, assembler $5. ZIPFAST, Box 12238, Lexington, KY 40581-2238.

BUSINESS OPPORTUNITIES

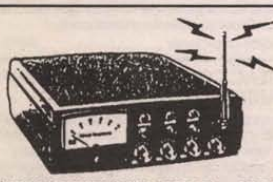
MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

THE CASE AGAINST PATENTS. Thoroughly tested and proven alternatives that work in the real world, $28.50. **SYNERGETICS PRESS**, Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

MILLIONS IN scrap gold are about to hit the market in the form of old computer junk. I'm making a bundle recycling this material and you can join me. Call 24-hour message: 603-645-4776.

DID YOU know Chaffin Electronics offers: Programming service, circuit board manufacturing, thousands of obsolete and hard to find ICs, same day shipping, computerized parts search? Call for more information. Phone: 614-574-4456 or 6906, FAX: 614-574-2124.



COUNTERSURVEILLANCE = $250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTERSURVEILLANCE! For free catalog call: **1-800-732-5000.**

GOLD! EXTRACTION, recovery and refining gold from scrap electronics. Book contains chemical formula and process $35. Strategic Technology, Box 145-V, Newville, AL 36353.

HOME AUTOMATION DEALERS WANTED. Free information. Call 1-800-838-4051 or fax name, address, and telephone to 402-729-3863.

INTERNET AD REPS WANTED in all parts of country. Make $100 to $200 per day. No dealership fees. No contracts to sign. Send $2 for additional information or $14.95 for complete kit. T. Technologies Services, 310 Busse Highway, Suite 239, Park Ridge, IL 60068. Ph: 847-518-8015.

RECOVER "SCRAP GOLD" from old computer junk. Free information packet. Call 24 hours: 603-645-4772.

Closing Date For Next Issue — April 10th!

REPAIRS/SERVICES

PICS, GALS READ if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

PINBALL MACHINES! Books, Magazines, Manuals, Diagrams, Supplies, Parts. $2 catalog, Marco Specialties, 5290-N Platt Springs Rd., Lexington, SC 29073-9252. 803-957-5500. FAX 803-957-6974. E-Mail: tilt@ix.net com.com http://magenta.com/marco

CABLE CONVERTER REPAIR: Specializing in all Zenith models. Very reasonable price. Give me a call. 619-630-1909, ask for Paul.

WELD ALUMINUM WITH PROPANE! EZ, INEXPENSIVE, STRONG. DETAILS: WEEKS, 36 CAROLINA ST., TAYLORS, SC 29687. FAX 864-244-6349. http://www.page biz.com/durafix/

HAM & TWO-WAY RADIO REPAIR: HF, VHF, UHF all brands, repeaters & amplifiers serviced, DUPLEXERS tuned. Prompt service, reasonable rates, FCC licensed. CENTURION COMMUNICATIONS, 892 N. DELSEA DRIVE, VINELAND, NJ 08360, 609-794-8000.

TIRED OF IRONING? SS PCB service. No $setup! **Free** scanning available. Get out those back issues! **FIRST PROTO**, 4201 University Drive, #102, Durham, NC 27707. 919-403-8243.

COMPUTER REPAIR, DATA RECOVERY, PRINTER REPAIR, UPGRADES, ETC. CALL TODAY 562-869-7088.

MARK V HV SCANNERS, REPAIR/CALIBRATION $89 plus $10 ret. Free unpublished operating notes. **FARRELL ELECTRONICS**, 127 Providence Ave., South Portland, ME 04106. 207-767-5698.

HP POWER SENSOR REPAIR AND CALIBRATION 8400 Series sensor repair from $230 with return loss plot. NIST traceable commercial calibration with new reference cal. factor chart from $110. Fast turnaround. MasterCard/Visa accepted. Call QuinStar Technology 310-320-1111, Fax 310-320-9968.

18,000 Plus TECHNICAL REPAIRS for **TVs, VCRs, projection TVs, CAMCORDERs, CD players, & audio** organized in an **EASY** to use computer program. **The TECHNICAL TIP REPAIR program. PROFESSIONAL BOARD LEVEL & COMPONENT LEVEL REPAIRS. ADD** your own tips. **PRINT** tips. Ask about our **TIP EXCHANGE** policy with **FREE updates.** Works on IBM compatible computers with a hard drive (also on some Apple Macintosh). **Only $150 & FREE SHIPPING.** Works in DOS, WINDOWS 3.1 & WINDOWS 95. **FREE DEMO. HIGHER INTELLIGENCE SOFTWARE, 60 FARMINGTON LANE, MELVILLE, NY 11747. CALL 1-800-215-5081/516-643-7740.**

(E)EPROM PROGRAMMING done quickly and economically. One day turn around typical. Simple copy $3 per device. Also prototyping, design, and consulting services available. Call or send SASE to: **Luzer Electronics, 4023 North Bayberry, Wichita, KS 67226. 316-687-4759, FAX 316-687-3103.**

ENGINEERING CONSULTING. Product development from conceptual to manufacturing stages. Digital, analog, and RF expertise. Microcontroller designs for HC05xx, HC11xx, PIC16C5x. Software design for IBM PC. ASIC design using XILINX. In-house schematic capture and PWB. Steve Hicks, DiaSystems Electronics, 7508 E. Granada Rd., Scottsdale, AZ 85257. 602-970-3162. E-Mail: diasys@cyberhighway.net website: www.cyberhighway.net/~diasys

SEMICONDUCTOR CROSS-REFERENCE library for IBM PC. Over 250,000 devices (transistors, diodes, ICs, etc.) specifications, lead and case drawings for most, $69 plus $6 S&H. Additional module, **FCC ID CODE** listing $10 with SCRL or $29 + S&H if purchased separately. Checks & credit cards accepted. E-Mail: customsoftware@usa.net Web: http://www.execnet.com/custom_soft ware/ Custom Software Creators, PO Box 1092, St. Bethlehem, TN 37155. 615-647-6120.

Events CALENDAR

Continued from page 77

MD - GAITHERSBURG - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880

NY - WHITE PLAINS - Computer Show. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229

SC - GREENVILLE - Computer Show. Palmetto Expo Center. 9:30am-4pm. MarketPro 201-825-2229

WY - CODY - ARRL Hamfest. Carol Jaussaud K7KD, 307-587-9764. http://www.wave.park.wy.us/cmarc/cmarc.htm

MAY 25

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

IL - CHICAGO - CARC Hamfest. DeVry Institute of Technology, 3300 N. Campbell. 8am-3pm. 773-545-3622

IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547

KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300

MD - WEST FRIENDSHIP - MFMA Hamfest. Howard Co. Fairgrounds. Craig Rockenbauch 410-987-6042

OH - COLUMBUS - Computer Show. Veterans Memorial. MarketPro 301-984-0880

OH - HILLIARD - Hamfest. Chris Lind, 614-267-7779

MAY 26

NJ - PARSIPPANY - Computer Show. Parsippany Hilton. 9:30am-4pm. MarketPro 201-825-2229

OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880

OH - NILES - Computer Show. Eastwood Expo Center. MarketPro 301-984-0880

PA - READING - Computer Show. Sheraton Berkshire. MarketPro 301-984-0880

VA - MANASSAS - Computer Show. Manassas Fairgrounds. MarketPro 301-984-0880

Continued on page 93

CALL TOLL-FREE
(800) 292-7711
Se Habla Español
C&S SALES
EXCELLENCE IN SERVICE
CALL FOR A FREE 60 PAGE CATALOG!
(800) 445-3201
AFFORDABLE, HIGH QUALITY ELENCO OSCILLOSCOPES
2 YEAR WARRANTY
STANDARD SERIES
S-1325 25MHz $325
S-1340 40MHz $419
DELUXE SERIES
S-1330 25MHz $459
S-1345 40MHz $549
S-1360 60MHz $749
Features:
• TV Sync • High Luminance 6" CRT
• 1mV Sensitivity • Complete Schematic
• X-Y Operation • Plus much, much more!!
2 FREE probes with each scope!!
Features:
• Delayed Sweep • Dual Time Base
• Automatic Beam Finder • Illuminated Internal Gradicule
• Z Axis Modulation • Built-in Component Test
• Plus all of the features of the "affordable" series!!
MX-9300
Four Functions in One Instrument
Features:
• One instrument with four test and measuring systems:
• 1.3GHz Frequency Counter
• 2MHz Sweep Function Generator
• Digital Multimeter
• Digital Triple Power Supply
• 0-30V @ 3A, 15V @ 1A, 5V @ 2A
$479.95
B&K 4040 w/ Frequency
• 2Hz to 20MHz
• AM and FM Modulation
• Linear and Log Sweep
• Counter Range 5Hz to 30MHz
• 5 Digit Display
$425
GF-8026 w/ Frequency
• .02Hz to 2MHz
• Linear and Log Sweep
• Counter Range 1Hz to 10MHz
• 4 Digit Display
$225
Model XP-581
4 Fully Regulated Power Supplies in One Unit
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A • Variable - 2.5 - 20V @ 2A
Ideal for laboratories, service shops and hobbyists.
$85
Fluke Multimeters
70 Series
Model 70II $69.95
Model 73II $97.50
Model 75II $135.00
Model 77II $154.95
Model 79II $175.00
80 Series
Model 83 $235.00
Model 85 $269.00
Model 87 $289.00
Model M-6100
Programmable DMM
Includes FREE Computer Interface and FREE Software
• Analog Bar Graph
• Large 3 3/4" LCD Display
• Menu Driven
• Triple Display
• RS-232 Interface
• True RMS
• 9 Basic Functions including cap. & freq.
• Auto Power Off
• Easy-to-use
$125
B&K Model 1688
High Current (25 DC amp) Power Supply
• Variable 3-14VDC
• 25 amps @ 135V
• Thermal Protection
$249.95
1.3GHz Universal Counter
Model F-1300
• Period
• Frequency & 8 other functions
$225
M-1700
Digital Multimeter
11 functions including freq to 20MHz, cap to 20μF. Meets UL-1244 safety specs.
$39.95
XK-550 Digital / Analog Trainer
Elenco's advanced designed Digital / Analog Trainer is specially designed for school projects. It is built on a single PC board for maximum reliability. It includes 5 built-in power supplies, a function generator with continuously sine, triangular, and square wave forms. 1560 tie point area.
XK-550
Assembled and Tested
$169.95
XK-550K - Kit
$139.95
Tools and meter shown optional
Kit Corner over 100 kits available
Model AR-2N6K
2 meter / 6 meter Amateur Radio Kit
$34.95
Model AM/FM-108
AM/FM Transistor Radio Kit
$29.95
Model M-1005K
Low cost, 3 1/2 digit LCD, 18 ranges, transistor test, diode test, overload protection and pocket size.
$19.95
Model TR-18K
Stereo Cassette Player Kit
• Transparent case
• High resolution
$15.95
WE WILL NOT BE UNDERSOLD
UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents Add 8% Sales Tax
C&S SALES
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 541-9904 (847) 541-0710
15 DAY MONEY BACK GUARANTEE
FULL FACTORY WARRANTY
PRICES SUBJECT TO CHANGE WITHOUT NOTICE
http://www.elenco.com/cs_sales/

AN EXPERIMENTER'S CHEAP ROBOTIC SONAR SYSTEM

by
Carl Motsinger

Does the word SONAR seem mystifying to you? Its implementation perhaps above and beyond your expertise? Here is a simple two-hour project you can make from junk box junk that works.

OVERVIEW

Since this was an experimental, one-time effort, making a fancy printed circuit board (PCB) was not necessary. A piece of scrap PCB 1" by 3" was used. The reader might prefer to use a copper clad perf board with the holes already drilled. I cut the circuit into the board with a Dremel drill using a #105 burr bit.

There is an aluminum hub on the stepper motor shaft. Two holes were drilled and tapped to mount the PCB on the hub; #6 bolts were used. This allows the sonar system to sweep as it operates. As presented here, 360-degree operation is not possible because of the wiring. The system sweeps about 80 degrees as it operates.

The master microcontroller is an 8051. The stepper motor is driven by a slave unit and runs continuously under most circumstances. Control of the slave unit is made through a 9600 baud serial link. Master control can stop the sweep in addition to adjusting the sweep angle if needed through the link. The master unit waits until a return is recognized, then takes control of the stepper motor.

Software for the return echo is still being developed. It would therefore be inappropriate to suggest to the reader how to implement software to recognize certain return signals. Learning how to get your system functioning with a sonar sweep system won't be a snap, yet it is very much worth the effort.

The system as described has a range of about 15". Right now, that is sufficient for my system. The primary purpose of this system is to find an opening for the robot to maneuver through. Two systems are used on my robot. One is forward looking, the other shoots down about 6" in front to the floor to detect obstacles in front of the wheels.

CONSTRUCTION OF THE PCB

A copper clad perf board available at Radio Shack would also work well for this project. Lay out the components similar to Figure 1. If you use a Dremel tool to etch the board, be sure to make a cut lengthwise down the middle of the board. This will isolate the two stages and also the two power supplies.

Beginners might want to install the middle components, then work out to the edges to keep everything in perspective. If you do, start with the opto-isolator. Half of it is a five-volt circuit. The other operates at 12 volts. There is no restriction to the size of the PCB. In fact, after you get all the components on, you can cut it down to size with a nibbler like I did. It is also not necessary to put all the components on the stepper mounted board. You can just put the elements on the board and use a flexible cable of some type to connect them to the component board. *This is an experimenter's project so feel free to experiment.*

Front mounting of the transducers might not work with your units as Figure 1 shows, so act accordingly. Mount them facing forward in whatever manner is possible. Finish by removing all copper from the area where the board will be mounted to the hub on the stepper motor. To do this, score across the board with a blade. Using a pair of diagonal cutters, grasp the copper along the edge and pull it up. This makes certain the stepper motor housing is not connected to the system power supplies.

A socket for the op-amp is recommended. Mount all the components. Place the opto-isolator so that it straddles the cut you made along the length of the board. Solder all leads. The 100-ohm, half-watt resistor (R4) is mounted on the bottom of the board. You should recheck your soldering. Since there is a small moat around the solder pads that you made, shorts should not be a problem.

WIRING TO YOUR SYSTEM

Stepper motor drive system requirements can vary widely even though the motor itself may be the same. The specifics of the stepper drive will not be covered except to mention that the driver is a UCN5804B IC. A data sheet for the UCN5804B is available from most suppliers. Driver software is included in the source code. Since it is I/O dependent, it must be rewritten to work with your board.

Two supplies are used: 5 and 12 volts. These supplies are isolated. The pulse signal from the microcontroller is at the five-volt level. The opto-isolator allows the signal to be transferred to a 12 system through the optical link inside the chip. All ground wires are BLACK. MARK all wires to prevent any disasters that would occur by mixing up the ground wires. The five-volt supply is colored RED while the 12-volt supply is ORANGE. A BLUE wire is connected to pin 1 of IC1. This is the RETURN line. A GREEN wire is connected to R1. This is the PULSE line.

Assembly source code is included to assist you in implementing this system into yours. Our artist was busy with other things and did not get to help with this project ...

THEORY OF OPERATION

Sound waves travel at about 1100 feet per second. That's .0011' every microsecond. An object 1' away would return an echo in 1818.18 usec equal to 2'/.0011; one foot to get there and one foot to return. A pencil at 3", .25', will return an echo in 454 usec equal to .5 (6")/.0011. As the project evolves, this distance will be displayed on the LCD console as the robot maneuvers around the shop finding openings and beeping as an obstacle is detected.

The transmitter puts out 10 pulses at 25 KHz. Observed on a scope, the return echo reached a maximum level in 200 usec, or about the fifth pulse. This will affect how well the system responds to an object within inches of the robot. It appears, though, that only five pulses are needed to get the job done. This is not a problem that concerns me because a future infrared system will be used for detecting objects very close to the robot down along the floor line.

A 25 KHz signal requires a 20 microsecond high and a 20 microsecond low (40 uS period)

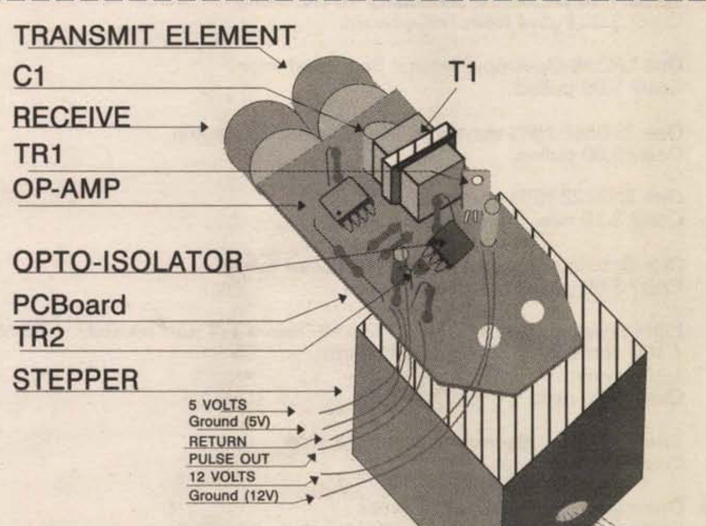


FIGURE 1

pulse fed to the opto-isolator from the microcontroller. More common transducers are 44 KHz and 50 KHz. These require a 22.7 uS period and a 20 uS period, respectively.

REFER TO FIGURE 2

TR1 is normally turned OFF by the voltage on pin 1 of IC2, TIL111 opto-isolator. This pulls the base of TR1 to ground by turning on the transistor inside IC2. A signal on the PULSE line will remove the voltage on pin 1 of IC2 by clamping the 100-ohm resistor (R2) to ground. This will turn OFF the LED inside IC2. When this occurs, the base of TR1 gets pulled high — ON — by the 1K resistor (R3) causing current to flow through the primary or T1. When TR1 turns OFF, a pulse is sent to the secondary. This pulse voltage can be very high. In this application it is five or more times the 12 volts applied to the primary.

When in operation, 10 cycles of a 25 KHz signal are applied to the base of TR2. As TR1 gets turned ON and OFF, voltage is applied to the secondary of T1. The 25 KHz signal is delivered by C1 to the element. The time — measured in millionths of a second — required for this transmitted signal to reflect and arrive at the receiving element indicates the distance the signal has traveled.

At the receive element, the return echo is amplified by one-half of IC1, the LM358 dual op-amp. The other half of IC1 buffers or conditions the signal for input to the microcontroller. The RETURN line gets a high signal when a return echo is received. This signal is delivered to the microcontroller where appropriate action is performed.

FREQUENCY TEST

No documentation was provided with the surplus elements I bought so the operating frequency was unknown. An audio generator and a scope were used to find the frequency. Once the frequency is determined, the pulse width can be adjusted to peak the output and input responses. The following is how I found the correct frequency. A scope should be used for the final adjustment.

Connect one side of the element to your generator output and the other to ground. Another element of the same type is connected to the scope. Place the two elements facing each other.

Observe the scope as you tune the audio generator through 10 to 100 KHz. You will naturally get a large signal response when the frequency matches the transducer's. You may need to put the scope's vertical control to 10 MV or less to get the response. My generator output was near 10 volts PEP and drove the transducer very well.

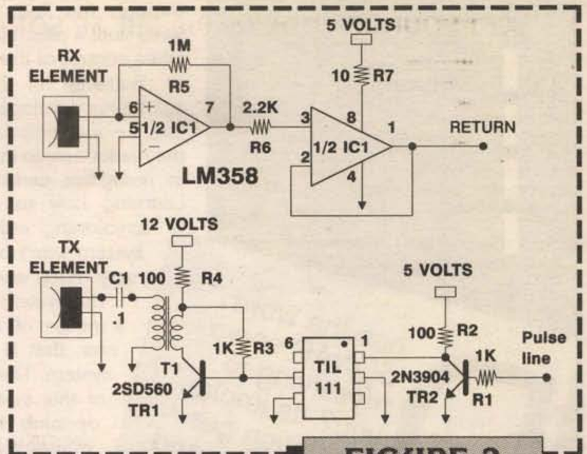


FIGURE 2

Center frequency for the 25 KHz elements was 24.850 KHz. Measuring the generator output with a frequency counter will give you the frequency of operation. It can be misleading due to any loading effect the transducer or frequency counter places on the generator output. I would guess that 25 KHz is probably correct.

I found that a 10% error greatly reduces the receiver response of these elements. This was not consistent with data sheets of other transducers. Some will operate at frequencies far removed from the center frequency. Since the transducer frequency can't be altered, you must adjust the pulse width of the driving signal to match the frequency of the element.

FINAL ADJUSTMENT

Adjusting the microcontroller pulse output is not too difficult. A scope really helps with this yet, in the absence of one, I would try using an AC voltmeter. The sonar system does not have to be connected to the stepper for tuning. I added two pushbutton switches to help in tuning the output pulses. The two pushbuttons were connected to two extra I/O pins on the 8031 stepper drive module. These switches are used to adjust a timing loop up or down. As the pulses are sent, the controller checks the two I/O pins to determine if I want to increase or decrease the pulse width for alignment purposes only. The buttons will be removed when the adjustment has been done.

The correct pulse width was estimated at an initial value and then adjusted as I proceeded to tune the software; 25 KHz is equal to a 40 uS period. I set the test program to provide a continuous 20 uS on pulse and a 20 uS off signal out the PWM pin on the module. This line is connected to the PULSE OUT wire in the schematic and pictorial diagram. The test program calls two routines that sample the pushbutton pins and a delay routine that sets the 20 uS pulse widths. This provides the control I need to correctly tune the software to the element frequency.

The delay is controlled by looking at a place in memory to get the timing value. If I push a button + or -, that memory location is incremented or decremented. I simply add or subtract to the initial value and come up with the best pulse width (frequency) for the transducer.

This is reached when the scope shows a maximum signal at the output of the OP-AMP, the RETURN line. (Not the maximum number of cycles, but the largest signal return on the scope in the vertical axis. It will be necessary to have something in front of the elements to give you a return signal.) Now I make a note of the mental value I reached as I pushed the two buttons. This is the best pulse width for the element and will be used in the final software.

ANOTHER WAY

IF YOU HAVE SYSTEM RESTRAINTS ON THE MAIN FREQUENCY, THIS MAY NOT WORK. IF THOSE RESTRAINTS ARE FOR AN ON-BOARD UART, YOU CAN USE THIS METHOD BECAUSE BAUD TIMING CAN BE WAY OFF — MORE THAN THIS — AND STILL WORK FINE.

You could adjust the main crystal frequency to reach the optimum pulse width if you do not have a scope. You will need an AC voltmeter. I would think that you already know the instruction cycle time for your microcontroller. Set the timing loop in your software to get as close to the period as you can.

Start the test program. Adjust the variable tuning capacitor on your crystal. If you don't have a variable, then change the value of one of the capacitors. You can even bend the caps over or closer to the crystal. That might change the timing enough to optimize the response of the elements.

A variable cap is the best choice, though. Connect the AC voltmeter — a DVM set to an AC low volt scale will do — to the output of the op-amp. Adjust the capacitor for largest signal value on the voltmeter as the transmitter is operating. You might get nothing but unstable random readings on the voltmeter. If you do, seek

SIMPLE CHEAP SYSTEM

PARTS USED IN THE PROJECT

1. Two 25 KHz Transducer elements. Manufacturer unknown.
   Receiver or Transmitter type? Unknown.
   Size? 3/4" diameter x 1/2" deep. Two leads protruding out the back of unit.
   Purchased surplus. Cost 2 @ $3.00 each, $6.00.
2. One UNIPOLAR stepper motor. 12 volt.
   Type? Pulled from TEAC floppy drive. 360K unit.
   Cost? $.00.
3. One miniature audio transformer. Manufacturer unknown.
   Type? Step-up.
   Primary 10 DC ohms. Secondary 70 DC ohms.
   Cost? $.00 Pulled from TelCo board.
4. One LM358 Op-Amp. National Semiconductor
   Cost? $.00 pulled.
5. One 2SD560 NPN transistor. TO-220 case. Darlington.
   Cost? $.00 pulled.
6. One 2N2222 NPN transistor.
   Cost? $.10 new.
7. One Opto-Isolator. TIL111. Open collector output.
   Cost? $.00 pulled from TelCo board.
8. Eight resistors. One 100 ohm 1/2 watt. Seven 1/4 watt resistors: 1-10 ohms, 1-100 ohms, 3-1K ohms, 1-2.2K ohms, 1-1M ohms.
   Cost? $.20 new.
9. Two capacitors electrolytic 10 uF/25 volts.
   Cost? $.18 new.
10. One capacitor Mylar .1uF/50 volts
    Cost? $.00 pulled.
11. One PCB. 1" x 3". Scrap. Hook-up wire.

Tools used other than the normal stuff: Dremel tool, Nibbler, small drill press, #6 tap.

