

# Nuts & Volts

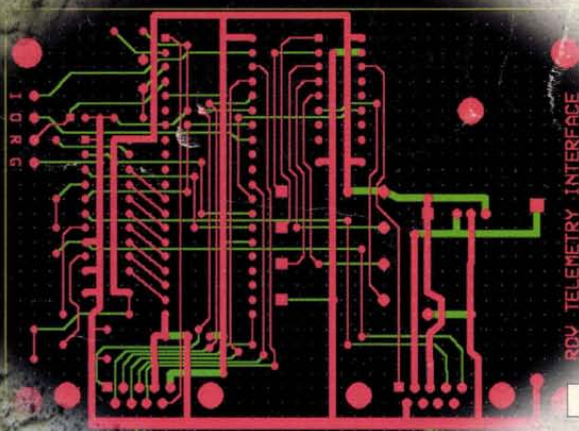
U.S. \$3.50  
CANADA \$4.50

Exploring Electronics And Technology For The Hobbyist And Professional

Welcome Robert Nansel —  
New Host of Amateur Robotics Notebook!

June 1998 Vol. 19 No. 6

**Described by the creators as “a car accident on wheels,” La Machine demonstrated its own version of a “smash fest” at the Robot Wars competition.**



**Printed Circuit Boards For Everyone!**

Thanks to ExpressPCB, prototyping with printed circuit boards can be inexpensive and hassle free.

**“To test the promise of ExpressPCB, we decided to re-design a circuit we had previously built using wire-wrap for an unusual hobby project: a home-brew underwater robot.”**





# CLONE, FORMAT, REPAIR AND TEST ANY DISK DRIVE



## STAND ALONE DRIVE DUPE-IT! CLONES ENTIRE DRIVES

Copy entire hard drives with ease. Why spend hours installing and formatting drives when you can do it instantly with Drive Dupe-It! Set up any SCSI or IDE drive with all your original software. Connect blank drives and press start. You'll copy entire drives instantly!

With our combo IDE/SCSI model, you can copy entire hard disk images from IDE to SCSI or vice-versa.

## HOT NEW TECHNOLOGY REPAIRS DRIVES

Don't throw those used drives away! Breathe new life into old drives with Dupe-It! Pro. Reassign and eliminate bad SCSI blocks and IDE defects. Put the built-in drive repair system to work for you. Here's how it works: First, a precise analysis system scans the disk surfaces for errors. Defects are then mapped around and effectively "erased". The built-in error correcting system "trains" the drive to permanently avoid defective areas. Your data is stored only on safe areas of the disk. Capacity is reduced by an insignificant amount, and the drive works flawlessly once again.

Get the technology used by major repair shops and modern data recovery centers. Dupe-It! Pro repairs all disk defects caused by normal wear. Drives with excessive mechanical damage may not be repairable.

## PRO MODEL INCLUDES FACTORY TEST SYSTEM

Choose the Dupe-It Pro, and you'll also have an entire factory drive test system for under \$1000. The Pro model gives you the ability to copy, reformat, repair, translate, and test any hard disk drive. Use the Pro to put any hard drive through its paces. A full factory final test and performance analysis is performed. Complete test and repair reports are sent to any standard printer.

STAND ALONE IDE DRIVE DUPE-IT  
P/N IDI ..... \$395.

COMBO IDE AND SCSI DUPE-IT WITH TRANSLATOR  
P/N SDI2 ..... \$795.

PRO MODEL LOADED WITH IDE AND SCSI INTER-  
FACES, TRANSLATOR, DRIVE MECHANIC, AND DRIVE  
DIAGNOSTIC TEST SOFTWARE WITH PRINTER PORT  
P/N SDIPRO ..... \$995.



**CORPORATE SYSTEMS CENTER**  
www.corpsys.com

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**408-743-8739**

CD DUPE-IT! IS SOLD AND INTENDED FOR BACKUP AND IN-HOUSE  
DUPLICATION PURPOSES ONLY. COPYRIGHT LAWS MUST BE  
OBSERVED. CALL FOR RACK MOUNT AND MULTI-DRIVE COPIERS.



# COPY ANY CD INSTANTLY!

## CD DUPE-IT!

Instantly duplicate master CDs for software distribution. Make spare backup copies of your favorite software on rugged, permanent media. Produce custom discs quickly and economically. No mastering or multimedia experience is required.

## ONE BUTTON OPERATION. NO PC NEEDED.

Insert your original disc and press "start". The multimedia processor quickly copies any CD to the internal A/V hard drive. Insert blank discs and make as many copies as you like. You'll produce identical, bit-for-bit duplicates. The system is totally self contained — no computer is needed. Just plug it in and press "start". You'll get perfect copies of any CD.

## BUILD YOUR OWN CUSTOM AUDIO DISCS!

You can make your own custom audio discs without a PC! Insert your original CDs, select the tracks you want, and copy them. Then insert a blank CD-R, and you'll have a custom audio disc with just the songs you want.

With the included CD mastering software, CD Dupe-It will work overtime. Just attach a SCSI cable to your PC or Mac, and you're ready to design and create your own original CDs.