8051 SOURCE CODE for the CHEAP SONAR SYSTEM

```
;**********************
;LRAC Robotic Systems
;EFJ Devices.
;**********************
;Carl Motsinger July 8, 1996
;#1 STEPPER MOTOR MODULE port assignment.
;Code is for Intel MCS51 microcontroller - 8031h
;Updated August 7, 1996
;Updated October 3, 1996
;**********************
;Ports 0 & 2 are used for addressing program memory.
;Port 1 provides STEP and DIRECTION for 2 UCN5804B IC's
;Port 3
;p3.0 is RxD.
;p3.1 is TxD.
;p3.2 is INT0
;p3.3 is unused
;p3.4 is unused
;p3.5 is Pulse
;p3.6 is Return
;p3.7 is unused
;p3.2 is also used for INT0. It is tied to p3.0. Pulled low by Master module on INT.
;Only when interrupts are enabled is it active LOW.
;Serial port link is also tied to p3.0 and p3.1  RxD is p3.0. TxD is p3.1
;Serial port is set to 9600 bps.
;**********************
;SYSTEM CONFIG
;**********************
#include      "Equates.051"
;*******************************************
        .ORG 0000H
        ljmp Begin
        clr ie.0
        ljmp SerInt
        ljmp Start

;*********************************
Begin:
        mov 20h,#10
        mov 21h,#10
        mov 22h,#36                     ;Here we set the sweep angle.
        mov p1,#0h
        setb p1.2
        setb p1.3
        mov p3,#0ffh
Start:
        lcall HardLeft
        ljmp More
HardLeft:
        mov r1,#100
SetLeft:
        setb p1.0 ;Push the Stepper hard left.
        clr p1.1                        ;against the post.
        lcall Wait1000
        setb p1.1
        lcall Wait1000
        clr p1.0
        lcall Wait1000
        clr p1.1
        lcall Wait1000
        djnz r1,SetLeft
        mov r1,#2
SetStart:
        setb p1.1                       ;Move right 2 steps.
        clr p1.0
        lcall Wait1000
        setb p1.0
        lcall Wait1000
        clr p1.1
        lcall Wait1000
        clr p1.0
        lcall Wait1000
        djnz r1,SetStart
        clr p3.3
        ret                             ;Here we should go to a Main program.
                                        ;Wait for Master to tell us to go.
More:
        clr p3.3                        ;Turn off LED.
                                        ;This is the sweep routine.
        mov r1,22h                      ;Sweep range is put in 22h at start
Fwd:
        setb p1.0                       ;and by Master when int is ON.
        clr p1.1                        ;Initialized to 36. 36 steps x 1.8 degree = 65
degree sweep.
        lcall Wait1000                  ;One step....
        setb p1.1                       ;Unipolar pulsing.
        lcall Wait1000
        clr p1.0
        lcall Wait1000
        clr p1.1
        lcall Wait1000
        lcall Pulse                     ;Do your thing...
        lcall Echo
        djnz r1,Fwd                     ;Are we done? >No!
        mov r1,#255                     ;Yes! The number 255 (ffh) is a reset flag.
        mov r2,22h
Rev:
        setb p1.1                       ;Now the other way.
        clr p1.0                        ;One step.
        lcall Wait1000
        setb p1.0
        lcall Wait1000
        clr p1.1
        lcall Wait1000
        clr p1.0
        lcall Wait1000
        lcall Pulse                     ;>GO send 10 pulses of 25 KHz.
        lcall Echo                      ;Get echo time.
        djnz r2,Rev                     ;Are we done yet? >No!
        mov r2,#255                     ;Yes.
        sjmp More
Echo:                                   ;10 pulses have been sent.
        mov tl0,#0                      ;Initialize timer.
        mov th0,#0
        mov Tmod, #11h
        setb Tcon.4                     ;Timer running.
EchoIn:
        jb p3.6,Round                   ;> if echo received.
        mov a,th0
        cjne a,#10,EchoIn               ;Times out at 2550 usec. 10 x 255.
        ret                             ;Adjust for optimum performance.

Round:
        clr Tcon.4                      ;Timer 0 has time for return echo.
        setb p3.3                       ;Echo received. Turn on LED.
```

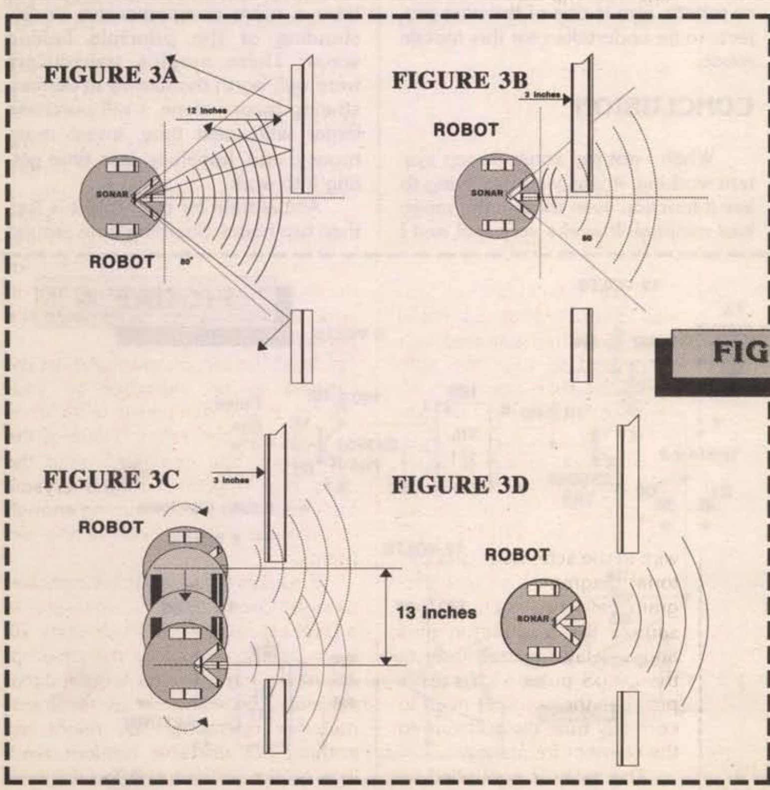


FIGURE 3

assistance from someone with a scope.

You might need to add or subtract a little in the timing loop should you not be able get the software adjusted. This could be because your initial value is already above or below the value needed to optimize the response. I found that calculating the timing loop and the actual time needed can vary widely. In your test, be certain that you can adjust the signal to a peak. You should be able to adjust the signal level through a low-high-low value as the crystal frequency is altered. That will give you the best response from your transducers.

IN PERSPECTIVE

Although no effort was made to match the components, the system is usable. Actual operating results were not as expected. This is due to the fact that the audio transformer does not drive the transducer well enough. It does work as designed and getting another transformer will greatly improve the operating range. Remember this project was made from parts on hand (JUNK) and the fact that it works is, in itself, an accomplishment.

I left out a few of the details in getting this sonar system up and running for the benefit of those that enjoy a challenge in taking on such a task as this. There is enough here for the beginner to solve most any difficulties.

One such problem may arise in the selection of an audio transformer; 50 KHz transducers are very common. As the frequency of operation increases to 50 KHz, a usable unit at audio (3 KHz) becomes useless. Another case in point is that using a very strong transmitter, the echo might continue to bounce back from the robot itself. Then you got an echo inside an echo. Ain't nothin' free, but it sho' is fun ...

RESULTS

Refer to Figure 3. The sonar system looks forward at the center of the robot at a height of 12" and sweeps 80 degrees continuously. Range is variable, depending on the reflectivity of the object in the path of the robot. A pencil held vertically reflects at 3".

```
;Code will go here to calculate distance.
        ret

;This routine was used for pushbutton adjustment of the timing loop.

Key:
        jb p3.6,Bak
        sjmp Take1
Bak:            jb p3.7,Key
        inc 20h
        sjmp More
Take1:dec 20h
        sjmp More
;*****************************************
;This is the PULSE routine. 9 djnz's of r3 produce 20 uS pulse
;at 12 MHz.

Pulse:
        mov r5,#10                      ;10 pulse at 25 KHz.
Loop1:
        mov r4,#9
        mov r3,#9                       ;9 equals 20 uS ON.
        setb p3.5
        djnz r3,$
        clr p3.5                        ;20 uS OFF.
        djnz r4,$
        djnz r5,Loop1                   ;Do it 10 times.
        ret

;**********************
;Main program goes here.
;Test serial ports first.
;**********************
SerInt:
        push psw;We're here because Master sent a dummy byte
        mov Scon,#0c0h                  ; to interrupt us.
        mov Tmod,#20h
        mov th1,#0fdh                   ;9600 baud 11.0592 MHz.
        mov Tcon,#40h
        clr ri
        setb p3.1
        setb p3.0                       ;Set-up for address byte.
Receive:
        jb p3.1,$                       ;Set here til master is ready with address byte.
        setb Scon.4
        jnb ri,$                        ;Getting address byte.
        mov a,Sbuf
        clr ri
        jb acc.2,ItsUs
        ljmp GetOut                     ;> Not for us - Go back to stepping.
                                        ;Bit 3 must be set to acknowledge the
                                        ;interrupt.
ItsUs: jnb ri,$
        mov 34h,Sbuf
        clr ri
        jnb ri,$
        mov 35h,Sbuf
        clr ri
        jnb ri,$
        mov 32h,Sbuf
        clr ri
        jnb ri,$
        mov 33h,Sbuf
        clr ri
        pop psw
        pop acc
        pop acc
        mov a,#8                        ;Push our own interrupt return
        push acc                        ;address.
        mov a,#0
        push acc
        reti
GetOut:
        lcall Wait1000                  ;Master sent four byte regardless.
        lcall Wait1000                  ;We have to wait because the INT line is being
                                        ;used.
        lcall Wait1000                  ;If we go back too soon we'll get a false interrupt.
        lcall Wait1000
        lcall Wait1000
        pop psw
        pop acc
        pop acc
        mov a,#8
        push acc
        mov acc,#0
        push acc
        reti
Wait1000:                               ;Not actually 1000 usec. 6400 + usec.
        mov r0,#64                      ;This will be changed when the module is
Pol:                                    ; optimized for the final integration.

        lcall Wait100
        djnz r0,Pol
        ret
Wait100:

        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        lcall Wait10usec
        nop
        nop
        ret
Wait10usec:
        nop
        nop
        nop
        nop
        nop
        nop
        ret
WaitLong:
        mov r5,#5
T22:            mov r6,#128
T52:            mov r7,#128
        ;lcall Key
        djnz r7,$
        djnz r6,T52
        djnz r5,T22
        ret
        .end
```

A piece of shiny plastic reflects a signal at 14". A wall produces an echo at about 9". A book held in front of the sonar produces an echo, but varies depending on the tilt of the object. Material and surface density affects this system to a large degree. Solving these problems is another story, and one I look forward to approaching head on.

Still the range is sufficient because the sonar is required to indicate an object in the path of the robot. Our next effort at this will be to produce a system to identify an object by size and shape. The transducer parameters in this system are not known and the maximum drive limit is elusive, to say the least. Overdriving may destroy the units. In this application, the TX element gets about 60 volts per pulse.

Final results tend to support the evidence that these transducer elements are for a receiver application. If you purchase surplus elements, get a few extra in case you want to experiment with maximum drive to the element.

System software is still being developed. An LED was used to indicate objects very close to the robot. The timer hardly has time to initialize when the object is within an inch or two. The stepper drive module turns the stepper one step, sends the 10 pulses, then starts a timer to count until an echo is returned.

In the case of no return, when the timer reaches 2500, another step is made, and so on, until the far end of the sweep is reached. The direction is reversed and it all starts again.

Source code is included here to assist you in developing your own system. It is for the MCS-51 series microcontrollers. This includes the 8x31, 8x32, 8x51, and 8x52. All I/O is system-dependent, of course, and will not work with your board.

The end result is a ranging system capable of detecting objects in the path of a mobile robot. Along with the next system (infrared) our robot will be able to move about on its own.

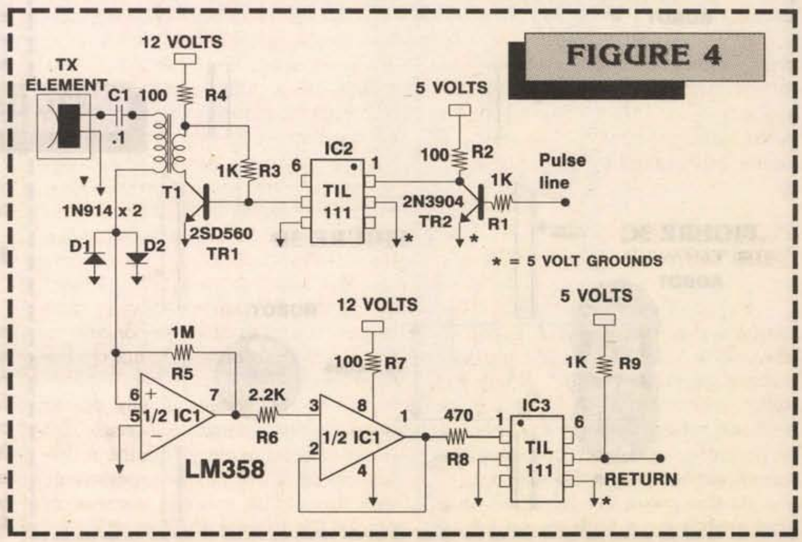
With this capability, the robot will be autonomous and other functions can more easily be incorporated into the system due to the fact that the robot will be in actual operation in its environment and not up on blocks (literally) on the bench. The use of an external manipulator or robotic arm is one of the next projects to be undertaken for this mobile robot.

CONCLUSION

When I got the sonar sweep system working, it was very gratifying to see it function even though the range was minimal. It works very well and I have a more comprehensive understanding of the principle behind sonar. These surplus transducers were well worth the money in demonstrating theory alone. I will purchase larger units next time, invest more money, and, hopefully, less time getting it to work.

Actual time for the project is less than two hours. Shuffling time around

FIGURE 4



to work on mine took a month. It is our hope you can undertake a project such as this with a little more knowledge and confidence that it can be done with minimal cost and maximum enjoyment.

TROUBLESHOOTING

NO PULSES TO TX ELEMENT

This is most likely due to the transformer. Are you sure you have the windings correctly wired? Are you sure the transformer is a step-up type unit? Are the two primary connections connected to the collector of TR1 and 12 volts? Check the windings with an ohmmeter for continuity. Use an AC voltmeter and determine the voltage on the TX element. It should be at least 60 volts when operating. Voltage at the base of TR1 will be less than one-volt DC. Is it?

Are you getting the pulses from the microcontroller? If so, what about the opto-isolator? Is it functioning properly? A logic probe can be used here. Are the pulses getting to the base of the driver, TR1? Simply follow the pulses from your micro to the element to find the problem in the circuit.

NO PULSES FROM THE RX ELEMENT

Most likely the op-amp has failed. A logic probe can be used at pin 1 to verify a signal return. You can see the return directly at the element with a scope to verify that the transducer is actually working. If you are sure that the element is okay and can't get a return, then replace the op-amp.

Don't forget: An object must be in front of the elements to get a reflection. I put an LED on the microcontroller as an indicator that an echo has been received.

Check all voltages on the op-amp. The input half of the LM358 amplifier inverts the signal. The other half is a buffer to condition the signal for the microcontroller. Pin 8 should be five volts. Pin 4 and 5 are ground. Pin 1 will go to five volts with a return. It is normally low. Pin 6 is the input from the transducer element. Pin 7 is an output. Pin 1, 2, and 7 will go high on return.

If you use an 8051 device, you must configure the pin connected to the RETURN line for an input by writing a 1 to it. It then operates somewhat like an open collector input lightly pulled high by internal circuitry.

HOW DO I USE THIS THING?

Figure 3 illustrates how a robot might find an opening and maneuver through a doorway. In 3A, the wall cannot be sensed at 12". When the robot gets within 2" to 3", in 3B, the wall will reflect because the robot is very close, and you can see the return will have to hit the element.

At this point, the robot will stop and search for a path to the left or right of its present position. The opening will be found when the sweep returns to near center. Now the robot will verify the position where the doorway edge is at by stopping the normal sweep and initiating slow, single step operations of the stepper motor.

In this situation, the robot will recognize an edge about 1" left of center. My robot has an incremental encoder for dead reckoning and has been measuring its distance and vectors taken from home. The robot's present location from 0,0 (its home position), will be stored in RAM and EEPROM.

In Figure 3C, a 90-degree rotation to the right is performed. Now the robot will move 13" forward. Caker, as the robot is called, is 12" in diameter and needs 13" of clearance to pass through the doorway. At 13", Caker stops and rotates 90 degrees left. With the sonar at center, the system seeks a return echo. As can be seen in 3C, no return will be found. Now Caker knows there is enough clearance for passage into the next room or area.

A hard left rotation is executed and Caker moves 6-1/2". Another rotation right is executed. Now Caker can pass through the doorway as shown in 3D. All operations have been saved. Later, hopefully, this opening will be anticipated as Caker maneuvers in the same room. Of course, there are drawbacks to this as you might imagine. What if an object was in the middle of the doorway?

CIRCUIT MODIFICATION

Figure 4 is a circuit modification for using a single element. It is presented here as experimental information for the reader. I have not tried making the mod to my system, but I intend to try it on my next project.

The key to the success of this circuit are the two diodes, D1 and D2; 1N914's should hold up to the voltage in my system. If your transmitter produces a somewhat higher signal, you might want to use 1N4001 devices here. Notice that it was necessary to add another opto-isolator. IC1 is now using the 12-volt supply.

Be sure to use a socket for IC1. The diodes will clamp any signal to .67 volts at the input to IC1. These diodes are a path to ground for the transmitted signal, yet the return echo will never be of sufficient amplitude to cause the diodes to conduct to ground. For receive purposes,they are effectively removed from the circuit and the echo sees a return through the op-amp.

The return echo will be attenuated by the transformer winding to a degree. This was of some concern to me and is the reason I did not try the modified circuit.

Once my system is fully operational, I may attempt to increase the range and experiment with the modified circuit. If any reader experiments with this circuit and has success or not, I'd like to hear about it. **NV**

Events CALENDAR

Continued from page 86

MAY 30-31-JUNE 1

NY - ROCHESTER - Atlantic Conv. Harold Smith 716-424-7184

WA - DRYDEN - ARRL Hamfest. Arlene Trotter KC7EW, 509-662-2344

MAY 31

CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com

CO - DENVER - Metro Computer Show & Swap Meet. 2950 W. 72nd Ave., Westminster. Reputable Systems 303-444-2664

CO - LOVELAND - Superfest. Larimer Co. Fairgrounds, 700 Railroad Ave. 8am-3pm. Michael Robinson N7MR, 970-282-1167

IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827

NH - SALEM - Computer Show. Rockingham Park Race Track. Northern Computer Shows 508-744-8440

NY - SYRACUSE - Computer Show. On Center. 9:30am-4pm. MarketPro 201-825-2229

TN - NASHVILLE - Hamfest. State Fairgrounds, Agriculture Bldg. 8am-5pm. Bill Pingley KT0C, 615-889-7376

VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880

MAY 31-JUNE 1

FL - JACKSONVILLE - Computer Show. Jacksonville Fairgrounds. MarketPro 301-984-0880

NC - WINSTON-SALEM - Computer Show. Lawrence Joel Veterans Memorial. 9:30am-4pm. MarketPro 201-825-2229

NJ - SOMERSET - Computer Show. Garden State Exhibit Center. 9:30am-4pm. MarketPro 201-825-2229

PA - KING OF PRUSSIA - Computer Show. Holiday Inn. MarketPro 301-984-0880

PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880

TN - KNOXVILLE - Computer Show. Tennessee Valley Fairgrounds. MarketPro 301-984-0880

JUNE 1997

JUNE 1

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

CT - NEWINGTON - Amateur Radio & Electronics Flea Market. Newington High School, Willard Ave. (Rte. 173). 9am-1pm. Ed Matthews KC1JV, 68 Wildmere Ave., Waterbury, CT 06705

IL - PRINCETON - Hamfest & Computer Show. Bureau Co. Fairgrounds. Bruce Burton KU9A 815-795-2201. E-Mail: brburton@mtco.com

IN - ANDERSON - AGI Computer Fair. Holiday Inn (just off I-69). 10am-3pm. 317-299-8827

MD - UPPER MARLBORO - Computer Show. The Show Place Arena. MarketPro 301-984-0880

NY - QUEENS - Hamfest. New York Hall of Science

Events CALENDAR

parking lot, Flushing Meadow Park, 47-01 111th St. Arnie Schiffman WB2YXB, 718-343-0172 eves.

NY - UTICA - Computer Show. Utica Memorial Coliseum. 9:30am-4pm. MarketPro 201-825-2229

VA - MANASSAS - Hamfest & Computer Show. Prince William Co. Fairgrounds, I66 W. to Rte. 234, S. on Rte. 234 to Fairgrounds. 8am-4pm. Mary Lu KB4EFP, 703-369-2877

JUNE 7

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

MA - WEST SPRINGFIELD - Computer Show. Eastern States Expo. Center. 9:30am-4pm. MarketPro 201-825-2229

MI - GRAND RAPIDS - Hamfestival. Hudsonville Fairgrounds, 5 mi. W. of Grand Rapids off I-196 x-way. IRA 616-534-6803

OH - TOLEDO - Computer Show. SeaGate Convention Centre. MarketPro 301-984-0880

PA - LANCASTER - Computer Show. Holiday Inn Lancaster Host. MarketPro 301-984-0880

JUNE 7-8

FL - MIAMI - Computer Show. Dade Co. Fairgrounds. MarketPro 301-984-0880

MD - TIMONIUM - Computer Show. Maryland State Fairgrounds. MarketPro 301-984-0880

NY - LAKE GROVE - Computer Show. Sports Plus. 9:30am-4pm. MarketPro 201-825-2229

PA - MECHANICSBURG - Computer Show. Holiday Inn Harrisburg West. MarketPro 301-984-0880

TN - NASHVILLE - Computer Show. Tennessee State Fairgrounds. MarketPro 301-984-0880

JUNE 8

IL - WHEATON - Hamfest. DuPage Co. Fairgrounds, 2015 Manchester Rd. 708-442-4961

IN - FORT WAYNE - Computer Show. Memorial Coliseum. MarketPro 301-984-0880

KY - ERLANGER - Ham-O-Rama '97. Kentucky Lions' Park, 8 mi. S. of Cincinnati at the end of Sunset Ave. Robert N8JMV 513-797-7252 evenings

NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229

OH - SUFFIELD - Family Picnic & Computer Fest. Goodyear's Wingfoot Lake Park, 10 mi. E. of Akron off State Route 43. 8am-4pm. Ken Phillips K8CHE, 330-733-5795. E-Mail: kenphillips@juno.com

RI - WEST WARWICK - Computer Show. West Warwick Civic Center. 9:30am-4pm. MarketPro 201-825-2229

Continued on page 96

New Product News

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

NUTS & VOLTS MAGAZINE
NEW PRODUCT EDITOR,
430 PRINCELAND CT., CORONA, CA 91719

VT-180 SERIES

Products Intl., Inc. introduces the new VT-180 series of electronic voltmeters from Kenwood.

The Kenwood VT series of high-sensitivity electronic voltmeters enables RMS measurements of AC voltages. In this series, the basic VT-181 features full-scale sensitivity of 1 mV, a measurement frequency response of 5 Hz to 1 MHz, an indication accuracy of 3%, and an attenuator with 10 dB steps.

The VT-183 features virtually the same specifications, with the addition of up/down attenuator type autoranging to provide an additional labor savings.

The VT-182, also called a noise meter, is an ultra high-sensitivity model with 10 uV full-scale sensitivity. It has built-in weighted characteristics filters (JIS-A, DIN-NOISE, DIN-AUDIO, CCIR, and CCIR/ARM) and is also capable of average-value and peak-value detection, making it extremely valuable in measurements of low-level voltages such as noise.

The VT-186 (300 uV full scale) is a two-channel voltmeter with attenuators for each channel that can either be linked or set independently, thereby simplifying voltage measurements and comparisons between channels.

For more information, contact:

PRODUCTS INTL., INC.
8931 BROOKVILLE RD.
DEPT. NV
SILVER SPRING, MD 20910
1-800-638-2020
FAX: 1-800-545-0058
E-MAIL: SMPRODINTL@aol.com

TRIPLE ACTION SOLAR CAR KIT

This futuristic solar car is an exciting way to demonstrate the use of alternative energy. It features an aerodynamic sports car shell design, four-wheel chassis, powerful 1.4-volt, 350-milliampere solar cell, and a transparent plastic body that can be painted or left clear to display the car's inner mechanical construction. The steerable front axle, rear wheel, and adjustable (directional/angle) solar panel mount are all independent, so you can take the original body parts and create your own solar project.

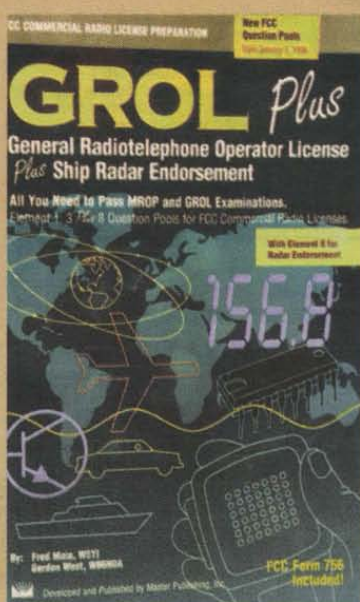
The Triple Action Solar Car Kit is convertible: The two-way source allows you to power the car by battery or solar, the kit design is an aerodynamic racer or tractor, and features a multi-speed transmission.

Suggested selling price is $39.95.

For more information, contact:

OWI INCORPORATED
1160 MAHALO PL., DEPT. NV
COMPTON, CA 90220-5443
310-638-4732 FAX: 310-638-8347

GROL PLUS



Gordon West announces the availability of his new *GROL PLUS* licensing book which covers 1,407 word-for-word questions, multiple choices, answers and explanations, for the newly updated FCC commercial radio examination Elements 1, 3, and 8. There are also new chapters on the global marine distress and safety system (GMDSS) including ship radar.

The fully illustrated, 496-page textbook contains the latest (effective January 1, 1996) question pools from which the marine radio operator permit, general radio operator license, and ship radar endorsement examinations are constructed. All questions are presented with their multiple-choice answers, and Gordon West provides the correct answer and a technical explanation on why the answer is indeed correct. Well-known commercial radio services educator and examination expert, Fred Maia, authors the Element 1 explanations, and also several chapters on commercial radio licensing regulations, spelling out when marine electronics personnel do or do not need a commercial radio license; which permit, certificate, and license or endorsement is required; and the examinations that must be passed to gain a particular license.

The *GROL PLUS* is available for $29.95 from most training schools.

For more information, contact:

NATIONAL RADIO EXAMINERS
2000 E. RANDOL MILL RD.
STE. 608-A, DEPT. NV
ARLINGTON, TX 76011
1-800-669-9594

AUDIO TRAINING COURSES FROM SHAKESPEARE ELECTRONICS

Shakespeare Electronics announces the availability of free audio cassette training courses.

The one-hour long audio cassette tapes have been developed and produced by Shakespeare Electronics with radio expert Gordon West developing and delivering the dialogue on the cassettes. The antenna cassette demonstrates how to select, install, and make best use of white fiberglass and stainless steel VHF antenna systems. On-the-air sound bites give audio demonstrations on what is meant by decibel antenna gain, marine antenna polarization, and the importance of selecting the right coaxial cable.

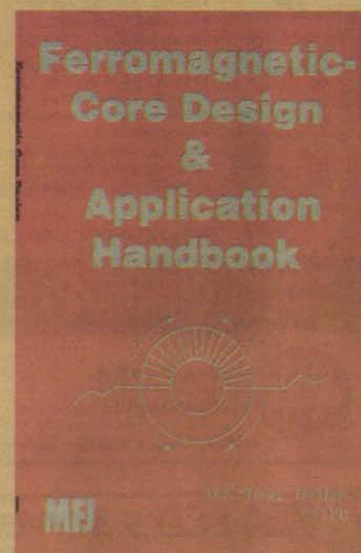
Unlike a simple talking cassette, the Shakespeare audio courses give graphic examples of how important a marine VHF antenna is by tuning into real-life VHF radio traffic.

The Shakespeare audio cassette on VHF antennas is available immediately, free to qualified instructors, as well as to United States Power Squadron and United States Coast Guard Auxiliary units. Shakespeare requests $5.00 to cover shipping and handling.

For more information, contact:

SHAKESPEARE FIBERGLASS & ANTENNA DIVISION
P.O. BOX 733, DEPT. NV
NEWBERRY, SC 29108
803-276-5504

FERROMAGNETIC-CORE DESIGN AND APPLICATION HANDBOOK



Ferromagnetic-Core Design and Application Handbook is available from MFJ Publishing for $19.95.

DeMaw gives you an in-depth understanding of basic theory and gives many practical circuit examples that use toroids, rods, and pot cores made of ferrite and powdered iron. All circuits were proven in the lab by the author.

Ferromagnetic-Core Design and Application Handbook gives you lessons about proper core selection versus operating frequency, circuit Q, power handling capability, and physical mass. DeMaw teaches how to avoid the wrong core material or misapplying the right core material that can ruin a perfectly good circuit.

For more information, contact:

MFJ ENTERPRISES, INC.
P.O. BOX 494, DEPT. NV
MISSISSIPPI STATE, MS 39762
601-323-5869 FAX: 601-323-6551
1-800-647-1800
WEB: http://mfjenterprises.com

Events CALENDAR

Continued from page 94

JUNE 13-14

GA - ALBANY - Hamfest & Computer Fair. GA Section Convention. Arthur Shipley N4GPJ, 912-439-7055. E-Mail: n4gpj@isoa.net

JUNE 14

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School.
Bill 909-822-4138 eves

KY - PADUCAH - "Dukefest." Executive Inn Convention Center. 9am-3pm. Craig Martindale WA4WBU, 502-444-6822 or 502-443-3860

ME - HERMON - Bangor Hamfest. Hermon High School. 8am-1pm. Roger W. Dole 207-848-3846

MI - MIDLAND - MARC Hamfest. Midland Co. Fairgrounds. 8am-1pm. 517-839-9371 eves.

NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229

OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880

VA - ANNANDALE - Computer Show. Northern VA Community College. MarketPro 301-984-0880

VA - ROANOKE - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880

JUNE 14-15

FL - ORLANDO - Computer Show. Central Florida Fairgrounds. MarketPro 301-984-0880

GA - KENNESAW - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827

KY - LOUISVILLE - Computer Show. Kentucky Fair & Expo Center. MarketPro 301-984-0880

MA - WILMINGTON - Computer Show. Shriner's Auditorium. 9:30am-4pm. MarketPro 201-825-2229

OR - SEASIDE - SEA-PAC Northwest Div. Ham Convention. Seaside Convention Center. Brad N7NVC, 503-657-1781

PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880

SC - CHARLOTTE - Computer Show. The Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229

JUNE 15

IN - CROWN POINT - LCARC Hamfest. Lake Co. Fairgrounds. Malcom Lunsford WN9L, 219-769-3925. 72202.230@compuserve.com

MA - CAMBRIDGE - Hamfest. MIT RS & Harvard Wireless Club. Nick Alternburnd 617-253-3776

MD - NEW CARROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880

MI - MONROE - Hamfest. Monroe Co. Fairgrounds, M-50 @ Raisinville Rd. 7:30am-1pm. Fred VanDaele 313-242-9487

NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229

OH - COLUMBUS - Computer Show. Ohio Expo Center. MarketPro 301-984-0880

VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0880

JUNE 21

CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827

NJ - DUNELLEN - Hamfest. Columbia Park, near intersection of Rte. 529 & 28. 8am-2pm. Bob Pearson WB2CVL, 908-846-2056

OH - NILES - Computer Show. Eastwood Expo Center. MarketPro 301-984-0880

VA - NORFOLK - Computer Show. Norfolk Scope. MarketPro 301-984-0880

JUNE 21-22

FL - FORT LAUDERDALE - Computer Show. War Memorial Auditorium. MarketPro 301-984-0880

GA - ATLANTA - HamFestival. City Hall East,

Continued on page 109

Don Lancaster's

RESOURCE BIN

number sixty three

A painless way to produce a student paper, fast.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja questing,* personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) *www.tinaja.com* — This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* and other columns.

You will get the best results if you have both *Netscape Gold* and *Acrobat Reader 3.0.* You download these from *www.netscape.com* or *www.adobe.com*

Creating a Research Paper

Okay, it's 11:43 pm and your semester paper is due at 8 am for tomorrow's class. So far, your extensive, careful, and dedicated research has more or less narrowed down a suitable range of possible topics. Sort of.

What to do?

I should not have to belabor all the obvious rules here: By far your best way to submit a thick report is to use thick paper. Form counts ridiculously more than content. So, be certain to use the glitziest materials, foil inlaid perfect bound parchment covers, and full color laser printing with bunches of fonts. Always be sure to place style over substance.

Make sure there's at least 23 entries in the bibliography. Always do make absolutely certain your instructor gets personally and lavishly referenced for not less than *one-third* of them.

But what if you also wanted to bust the curve by having actual *content* in your paper? Within your time frame, of course. And while never, but never, actually learning anything?

The trick is to hit the web running with a winning topic. One which your instructor has not heard of, but sorely wishes he had. And stuff that nobody else is likely to come up with.

Here is how it is done: Get on the web. Click to my *http://www.tinaja.com* — Next select the *Surf to interesting web sites* button. Select the *Web related sites* button. Select the *Search all sites at once* button. Then scroll to *Alta Vista.*

Punch the topic into Alta Vista. Get the first 20 or so entries, ignoring false hits. Or most weaker ones. Print the good guys out. Read all the sheets and mark them with a page highlighter. Scan or key in the highlighted words.

Print and submit your paper.

More on doing web research can be located on the *Webmaster* library shelf of *www.tinaja.com*

NEXT MONTH: Don shows methods to explore Usenet, newsgroups and newsletters.

Especially check RESBN60.PDF. Here are my current selections for a few sure-fire paper topics ...

Aerogels

Aerogels are the fifth state of matter that consist of a solid suspended in a gas. Sort of "solid smoke." Aerogels are astonishingly light and are superb insulators. They are often made from silicon, but carbon versions have been made from seaweed. Aerogels block heat and sound but freely pass light. Some now offer optical clarity good enough for energy efficient windows and skylights.

Other uses include everything from capturing tiny meteors to advanced batteries to light loudspeaker cones to desalinization of seawater.

One printed source of aerogel info is that *Journal of Non-Crystalline Solids.* An aerogel tutorial site can be found at *eande.lbl.gov/ECS/aerogels/sabib.htm* — An intro and aerogel resource list do appear in my MUSE112.PDF.

Archaeomagnetism

Any magnetic mineral or material has a *Curie point* above which it loses all its magnetic properties. If you heat anything above its Curie point, apply a magnetic field and then cool it, the strength and direction of the magnetic field should get "locked" in. Making a somewhat permanent magnet.

The earth's magnetic north pole is nowhere near true north. It wanders all over the lot. The poles might even suddenly *reverse* themselves. Literally flipping out. Both effects are caused by chaotic pertubations of the earth's magnetohydrodynamic field. Records of this *polar wandering* over time are readily found.

At any point on the earth, the pole wandering will create a change in the *declination* and *inclination* of the field vector. Take a ceramic pot with some iron minerals in it. Fire it. The heating removes all the previous magnetism. Then cool the pot. Your cooling locks in the inclination and declination of the earth's magnetic field.

Since most pots are fired rightside up, any piece of any pot should hold a record of the magnetic inclination that matches the polar wandering position at the time of firing.

Giving you a powerful prehistoric dating tool called *archaeomagnetism.* One that can tell you an absolute date if you already have a ballpark guess. Telling you how far distant tradeware pottery ranged. You'll have to be very careful to preserve the *exact position* of the pot before you make a lab test.

You could also find the last time a firepit was actually used. Once again, by carefully orienting a sample before you remove it for analysis.

If you are more interested in rocks than pots, you refer to the same effect *Paleomagnetism.* Then apply it to study the history of rock formations.

Or to study those polar wanderings all by themselves.

I did a tutorial way on back in the September 1969 *Electronics World* on pages 23-26+. Lots of newer material is easily found on the web.

Buckyballs

Until recently, a mere two forms of carbon were known to exist. Ultra-soft graphite and ultra-hard diamond. But a bizarre third carbon form was found only a few years

STUDENT PAPER RESOURCES

Academic Press 525 B Street Ste 1900 San Diego CA 92101 (800) 321-5068	**DTM** 1611 Headway Cr B2 Austin TX 78754 (512) 339-2922	**Jnl Infrared & MM Waves** 233 Spring St New York NY 10013 (212) 620-8495	**Netscape Gold** 501 E Middlefield Rd Mountain View CA 94043 (415) 528-3777	**Synergetics** Box 809 Thatcher AZ 85552 (520) 428-4073
Adobe Acrobat System 1585 Charleston Rd Mountain View CA 94039 (800) 833-6687	**Exar Corp** PO Box 49007 San Jose CA 95161 (408) 732-7970	**Jnl Non-Crystalline Solids** Box 945 New York NY 10159 (212) 633-7300	**Scientific American** 415 Madison Ave New York NY 10017 (212) 754-0550	**3D Systems** 26081 Ave Hall Valencia CA 91355 (805) 295-5600
American Scientist Box 13975 Research Tri Pk NC 27709 (919) 549-0097	**Harshaw Bicron** 6801 Cochran Rd Solon OH 44139 (800) 472-5656	**MER Inc** 7960 S Kolb Rd Tucson AZ 85706 (520) 574-1980	**Stratasys** 14950 Martin Dr Eden Prairie MN 55344 (612) 937-3000	**Vortec** 10125 Carver Rd Cincinnati OH 45242 (800) 441-7475

back. By selecting 20 hexagonal arrangements of six carbon atoms and then fusing them with 12 pentagonal groupings of five carbon atoms, a *hollow* geodetic pure carbon molecule of 60 atoms is created.

Because this hollow all-carbon C-60 molecule appears just like a geodetic dome or a soccer ball, it was named after the late Buckminster Fuller, one leading early proponent of geodetic dome structures.

Potential buckyball uses do include super lubricants, new batteries, ultra strong fibers, better semiconductors, and entire new classes of materials.

Buckyballs are now fairly low cost. One source is *MER*, short for *Materials and Electrochemical Research.* You will find a thousand or so web hits on this leading edge topic. My take on all this appeared as HACK43.PDF.

Magnetic Refrigeration

It would be wrong to call this a hot topic. Because it is really an extremely cold one. Brrrr.

As we saw with archaeo-magnetism, anything magnetic has a *Curie point.* Above which it is no longer magnetic. If you magnetize something, you raise its internal energy. If you then heat it above its Curie point, the magnetism "goes away." Releasing stored energy in the form of heat.

This process is sometimes called the *magnetocaloric effect.*

At some low temperature, you put energy in. At higher temperature, you take energy out. Other names for such devices are *heat pumps* or *refrigerators.*

Magnetic refrigeration is best suited for cryogenic and related lower temp apps. Although it someday may see a few room temperature uses.

Efficiencies as much as 40:1 better than mechanical systems are possible. One good material is gadolinium. The temperature range is carefully chosen so that the heat *source* ends up *below* the Curie point. And your *heatsink* is *above* the Curie point.

The horse's whatever paper on this is Andri Andreenco's *Magnetocaloric Effects in Rare Earth Magnetic Materials.* Appearing in *Soviet Physics Usp.* On pages 32-39 of Volume #8 for August 1989. I have got some references and background info in HACK33.PDF and HACK35.PDF.

Mass Teleportation

Lots of quiet progress has recently been made in this arcane field. Start with Barfoot and Gentry's tutorial in the *International Journal of Teleportation & Mass Transference.* Way on back in Volume XVIII, pages 1146-1198+. Also check out the construction project by Chediski, Colcord, and Elden in the same issue on pages 1245-1277.

A key component is the brand new short ultraviolet solid-state laser from *Atascotia Industries.* This $1.49 device has a 5.0 watt power rating (when it is properly heatsunk) and is quite easily coupled to any suitable dissociation or association chamber.

Using fiber optics.

Plug-in cards for both teleportation transmission and reception are newly offered for the more popular personal computers. For sane replication times, a 33K modem is needed. *Swampfelder Industries* is a leading supplier.

These mass teleportation cards are very much in demand by importers of specialty herbs and spices. The card's 4X long distance cloning feature can completely eliminate all of those long lines at Customs. It also lets you set your own foreign currency exchange rates as well.

Additional details appeared back in HACK16.PDF.

The Mystery Band

How far is it from radio to heat? A lot further than most people believe. Radio microwaves top out at 100 Gigs or so. Heat starts at 3200 Gigs. Leaving a humongous *five octaves* of largely unused and unregulated spectrum. A spectrum so vast that everyone in the world can have a dozen of their very own private HDTV stations.

Others refer to the mystery band as the *submillimeter wavelengths.* We are only now beginning to discover how to create signal sources, amplifiers, or oscillators at these frequencies.

Radio astronomers often use a pair of windows in this frequency range to listen to the universe. Sometimes by using a diode and downconversion to "Get out of Dodge."

Your untapped opportunities here boggle the mind.

The leading publication seems to be that *Journal of Infrared and Millimeter Waves.* Good web search keys include "submillimeter" and "Terahertz." I did an intro in HACK84.PDF.

Santa Claus Machines

Otherwise called *rapid prototyping.* Any scheme to construct solid objects from a data base or a comm channel. Letting you replicate a car part, a $20.00 bill, or a roast beef sandwich.

We already have a few of these RP machines available today. But most of them remain a tad pricey. Like a house and two cars. And so far, the roast beef sandwiches leave a distinct acrylic aftertaste.

But these are low in cholesterol and totally fat free.

One early RP method uses a laser to selectively harden a photopolymer. A second uses a scanning laser to sinter together zillions of very tiny metal or plastic spheres. A third is basically a high-tech glue gun extruding plastic string. A fourth uses inkjet techniques to selectively apply the hardener. You will also find a dozen or more "also ran" technologies competing for some really big megabucks.

Leading companies here are *3-D Systems, DTM,* and *Stratasys. The Edge* is a 3-D Systems house publication. My Santa Claus columns are HACK01.PDF, HACK36.PDF, and HACK47.PDF. See HACK77.PDF as well.

Solitons

A *soliton* is a very specialized pulse waveshape. One originally observed from a canal bank hundreds of years ago. A wave that "goes forever."

A soliton can have the remarkable property that it "rebuilds itself" as it travels along. Neither squashing itself together nor spreading out. Solitons demand a slightly non-linear media that they precisely interact with.

Solitons let you transmit fiber optic communications all the way around the world without repeaters. They are basically a way to communicate faster over longer distances.

One project I would sort of like to develop is a soliton water cannon. Or more correctly called a *monitor* or *deck gun* by us fire service folks. Effective firefighting streams tend to max out at 250 feet. There's lots of times when you'd want to reach a lot further.

Sure enough, when you turn your garden hose on and off suddenly, an initial "packet" of water spurts much further than the steady state stream. Can you "soliton" these packets into a controllable and effective long range stream? Big bucks here.

While long distance comm is your soliton biggie, the latest of studies are on microminiature *soliton circuits.* In which tiny wave pulses communicate with each other going over a special conductive nano scale plastic. These can reduce integrated circuit sizes by *thousands* of times.

There's tons of soliton info on the web. One fairly good print tutorial is Russell Herman's *Solitary Waves* in *American Scientist* for July-Aug 1992. I did a soliton tutorial and a resource listing back in HACK77.PDF.

Sonoluminescence

Sonoluminescence, otherwise known as "light from sound" is an emerging research topic having some stunning new uses. Take a small flask of water. Then couple it to a 25 KHz ultrasonic transducer. Cavitating bubbles should rapidly form.

Some of the collapsing bubbles will emit blue light!

What is apparently coming down is that the sonic energy gets spherically focused by as much as *12 orders of magnitude.* Their blue light is actually UV centered on 310 nanometers. The collapse heats the air at the center of the bubble to 10,000 degrees.

And possibly *much* higher.

Even more intriguing, all of these light pulses are a mere 50 picoseconds long. Future uses include generating light pulses for use in laser research and spectroscopy. And — just maybe — a new fusion-related energy source.

There's some 500 sono-luminescence hits on the web. Including some great tutorials. A construction project was in the

Scientific American for Feb. '95. In the *Amateur Scientist* column, pages 96-98. My own backgrounder is HACK73.PDF.

Thermolumnescence

Take a piece of limestone. Gently crush it and slowly heat it to kitchen oven temperatures. Chances are the powder will emit light. But only while being heated. And only while the heat is increasing. Cool it and repeat the process. Nothing happens. Why?

Ceramics, selected chemicals, and certain geological materials have tiny atomic features inside themselves that are called *traps*. Should some nuclear radiation show up, an electron might get blasted into a higher level trap. Heat the trap, and the blasted higher level energy gets released as a flash of light. Reheat it, and nothing happens because the trap is empty.

The higher the radiation, the more energy in the traps. And the more the recovered light on heating.

This light is *thermoluminescence*. Uses? Disposable dosimetry badges. Geological dating. Finding out if a potsherd is ancient or modern. (The old one will thermoluminesce. The modern one will not.) Lunar research because the moon thermolumineses.

Harshaw Bicron is one main source for badges and instrumentation.

McDougall's *Thermoluminescence of Geological Materials* is one text from *Academic Press*. Also see my ancient story on this in the March 1969 issue of *Electronics Now*. On pages 43-46.

Vortex Coolers

Take a magic "Tee" shaped pipe. An "empty" one having no moving parts. Blow air into the middle. Believe it or not, *cold* air comes out one end and hot air will come out the other. To -40 degrees, even.

These are often called *Hilsch Tubes* or *Ranque-Hilsch Tubes*. An adjusting screw can let you optimize for lowest temperatures, maximum cooling, or anything in between.

How does it work? By conservation of momentum. A high-speed hollow *vortex* gets created on your inlet side. Some of your air will go out your hot exhaust, while the rest continues as a vortex *inside* the input one.

Since the angular momentum of a smaller radius stream has to be lower, energy has to get transferred from the input stream to the output one. Thus heating input and cooling output.

Apps? Everything from cooling the needles on large sewing machines to keeping temperatures down inside of electronic cabinets.

Although the efficiency is typically rather low with a COP of only 0.4 or so, the actual energy goes in at the air compressor across the room. All the excess heat gets dumped out its own pipe. Unlike a thermoelectric device where heat from its incredibly poor efficiency ends up in the wrong place.

Two leading suppliers are *Vortec* and *Exair*. There's a rich selection of web sites on this subject. My intros are HACK35.PDF and ELEGSIMP.PDF.

Some Also Rans

I guess we are pretty near out of room. Other workable paper subjects include GPS (MUSE92.PDF), Fibonacci Sunflowers (in MUSE89.PDF), Electric Discharge Machining (HACK60.PDF or HACK63.PDF), Fractals (HACK25.PDF and HACK47.PDF), and Wavelets (try HACK38.PDF and HACK49.PDF).

This Month's Contest

For our contest this month, just tell me any sure fire winning subject for a student paper. One that meets the guidelines we just looked at. Or send me a copy of your paper on any of the above topics. Or one that belongs on the list that I've overlooked.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

Send all your *written* entries to me here at *Synergetics*, rather than to Nuts & Volts editorial. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at ***(520) 428-4073****, besides offering all of his own books, reprints, and consulting services. Don also offers a free catalog full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.*

Don is in the process of setting up his Guru's Lair at http://www.tinaja.com

Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his US Internet address of ***don@tinaja.com***

WE' VE BEEN MOVED !
Due to Popular Demand !

COLOR TV, 8MM VCR, VIDEO MONITOR, Cable Ready Too!

We have just received a limited quantity of these feature packed 5" Color TV/Monitor and 8mm VCR combo units. These new or like new Memorex, Model 17's can be used almost anywhere with the included AC adapter and 12VDC power cord. Perfect for operation in your car, RV or boat. The cable ready 179 channel tuner can record TV programs or surveillance transmissions from our TVX-100 right off-the-air. Other features include: A flying erase head for smooth transitions between recordings, Digital auto-tracking, Auto channel memory programming, Real time counter with memory, Dual speed playback, Audio video in/out jacks, Telescoping antenna, On screen display of TV and VCR functions, Built in handle and Tilt stand, Top loading tape. This unit has it all. The ideal system for quick turnkey surveillance or child monitoring.

MODEL 17, 8mm VCR/TV........$399

$4500 SURVEILLANCE SYSTEM NOW $599!!

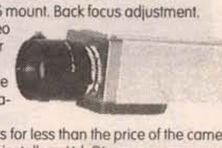
- MOTORIZED, 6X or 10X ZOOM LENS
- MOTORIZED, 360° CONTINUOUS PAN
- MOTORIZED, TILT up to 90°
- PHILIPS HIGH RES. 1/2" CCD CAMERA
- OPAQUE BLACK INNER DOME
- CLEAR ACRYLIC OUTER DOME

Walk into any major dept. store and you will see these fully integrated systems in use. From the same mfg. who supplied the Atlanta Olympics! These late model, new in the box systems are virtually ready to use. All you add is power and toggle switches for remote control. Philips CCD camera, 450 lines res., 0.05 Lux sensitivity! The CCD is their best grade. All anodized aluminum construction. Camera plus Pan & Tilt are powered by external 24VAC. Zoom lenses are powered by external 6VDC. Integrated lens controller with camera power supply available. Size of dome: 14"diam. Includes mout for drop ceiling. Two models: The 6X, f1.2, or the 10X f1.8 system. Ltd. Qty. **MODEL 6X............$599 MODEL 10X..............$699**
LENS CONTROLLER w/CAMERA PWR. (for either model)....$199

SEE IN TOTAL DARKNESS, New model, CCD

micro camera suits many applications. The GM-164B-IR has a 78° FOV, provides 410 Lines resolution with 0.1Lux sens. AGC and Electronic shutter. Low power 12VDC @ 225mA operation, (with 6 IR LED's illuminated). Invisible, 780nm, Infrared LED's allow observation in total darkness up to 15 feet. Perfect for garage, door, or hallway. Size: 1.9" square. X 1d" First quality.. **GM-164B-IR...$119**

1/2" COLOR CCD CAMERA, New JVC TK-885U, Industrial Quality, 330 Lines, Auto Iris Lens



Rugged aluminum housing. Standard C or CS mount. Back focus adjustment. Removable 1/4-20 mounting plate. NTSC video on BNC jack. Four pin auto iris jack. DC power screw terminal strip. (What could be easier?) External AGC on/off, Adjustable white balance and normal or fast 1/1200 shutter speed. Ultra-fast, CANON 6mm, f1.2 Auto Iris lens. A no nonsense, color surveillance camera and lens for less than the price of the camera alone! You can't touch this for less. Perfect for installers. Ltd. Qty.