CD DUPE-IT! ..... \$1095.  
CASE OF 100 BLANK DISCS (Green/Gold) ..... \$159.  
CASE OF 100 BLANK DISCS (Gold/Gold) ..... \$199.



# HSC Electronic Supply

Serving  
Silicon Valley  
since 1964!

...brings you a potpourri of high-tech goodies for the techno-tinkerer!  
For thirty years we have been your source for Silicon Valley exotica!

## Ruby Laser Rarity!

- ◆ That's right, be the first on your block to own a Laser Rangefinder module from an M-1 Tank!
- ◆ Optics module from Q-switched Ruby Laser includes cavity, ruby rod (3"), flash tube, spinning prism with high-speed DC motor, half-effect switch, thermistor, etc.
- ◆ Factory refurbished units with spec. / test sheets
- ◆ Does not include power supply or control circuitry
- ◆ Caution...high power bursts -- not for amateurs!
- ◆ Overall measurements 8" long x 2.5" x 1.5" (excl. motor)



HSC#17263 \$65.00

## External SCSI Drive Cases

- ◆ Bargain case for 5.25" drives, brand new!
- ◆ 7" x 4.5" x 10.5" overall size
- ◆ 50-pin SCSI connectors
- ◆ SCSI ID switch
- ◆ 65W Power supply (lots of power for hard drives, etc.)
- ◆ Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17130 \$39.95

- ◆ High quality low profile case for 5.25" drives, brand new!
- ◆ 7" x 2.25" x 11" overall size
- ◆ 50-pin SCSI connectors, RCA Audio connectors
- ◆ SCSI ID switch, termination switch
- ◆ Tiny 12W Power Supply (5VDC @ 1.4A, 12VDC @ .4A, probably only good for CD-ROM's)
- ◆ Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17357 \$29.95

- ◆ High quality case for 3.5" drives, brand new!
- ◆ 6.5" x 2.5" x 10" overall size, good for tape drives!
- ◆ 50-pin SCSI connectors, SCSI ID switch
- ◆ Drive bay snaps out for easy access to cables
- ◆ 40W Power Supply (5VDC @ 2A, 12VDC @ 2.5A)
- ◆ Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17356 \$24.95

## Sound Card Specials!

- Diamond Multimedia Wavetable Sound Card
- ◆ Multi-interface for CD-ROM (Sony, Mitsumi, Pana., IDE)
- ◆ Full featured sound capability, 2MB Wavetable, 24 voice
- ◆ Line-in, Line-out, Mic., Speaker & MIDI/Game jacks
- ◆ New OEM pack, instruction sheet, 90-day HSC warranty

HSC#17142 New - Lower Price! \$17.95

Media Vision PCMCIA Sound Card

- ◆ Great for Portables, Laptops with PCMCIA Slot
- ◆ External pod has joystick port, mic. input, line in & line out jacks, volume control
- ◆ Installation software, instructions included
- ◆ Windows 3.x, Windows 95 compatible
- ◆ New in OEM packaging (no box), 90-day HSC warranty
- ◆ We had these before at \$39.95 and they went fast!

HSC#17036 \$29.95

## House that Equipment!

- ◆ Bargain on used, knee high 19" rack cabinets!
- ◆ 29.5" tall, with room for 21" of vertical instrument height
- ◆ 23.25" wide, and 30" front-to-back, textured black finish
- ◆ Made by AMCO Engineering
- ◆ Units are used, but in good shape
- ◆ Best if you pick up (cannot go UPS)
- ◆ Last time we had these at \$149.00, and they went fast! Quantity discounts available.



HSC# 17069 \$99.00

## Absolute Last of the Red Hot Reno!

- ◆ Now at clearance price -- Media Vision Reno:
- ◆ Consists of new external Reno CD-ROM drive, docking bay with SCSI II port, AC Adapter, cable kit, travel pouch, headphones
- ◆ Late Model version Uses AC adaptor (included) or AA alkaline batteries (not included)
- ◆ Double-speed 180MS drive is lightning fast!
- ◆ Drive detaches from docking bay, use with headphones as a portable personal audio CD player
- ◆ Great for Mac or IBM (adaptor bracket included)
- ◆ SCSI Controller & software required for IBM use
- ◆ Brand new, 90-day warranty



Available Separately:  
A. Macintosh Powerbook SCSI Adapter (HDI-30 to 25-pin D connector) HSC#15704 \$12.50 if purchased alone, or with purchase of Reno Kit \$5.00

## Super Sounding Speakers!

Tired of the cheesy sound coming from those give-away speakers in your multimedia kit? Try upgrading to these sonic wonders...you'll have to hear them to appreciate the difference these will make without blowing your budget!