Camera with A/I Lens and DC adapter.........$229
Camera less lens...$179

SONY, 450Line, 8X, NTSC & Y/C OUT COLOR VIDEO CONFERENCE CAMERA,

Serial Control of all functions: Pan, Tilt, Zoom, Auto Iris Auto Focus. Like having your own R2D2, Intended for high end use in fortune 500 board rooms. The video performance is absolutely stunning. Superior to anything we have seen. Camera and lens is an integral assembly. Excellent Condition. Rugged black ABS enclosure. Mini-DIN I/O. 8"Dx6.5"H. Sorry, we have no data on using the serial port. The units self test on power up and the video is active. 1993 price over $4K. We were sold out but managed to obtain another small quantity. Don't be left out. **Conference Camera............$299ea.**

MICRO CAMERA, w/audio

1/3" CCD, 420 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. 9VDC @100mA, Std. model, 3.7mm, 78° FOV lens, Pinhole, 72° FOV. A real glass lens.Both focus from 10mm to infinity. WHY BUY DISCONTINUED OR SURPLUS? Std. NTSC video out. 1/2 once! SENSITIVE to IR. Size Std: 1.2"sq. x 1"d. PH is .75"d,Both with 8" leads.
WARNING: Don't be dissappointed by LOW RESOLUTION, HIGH LUX C-MOS CAMERAS. They may be lower on power but they are much lower on performance. They are cheap for a reason.
GM-1000-STD,..$99 GM-1000STD/Audio,..$119
GM-1000-PH,....$99 GM-1000-PH/Audio....$119

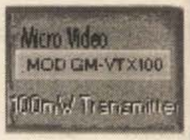
SEE in TOTAL DARKNESS! InfraRed SPOT or FLOOD! NOW, WEATHER PROOF!

Architectural bronze colored aluminum housing. Tilt and swivel adjustable. Can be mounted to any std,. electrical box, as well as pole or ground mounted. Halogen powered. 60Watt, 110VAC, Military quality IR filter. Projects up to 50 feet. Size only 3"Diam. x9"L including base. Specify spot or flood.
High Power IR Source Special.....$149

RADIOLOGICAL SURVEY METER, Civil Defense type.

Designed to determine contamination levels in the event of a nuclear disaster. Hermetically sealed ionization chamber type sensor. Simple transistorized circuitry will operate up to 150 hours from one "D" cell. (not incl.) Measurement range 0.1R to 500R per hour in four ranges. Accy. is 20% over -20° to +125°F, RH to 100%, alt. to 25,000ft. Indication on meter. Only 3.5lbs., Size: 8.5"L x 4.5 "W x 6.5"H, Bright yellow aluminum case w/red and blue "CD" logo. Manual w/ schematic included. UNTESTED **Special............2/$39**

WORLDS SMALLEST VIDEO TRANSMITTER, Incredibly only 1.15" x 0.8" x 0.4" in size.



Transmits crystal controlled hi-res. images with 100mW output! The transmitter you've been waiting for. **Shown actual size.** Much smaller than the 9V battery which powers it. Draws only 35mA! Factory tuned ready to receive on cable channel 59. Will work with color or B&W cameras. UHF Bow tie antenna with balun, 3' F cable and adapter for TV Included. Perfect with our GM1000 PH camera and Memorex TV/RECORDER shown at Left. Can fit in a cigarette pack!

TVX-100....$199. TVX-100 with GM-1000PH Camera....$299.

LASER OPTICS and ACCESSORIES (see photos below)

A. MIRROR GALVOS, Closed Loop, X/Y NOT SHOWN, with 25mm, first surface mirrors. Galvos are General scanning model Z1483. Both are pre mounted on a black anodized aluminum plate and pre aligned for operation....**Pair/$249**

B. SPATIAL FILTER, NOT SHOWN, Rugged machined aluminum construction with pinhole adjustment screws. Removed from system. No Specs...................**$29**

C. CUBE BEAM SPLITTER w/FREE EG&G detector & signal conditioner board. EG&G, SGD 100A detector mounted at the approx. 7% split output of a 13mm cube beam splitter. Transmission is about 85% straight through. The signal conditioner board operates from +- 15 VDC. All optical components are mounted on a anodized adjustable mount. Good condition. **$29**

D. NEWPORT XYZ MOUNT, model 462M with 25mm travel micrometers. Like new condition. All stainless steel construction. Ultra precision.
Newport price..........$1150 Our Price.................$495

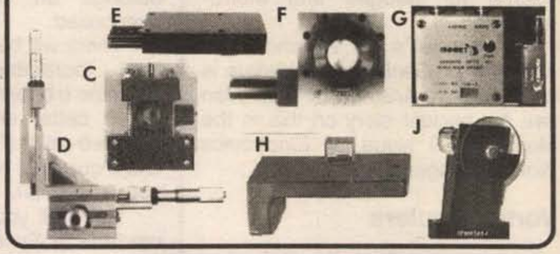
E. LINEAR SLIDE, NEAT Model SC300, Anodized aluminum, construction. Ball bearing, 50 lbs. capacity. Like new, but scratched on the edge where a dummy used a utility knife to open the boxes. Size: 1.75"Wx4"Lx.75"H with 3.4" travel.
Reg. Price.................$86ea. Our Price.....$35ea. 3/$89

F. NEWPORT MOTORIZED ROTARY STAGE, model 495A, NEW. Bidirectional 360° continuous rotation with 0.001° resolution. Integral DC motor and precision encoder. Load independent velocity servo. Can be mounted in any orientation. Load capacity: 55lbs. Size: 4.75"x5"x1.35" With 2" clear aperture.
Newport price............$2141 Our Price..................$595

G. ACOUSTO-OPTIC MODULATORS, Isomet #222E driver & 1205C-1 AOM. Connectors on driver and crystal. (cables supplies) AOM mtd. on alum. riser/base. Optical height 46mm. 28VDC power. Mint cond. No other specs.......**$49set**

H. CUBE BEAM SPLITTER, 13mm Two precision right angle prisms, flat to two waves, Bonded and AR coated. Permanantly mounted on alum. plate. Split approx: 88% thru, 6% split **Our Price...........$15ea. or 2 for $25**

J. VARI-DENSITY BEAM SPLITTER, Motorized, 50mm diam. wheel, mtd. to 3VDC mini gearmotor. Includes a 5mm PV cell for feedback. Machined riser base. Optical center 46mm high. Size: W63mm x H92mm x D69mm. Mint cond. **$79ea.**



BROADBAND LINEAR AMP., DC to 500MHz, Comlinear, CLC100, Machined alum. housing w/SMA connectors.

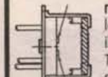
GAIN: 20dB	FLATNESS: .05dB typical
NOISE: 20uv	IMPED: 50 ohms
OUTPUT PWR: 12dBM	SIZE: 1.9"x4.1"x1.1"
SMA CONNECTORS	PWR: ±.15VDC @ 40mA.

ORIG.OVER $325 OUR PRICE.$49.95

WEATHER RESISTANT Camera Enclosure

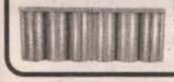
Solid extruded aircraft aluminum .Size: 3.5"W x 3.7"H x14"L, Glass window.
NEW,............$59ea.

IR LASER DIODE, 5mW, SHARP LT022MD, Brand new!



Popular 5mw, 780nm laser diode. Excellent for laser communications, alarm systems, covert illuminators etc. Highly visible to CCD cameras. These must be protected from excess current and static electricity. Individually tested. **$7.95, 3/$20**

GATES GEL PACKS, 12 to 48VDC, @ 8 to 32Ah,



Each pack is 12V 8Ah. Pack size: 2"Wx4"Hx11"L, **$10/pack or** Metal box w/4 packs, (can be wired in series or parallel) **super deal $29**

NEW! Now operate from 4.5 to 9VDC !

SPECIFICATIONS:
DC Power: 4.5 - 9V, @65mA
Power out: 4.5mw max.
Range: 100-800 Meters
Glass Collimator
Size: 0.41"diam.x0.7"L

Shown Actual Size

670nm................$35
650nm................$45
635nm................$69
***635F adj. focus...$79**

The best value quality available for commercially made, Subminiature, laser modules. A glass collimating lens provides 1.5mRad performance. (divergence comparable to HeNe lasers.) Wide input range, internal surface mount, 4.5 to 9VDC power supply. Machined brass package for excellent thermal characteristics. Truly a quality laser module.

Our Exclusive "LAB STYLE" LASERS, 650nm and 635nm, Rugged, Dependable. One year warranty.

Adjustable X and Y beam position. Aircraft aluminum housing. Internal battery and on-off switch included. Makes a super pointer. .75d x 2.75"L

650nm LABLASER....$79 635nm LAB LASER.......$119

ARTICULATED BEAM DELIVERY ARM for CO2 LASER.

Precision anodized aluminum constuction. Smoothly counterbalanced for fingertip control. Arm has seven degrees of freedom. Direct reflecting system with gold mirrors. Approximate reach is 6 feet! Very good condition. Removed from medical laser system. A rare find, perfect for use with our sealed CO2 lasers. **Only one available..........$1495 with 60W Laser Head $2495set**

We are looking for Thermal Imagers, Image Intensifiers and other unique or esoteric, electro-optics and devices.

MOUNTED, FRONT SURFACE MIRRORS,

adjustable. Each 1.5" diam adj. mirror cell holds one 14mm FSM. Mounts are easily removed from sturdy solid aluminum base. Four allen screws for adj. Single mirror base unit is: 5.25"H x 3"W x 1.6"D, Daul mirror base unit is: 4"W x 3"D x 2.75"H Perfect for home holography. Removed from system.
Single Mnt..$15.95 3/$45 Double Mnt..$19.95 3/$50

MOTORIZED ZOOM LENSES,

All models are new or like new. Fabulous hi-res. optics with standard C-Mount. Superior Fujinon, Vicon and Computar lenses would cost from $400 to $1500. Now you can afford the best. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. The Auto iris models have a built in EE amp which uses the camera video output for control. They will work with any camera whether or not it has an "auto iris" connector. Use with our GM410 for a long range stealth-cam!

Type	Focal Length	A/I	Price
B:	11 to 110mm, 10X, f1.8	NO	$299
C:	11 to 110mm, 10X, f1.8	YES	$399
D:	12.5 to 75mm, 6X, f1.2	NO	$149
E:	8.5 to 51mm, 6X, f1.2	NO	$199

RESOURCES UN-LTD.

NOTE NEW ADDRESS: 300-F BEDFORD STREET , MANCHESTER, NH 03101
VISA, MC, AMEX, DISCOVER, COD. ORDER: 800-810-4070 TECH. 603-668-2499 ORDER FAX: 603-644-7825 E-MAIL unltd4u@tiac.net

Write in 32 on Reader Service Card.

POWER UP

TO THE FUTURE with the

FCC & U.L. APPROVED

MOST ADVANCED INTERACTIVE CABLE CONVERTER YOU CAN BUY.

NAVIGATOR II

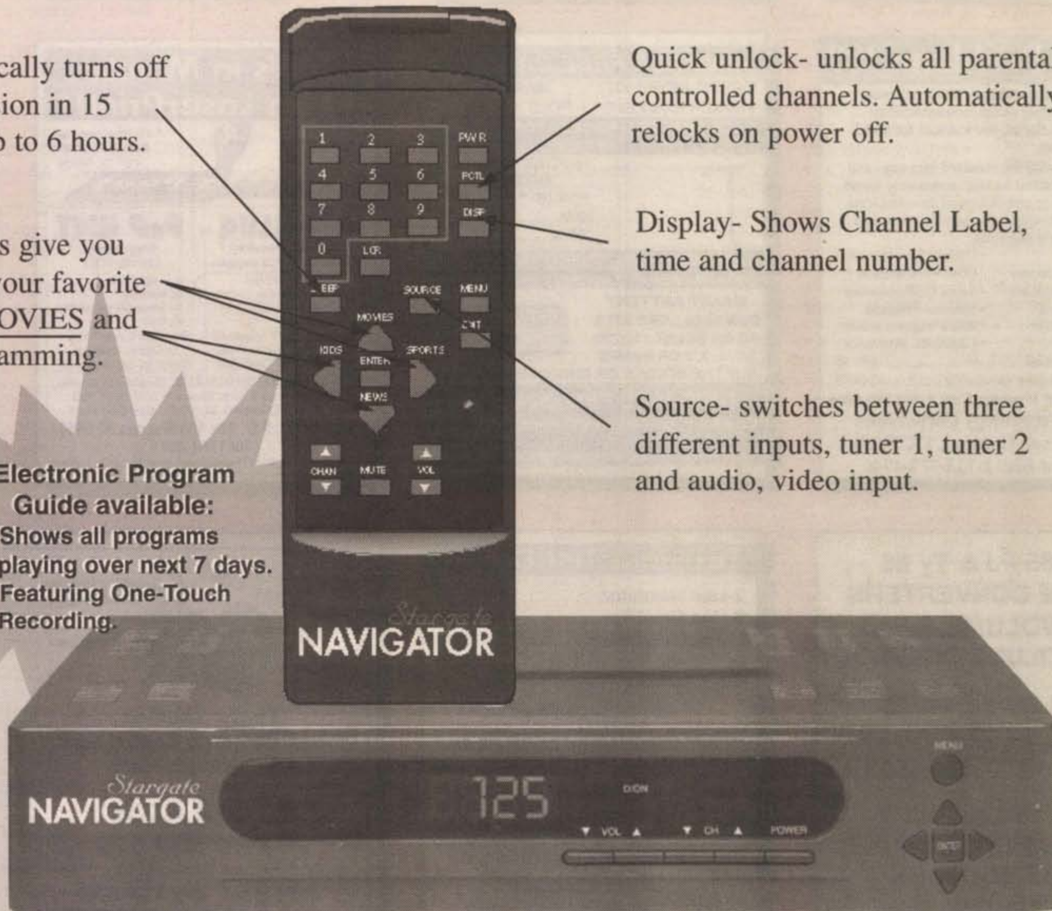
Sleep timer automatically turns off Navigator and television in 15 minute increments up to 6 hours.

Dedicated theme keys give you one touch access to your favorite SPORTS, NEWS, MOVIES and CHILDREN'S programming.

Quick unlock- unlocks all parental controlled channels. Automatically relocks on power off.

Display- Shows Channel Label, time and channel number.

Source- switches between three different inputs, tuner 1, tuner 2 and audio, video input.



Electronic Program Guide available:
* Shows all programs playing over next 7 days.
* Featuring One-Touch Recording.

- ✓ INTERACTIVE COLOR ON SCREEN PROGRAMMING
- ✓ CABLE CARRIER (HRC, IRC, STD) AUTO DETECT
- ✓ DUAL TUNERS WITH 125 CHANNEL CAPACITY
- ✓ DATA TAPS ALLOW FOR ADDRESSABILITY AND PROGRAMABILITY
- ✓ MODULAR CARD SLOTS ALLOW EASY UPGRADES.
- ✓ ADVANCED USER FRIENDLY PARENTAL CONTROL FEATURES, INCLUDE CHANNEL LOCKOUT, CHANNEL TIMERS AND V-CHIP READY.
- ✓ OVER 100 PRELOADED PROGRAM LABELS SUCH AS CNN, MTV, ETC.

NEW ELECTRONICS 800-228-7404

INFINITE ELECTRONICS 888-597-1599

MILLENNIUM ENTERPRISES 800-715-6789

IMAGE ELECTRONICS 800-215-9412

Science & Electronics Supplies

B/W CCD Video Camera

B/W CCD Camera
Surveilance & Robotics.
.03 Lux - 430 TV Lines
Size 1-1/4" x 1-1/4"x 1-1/8"
Power 12VDC
Light Weight 1/2 oz.
CAM-04 $85.00

Free Catalog

Solar Engine Kit

Complete solar power plant w/ motor for Beam style robotics Solar Engine Kit
SLE-10 $19.95

Components

Air Muscle $16.75
Bend Sensor $ 5.00
Stepper Motor $10.00
Digital Comp $14.95
Servo Motor $ 16.00

Visit us on the Internet
http://www.imagesco.com
Images Company
PO Box 140742
Staten Island NY 10314
(718) 698-8305

SURPLUS SALE

200,000 WALL TRANSFORMERS

3.6 VDC....900 MA.....2.25
12 VDC....100 MA.....1.10
12 VDC....500 MA.....1.75
12 VDC....800 MA.....2.10
14 VAC....500 MA.....1.75
16 VAC....1.25 A.......2.95
Min 1000/type - - Call for other types

SURPLUS TRADERS
PO Box 276,
Alburg, Vt. 05440
Tel: 514-739-9328
Fax: 514-345-8303
FREE CATALOG!

PROGRAMMERS OVER 50 MODELS

ADVANTECH EETOOLS NEEDHAMS DATA I/O ICE TECHNOLOGY HILO SYSTEM GENERAL CHROMA MODULAR CIRCUIT TECHNOLOGY XELTEK

PROMAX EMP-20 MEGAMAX MEGAMAX4 SIMM/SIP TESTER EMUPA

CALL ADVANTECH LABTOOL	599 EETOOLS SIMMAX
629 ICE TECH MICROLV	795 CHROMA SIMM/SIP
650 EETOOLS ALLMAX +	359 MOD-MCT-EMUPA/R
409 EETOOLS MEGAMAX	279 MOD-MCT-EMUP/R
509 EETOOLS MEGAMAX4	49 EPROM 1G TO 512K
369 XELTEK SUPERPRO II	69 EPROM 1G TO 1MEG
409 XELTEK SUPERPRO II P	99 EPROM 4G TO 1MEG
249 XELTEK SUPERPRO L	199 EPROM 16G TO 1 MEG
165 XELTEK ROMMASTER II	89 EPROM 1G TO 8MEG
479 MOD-MCT-EMUPA	129 EPROM 4G TO 8MEG
739 STAG ORBIT-32	250 EPROM 8G TO 8MEG

LABTOOL48 MICROMASTER SUPERPRO ALLMAX PLUS ROMMASTER2

General Device Instruments
Sales 408-241-7376 Fax 241-6375 BBS 983-1234
Web www.generaldevice.com E-Mail icdevice@best.com

BCD electro

We'll Buy your excess Inventory

IC's, Transistors, Diodes, capacitors, trimpots, etc. etc.
•Purchase outright
•Consignment
•Partnering agreements
Send your excess list for a quick offer!
Contact Bob Harris
Phone (214) 343-2170, FAX 1854
email - bcdelect@onramp.net
web - http://www.bcdelectro.com

Serial Problems???

Use your PC compatible desktop or laptop computer to debug serial communications problems with **Serial**, our test tool for serial communications.

Serial works with the standard data rates and asynchronous serial formats commonly found in modern office and industrial environments. Suitable for development, service work, and end-user problem diagnosis.

- Easy to Use
- Menu and Windows
- Highly Configurable
- Contextual Help
- Autobaud Detect
- Time Stamping
- Custom font editor for EGA/VGA Screens
- Saves Configurations
- Extensive Manual
- Block transmit ability
- CRC/LRC generation

Serial, with manual $99.95
Cable for full duplex monitoring $49.95

For Orders and Inquiries Call: 1-800-980-9806
Allison Technology Corporation
8343 Carvel, Houston, TX 77036
FAX and BBS 1-713-777-4746

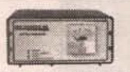
SEND FOR FREE CATALOG

CURTIS KEYER KIT MARCONI
VIBROPLEX® KEYS J- POLE ANTENNAS
CODE PRACTICE OSCILLATOR KIT. SEE ARRL'S NOW YOU'RE TALKING! ..$23.45 PP

HI-POWER MARCONI ANTENNAS
FOR UP TO 1500 W.
80 M. ....$71.45 PP
160 M. ....$86.45 PP

JADE BOOK: HARD TO FIND ENGINEERING DATA, HUMOR, FOLKLORE .... $ 6.00 PP

SMART BATTERY CONTROLLERS KITS
AC OR SOLAR 110/220
1/2, 1, 3, 5 OR 6 AMPS
BUY THE MODULE OR ENCLOSED VERSION



1-800 JADE PRO (523-3776)
Check our specials on www.jadepro.com/
VISA, MASTERCARD, AMEX, NOVUS, CHECK OR MO
JADE PRODUCTS INC. E. HAMPSTEAD NH 03826-0368

PCB's in Minutes From LaserPrint!*

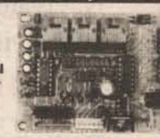
8 1/2" x 11" Sheets
* Or Photocopier Use household iron to apply.

PnP BLUE	or	PnP WET
For High Precision Professional PCB Layouts		Easy Hobby Quality PCB's
1. LaserPrint 2. Iron-On 3. Peel-Off 4. Etch		1. LaserPrint 2. Iron-On 3. Soak-Off w/ Water 4. Etch
Adds an Extra Layer of Resist for Super Fine Lines on Std Clad Bds		Transfers Laser Printer or Copier Toner as Resist to Std Clad Bds

20Sh$30/40Sh$50/100Sh$100 Blue/Wet (No Mix)
Sample Pack 5 Shts Blue + 5 Shts Wet $20
VISA/MC/PO/CK/MO $4 S&H -- 2nd Day Mail
Techniks Inc. P.O. Box 463 Ringoes NJ 08551
(908)788-8249
100% Money Back Guarantee!-Dealer Inquiries Invited

Convert RS-232 to RS-485 or TTL/CMOS for Only $49.00

Communicate up to 4,000 feet, at up to 1 MEGA—BPS, full or half duplex, up to 32 units on one serial link, with 31 jumper options for flexible configuration, LED indicators.



COMMUNICATIONS CONVERTER

- FULL SCHEMATIC AND DOCUMENTATION
- FULL FAMILY OF MODULAR DESIGNS
- RS-485/RS-422 REMOTE I/O MODULE KITS
- NETWORK SOFTWARE AND SOURCE CODE
- AUTOMATIC OR RTS UNITS AVAILABLE
- RJ-11/12 CONNECTORS OR TERMINAL STRIP
- TURN YOUR PC INTO A DISTRIBUTED DATA ACQUISITION AND CONTROL SYSTEM

R.E. SMITH
(513) 874-4796
4311 TYLERSVILLE RD. ■ HAMILTON, OHIO 45011
FAX (513) 874-1236

TV 85 PJ & TV 86 CABLE CONVERTERS VOLUME & NON-VOLUME CONTROL

SALES/SERVICE
VOICE 1-800-473-0506
FAX 1-800-488-0525

FOSS WAREHOUSE DISTRIBUTORS
285 Schenck St.
N. Tonawanda, NY 14120
www.fossw.com

TELEPHONE TEST DEVICES

2 Line Simulator......... $185.00
7 Line Simulator......... $399.00
Caller ID Simulator...... $395.00
20 HZ Ringing Module $49.95
9-1-1 Training System $370.00
** * * And Much More * * **

Check out our Web Site for detailed info about our unique line of test equipment. The CID-max Caller ID Simulator is a stand alone test unit that generates 10 different Caller ID messages per the Bellcore Specs!

Call John Today!
http://www.infinet.com/~jectech
1-800-631-0349

While They Last!

Quantity Pricing Available

Peltier Junction What's your function?
1 3/16 x 1 3/16 cooling area

Peltier Junction (Thermoelectric Cooler) with heatsink and leads
$15 EACH OR TWO FOR $25

plenty of technical uses

TOUCH-SENSITIVE TRACKPAD SUBASSEMBLY
Originally designed for Apple PowerBook 500 series
ONLY $10 EACH

Shreve Systems
318-424-9777
Ask for Jake

Returns subject to a 15% restocking fee. Prices are subject to change without notice.
WE ACCEPT VISA, MASTERCARD, AMEX, DISCOVER
http://www.shrevesystems.com

SPECIAL

ALL MAJOR BRANDS · ALL GUARANTEED

MICRO-PROCESSORS	EPROM	MEMORY MODULES	
PIC 16C54	2716	1MEGX32 SIMM	
PIC 16C56	2732	2MEGX32 SIMM	
PIC 16C57	27C64	4MEGX32 SIMM	
PIC 6C58	27C512	**CONTROLLERS**	**PROCESSORS**
GAL 16V8LP	27C256	8748	80C31
GAL 20V8LP	27C128	8749	8255
GAL 22V10LP	27C010	8751	8254
STATIC RAM	27C020	87C51	8253
6116	27C040	8752	8284
6264	27C080		8275
62256			8259
628128			

AND MUCH MORE . . .
WE BUY YOUR EXCESS INVENTORY
SINACO ELECTRONICS 818-705-1880 FAX 818-705-1881

ADAPT-11 • 68HC11 Module for Solderless Breadboards & Embedded Applications

•low-cost, versatile, compact (2.8" by 1.7") module
•reset circuit, pushbutton, & mode select switch
•RS-232 interface, 5V regulator & external power connector
•I/O lines brought out to breadboard-compatible header

Starter Package (AD11-SP) has ADAPT-11 module, 68HC811E2 microcontroller (2K EEPROM on-chip), PC serial cable for downloading code, Motorola Programming Reference Guide, User Manual, freely distributable 68HC11 software, & ADAPT-11 demo program. US $74.95 + $5 S&H (discount available for qty 5 or more)

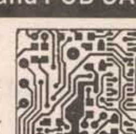
NEW MODULES
• **ADAPT-11C75:** Module for use with 68HC11 & X68C75 (adds 8K EEPROM + dual I/O ports); same size/pinout as ADAPT-11...from US $48, depending on configuration.
• **ADAPT-11C75DX:** Same as above, but includes 32K SRAM on a slightly larger board (2.8" x 2.1"). Use with a 68HC711E9 to get 12K EPROM, 8K EEPROM, and 32K RAM, all on one compact board! ...from US $87.
• Choice of 6 header styles for the ultimate in flexibility!

Use any PLCC with your solderless breadboard! Socket adapters for most PLCC sizes, from $7.50 Solderless breadboard adapters also available for DB9 & DB25 connectors, and IDC (ribbon cable) connectors.

TECHNOLOGICAL ARTS
voice/fax: (416) 963-8996 www.interlog.com/~techart
309 Aragona Blvd., Suite 102-418, VA Beach, VA 23462
1644 Bayview Ave., Suite 1704, Toronto, ON M4G 3C2

NEW BOARDMAKER SCHEMATIC and PCB CAD

For IBM PC and compatibles



BOARDMAKER
Entry Level — Only **$95**
Easy to use
Dot matrix, laser, plotter
Gerber & NC drill output

Advanced — **$395**
Accepts netlists
Design rule checking

Board Capture — **$395**
Full feature schematic capture

Board Router — **$200**
Gridless autorouter

Free Demo

OHIO AUTOMATION Inc.
7840 ANGEL RIDGE ROAD
ATHENS, OHIO 45701
(614) 592-1810
Visa & MasterCard Accepted

This Could Be
YOUR AD

Read by thousands of electronics consumers.

For information, write or call:
Nuts & Volts Magazine
430 Princeland Ct., Corona, CA 91719
(909) 371-8497
FAX (909) 371-3052

Get up to speed *fast!*

Quick PIC

PIC 16Cxx/17Cxx MicroControllers

Manuals, Kits, Boards
Ready-to-use
Software & Hardware

Data Acquisition, Sensors, Transducers, LCD, RS232 Interfacing

Easy-to-use, easy prices

For more information, contact us at:
http://www.QPIC.com
info@QPIC.com
(603) 643-8243

Quick PIC

MicroBoards

Prefab, PIC based, tiny, low power, industrial, building block solutions to

Data Acquisition, Sensors, Interfacing, Data Logging, Process Control

Connect to each other and the outside with high speed RS232/485.

Cost effective and easy-to-use.
Many applications can be put together in less than 20 minutes.

CCTV SPECIALS

Panasonic WV-BP312
1/3"B/W CCD Camera

0.06 lux @ f1.2
570 line resolution
12vdc • C/ CS mount
ALC or Electronic Shutter
OVERSTOCKED!
$259

Panasonic AG-RT600
40 hour Real Time VCR

8/24/40hr
Time/Date Generator
Auto Repeat Recording
Alarm Search • Alarm Input
Auto Rewind • Tape End Alert
$749

Panasonic Industrial
AG-720 • Miniature VHS VCR

12vdc • Under 5 pounds
Small! 9.75 x 3.5 x 8.2 in.
2/6/8 hour Audio & Video
S-VHS Model Available
NEW!
$895

Computar
CEC-E38 • 1/3" B/W Camera

380 lines • 9 VDC
45 or 70 degree lens
BNC Video • power strip
Indoor wall/ceiling mount
$169

DETECTION DYNAMICS

Panasonic Color Cameras from $395 • Board Cams
Quad Splitters $415 & up
OEM & Dealer Discounts

4700 Loyola Lane, Suite 119 Austin, Texas78723
(512) 345-8401 • FAX 926-0940
CCTV CATALOG $5.00 - REFUND W/PURCHASE

EPS

EPROMS AS LOW AS **50¢**

27C256	27C040	27C1024	87C51
27C512	27C400	28F010	8751
2732A	27C4096	28F020	8755
27C32	574000	28F040	68705
27C128	574200	8749H	2564
27C64	27C402	8748H	2516
2716	27C020	8741	
2708	27C210	8742	
27C512-90	27C010	8744	

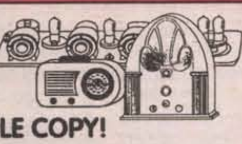
PROCESSOR: 8255, 8254, 80C31, 8219, 8202, 8253, 8284

STATIC RAM	MEMORY
6264	1X1 SOJ-DIP ZIP
62256	1X4 SOJ-DIP ZIP
6116	4X1 SOJ ZIP
2016	256X4 SOJ-DIP ZIP

Many more parts in stock. Call us for all those hard-to-find ICs and this month's special. Also memory for all PCs & laser printers.

TEL: (818) 774-9444 • FAX: (818) 774-0822

WE BUY EXCESS INVENTORY



FREE SAMPLE COPY!

ANTIQUE RADIO CLASSIFIED

Antique Radio's Leading Monthly Magazine

Articles – Classifieds – Ads for Parts & Services. Also: Ham Equip. – Books – Telegraph – 40's, 50's & 60's Radios – Early TV – Auction Reports & more...

1-Year: $38.95 ($55.95 by 1st Class)
6-Month Trial - $19.95. Foreign - Write.

A.R.C., P.O. Box 802-G19
Carlisle, MA 01741
Call: 508-371-0512 — Fax: 508-371-7129
Web: www.antiqueradio.com

EQUIPMENT FOR SALE

ELECTRONIC TEST

Tektronix	EXT 330
Hewlett-Packard	EXT 331
Other Manufacturers	EXT 332
MEASURE & INSPECT	EXT 333
VIDEO PRODUCTS	EXT 370
SCIENTIFIC & LAB	EXT 335
LASERS	EXT 340
POWER SUPPLIES	EXT 334
COBWEB CORNER MFG	EXT 380
COMPLETE INDEX	EXT 300

To obtain information via FAX: A) Have your fax number ready. B) Dial 1-800-547-4636. C) Request above Extension Numbers.

DEXIS CORPORATION
(612) 944-7670 FAX (612) 942-9712
9749 HAMILTON ROAD
EDEN PRARIE, MN 55344

CUT COSTS!

MEXICO

MANUFACTURING FACILITIES

- PCBs (Mfg./Design/Prototype)
- SHEET METAL (Cabinets/Brackets)
- SILK SCREEN PRINTING
- INJECTION MOLDING
- MOLD MANUFACTURE
- ALUMINUM EXTRUSION

ENHANCE YOUR PRODUCT WITH CUSTOM CASE/PRINTING.

Very competitive pricing.

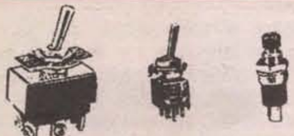
USA Office: **V&V Mach. & Equipment, Inc.**
Ph: (713) 397-8101, Fax: (713) 397-6220.
Mexico Plant: **Marketing Tech.**
Ph: 011 (525) 361-3351, Fax: 011 (525) 361-5996.

HIGH PERFORMANCE ULTRA-MINIATURE PINHOLE LENS CAMERA W/ AUDIO

The PH200A is the smallest pinhole camera in the industry. •High Sensivity - needs only .2 lux •High resolution - more than 400 lines •Ultra miniature - measures only 30mm x 30 mm x 14 mm •Camera comes complete with connectors and power supply • Includes 5.5mm wide angle pinhole lens •Can be easily mounted behind a 1/16" hole for any custom or covert applications. *ONLY...$105.00*

Surveillance Catalog $5.00

SPY OUTLET
2468 Niagara Falls Blvd
Tonawanda NY 14150
(716) 695-8660 Fax (716) 695-7380



TOGGLE SWITCH SUPERMARKET WHOLESALE PRICES

FERTIK'S
5400 ELLA ST., PHILA., PA 19120
FREE LIST PH/FAX
215-455-2121

T-Handle Security Opener

Opens Inverted Torx screw heads:

- Super Nintendo Control Deck
- SEGA 1602 AC adaptor
- Selected: • SEGA game cartridges • Cable boxes

$9.95 ea. (includes postage)

Send check or money order to:

Irata Systems
P.O. Box 4830
Mesa, AZ 85211
(602) 668-7977

CONTROL • MEASURE • INPUT

MODEL 40–$109

- RS-232 interface
- 28 lines digital I/O
- Eight analog inputs
- PWM output
- Three stepper ports

MODEL 100–$279

- 12-bit 100KHz A/D • Four analog outputs
- Three timer counters • 24 digital I/O

PRAIRIE DIGITAL, INC.
920 SEVENTEENTH ST., INDUSTRIAL PARK
PRAIRIE DU SAC, WI 53578
TEL: (608) 643-8599 • FAX: (608) 643-6754

LOWEST PRICES UNDER THE SUN!

SOLAR ELECTRIC INC.

5555 Santa Fe St. #J
San Diego, CA 92109-1602
(619) 581-0051
(619) 581-6440 fax
TOLL FREE 1-800-842-5678
e-mail: solar@cts.com
http://www.solarelectricinc.com

FREE DETAILED PRICE LIST

SIEMENS   UNI-SOLAR

Stereo microscopes new from $250.00
Down load "Photomicrography a primmer" and view the catalogue at www.seabirdt.com

Seabird Technical (415) 367-8320
3580 Haven Ave. Redwood City
Calif. 94063 Fax (415)365-5845

CELLULAR PHONE SURPLUS SALE

as low as
$49

Thousands of phones, both digital and analog. All major brand names. All current models. Like: Motorola, Nokia, Erickson, and many more for below wholesale cost. Accessories. Unbelievably low prices. Quantity discount.

PAN OCEAN CELLULAR WHOLESALE
1-800-328-7120
954-731-7120
FAX 954-730-3326

---

http://www.xtronics.com/kits.htm

Electronic Kits! *See these and more on our WEB site!*

Solderless Kits	
Crystal radio	$5.75
Metal Detector	$8.50
MW IC Radio	$9.50
Bend Wire Game	$7.95
Audio Amplifier	$8.50
Rain-Flood Alarm	$7.95
Test Equipment Kits	
Function Gen w/FM	$28.00
Function Generator	$14.95
Pulse Generator	$28.00

RF Sig Generator	$28.00
Other Kits	
FM Microphone	$6.95
Ultrasonic Translator (Hear ultrasonic-sound)	$18.50
Glitter-Globe Buckminster Fuller sphere 64 LEDs EN12/92	$45.00
Deluxe IC Radio	$11.95
World Radio	$25.95
Train Sound Module	$3.80
Sound operated control	$3.90

Assembled Metal Detectors from $18.50

Transtronics
3209 W. 9th Street
Lawrence, KS 66049

ph 913 841 3089
FAX 913 841 0434

Minimum Order $20.00
Shipping - up to 4 lb $5.00
We ship over seas!

Notch Filters

www.tvfilter.com

Assembled		Filter Kits	
1 to 2	$30 each	1 to 2	$20 each
3 to 9	$25 each	3 to 9	$15 each
10 to 49	$16 each	10 to 20	$9 each
50 or more	$14 each	21 or more	$7 each

Video Media
P.O. Box 93/6025
Margate, Fl. 33093-6025
(954)-752-9202 Fax (954)-340-5201

by Harry Helms

Software Wizardry

All About Java

Unless you've been hiding in a cave for the past two years, you've heard about Java. A Java program is cross-platform, able to execute equally well under Windows, the Macintosh, or Unix.

According to its backers, Java will soon become the only programming language you'll need to know. Java programs will soon break Microsoft's stranglehold on the PC software market, they claim, and businesses will save millions and millions of dollars in PC configuration and maintenance costs by going to applications written in Java.

I think Java has been grossly overhyped. Java won't put Microsoft out of business, and you'll be able to do quite well as a programmer without learning anything about Java. But Java does have some compelling features as a general-purpose programming language. In fact, it wouldn't surprise me if Java – if a key new feature were to be added – eventually surged past C and C++ in popularity.

Java Is Really Domesticated C++

Java was never intended as a Web programming tool. It actually began life as a version of C++ for game and controller applications. A lot of C++ features not necessary for those purposes were removed and, in the process, a language well-suited for network distributed applications was inadvertently produced.

In one key respect, Java is a throwback to the early days of PCs, circa 1980. At that time, the PC market was highly fragmented among incompatible systems such as the Apple II, Radio Shack's TRS-80, the Osborne I, etc. This was a big problem for software developers, since no PC company had more than a small fraction of the total market and it was difficult to determine which systems to support.

The solution was developed at the University of California-San Diego and was known as the "UCSD p-system." The "p" stood for pseudocode. Instead of writing applications in each PC system's native microprocessor code, applications were written in an ersatz language not specific to any microprocessor. Applications would be distributed with a standard conversion program that would take the pseudocode and convert it into the microprocessor code used by a specific PC. Instead of writing separate native code versions of a program for the Apple II, TRS-80, and Osborne I, you would write just one version in pseudocode and then distribute it with the standard conversion program for the appropriate PC.

Neat, huh? Unfortunately, the UCSD p-system was released just about the time IBM released its PC running MS-DOS. Suddenly software developers had the standard they had wanted, and the UCSD p-system was soon forgotten.

But everything old eventually becomes new again, and Java resurrects key elements of the p-system. When you write a Java application, you don't write it for a Windows or Macintosh. Instead, you write to run under something known as the Java virtual machine (JVM). This is the secret to Java's platform independence. To a Java program, there's no such thing as a Windows or Macintosh PC; instead, there's only a JVM. Java uses the term bytecode instead of pseudocode to refer to programs that a JVM can execute.

Another advantage of the JVM is that it minimizes the consequences of a software bug. Instead of crashing the entire PC, a Java bug will only crash the JVM.

Java does away with several aspects of C++ that are often troublesome. Maybe the biggest change is that Java does not support pointers. A pointer is somewhat like a variable, but instead contains the address used to access a physical location in memory. The concept of a pointer is one of the most difficult things for most people to master in C/C++ (in fact, it's been said that if you don't understand pointers you really don't understand C/C++). It's almost impossible to handle arrays in C/C++ without using pointers. But misusing pointers in C/C++ can have catastrophic results. As I found out the hard way when I was learning C, it's easy to accidentally set a pointer to access an address in memory where part of the PC's operating system resides ... and for the computer to come crashing down as a result! Java has improved array declaration and manipulation capabilities that make pointers unnecessary for array handling, so pointers are eliminated from Java.

Java also has improved "garbage collection" compared to C++. In C++, variables and objects that have been previously referenced in a program still occupy memory even if they are no longer needed or being used. These surplus variables and objects must be deleted from memory by the C++ program (thus the term "garbage collection") or the program could soon run out of memory. (This problem is especially acute with programs that use arrays or otherwise manipulate large amounts of data.) By contrast, Java programs automatically delete unused variables and objects and release the memory for other uses.

Unlike C++, Java does not allow objects to have more than one parent class (see the sidebar titled "Classes and Objects" in case you're not familiar with classes and objects). This means that an object cannot inherit behaviors and characteristics from two very different classes, such as from an "airplane" class and a "vegetable" class. This is another change from C++ that eliminates a major source of logic errors in Java programs. Some C++ programmers consider the restriction to just one parent class to be a serious shortcoming of Java, but intelligent definition of a parent class should eliminate the need for objects to have more than one parent class (this is known as multiple inheritance).

Execution In A Sandbox

Java is touted as the programming language for applications delivered over networks and the World Wide Web. Yet most of us have experienced having our PCs infected with a virus delivered via shared software or files. What's to prevent a PC contracting a virus through a Java applet downloaded via a Web page?

The answer is that Java programs delivered via the Web normally execute inside something called the sandbox. The sandbox prevents Java programs from directly accessing critical PC elements like hard drives, system RAM, the operating system, directories, and files. You don't have to worry about a Java applet deleting some critical files from your PC's hard drive because it can't read or write any files anywhere on your PC. Applets can't communicate with any PC or server other than the one from which it was downloaded. Applets also can't call or use any executable files on your PC. In addition, the Java virtual machine will check all Java code when it is loaded for execution and will suspend execution if the code attempts to do something unusual for Java.

To execute Java applets outside the sandbox, Microsoft's Authenticode technology can be used. Authenticode was developed by Microsoft for use with its ActiveX controls running in its Internet Explorer 3.0 Web browser; Netscape is expected to soon support Authenticode as well. Authenticode uses a "digital signature" in each Java applet or ActiveX control to verify the origin of the control or applet and to confirm that the program file hasn't been opened or altered since the digital signature was applied. The digital signature for each applet or control downloaded is checked by the browser. The browser can be set up to reject any applet or control that does not have a digital signature or those that have their origin in a source that is not completely trusted. With Authenticode technology, Java applets can be used outside of the sandbox and directly access system resources like hard drives and RAM.

These are some of the reasons why Java is considered a secure language for Web-delivered applications. Java is clearly superior to ActiveX technology in this respect. However, some hackers have created applets without digital signatures that can "escape" the sandbox and directly access system resources. Work is ongoing to plug these leaks, but it is a good bet that other security holes will eventually be found. Thus, Java applets should be considered highly secure when delivered via the Web, not absolutely secure.

The sandbox only comes into use when a Java program is Web-based; that is, when it is downloaded via the Web and executed inside a browser like Netscape or Internet Explorer. If a Java program is delivered via a disk or CD-ROM, it runs outside the sandbox and can directly access hard drives, system memory, etc.

Table 1. Java Reserved Words

		throws
abstract	import	transient
boolean	instanceof	try
break	int	void
byte	interface	volatile
case	long	while
catch	native	
char	new	Reserved for
class	null	Future Use
continue	package	
default	private	byvalue
do	protected	cast
double	public	const
else	return	future
extends	short	generic
final	static	goto
finally	super	inner
float	switch	operator
for	synchronized	outer
if	this	rest
implements	throw	var

Software Wizardry

The Elements of Java

Structurally, Java is similar to C/C++. If you've had some experience with C/C++, you should have a short learning curve with Java. Table 1 lists the reserved words in Java. This list is similar to the one in most implementations of C/C++ and the meanings of most keywords are the same. Table 2 lists the data types in Java, the largest value each can contain, and the default value of each if a variable of each type is not initialized to a value. Table 3 lists the operators in Java. Again, this list is similar to the operators in C/C++.

Java identifiers (for variables, class names, etc.) must start with a letter of the alphabet, a dollar sign ($), or an underscore (_). The remaining characters in an identifier can include the digits of 0 to 9. If an identifier is used with a variable, the first letter of the identifier should indicate the data type of the variable. For example, the identifier nSocialSecurityNumber could be used for an integer variable while cUserName could be used for a character string.

Variables are declared by preceding their identifier by their desired data type, as in this example:

```
int nSocialSecurityNumber
```

When a variable is declared in this way, its default value is equal to the default values indicated in Table 2. A value can be explicitly declared as follows:

```
int nSocialSecurityNumber = 000000000
```

The conversion of one data type to another is called a cast. To convert the integer value nSocialSecurityNumber to a string value called cSocialSecurityNumber, the following can be done:

```
nSocialSecurityNumber =
(char)cSocialSecurityNumber
```

As mentioned earlier, Java supports arrays. Array subscripts begin with 0 in Java. Array declarations follow this form:

```
int nSocialSecurityNumber[ ]
```

Comments can be inserted in Java in two main ways. If a line begins with a pair of slashes (//), the comment begins from that point to the end of the line. Here is an example:

```
int nSocialSecurityNumber // This will be unique for
each person
```

Java also supports the C/C++ method of commenting, with /* used to denote the start of a comment and */ indicating the end of a comment. As a general rule, /* and */ are used for multi-line comments (such as when commenting out a section of code during development) while // is used for single line comments.

Operations on variables are done with the operators in Table 3. These operators usually function in the same way as their C/C++ equivalents. The order of precedence for operations is also the same, and the order of operations can be altered by placing operators in parentheses. Operations in parentheses are performed first.

Pairs of brackets, { }, are used to indicate the starting and ending points of classes and functions in Java. Java program flow control statements are almost identical to those in C/C++. Two of the most common, the while and if statements, depend on the value of a boolean expression to determine whether they are executed. A boolean expression is one that evaluates to a value of "true" or "false." For example, the boolean expression (x > 5) is true if x is greater than 5 and false when x is equal to or less than the 5.

The general form of a while statement is:

```
while (boolean expression)
{
    // statements go here;
}
```

As in C/C++, program lines in Java that are not comments are terminated with a semicolon (;). In the construct above, the statements within brackets are executed as long as the boolean expression evaluates to true. When it evaluates to false, program control goes to the next line following the ending bracket.

A variation of the while statement is:

```
do
{
    // statements go here;
} while (boolean expression)
```

The if statement is similar to that found in many other languages. Its general form is:

```
if (boolean expression)
{
        // statements go here;
}
else
{
        // statements go here;
}
```

The boolean expression following if is evaluated. If the statement evaluates to true, the statements following if are executed. If the boolean expression is false, the statements following else are executed. The else statement is optional. If it is omitted and the boolean expression is false, the statements following if are ignored and program control passes to the first statement after the ending bracket.

The for statement construct uses three parameters for its execution. Its form is similar to that in other languages:

```
for (index variable initialization;
boolean expression; index increment)
{
        // statements go here;
}
```

The index variable is one whose value changes each time the statements following for are executed. It is set to a starting value before the statements are ever executed. The boolean expression evaluates to true or false depending on the current value of the index variable. If the boolean expression is true, the statements following for are executed; if the expression is false, control passes to the first statement following the ending bracket. The index increment changes the value of the index variable each time the statements in the for loop are executed. Here's a typical example of the first line of a for statement:

```
for (i=1; i<6; i++)
```

In this example, the index variable i is first set to 1. The boolean expression evaluates the value of i. If the value is less than 6, the statements following for are executed and control returns again to the for statement. Each execution of the statements causes the index variable to change. In this example, the index variable is incremented by 1 after each execution of the statements. It could also have been decremented (i--), squared or cubed, etc. In this example, the statements following for will be executed five times. After that, the value of i will no longer be less than 6 and execution will go to the first statement after the ending bracket.

The switch statement is useful when you need to select from several possible alternatives depending on the value of an expression. The form of this is:

```
switch (expression)
{
     case (expression value #1);
          // statements go here;
          break;

     case (expression value #2);
          // statements go here;
          break;

     default:
          // statements go here;
}
```

The expression following switch is evaluated. The resulting value is compared to the values following each instance of case. If there is a match, the statements following the matching value are executed. The break keyword then causes program control to flow to the first statement after the ending bracket of the switch construct. If the value of the expression does not match any of the values following the case statements, the statements following default are executed.

Table 2. Java Data Types

Type	Bit Size	Maximum Value	Default Value
boolean	8	——	false
byte	8	255	0
char	16	——	'x0'
double	64	253*21000	0.0D
float	32	224*2104	0.0F
int	32	2,147,483,647	0
long	64	9,223,372,036,854,775,807	0
short	16	32,767	0

Table 3. Java Operators

=	assignment of a value	++	increment
==	is equal to	—	decrement
!=	is not equal to	-	negation
+	addition	~	bitwise logical negation
-	subtraction	&	bitwise AND
*	multiplication	|	bitwise OR
/	division	^	bitwise XOR
%	modulus	<<	shift bit left
>	is greater than	>>	shift bit right
>=	is greater than or equal to	>>>	shift bit right with zero fill
<	is less than	!	logical negation
<=	is less than or equal to	&&	conditional AND
		||	conditional OR
		?:	conditional

Table 4. Java Library Packages

java.lang
This includes the fundamental classes needed by all Java programs, such as the class that defines the properties and behaviors of all other classes.

java.applet
This includes classes necessary to create applets for distribution over the World Wide Web.

java.awt
This includes the "abstract windows toolkit," a collection of classes to create platform-independent windows.

java.io
This package includes classes necessary for basic file input/output.

java.net
This package includes classes necessary for internet and network data transfers.

java.util
This package includes numerous utility classes for miscellaneous functions such as reading the system date and time.

Software Wizardry

Figure 1.

```
/*
 * Copyright (c) 1994 Sun Microsystems, Inc. All Rights Reserved.
 */

import java.awt.*;
import java.util.StringTokenizer;

/**
 * I love blinking things.
 *
 * @author Arthur van Hoff
 */
public class blink extends java.applet.Applet implements Runnable {
    Thread blinker;
    String lbl;
    Font font;
    int speed;

    public void init() {
        font = new java.awt.Font("TimesRoman", Font.PLAIN, 24);
        String att = getParameter("speed");
        speed = (att == null) ? 400 : (1000 / Integer.valueOf(att).intValue());
        att = getParameter("lbl");
        lbl = (att == null) ? "Blink" : att;
    }

    public void paint(Graphics g) {
        int x = 0, y = font.getSize(), space;
        int red = (int)(Math.random() * 50);
        int green = (int)(Math.random() * 50);
        int blue = (int)(Math.random() * 256);
        Dimension d = size();

        g.setColor(Color.black);
        g.setFont(font);
        FontMetrics fm = g.getFontMetrics();
        space = fm.stringWidth(" ");
        for (StringTokenizer t = new StringTokenizer(lbl) ; t.hasMoreTokens() ; ) {
            String word = t.nextToken();
            int w = fm.stringWidth(word) + space;
            if (x + w > d.width) {
                x = 0;
                y += font.getSize();
            }
            if (Math.random() < 0.5) {
                g.setColor(new java.awt.Color((red + y * 30) % 256, (green + x / 3) % 256, blue));
            } else {
                g.setColor(Color.lightGray);
            }
            g.drawString(word, x, y);
            x += w;
        }
    }

    public void start() {
        blinker = new Thread(this);
        blinker.start();
    }
    public void stop() {
        blinker.stop();
    }
    public void run() {
        while (true) {
        try {Thread.currentThread().sleep(speed);} catch (InterruptedException e){}
            repaint();
        }
    }
}
```

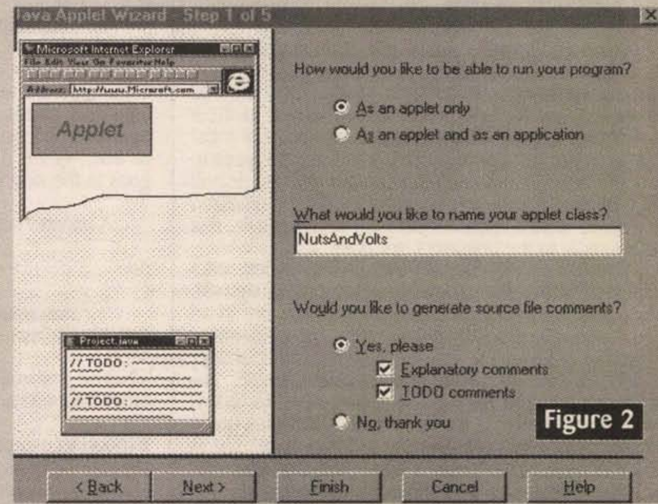


Figure 2

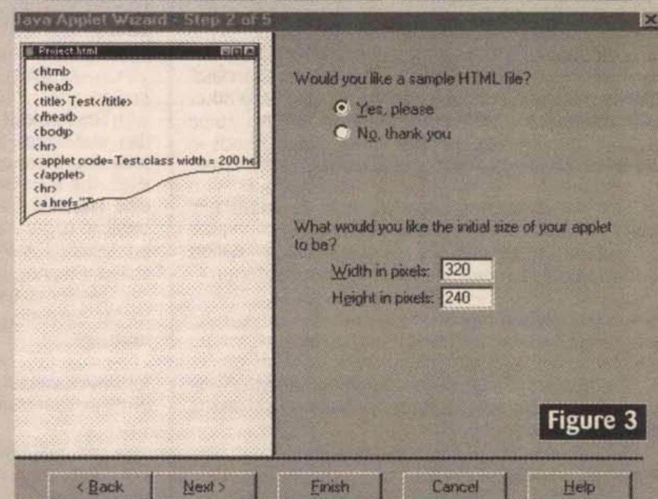


Figure 3

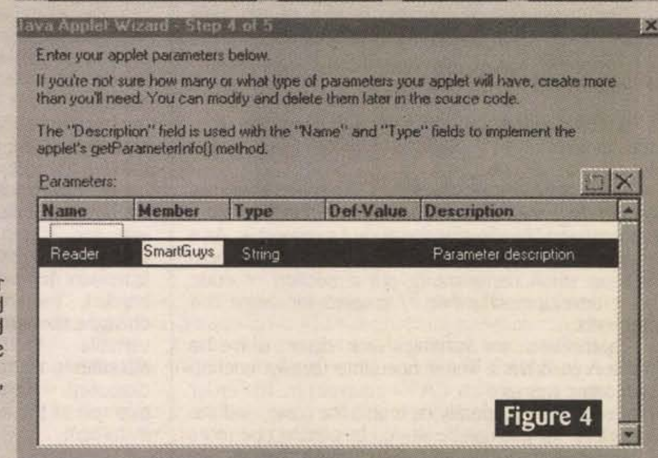


Figure 4

The break and continue statements can be used within any of these flow control constructs to immediately exit from the construct. As noted above, break causes program control to go to the first statement after the ending bracket of the construct. The continue statement causes program control flow to shift to the line containing the boolean expression of the construct.

Classes and Packages

The class is the fundamental "unit" of Java programming. When you write a program in Java, you're really writing a class. A Java class includes data members, which describe the attributes and properties of the class, and methods, which describe the behaviors of the class. "Method" is the Java term for what are known as functions in other languages like C/C++. A function cannot exist in Java outside of a class.

Every class belongs to a package. As mentioned in the sidebar titled "Classes and Objects," packages are collections of classes having some sort of logical relationship to each other. For example, classes named "automobile," "airplane," and "railroad" could belong to a package known as "transportation."

A class named "automobile" would be declared in Java this way:

```
class Automobile
{
    // "body" of the class goes here
}
```

The body of a class includes its data members and its methods (functions). The body also includes static data, static methods, inheritance, and constructors. Static data and methods are those shared by all objects of a given class. Inheritance is how a class can inherit data members and methods defined in another class. The keyword extends is used to allow a class to inherit properties and behaviors. Consider the following:

```
class Chevrolet extends Automobile
```

This would define a new class called "Chevrolet" that inherits properties and behaviors from the "automobile" class. In the "Chevrolet" class, we would concentrate on defining properties and behaviors unique to Chevrolets. Characteristics common to all autos, including Chevrolets (such as four wheels, etc.), would be inherited from the "automobile" class.

A constructor is a method that is used to initialize the value of each object when it is created. For example, a constructor can be used to initialize a boolean object to false or an integer object to 0. Each class declared in Java must have at least one constructor.

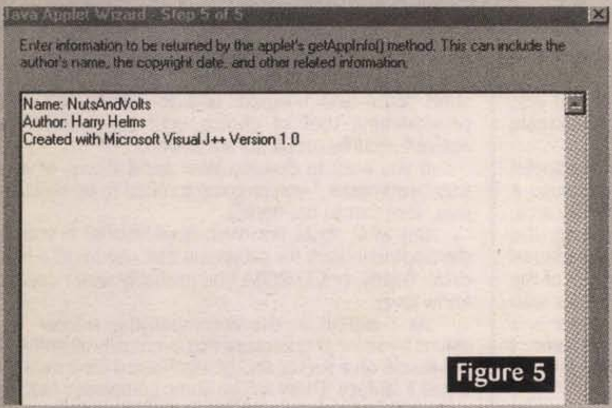


Figure 5

You can specify the degree of access other classes have to a class and its members. You may want to allow other classes to "reach inside" another class and modify its data members and methods while, in other cases, you may want a high degree of security. Access to a class is determined by a specifier that precedes the class declaration. If no specifier precedes class, the class will be a "friendly" class. This means the class' data members and methods will be accessible to other data members and methods found in the same package. If the public specifier is used, all methods in any other class can access the members of the class. By contrast, the private specifier restricts access to members of a class to other members of the same class.

C/C++ programs usually begin with the library files used with the program, such as input/output file libraries. Java programs usually begin with an import statement followed by the name of the package(s) being imported into the program. For example, there may be a package of classes, named srd.math, to perform certain mathematical computations. To include this package in a Java program, you would use the following line at the beginning:

```
import srd.math.*;
```

The asterisk at the end of the package name indicates that all classes in the package are to be imported. If the asterisk is omitted, you have to specify which classes in the package you want to import.

Java comes with several packages, and these are listed in Table 4. The first, java.lang, is automatically imported into every Java program that you write. You must specify others with the import statement.

The java.awt package is where you create the user interface. Since Java is platform-independent, you can't call the various controls (windows, message boxes, input boxes, etc.) making up the Windows user interface directly from Windows (or their equivalents from the Macintosh toolbox). In Java, all user interface elements are derived from the container class in java.awt. The container class is the parent class for the window, dialog (dialog box), frame, panel, and applet classes.

Since Java cannot call the Windows window control, the window class in Java must describe how a window is to be "mapped" on the PC's monitor. Among the methods of the windows class are show (makes a window visible), dispose (removes a window from the screen and releases all system resources associated with that window), resize (changes the size of a window), setResizable (lets the user change the size of a window), Move (lets the window be moved about in the monitor display area), and pack (assures the window is drawn correctly). Other properties of the window class – such as its preferred size and layout – are inherited from the container class.

A powerful feature of Java is its thread class. A thread is a task that executes independently of other tasks that may be taking place at the same time. Threads enable a Java program to perform multiple tasks simultaneously. For example, a "scrolling marquee" applet needs to display text in the marquee at the same time the text appears to be moving in the marquee display area. If the program handles just one task (like displaying text), processing of the other task will come to a halt until the first is completed. This means that a satisfactory scrolling marquee would be impossible to implement without using threads. Threads let the Java program rapidly switch between the two tasks and create the scrolling marquee.

While very useful, threads are also a big cause of "gotchas!" in Java. The different threads of a Java program execute in the same memory space. If one thread crashes, then all other threads in the program will crash as well.

Applets

Although Java programs can be delivered on a disk, most of the excitement about Java involves applets. An applet is a Java program designed for execution within a Web browser like Netscape or Internet Explorer. Applets are "placed" within <APPLET CODE and /APPLET> tags in a HTML file. Information placed within these tags include the applet's name (such as NewApplet.class) and the applet's position on the displayed Web page.

As noted above, the applet class is derived from the container class. Each Java applet you create is derived from the applet class and all Java applets must be declared public. The general form of a new applet called NewApplet would look like this:

```
public class NewApplet extends Applet
{
    //data members and methods go here;
}
```

When a Java applet is executed, the init (initializes variables), start (creates and starts applet threads), and paint (creates the applet's display area) methods are automatically called. This differs from other Java applications, like those distributed on disks, in which the main method is the only one that is automatically called.

When the applet class is used, the sandbox comes into play. This means, for example, the applet class cannot read or write to system files or otherwise access PC system resources.

Numerous applets have been created by Sun, Microsoft, Javasoft, and other companies that supply Java development tools. These applets are typically well-documented, and you can use them "as is" or use them as the starting point for your own applets. Figure 1 shows code developed by Sun to implement an

Classes and Objects

Object-oriented languages like Java use concepts that might be unfamiliar to you if have never used an objected-oriented language (like C++). Two such concepts are classes and objects.

A class can be thought of as a general definition or "blueprint" for individual objects. A class has the following characteristics:

• A class defines something that is easy to conceptualize. A good test of this is whether the name of the class immediately produces a clear, unambiguous idea in your mind as to what the class represents.

• A class defines something in a self-contained manner; you don't have to refer to another class for defining characteristics of the class.

• A class has a well-defined interface for interacting with other classes, objects, and other software.

• A class has clearly defined behaviors. It will respond to certain inputs but not to others, for example. A good class should be robust; for example, an unexpected input (like striking the wrong key) shouldn't crash the software.

Okay, but what exactly is a class? Let's take a concept we're all familiar with: the automobile. If "automobile" was a software class, it would be easy to conceptualize what we were talking about. The name is immediately descriptive. Within the class, we could include all of the characteristics of the "automobile" class, such as having four wheels, an internal combustion engine, headlights, brakes, etc. The "user interface" would include a steering wheel, gas pedal, speedometer, turn signals, etc. Finally, the behaviors of the "automobile" class would be predictable and robust. If we press the brake pedal, the automobile's speed will decrease, not increase. And if we turn on the left turn signal but then turn right, the automobile will not come to a stop or suddenly speed up.

Objects are instances (individual examples) of a class. Fords, Chevrolets, BMWs, and Jeeps are all objects belonging to the class "automobile." While such cars have significant differences with each other, they do share common characteristics (such as steering wheels, four tires, a brake pedal, a speedometer, etc.) defined by the class "automobile." The real power and utility of classes lie in how they simplify the creation of additional objects. If we wanted to add a new object called "Mercedes-Benz" to the class "automobile," we would only have to define those characteristics unique to that object. We wouldn't have to repeat any of the characteristics (four wheels, internal combustion engine, brake pedal, etc.) used to define the class "automobile."

The savings in time and effort are actually greater than this simplified "automobile" example implies. Classes let us easily re-use large chunks of code in new individual objects. For example, the interface between a software object and other objects and programs is usually time-consuming and difficult to properly implement. If we can do it once at the class level, we can crank out additional objects from that class with minimum effort and bugs. The same applies to class behaviors. If we define a class as responding only to a mouse button click, we don't have to worry about individual objects responding to keystrokes or other events.

The characteristics shared by all objects in a class are known as class members. If we have a class called "StudentData," the members of that class could be such things as "SocialSecurityNumber," "DateOfBirth," "Sex," "HomeTown," "GradePointAverage," etc. While the values of "SocialSecurityNumber" and "DateOfBirth" will be different for each object of the class, all objects belonging to class "StudentData" will have those members. Class members are sometimes referred to as properties. It is also possible for objects to have members or properties not shared with all other objects of the class; these are known as object members.

It's possible for a class to inherit characteristics and behaviors from another class. The class from which characteristics and behaviors is inherited is known as a parent class or a super class. A collection of specific related classes is known as a package.

The behaviors of each object belonging to a class are defined by functions. The definition of a function here is the same as in languages that are not object-oriented; a function either performs some task (such as displaying a message box) or returns a value (such as the square root of a number).

applet that causes text to blink. You can find more applets at the Web sites maintained by Sun and Microsoft.

Java Development Tools and Wizards

There are several Java development tools available. Since the output will be Java bytecode instead of a compiled .exe file, many of the usual measures used to assess a development tool (size of .exe file, for example) are not relevant in comparing Java tools. This is really good news for developers, since you can select a Java development tool based mainly upon your personal preferences and still produce satisfactory bytecode.

As might be expected, Microsoft has a Java development tool available at an aggressive price. I'm going to discuss it here because it has some interesting features and is widely available, not because it is the "best."

Microsoft's entry is known as Visual J++. Don't let its name fool you; it's not a visual development tool along the lines of Visual Basic. You'll still have to do a lot of "codesmithing" to produce a Java applet with it. The "visual" comes from the fact that it shares the common Developer Studio interface used by Visual C++ and other Microsoft development tools.

One of the useful features of Visual J++ is its use of wizards. Microsoft uses the term "wizard" for utilities that handle some of the "grunt work" of developing a program (or to perform certain tasks within an application). In J++, the applet wizard does things like include Java packages and classes necessary for applets.

Figure 2 shows the dialog box displayed when a new Java project is started in J++. On the left side, you can choose between a Java applet and a program that can execute as an applet and application. If the applet option is selected, the resulting program will be restricted to execution within a Web browser. It also includes a space for the name of the class you create (NutsAndVolts, in this case).

Figure 3 shows another dialog box from the applet wizard. This is one that I especially like because it greatly simplifies the sizing of the applet's display area. Figure 4 shows a dialog box for entering the parameters of the applet. In this example, I've entered a parameter called "Reader" which is a member of the "SmartGuys" class. (Do I know how to curry favor with *Nuts & Volts* readers or what?) The parameter is a string value and has an empty (null) default value. I didn't enter a description of the parameter, but J++ allows this option.

When an applet is created using the J++ applet wizard, a public method called getAppInfo is automatically included. Whenever the getAppInfo method is invoked, any information included in the dialog box shown in Figure 5 is displayed. You could include the name(s) of the applet creator(s), a copyright statement, date of creation, etc. This is similar to the "About. . ." item under the "Help" menu in the Windows interface.

The Future of Java

In a nutshell, Java is going to be big. Very big. But will it be essential to know?

Java is already being widely used for Web page applets, and I expect that popularity to increase at a rapid rate. Despite Microsoft's efforts to push ActiveX as an alternative to Java, ActiveX is still markedly inferior to Java in terms of protection from viruses and other malign applications downloaded from the Web. That looks like it will remain the case for at least the short term, and I expect Java to remain the Web programming tool of choice until (or unless) the ActiveX security problems are solved.

If you want to develop Web applications, or be a true "webmaster," you're going to need to be skilled in Java. Take that to the bank!]

But what about non-Web applications? If you do development work for programs that reside on a hard drive, floppy, or CD-ROM, you probably won't need to know Java.

As I explain in the accompanying sidebar, the claims by some Java backers that eventually all software will reside on a server and be distributed via a network is just a fantasy. There will be some companies that will go to internal networks of distributed Java applications, but this will be a very small percentage of the computing universe. I strongly feel that businesses will have a far greater need for skilled Visual Basic programmers in the years ahead than they will Java programmers.

At the beginning of this column, I said Java could pass C/C++ in popularity if one key change was made. That change would be to add the ability to produce true native code (Pentium, PowerPC, etc.) executable files in addition to files that execute in the Java virtual machine. With that addition, Java would become a superb tool for developing operating systems, device drivers, embedded applications, etc.

There's even more to the Java story. In a future column, I'll look at other Java development tools and utilities. **NV**

Java and Network Computers: What's Hype? What's Reality?

A network computer (NC) is a computer designed to use Java applications distributed over a network. NCs will not have hard drives or an operating system like Windows; all applications and data will be downloaded from a server. In my Nov. '96 column, I voiced my doubts about the entire concept of the NC and its future. The Jan. '97 issue of *Nuts & Volts* carried some reader responses to my comments. Since a large chunk of Java's projected future involves NCs, we need to further discuss the issues I raised last November.

First of all, I thank all readers who commented by letter and E-Mail. It's gratifying to write something readers respond strongly to, even when they disagree! But I still feel that NCs will not have as big an impact as their boosters predict, and that Java's most significant impact will be in developing Web applets and, later, as a general-purpose language.

A couple of letters in the January issue noted that the main use of the NC will be in business environments, not the home. I agree with that, but look at the public comments of NC proponents like Larry Ellison of Oracle and Scott McNealy of Sun Microsystems. They are the ones describing a future where all software is downloaded via the Web and Microsoft is put out of business, not me.

A common point made was the high cost of maintaining Windows PCs (one figure given by a reader was $13,000.00). A figure often quoted by many NC advocates is $9,784.00 which was determined by the Gartner Group, a well-known consulting organization. But how realistic are such figures?

As I responded via E-Mail to one reader, my company has two networks of a dozen Windows PCs each and our support costs for the entire year aren't even $13,000.00! Many *Nuts & Volts* readers work in companies with networks of Windows PCs, and most of you own a PC. Are your support costs that high? Do the figures quoted agree with your experience and knowledge? Moreover, how were the costs in such figures determined? "Lost productivity" due to PC down-time may be a real drain on a business, but I don't know a company that can accurately measure that or has an expense account item for it!

For the sake of argument, however, let's assume that it indeed costs $13,000.00 per year to support a Windows PC. But will it cost $15,000.00 to support a NC using Java applications? No one knows. NCs are currently an idea, not a reality. We don't have enough real-world data to know whether NCs would really be more or less expensive than Windows PCs.

There is nothing magical about any number. You have to know how a number was determined and whether the data used to derive it was complete, accurate, and relevant to what the number represents. A number based on no real-world data at all, like the projected savings in using NCs, is just a guess.

Many of those who responded said that most PC support problems are software-related and that such problems would go away with Java applications and NCs. However, this response overlooks some important points.

Most Windows problems (as well as Mac problems) are not the fault of the operating system. Instead, developers fail to write software that can run correctly under the operating system. (This problem is especially acute when using 16-bit applications under Windows 3.1/95, where a poorly-written application can monopolize the 16-bit message queue and bring the entire system to a halt.) However, it is just as possible to write poorly designed, badly coded, and inadequately tested software in Java as it is in C++ or Visual Basic. Dumb programmers will still do dumb things in Java. Switching to Java will not remove the human element that is ultimately the cause of all software problems.

It is true that Windows PCs, especially networks of them, are often plagued with configuration problems. But this is again mainly a human problem, namely inadequately skilled persons attempting to install and maintain the PCs. Maybe one reason why support costs are so low at my company is that we use only persons who have passed Microsoft's certification exams to configure and maintain our systems. Persons holding a Microsoft certified system engineer (MCSE) credential command higher salaries, but I suspect using them is a big reason why our NT 4.0 servers perk along with no problems.

Even the Gartner Group, in the same report that gave the $9,784.00 figure, admitted that "we believe users can get a 25% to 30% cost reduction by managing their current PC environment better."

Some NC advocates claim that installing and maintaining their hardware will be simple, almost like installing and maintaining a home stereo system. I certainly hope that's true, but I wouldn't bet my life savings on it. It's really frustrating when a PC network goes down in a business, but at least you can still use the applications and data on each PC's hard drive. REAL frustration will come when a NC server goes down, the NCs sit quietly on each desk, and the whole business is brought to a halt!

While it's impossible to determine their magnitude at this point, there will obviously be costs associated with a change to NCs, including hardware, software, employee training, and down-time during the transition.

I've got a lot of other questions that NC advocates aren't answering. How much will it cost to upgrade network hardware (switches, routers, etc.) to handle the additional load and to build in fail-safe reliability? Will employees familiar with Windows software like WordPerfect and Excel have to learn entirely new applications? How much will it cost to hire programmers to develop and upgrade distributed applications? What happens when the developer of an application has quit but didn't comment the code adequately? How will access to various files be controlled? How will PC format data be transferred to the new NC environment? How will multitasking be handled within browsers? And what about the notebook PCs that are becoming such a critical part of business computing, particularly for traveling employees like sales representatives? How will they fit into an NC universe?

In other words, how much will it cost to save money with NCs?

Here's my fearless prediction: I expect NCs to find their main use as a replacement for existing dumb terminals and for single-purpose applications, such as order entry. But we are decades away from having NCs being as common and as widely used as PCs.

Events CALENDAR

Continued from page 96

Exhibition Center, 675 Ponce de Leon Ave. Atlanta HamFestival, POB 942150, Atlanta, GA 31141-2150. http://www.saf.com/arc E-Mail: dickb@akorn.net
GA - NORCROSS - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880
IN - INDIANAPOLIS - Computer Show. Indiana State Fairgrounds. MarketPro 301-984-0880
MD - GAITHERSBURG - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
NJ - SECAUCUS - Computer Show. Meadowlands Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
PA - HARRISBURG - Computer Show. Farm Show Complex. MarketPro 301-984-0880

JUNE 22

KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300
OH - YOUNGSTOWN - Computer Show. Canfield Fairgrounds. MarketPro 301-984-0880
VA - VIRGINIA BEACH - Computer Show. Virginia Beach Pavillion. MarketPro 301-984-0880

JUNE 28

CO - DENVER - Metro Computer Show & Swap Meet. 2950 W. 72nd Ave., Westminster. Reputable Systems 303-444-2664
DE - NEWARK - Computer Show. University of Delaware. MarketPro 301-984-0880
VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880

JUNE 28-29

FL - WEST PALM BEACH - Computer Show. South Florida Fairgrounds. MarketPro 301-984-0880
IN - SOUTH BEND - Computer Show. St. Joseph Co. 4H Fairgrounds. MarketPro 301-984-0880
NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229
PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880

JUNE 29

IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
MD - UPPER MARLBORO - Computer Show. The Show Place Arena. MarketPro 301-984-0880
PA - DICKSON CITY - Computer Show. Genetti Manor. MarketPro 301-984-0880

JULY 1997

JULY 5

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MA - WEST SPRINGFIELD - Computer Show. Eastern States Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
NC - SALISBURY - Firecracker Hamfest. Salisbury Civic Center. 8am-1pm. Walter Bastow N4KVF 704-279-3391

JULY 5-6

NY - WHITE PLAINS - Computer Fair. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229

JULY 6

NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229

JULY 11-12-13

NV - LAS VEGAS - DEF CON V Convention. Aladdin Hotel & Casino. 206-790-3628

JULY 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
WI - OAK CREEK - Swapfest '97. American Legion Post 434. 414-762-3235

JULY 12-13

GA - KENNESAW - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827

JULY 13

NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229
PA - KIMBERTON - Valley Forge Hamfest. Fire Co. Fairgrounds, Rte. 113, S. of the intersection w/Rte. 23. Bob Haase W3SA, 610-293-1919

JULY 19

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
NH - NASHUA - Electronic Fleamart. Res. Ctr. Church. 617-923-2665

JULY 19-20

NC - CHARLOTTE - Computer Show. The Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229

JULY 20

MA - CAMBRIDGE - Hamfest. MIT RS & Harvard Wireless Club. Nick Alternburnd 617-253-3776
OH - VAN WERT - Hamfest. Van Wert Co. Fairgrounds, US 127 South. Bob Barnes WD8LPY 419-238-1877

JULY 25-26

OK - OKLAHOMA CITY - Ham Holidays '97. Oklahoma State Fair Park, Hobbies, Arts & Crafts Bldg., intersection I-40 & I-44. Fri: 5pm-8pm, Sat: 8am-5pm. CORA Web site: www.geocities.com/heartland/7332 E-Mail: n1lpn@swbell.net

JULY 26

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
NC - WAYNESVILLE - Hamfest. Haywood County Fairgrounds, off Exit 24 on I-40. 8am-4pm. Tommy Queen K4BNP, 704-258-2639

DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

ALABAMA

Little Professor Book Center
2717 S. 18th St.
Birmingham 35209

RT Systems Amateur Radio Supply
8207 Stephanie Drive
Huntsville 35802

ARIZONA

Batteries, Batteries
3415 W. Glendale Ave. #4
Phoenix 85051

1829 E. Southern Ave.
Tempe 85282

6245 E. Bell Road
Scottsdale 85254

Elliott Electronic Supply
1251 S. Tyndall Ave.
Tucson 85713

Tower Records
3 E. 9th St.
Tempe 85281

CALIFORNIA

Abletronics
9155 Archibald Ave. Unit E
Cucamonga 91730

Advanced Computer Products, Inc.
1310 "B" E. Edinger Ave.
Santa Ana 92705

All Electronics
905 S. Vermont Ave.
Los Angeles 90006

14928 Oxnard St.
Van Nuys 91411

Allen's To Go
13461 Hwy. 88
Lockeford 95237

Alltronics
2300-D Zanker Road
San Jose 95131

Black Feather Electronics
3004 E. 7th St.
Long Beach 90814

Brand Newsstand
234-1/2 N. Brand Blvd.
Glendale 91203

Centerfold International
716 N. Fairfax Ave.
Los Angeles 90048

Computing Technology
251 Balsam St.
Ridgecrest 93555

Darcell Electronics
4910 Santa Anita Ave.
El Monte 91731

Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505

Digicity.Net
4549 Quail Lakes Dr.
Stockton 95207

Ford Electronics
8431 Commonwealth Ave.
Buena Park 90621

Gentek Electronics
11652 Monarch St.
Garden Grove 92841

Harding Way News
113 W. Harding Way
Stockton 95204

HdB Electronics
2860 Spring St.
Redwood City 94063

Hi-Fi Doctor
1814 E. Ball Road
Anaheim 92805

HSC Electronic Supply
4837 Amber Lane
Sacramento 95841

3500 Ryder St.
Santa Clara 95051

6819 Redwood Drive
Cotati 94931

JK Electronics
6395 Westminster Ave.
Westminster 92683

Laurel Park News
4346 Laurel Canyon Blvd.
Studio City 91604

Lion Electronic Labs
4948 East Townsend Ave.
Fresno 93727

Olive Drab Enterprise
12819 Loma Rica Dr. #153
Grass Valley 95945

Op Amp Technical Books
1033 N. Sycamore Ave.
Los Angeles 90038

Pace Electronics
369 Hampshire Road
Thousand Oaks 91361

Panorama Electronics
8737 Van Nuys Blvd
Panorama City 91402

Porter Ranch News Stand
18473 Devonshire St.
Northridge 91325

Quantum Enterprises
1566 Simpson Way
Escondido 92029

Sandy's Electronics Supply, Inc.
20655 Soledad Cyn. Rd. #15
Santa Clarita 91351

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove 92643

Survival Books & Equipment
11106 Magnolia Blvd.
North Hollywood 91601

The Radio Place
5675-A Power Inn Road
Sacramento 95824

Tower Books
211 Main St.
Chico 95928

7840 Macy Plaza Dr.
Citrus Heights 95610

1280 E. Willow Pass Road
Concord 94520

630 San Antonio Road
Mountain View 94040

1600 Broadway
Sacramento 95818

5950 Florin Rd.
Sacramento 95823

2538 Watt Ave.
Sacramento 95812

2727 El Camino Real
San Mateo 94403

Tower Magazines/News
811 Wales Dr.
Folsom 95630

2605 Del Monte St.
West Sacramento 95691

Tower Records/Video
220 N. Beach Blvd.
Anaheim 92801

2520 Durant
Berkeley 94704

212 F St.
Davis 95616

5703 Christie Ave.
Emeryville 94608

5611 Blackstone
Fresno 93710

2052 Redwood Hwy
Greenbrae 94904

6310 E. Pacific Coast Hwy.
Long Beach 90803

2280 Market St.
San Francisco 94114

3205 20th Ave.
San Francisco 94132

2525 Jones St.
San Francisco 94133

871 Blossom Hill Road
San Jose 95123

14570 Ventura Blvd.
Sherman Oaks 91403

1205 W. Covina Pkwy
West Covina 91790

Valencia Newsstand
23164 W. Valencia Blvd.
Valencia 91355

Video Electronics
3829 University Ave.
San Diego 92105

CANADA

Com-West Radio Systems Ltd.
48 E. 69th Ave.
Vancouver, BC V5X 4K6

Lectron Enterprise
120-11 Ave. N
Creston, BC V0B 1G0

Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

COLOMBIA

Roboti-K
Carrera 38 No. 10-60,
Local 258, Bogota

COLORADO

Fistell's Micro Electronics
7023 E. Colfax Ave.
Denver 80220

International Tesla Society
2220 E. Bijou St.
Colorado Springs 80909

TH Electronics
216 Commerce Dr., Unit 2
Fort Collins 80524

Tower Records/Video
2500 E. 1st Ave.
Denver 80206

Western Test Systems
530 Compton #C
Broomfield 80020

CONNECTICUT

Archway News
64 Bank St.
New Milford 06776

Derric Electronics
1660 Whitney Ave.
Hamden 06517

DISTRICT OF COLUMBIA

Tower Records
2000 Pennsylvania Ave.
Washington 20006

FLORIDA

Alfa Electronic Supply
1502 S. St. Rd. #7
Hollywood 33023

Clarks Out of Town News
303 S. Andrews Ave.
Fort Lauderdale 33301

Mike's Electronic Distributing Co.
1001 NW 52nd St.
Fort Lauderdale 33309

Skycraft Parts & Surplus, Inc.
2245 W. Fairbanks
Winter Park 32789

Sunny's At Sunset, Inc.
8260 Sunset Strip
Sunrise 33322

GEORGIA

Tower Records
3400 Around Lenox Drive
Atlanta 30326

HAWAII

SolarWorks!
525 Lotus Blossom Lane
Ocean View 96737

Tower Records
4211 Waialae Ave.
Honolulu 96816

611 Keeaumoku
Honolulu 96814

IDAHO

Hi-Tech Surplus
605 E. 44th St.
Boise 83714

The Current Source
5159 Glenwood
Boise 83714

ILLINOIS

City Newsstand
4018 N. Cicero
Chicago 60641

Pick's Electronics
Lewis Park Mall
Carbondale 62901

Tower Records/Video/Books
383 W. Army Trail Road
Bloomingdale 60108

2301 N. Clark St. #200
Chicago 60614

1209 E. Golf Road
Schaumburg 60173

INDIANA

Harbourtown Sales
108 Park 32 West Dr., #D
Noblesville 46060

KANSAS

Lloyd's Radio & Electronic, Inc.
220 W. Harry St.
Wichita 67213

LOUISIANA

Gameforce Central HQ
13623 Hooper Rd. #CA
Baton Rouge 70818

Lakeside News
3323 Severn Ave.
Metairie 70002

Tower Records
408 N. Peter St.
New Orleans 70130

MARYLAND

C.S.A. Paging
3205 Old North Point Rd.
Dundalk 21222

Silicon Valley Electronics
2014-A Industrial Drive
Annapolis 21401

Tower Records/Video
2566 Solomons Island Road
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS

Tower Records #172
360 Newbury St.
Boston 02115

MICHIGAN

Family Electronics
111 E. Superior St.
Alma 48801

Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124

MW Electronics
229 E. Michigan Ave.
Paw Paw 49079

Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

Tower Records
1214 S. University Ave.
Ann Arbor 48104

MINNESOTA

Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI

Accurate Instruments
11201 E. 24 Highway
Independence 64054

Electronics Exchange
8644 St. Charles Rock Road
St. Louis 63114

Stewart & Associates
204 Sonderen St.
O'Fallon 63366

NEVADA

Amateur Electronic Supply
1072 N. Rancho Drive
Las Vegas 89106

Less Buster's Electronics
2930 N. Las Vegas Blvd. VSTG-22
North Las Vegas 89030

Radio World
1656 Nevada Hwy
Boulder City 89005

Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 South Virginia
Reno 89511

NEW JERSEY

JR Tech Systems
1309 Highway 71
Belmar 07719

NEW YORK

All Phase Video Security, Inc.
70 Cain Drive
Brentwood 11717

Ham Central
3 Neptune Road
Poughkeepsie 12601

Hirsch Sales Corporation
219 California Drive
Williamsville 14221

Hi-Tech Repair, Inc.
270 Neelytown Rd.
Montgomery 12549

Tower Records/Video
105 Old Country Road
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO

Compustuff
2751 Medina Road
Medina 44258

Dayton Software
3903 Wilmington Pike
Kettering 45429

Digital One
7603 Mentor Ave.
Mentor 44060

Footsteps
4925 Jackman Rd. Store #58
Toledo 43613

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952

Keyways, Inc.
611 S. Main St.
Miamisburg 45342

Leo's Book Shop
330 N. Superior St.
Toledo 43604

Magazines & More
26880 Brookpark Rd Ext.
North Olmsted 44070

Powermaxx, Inc.
1587 U.S. Route 68 North
Xenia 45385

OREGON

News & Smokes
2295 W. Main St.
Medford 97501

News & Smokes #8
259-C Barnett Road
Medford 97501

Norvac Electronics
7940 SW Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial NE
Salem 97303

Powell's Technical Bookstore
33 NW Park
Portland 97209

Tower Books
1307 NE 102nd Ave.
Portland 97220

PENNSYLVANIA

Business & Computer Bookstores
213 N. Easton Rd.
Willow Grove 19090

Lehman Scientific
2997-F Cape Horn Road
Red Lion 17356

Penn Electronics
2310 A Walnut St.
Harrisburg 17103

Surplus Al
RR 1 Box 337
Hunlock Creek 18621

Tower Books
425 South St.
Philadelphia 19147

Tower Records
340 W. Dekalb Pike
King of Prussia 19406

SOUTH CAROLINA

555 Electronics
5646 Farrow Road
Columbia 29203

TENNESSEE

Tower Books
204 West End Ave.
Nashville 37203

TEXAS

Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063

Tanner Electronics
1301 W. Beltline #105
Carrollton 75006

The Communication Source
2713 Galleria Drive
Arlington 76011

Tower Records
2403 Guadalupe
Austin 78705

UTAH

Omega Electronics
1500 North 150 West
Provo 84604

VIRGINIA

Electronic Equipment Bank
323 Mill Street NE
Vienna 22180

Riley's Distributing
1045 Edom Road
Harrisonburg 22801

Satellite Headquarters
7920 Timberlake Road
Lynchburg 24502

Tower Records/Video/Books
6200 Little River Tpk.
Alexandria 22312

4110 W. Ox Road #12124
Fairfax 22033

1601 Willow Lawn Drive
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

VA Ham Radio Supply, Inc.
2208 Childress Rd.
Christiansburg 24073

WASHINGTON

A-B-C Communications, Inc.
17541 15th Avenue NE
Seattle 98155

Amateur Radio Supply Co.
5963 Corson Ave. S. #140
Seattle 98108

Supertronix
18650 68th Avenue South
Kent 98032

Tower Books
10635 NE 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN

Amateur Electronic Supply, Inc.
5710 W. Good Hope Road
Milwaukee 53223

News & Hobby Center
4758 Packard Ave.
Cudahy 53110

Tech Forum - Continued from page 75

The digital output from the reader is routed back to a PC, which processes the data as needed. I priced this system a few years ago, and the cost was in the tens of thousands of dollars — certainly out of the "Radio Shack" range. Even at that price, though, it won't read consumer credit cards, which you want to do.

Greg Miller
State College, PA
a.v.guru@juno.com

ANSWER TO #39723 - MARCH 1997

Here's how to figure out whether you can run your natural gas furnace and its motor using power from your gasoline generator. There are two issues: the amount of peak current needed to start the motor, and the amount of continuous current needed to run the motor. A motor's starting current is much greater than its full load current. Likewise a generator can supply more "peak" or "intermittent" current than continuous current.

You said you have a 1/3 HP motor. I'd guess this motor draws around six or seven amps at full load (i.e., when it's actually delivering 1/3 HP to the mechanical load). Check the nameplate for an exact figure. The starting current will depend on several factors, but it will be much higher than the full load current. As a rule of thumb, assume the starting current is three times the running current.

Also, you said you have a 1,000-watt generator: it's important to know whether this is the "peak" or "continuous" output rating. Check the manual or call the manufacturer, because this is the key to your answer. You need to know both the peak output current and the continuous output current from your generator. Even if the generator is advertised as "1,000 watt," it may only be able to deliver that amount of current for a short period of time.

Once you know the motor's full load (continuous) current, add a safety factor of perhaps 25%; then compare that number with the generator's continuous output current. If your motor needs seven amps, the generator should provide at least 8.4 amps. If your generator is rated at 1,000 watts continuous, that's 8.0 amps ($P/E = I$, so 1,000 watts/125 volts = 8.0 amps). In my book, that generator's too small.

Now compare the motor's starting current to the generator's peak current. If running current is seven amps, estimate starting current at 21 amps. Multiply that by 125 volts, and your generator needs to provide a peak output of 2,625 VA. If there's no peak VA rating given, then the generator should supply a peak of 2,625 watts. That's probably a lot more than your generator can produce.

As a rule of thumb, I've just checked through published data for dozens of gasoline-powered generators, made by a number of manufacturers. In addition to the output current, the specs always indicate the largest size motor that can be safely operated by a given generator. They typically show a generator around 2,000 watts continuous and 2,500 VA peak, to run a 1/3 HP motor.

Even though you've powered your furnace from your generator a few times, I'm afraid it doesn't appear that it would be safe or reliable to do so on a long-term basis.

Greg Miller
State College, PA
a.v.guru@juno.com

ANSWER TO #39724 - MARCH 1997

There are two possible problems with Elastomer keyboard contacts. Due to age and some air pollutants, the black carbon infested rubber contact pads can gain a hard glassy surface patina which is non-conductive. To restore these type pads, wet a "Q-tip" with a solvent such as lacquer thinner, or fingernail polish remover (acetone), and scrub the pads gently. They should be flat black with no sheen to them. On the extremely cheap pads, where the actual carbon coating has worn off (showing the color of the membrane sheet itself, rather than being flat black), try re-coating them with India ink. You may want to put several coats on, allowing the ink to dry between each. Unlike silver or nickel print, which is enamel based, India ink won't crack or peel off. Try the above cleaning first, however, as it is not necessary to ink perfectly good pads if they will clean up.

Bomarc Services
Casper, WY

ANSWER TO #39729 - MARCH 1997

What a great idea! Making it work shouldn't take more than a BASIC Stamp II and a back-lit Backpack LCD display. The BS II runs on 5 to 15 volts and has 15 input/output pins; you'll need only one to talk to the LCD display, leaving 14 for your use. You should be able to tie one to each of the scan LEDs (to sense if it is lit), and one to the squelch output (this is the circuit that stops the scan by bringing a line high or low) or "Busy" LED.

If you're lucky, both the LED and squelch levels will be suitable for direct interface to the BS II and you won't need any buffer chips (i.e., the levels are close to the 0-5 volt range). If that's the case, the circuit will go together in minutes. Then you just need to write a short BASIC program to check and see which LED is lit when the squelch line goes high. Look up the appropriate label (e.g., "Bridgewater

TECH FORUM

PD Tac 1") and send it out to the display. (If you've got short labels and only a few channels on your scanner, you might be able to squeeze the code into a BASIC Stamp I.)

As long as you're writing code, you might think about dropping the label down to the second line of the display after the transmission stops. Then, if you don't get a chance to look immediately at the display, you'll be able see who transmitted last. For further data, read the back issues of *Nuts & Volts* for Scott Edwards' great series on the BASIC Stamp (available on the *Nuts & Volts* website). The Backback LCD is available from Scott Edward Electronics at **520-459-4802**. The BS II and tools are available from Parallax, Inc. at **916 624-8333** or www.parallaxinc.com

George Scott
Alexandria, VA

ANSWER TO #39727 - MARCH 1997

I'm going to guess that the scanner system you have was produced by MSI, Mycom Systems Integration. You can find them on the web at http://www.mycom.com/msi/index.htm where you can send them E-Mail. A phone number for Mycom is 1-800-338-1354. The firm makes barcode equipment including scanners and portable data acquisition scanning equipment.

The unit you have sounds similar to one I bought from the Toolwatch folks in South Chicago Heights, IL, though mine has the Toolwatch ID on it. It included a self-contained wand and a charging base with RS-232 connection. The software that came with that unit was proprietary and required a hardware key to run it. The communication protocol was not addressed in the manual since it was sold as a complete package. Hopefully, MSI can give you some more information on the specific model you have.

Richard M. Nelson
Newport News, VA

ANSWER TO #39718 - MARCH 1997

I have an answering machine that I used, to do the exact thing you are wanting to do. It is the model "Friday" by BOGEN. It can be set up (as many other models of BOGEN answering machines can) to tell the caller in your own voice, to press 8 (This is the FAX mailbox which you can select to have a password option). The caller will then be asked to enter a password or code, and if correct, the unit has a modular jack that will generate ring voltage to ring another phone or answering machine (or FAX) and the caller will be connected to whatever picks up. Since you can record your own voice messages, you can tell the caller (if he enters the wrong code) to press 1 (or whatever) to be able to leave a message on the unit, or you can have it just hang-up. I found a dealer in Broomal, PA, **610-356-8710**. I have also seen these machines at Office Max/Office Depot and those phone stores in malls.

Paul Patch
Wheeling, IL

by Neil Heckt

ALMOST ALL DIGITAL ELECTRONICS L/C METER IIB

BUILD THIS SELF-CALIBRATING, AUTORANGING INDUCTANCE/CAPACITANCE METER AND SORT OUT ALL THOSE RF AND AUDIO CHOKES AND CAPACITORS YOU HAVE STASHED IN YOUR JUNK BOX. ITS RANGE — FROM .001 UHY TO 100 MHY AND .01 PF TO 1 UFD — COVERS THE VAST MAJORITY OF COMPONENTS FOR RF AND AUDIO FILTERS, AMPLIFIERS, AND OSCILLATORS.

Back in the 1950s, my dad and I built a lot of amateur radio equipment which involved winding our own coils for tuned circuits. The one thing we always wished for was a piece of test equipment to measure small values of inductance and capacitance. More than 40 years later, I have developed just such a piece of equipment, and — although my dad is no longer with me — I'm sure that other amateurs, engineers, and electronics enthusiasts will appreciate being able to measure small inductors and capacitors.

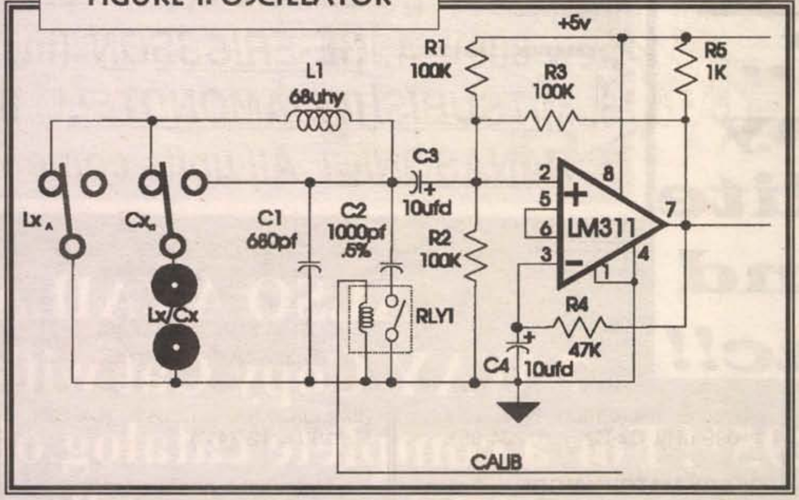
L/C Meter IIB is a handheld digital inductance/capacitance meter that features AUTOMATIC RANGING and SELF-CALIBRATION. If you do a good job of soldering, it is a "turn it on and it works" project.

Specifications

The unit displays values in one of two modes which can be changed during operation. The "micro mode" displays values in uHy, mHy, pF, and uF when applicable. In this mode, for example, 10.00 nano-Farads displays as .01000 micro-Farads and 1 nano-Henry displays as .001 micro-Hy. It is for old timers like me and is the way many parts are marked. The "nano mode" is for those more metrically inclined. Table 1 shows how each range is displayed in each mode.

One input pin to the microcontroller is a jumper which determines if the unit powers up in the "micro mode" (jumper open) or "nano mode" (jumper shorted).

FIGURE 1: OSCILLATOR



Operating Modes

When the Lx and Cx switches are off, pressing the ZERO button sequences L/C Meter IIB through five different operating modes:

READY MEASURE n measures Lx or Cx and displays the result in "nano mode" (i.e., Lx = 99 nHy, Cx = 12.34 nF).

READY MEASURE u measures Lx or Cx and displays the result in "micro mode" (i.e., Lx = .099 uHy, Cx = .01234 uF).

READY MATCHnMODE first measures a reference component Lz or Cz and displays the value in "nano mode." When the ZERO button is pressed, this value is stored in RAM and the difference between it

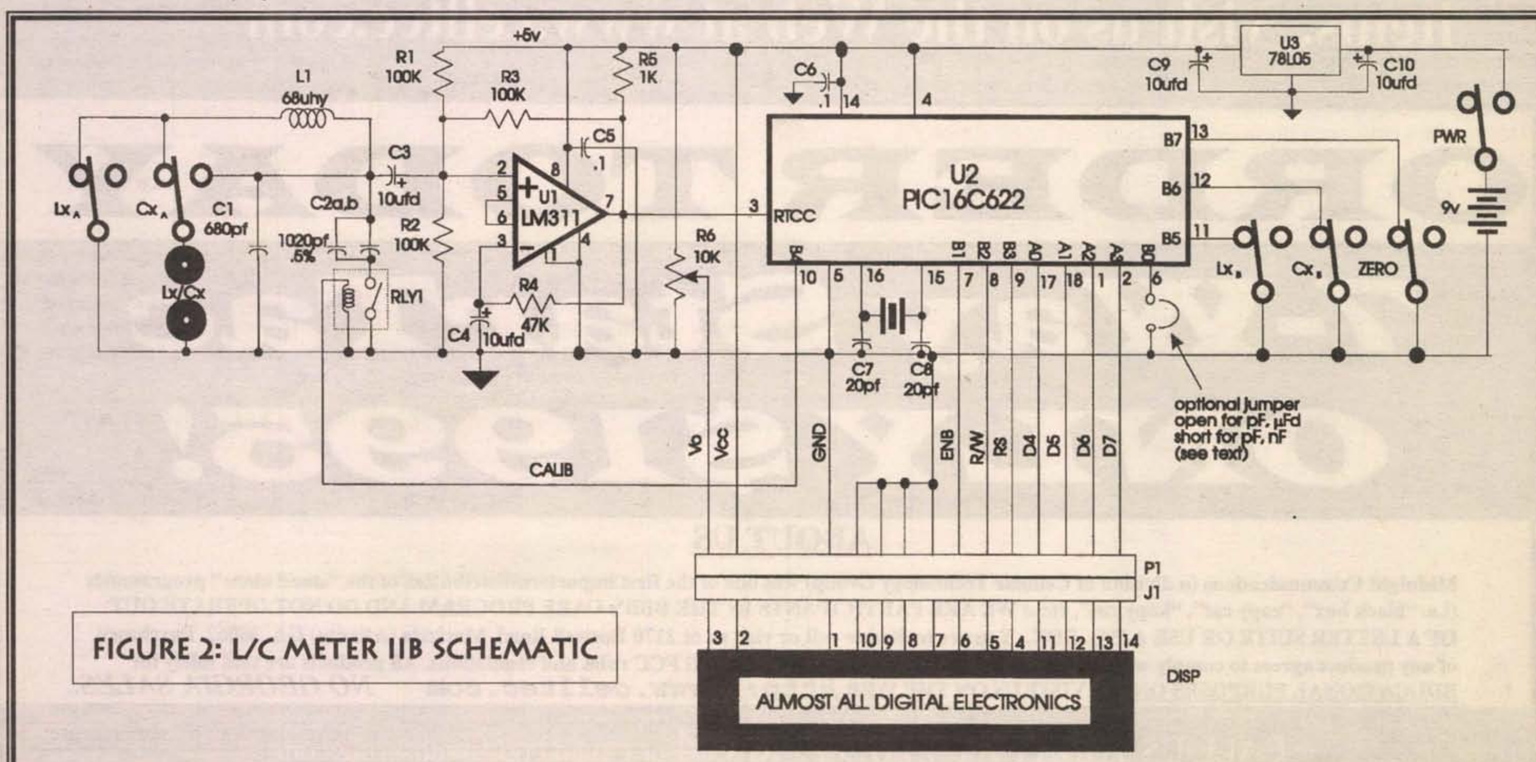


FIGURE 2: L/C METER IIB SCHEMATIC

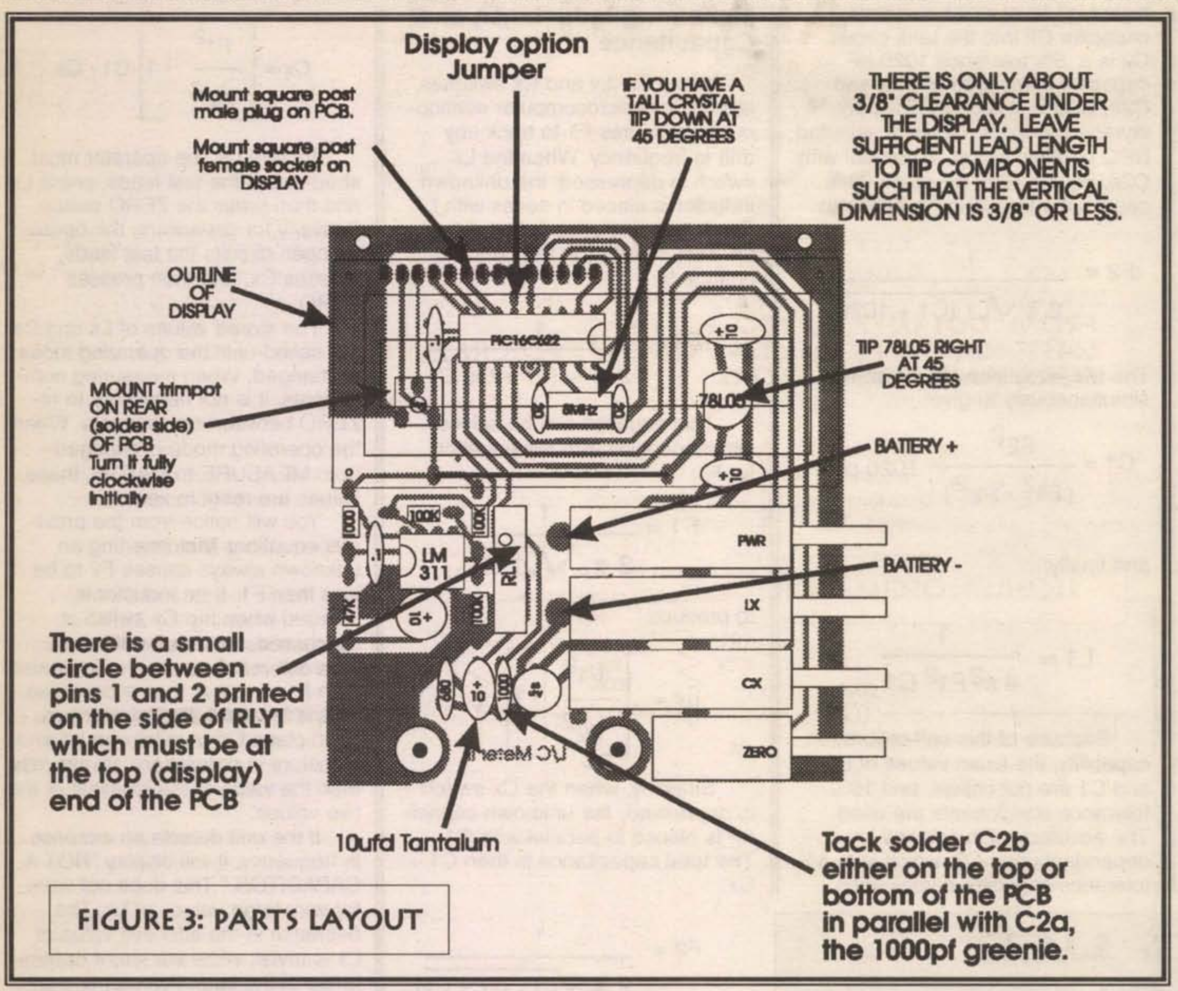


FIGURE 3: PARTS LAYOUT

and subsequent components is displayed in "nano mode" (i.e., Lx-Lz = 99 nHy, Cx-Cz = 12.34 nF).

READY MATCHuMODE first measures a reference component Lz or Cz and displays the value in "micro mode." When the ZERO button is pressed, this value is stored in RAM and the difference between it and subsequent components is displayed in "micro mode" (i.e., Lx-Lz = .099 uHy, Cx-Cz = .01234 uF).

READY MATCH%MODE first measures a reference component Lz or Cz and displays the value in "nano mode." When the ZERO button is pressed, this value is stored in RAM and the ratio of the difference between it and subsequent components is displayed in percent (i.e., (Lx-Lz)/Lz*100 = 12.34%, (Cx-Cz)/Cz*100 = 12.34%).

Note that a positive reading in the matching modes means Lx is greater than Lz, or Cx is greater than Cz, and vise versa.

The L/C Meter IIB is intended to measure inductors and capacitors "out of the circuit." Inductors must have a reasonable Q for their value and negligible distributed capacitance for their value. I have tested it using commercially available RF chokes ranging from 0.1 micro-Henry to 1000 micro-Henry. Hash chokes up to 100 micro-Henry wound on ferrite rods; on Pi-wound, RF chokes up to 7.5 milli-Henry; on toroid-wound inductors, up to 150 milli-Henry (such as the HI-Q series obtainable from Mouser Electronics); and on several slug-tuned inductors from a Coilcraft Slot-10 designers kit (similar to the TOKO line of tunable inductors).

Circuit Description

The Oscillator

The key to L/C Meter IIB's operation is the oscillator circuit in Figure 1. The LM311 is a voltage comparator. When power is applied, the voltage at pin 2 is 2.5 volts, causing the output to be at a level of five volts. This charges capacitor C4 through resistor R4 until the voltage at pin 3 equals 2.5 volts.

As it reaches 2.5 volts, the output switches to a low level, inducing a transient into the tank circuit composed of L1 and C1. The transient causes the tuned circuit to ring at its resonant frequency. The ringing causes a squarewave at the resonant frequency to appear at the output of the voltage comparator. The squarewave is coupled back to the tuned circuit through R3 and C3 sustaining oscillation.

For the nominal values of L1 (68 µHy) and C1 (680 pF), an increase in L of 1 nHy (.001 µHy) or an increase in C of .01 pF produces a frequency change of slightly more than 5 Hz. A 0.2-second measuring period can resolve 5 Hz, and therefore .001 µHy or .01 pF.

Besides being simple, this oscillator circuit is very reliable in that it always starts and can tolerate a large variation in the inductance and capacitance used in the tank circuit.

The Micro-Computer

The complete schematic is shown in Figure 2. The output of the oscillator is applied to the RTCC (Real Time Clock Count) pin. This increments an eight-bit counter inside the microcomputer. The microcomputer accumulates the count for a period of 0.2 seconds. The frequency is then the accumulated count divided by the period. Discrete signals from the Lx, Cx, and ZERO switches are input to the microcomputer so it knows what the operator wishes it to do.

SPECIFICATIONS

Range:
.001 µHy to 100 mHy (most units measure to 150 mHy)
.010 pF to 1 µFd
(capacitors must be non-polarized)
AUTOMATIC RANGING

Accuracy:
1% of reading AVERAGE*
*average error of 83 components compared to an:
1) HP 4275A digital L/C meter (test frequency 1 MHz) for components ranging from .1 uHy to 1 mHy and 2.7 pF to .068 uFd.
2) B & K 878 digital L/C meter (test frequency 1 KHz) for components ranging from 1 mHy to 150 mHy and .1 uFd to 1.68 uFd

SELF-CALIBRATING

Display:
16-character intelligent LCD
Four Digit Resolution
Direct display in engineering units, i.e.: Lx = 1.234 µHy/Cx = 123.4 pF

Sampling Rate:
Approximately five samples/second

TABLE 1: DISPLAY OPTIONS

INDUCTANCE nano mode	INDUCTANCE micro mode	CAPACITANCE nano mode	CAPACITANCE micro mode
1 - 999 nHy	0.000 - 0.999 µHy	0.00 - 0.99 pF	0.00 - 0.99 pF
1.000 - 9.999 µHy	1.000 - 9.999 µHy	1.00 - 9.99 pF	1.00 - 9.99 pF
10.00 - 99.99 µHy	10.00 - 99.99 µHy	10.00 - 99.99 pF	10.00 - 99.99 pF
100.0 - 999.9 µHy	100.0 - 999.9 µHy	100.0 - 999.9 pF	100.0 - 999.9 pF
1.000 - 1.999 mHy	1.000 - 1.999 mHy	1.000 - 9.999 nF	1000 - 9999 pF
10.00 - 99.99 mHy	10.00 - 99.99 mHy	10.00 - 99.99 nF	.01000 -.09999 µF
100.0 - 999.9 mHy*	100.0 - 999.9 mHy*	100.0 - 999.9 nF	.1000 -.9999 µFd
		1.000 - 9.999 µFd*	1.000 - 9.999 µFd*

*Some values out of range.

U2, a PIC16C622 microcomputer, is L/C Meter IIB's brain. The PIC16C622 is an advanced version of the familiar PIC16C54 18-pin microcomputer. The 16C622 has a 14-bit instruction allowing CALLs and GOTOs to anywhere in its 2048 instruction program memory without the page management overhead of the 16C54.

It has 128 bytes of RAM and an eight-level deep stack rather than the two-level stack of the 16C54. It also has interrupts which are not used in L/C Meter IIB. Another useful feature is built-in pull-up resistors on the inputs which helps reduce the parts count.

Self-Calibrating

During the calibrate cycle, the microcomputer first measures F1, the frequency when only L1 and C1 are in the tank circuit. The frequency will be:

$$F1 = \frac{1}{2\pi\sqrt{L1\,C1}}$$

In order to obtain another equation, so that we can solve for both L1 and C1, a known capacitor is switched into the tank circuit. The microcomputer energizes relay RLY1 by raising the CALIB line to a logic high level which switches capacitor C2 into the tank circuit. C2 is a .5% tolerance 1020 pF capacitor composed of C2a and C2b. C2a is a 1000 pF 2% polystyrene capacitor. C2b is a selected NPO ceramic which, in parallel with C2a, equals 1020 pF ±5 pF. This causes the frequency to become:

$$F2 = \frac{1}{2\pi\sqrt{L1\,(C1 + 1020)}}$$

The two equations can be solved simultaneously to give:

$$C1 = \frac{F2^2}{(F1^2 - F2^2)}\ 1020\ \text{pF}$$

and finally:

$$L1 = \frac{1}{4\pi^2 F1^2\, C1}$$

Because of this self-calibration capability, the exact values of L1 and C1 are not critical, and 10% tolerance components are used. The accuracy of the device is dependent upon C2, which is a .5% tolerance capacitor combination.

PARTS LIST

R1, R2, R3	100K ohm 1/4 watt	
R4	47K ohm 1/4 watt	
R5	1000 ohm 1/4 watt	
R6	10K ohm potentiometer	Digi-Key D4AA14-ND
C1	680 pF	
C2	1000 pF 2%	Mouser 140-PF2A102F
C4, C5	.1 µFd ceramic	
C3	10 µFd/10V tantalum	
C3, C8, C9	10 µFd/10V electrolytic	
C6, C7	22 pF ceramic	
X1	8.0 MHz crystal	
L1	100 µHy	Mouser 434-1120-101L
U1	LM311N voltage comp'	
U2	PIC16C622 microcomputer	
U3	78L05 voltage regulator	
RLY1	SPST N.O. reed relay	Digi-Key HE206
DISP	LM-16151 or equiv.	Digi-Key OP116
J1	14-pin square post socket	Digi-Key 929974-01-36
P1	14-pin square post plug	Digi-Key S1022-36
Lx, Cx, PWR	DPDT alternate action SW	Digi-Key EG1001
ZERO	DPDT momentary SW	Digi-Key EG1002
SW buttons		Digi-Key EG1098
Case		PacTec HP9VB
Test Jacks	5-way binding posts	

The following are available from:
Almost All Digital Electronics (Visa/MC)
1412 Elm St., S.E.
Auburn, WA 98092
Voice: 206-351-9316 9am-9pm (usually available on weekends)
FAX: 206-931-1940
(**NOTE:** our area code is scheduled to change to 253 after Apr. '97.)
E-Mail: neil@aade.com
http://www.aade.com

Programmed U2	$29.95
Complete Kit	$89.95 (includes machined case with panel decal)
Assembled Unit	$109.95

(INCLUDE $4.00 shipping and handling USA and Canada, $10.50 elsewhere.) (Washington State residents add 8% sales tax.)

Measuring Inductance and Capacitance

When the Lx and Cx switches are off, the microcomputer continuously measures F1 to track any drift in frequency. When the Lx switch is depressed, the unknown inductor is placed in series with L1. The total inductance is then L1 + Lx. This causes the frequency to change to:

$$F2 = \frac{1}{2\pi\sqrt{(L1 + Lx)\,C1}}$$

This equation can be solved simultaneously with the equation for F1:

$$F1 = \frac{1}{2\pi\sqrt{L1\,C1}}$$

to produce:

$$Lx = \left[\frac{F1^2}{F2^2} - 1\right] L1$$

Similarly, when the Cx switch is depressed, the unknown capacitor is placed in parallel with C1. The total capacitance is then C1 + Cx.

$$F2 = \frac{1}{2\pi\sqrt{L1\,(C1 + Cx)}}$$

which is solved for Cx, with the equation for F1, to produce:

$$Cx = \left[\frac{F1^2}{F2^2} - 1\right] C1$$

Stray Inductance and Capacitance

The circuit traces on the PCB, the switches, and the test leads all contribute a small amount of "stray" inductance (Ls) and capacitance (Cs). These stray values add to the values of L1 or C1 when the Lx or Cx switches are pressed, slightly effecting the frequency of F1.

The unit is zeroed by pressing the ZERO switch which causes the unit to store the values of stray inductance or capacitance and subtracts them from the measured values. The values displayed are:

$$Lx = \left[\frac{F1^2}{F2^2} - 1\right] L1 - Ls$$

and:

$$Cx = \left[\frac{F1^2}{F2^2} - 1\right] C1 - Cs$$

To zero Ls, the operator must short-circuit the test leads, press Lx and then press the ZERO button. Similarly for capacitors, the operator open circuits the test leads, presses Cx, and then presses ZERO.

The stored values of Ls and Cs are saved until the operating mode is changed. When measuring components, it is not necessary to re-ZERO between components. When the operating mode is changed from MEASURE to MATCH, these values are reset to zero.

You will notice from the previous equations that inserting an unknown always causes F2 to be less than F1. If an inductor is inserted when the Cx switch is depressed, the result will be an increase in frequency — F2 greater than F1 — rather than a decrease. This is because the inductor has been placed in parallel with L1 and inductors in parallel are always less than the value of the smallest of the two values.

If the unit detects an increase in frequency, it will display "NOT A CAPACITOR." This does not work for very large values of Lx. The decrease in the effective value of L1 is trivial, while the shunt capacitance of the large inductor is significant, and the frequency will decrease causing an erroneous reading.

The effect of putting a capacitor in when the Lx switch is pressed is similar, except the oscillator tends to stop, causing F2 to be zero. The unit detects this and displays "NOT AN INDUCTOR." This is not true for very large values of Cx in which case the unit may display an erroneous reading.

L/C Meter IIB can zero out ANY value in its range. If a value is inserted and ZERO'd, the unit will display the difference between it and subsequent components similar to the MATCHnMODE and MATCHuMODEs. The difference in the MATCHxMODEs is that the range is frozen to the resolution of the initial component. This limits the minimum difference in values to be one part in 10,000, or .01%. The reason for this may not be obvious. The maximum resolution of the unit is four digits *at the value of the components being measured.*

Consider two components: one with an exact value of 5000 pF, and the other with exact value of 5010.25 pF. The difference would be 10.25 pF; however, the unit cannot resolve less than 1 pF at this range, and it would be misleading to display the fractional portion of the difference.

Floating-Point Math

From all of the previous equations, it would seem that there is some relatively high-powered math involved — and there is. The upper portion of program memory in the microcomputer contains a complete 32-bit floating-point math package. The math package includes ADD, SUBTRACT, MULTIPLY, and DIVIDE. It also contains conversion from INTEGER to FLOATING-POINT, FLOATING-POINT to INTEGER, and INTEGER to BCD.

The computer measures frequency by counting the number of oscillator cycles for a period of 0.2 seconds. The result is an integer. This number is converted to floating-point, and all calculations are done in floating-point. When the values of Lx or Cx are finally computed, the answer is converted to an integer and then to BCD for display.

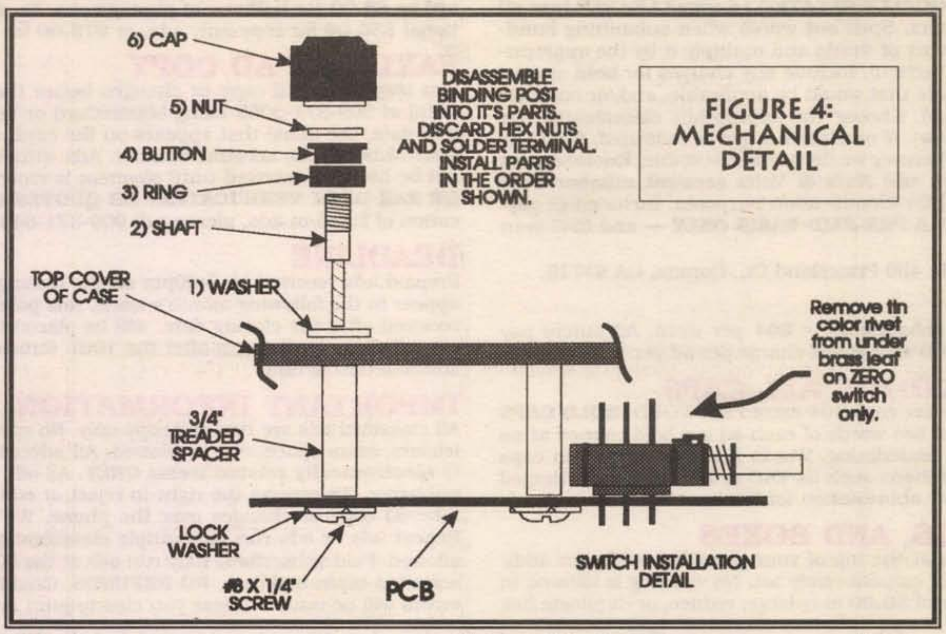


FIGURE 4: MECHANICAL DETAIL

Construction

These instructions generally apply to a kit purchased from AADE, but will be of considerable interest to scratch builders.

The unit is indeed simple, and there is no particular order of assembly. Refer to Figure 3, *Parts Layout,* for important information.

NOTE: There is only 3/8 inch space under the display. Leave enough lead length to tip taller parts at an angle so that the vertical dimension does not exceed 3/8 inch.

Solder P1 — the male square post header — at the top of the PCB. Install the contrast control, R6, on the back of the PCB — otherwise you will not be able to adjust it with the display installed. Install the two 3/4-inch spacers for the test jacks, as shown in Figure 4, *Mechanical Detail.* This should complete the PCB assembly.

Solder J1 to the display unit. If the display module has 16 holes, install the display connector in pins 1-14 of the 16 holes in the display (left 14 holes when viewed from the front). Of interest to scratch builders — who may have an intelligent 16-character display — there are two types of these. The first is organized as two lines of eight characters; that is, the 16 characters are not in contiguous RAM locations. It can be recognized as having one large IC on the back of the unit. That is the type for which L/C Meter IIB's microcontroller is programmed.

The second is organized as one line of 16 characters in contiguous RAM locations. It has two ICs on the back. Remember to remove the protective film from the display module before putting on the front cover.

Decide which type of capacitor display you prefer the unit to be in upon power-up. If you prefer the nF method, solder a jumper wire as indicated on the parts layout.

Pass the leads from the battery clip through one of the slots in the battery box of the case and solder them to the appropriate pads of the PCB. Plug in the display, turn the contrast control fully clockwise, and turn on the unit. The unit will display "WAIT" for 10 seconds, followed by "CALIBRATING" for two seconds, followed by "READY MEASURE x."

If so, you're up and running. Adjust the contrast control so the background is just barely visible. Install the PCB in the bottom of the case using three #4 sheet metal screws. Install the top cover of the case, and install the binding posts as shown in Figure 4. Test leads should not exceed four inches in length with a banana plug at one end and an alligator clip at the other.

It may be necessary to "move" the edge of a hole or slot in the case. This is easily done using sandpaper, file, or hobby knife. Before fitting the test jacks or screws in the back of the case, fit the cover and squeeze the case together while testing the switches for binding to the edge of the slot. "Move" the edge as required.

This PCB is single-sided and has one jumper wire. The kit unit uses double-sided, plated thru-hole boards and no jumpers are required.

Troubleshooting

It is very unlikely you will have any problems; however, if you purchased your kit from AADE, they will try to fix it free, except for a $4.00 return postage and handling fee.

If it did not work, remove the PCB and carefully inspect to see if you have soldered everything that should be soldered and have not soldered anything that should not be (look for solder bridges). Bad soldering accounts for 99% of units failing to work immediately. Here are some hints on where to look.

Blank display: Contrast control not adjusted correctly. Start with it fully clockwise.

Blank display: Check five-volt power to CPU and display.

Displays eight black squares: CPU not communicating with display. Check solder around CPU and display. CPU crystal not oscillating. Check with oscilloscope, if possible.

Displays WAIT, then CALIBRATING and sticks in CALIBRATING: Oscillator (LM311) is not oscillating. Check soldering around LM311, LM311 properly installed, parts properly installed. C3 in backwards?

Displays WAIT, then CALIBRATING and sticks in CALIBRATING: ZERO button stuck in or not soldered. Check continuity to ground from pin 13 of the CPU.

Operation

The typical stray inductance is .04 to .06 µHys, and the typical stray capacitance is 5 to 7 pFs. When measuring inductors less than 5 µHys or capacitances less than 50 pFs, it is advisable to ZERO the unit first. For larger values, the strays are insignificant to the result. It is difficult to retain a reading of 0.000 pFs because of the extreme sensitivity of the unit. Your body capacitance influences the reading. Try ZEROing the capacitance and then move your hands around the test leads without touching them. You will find you can adjust the reading a few hundredths of a pF.

To measure inductance, place the unknown across the test leads and depress Lx. To measure capacitance, place the unknown across the test leads and press Cx.

The oscillator tends to drift a few Hertz during the first few minutes of operation. When measuring very small values, the unit should be allowed to warm up for about five minutes.

With a resolution of 5 Hz, thermal drift will always occur, as evidenced by a slowly drifting reading. The first readings after pressing Lx or Cx are the most accurate.

Accuracy and Resolution

L/C Meter IIB is specified at 1% of reading. I have about 60 components which I had measured on an HP 4275A L/C meter. Measuring these components on L/C Meter IIB found an average error of 0.23% for inductors and 0.24% for capacitors. These values ranged from .1 µHy to 6.8 mHy and 2.7 pF to .068 µFd. These measurements were for a single unit and could vary from unit to unit by .5% as a function of the exact value of C2.

L/C Meter IIB has a four-digit resolution which, for small values of L and C, are 1 nHy and .01 pF. You cannot accurately measure values this small. The resolution greatly exceeds the accuracy. You can measure values as small as .01 µHy and .1 pF with about 15% accuracy. You generally won't find components this small.

For example, a piece of wire less than one inch long is .01 µHy. The resolution is, however, relative and can be used for sorting a batch of similar components as it truly does indicate which are slightly larger or smaller than others. Also, for small values of inductance, the leads will contribute quite a bit to the value. Measuring from the ends of the leads instead of next to the body of the component can add up to .25 µHy.

For small values, the frequency of operation (test frequency) is about 750 KHz decreasing to about 60 KHz at .1 µFds or 10 mHys and about 20 KHz at 1 µFd or 100 mHys. **NV**

HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE, 430 Princeland Ct., Corona, CA 91719.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **$5.00** to enlarge, reduce, or duplicate line art, or **$8.00** for halftone of photographs. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos.

FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the 10th) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the closing date (10th of the month) will appear in the following month's issue. Ads postmarked through the 10th, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 10th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from the classifications listed below.

10. Ham Gear For Sale
20. Ham Gear Wanted
30. CB/Scanners
40. Music & Accessories
50. Computer Hardware
60. Computer Software
70. Computer Equipment Wanted
80. Test Equipment
85. Security
90. Satellite Equipment
95. Military Surplus Electronics
100. Audio/Video/Lasers
110. Cable TV
115. Telephone/Fax
120. Components
125. Microcontrollers
130. Antique Electronics
135. Aviation Electronics
140. Publications
145. Robotics
150. Plans/Kits/Schematics
155. Manuals/Schematics Wanted
160. Misc. Electronics For Sale
170. Misc. Electronics Wanted
175. BBS & Online Services
180. Education
190. Business Opportunities
200. Repairs/Service

ADVERTISER'S INDEX

ADVERTISERS INDEX

FIND what you need . . . FAST by PRODUCT OR CATEGORY

INDEX BY PRODUCT

Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

Rubber Boot Included

Our Best Offer Ever on a High Quality Full Sized DMM

$19.00 any qty

General
Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
*Dimensions:*188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input. 2A/250V fuse.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test
Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets

(Selectable X1/Ref/X10)
These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

CCD Camera - IR Responsive

As Low As $85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.

Power Supply Regulating Kit for CA-H34 This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$99.00	$85.00
A34	Power Supply Regulating Kit	$6.95	—

PM-128: 3-1/2D LCD Digital Panel Meter; PM-129: 3-1/2D LED Digital Panel Meter

Features
- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input : 199.9mV DC
Maximum Display : 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication
Indication Method : PM-128 - LCD Display; PM-129 - LED Display
Measuring Method : Dual-Slope Integration A/D Converter System *(cont.)*

(cont.)
Overrange Indication : "1" Shown in the Display
Reading Rate Time : 2-3 Readings per sec.
Input Impedance : >100 Mohm
Accuracy : +-0.5% (23+-5°C, <80% RH)
Power Dissipation : PM-128 - 1mA DC; PM-129 - 60mA DC
Decimal Point : Selectable w/Wire Jumper
Supply Voltage : PM-128 - 9V DC; PM-129 - 9V DC
Size : 67mm x 44mm

Applications Include:
- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

REDUCES ETCHING TIME!

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Digital Panel Meters (LCD & LED)

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2D LCD Digital Panel Meter

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.

Specifications - PM-328
Maximum Input : 199.99mV DC
Maximum Display : 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication
Indication Method : LCD Display
Overrange Indication : "1" Shown in the Display
Input Impedance : >100 Mohm
Accuracy : +-0.05% (23+-5°C, <80% RH)
Power Dissipation : 1mA DC
Decimal Point : Selectable w/Wire Jumper
Supply Voltage : 9V DC
Size : 67mm x 44mm

Features:
- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

!!!!!!!!!! SEE OUR ON-LINE CATALOG AT www.cir.com !!!!!!!!!!

Circuit Specialists Inc. www.cir.com

SINCE 1971
CIRCUIT SPECIALISTS, INC.
800-811-5203
602-464-2485
602-464-5824(FAX)

WE ACCEPT:

RECEIVE OUR LATEST 132 PAGE CATALOG!

It's chock full of all types of electronic equipment and supplies. We've got I.C.'s. capacitors, resistors, pots, inductors, test equipment, breadboarding supplies, PC supplies, industrial computers, data acquisition products, personal computers and computer parts, plus much, much more. FAX us your name and address or call 800-811- 5203, ext. 5, to leave a message on our catalog request line. ***www.cir.com***

Write in 98 on Reader Service Card.

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 91719

ADDRESS CORRECTION REQUESTED

BULK RATE
U.S. POSTAGE
PAID
V.Q.S.
ENTERPRISES