- GNT2500 2-way Bass-Reflex speakers
- ◆ 3.5" woofer, 1" piezo tweeter
- ◆ 15W built-in amplifiers, 80W peak, 5.4W RMS
- ◆ 40 - 20,000 Hz, built-in SRS 3-D stereo
- ◆ Measure approx. 3.75" x 6.125" x 9.25" tall
- ◆ AC adaptor, audio cables included
- ◆ On-off switch, 3-D switch, tone & volume controls
- ◆ Attractive off-white finish with grey grille-cloth



HSC#16670 \$29.95

- GNT3000 3-way Bass-Reflex speakers
- ◆ 4" woofer, 2" midrange, 1" piezo tweeter
- ◆ 23W built-in amplifiers, 120W peak, 20W RMS
- ◆ 20 - 20,000 Hz, similar to GNT3500, but no SRS 3-D
- ◆ Measure approx. 6.25" x 6.5" x 9.75" tall
- ◆ AC adaptor, audio cables included
- ◆ On-off switch, bass, treble & volume controls
- ◆ Attractive off-white finish with grey grille-cloth



HSC#17085 \$39.95

## X-Windows Terminal!

- ◆ Tiny Axil-Hyundai X/11C smart terminal has big features!
- ◆ Connect to Ethernet (Coax or AUI), SLIP, or both!
- ◆ Built-in 10Base2 transceiver, 10Base5 AUI interface
- ◆ Uses a variety of protocols, TCP/IP, SLIP, TELNET, RARP, BOOTP, XDMCP, or PPP
- ◆ Comprehensive self-test and help menus for setup
- ◆ Requires 63.775KHz Horizontal, 67.9Hz Vertical (workstation-type) monitor, resolution is 1152 x 900
- ◆ RAM can be upgraded to 16MB (4MB SIMM included)
- ◆ New in box, includes 101-key keyboard, mouse, manual
- ◆ Measures 11.5" x 11" x 2", keyboard is 18" x 7"



HSC#17213 \$149.95

## Infrared Connections!

- ◆ IBM "Options" series ISA-Bus and PCMCIA card adaptors will add industry standard infrared communications capability to your desktop PC (with ISA slots) or notebook computer! (Win95 instructions available on our website)
- ◆ Allows wireless connection to compatible notebooks, workstations, printers, and other peripherals supporting the Infrared Data Association (IrDA) standard.
- ◆ Also will emulate a COM port for cable-less hook-ups
- ◆ Communicates up to 115Kbps, or up to 1.152Mbps with the included TranXit Software.
- ◆ Operates over distances up to 3 meters (10 ft.)
- ◆ Includes Card, transceiver module, driver disk & book
- ◆ Both styles new in box, 90-day warranty



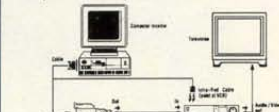
HSC#16483 PCMCIA Version \$19.95

HSC#16813 ISA-Bus Version \$19.95

Or a package deal...get both for \$29.95

## PC Videotape Editor!

- ◆ Use your computer to edit your home videos!
- ◆ Delete footage, rearrange up to 99 scenes automatically!
- ◆ No expensive computer cards to install
- ◆ Requires 386 or higher computer, Sony-type Control-L (LANC) source camcorder and a recording VCR with infra-red remote control with TV or video monitor.
- ◆ Unit consists of a cable to control the playback of your camcorder, and an infra-red transmitter to control VCR
- ◆ Plugs into parallel port of your computer -- no disassembly of your computer required!
- ◆ Includes software (Win 3.1 compatible) cables and manual
- ◆ New in box - 90 day warranty
- ◆ Requires 9V battery, not included



HSC#17154 \$29.95

## Little Pump That Could!

- ◆ Tiny Gast Vacuum/Pressure diaphragm pump
- ◆ Model MOA-V112-AE -- oil-less design means clean air!
- ◆ Measures 7" long, 3.375" dia., 4.75" tall
- ◆ 115 VAC, new in box with installation & parts diagram



HSC#17360 \$74.95

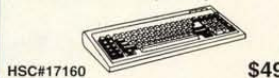
## PCMCIA GPS Card

- Trimble Mobile GPS Gold Card
- ◆ Turn your notebook into a GPS locator!
- ◆ Receiver is PCMCIA Type I card
- ◆ Includes roof or panel-mount antenna with 15' cable
- ◆ Trimble Mobile GPS software & instructions included
- ◆ Software gives coordinates, not maps
- ◆ New, OEM pack, 90-day warranty

\$149.00

## Parallel-Port Keyboard!

- ◆ Perfect for notebook computers, laptops, palm-tops, etc.
- ◆ Full-size 101 keyboard by ALPS, model LPT 101
- ◆ Includes manual, installation diskette
- ◆ New in OEM box, 90-day warranty



HSC#17160 \$49.95

## Rugged Mike & Speaker!

- ◆ Extra-heavy duty hand-held microphone & enclosed speaker for extreme environmental use
- ◆ Made by GE for Ericsson EDACS "Orion" mobile radios
- ◆ Easily modifiable for your own use (ham, CB, etc.)
- ◆ Brand new in box, with custom Ericsson power cable



HSC#17172 \$29.95

## Briefcase of Goodies!



- ◆ These handsome hardshell cases were used to carry a laptop-computer estimating system (laptop not included)
- ◆ They were used with a Compaq LTE laptop, and provided a SCSI port for a CD-ROM drive with battery back-up
- ◆ Large Nicad pack has 10 D-size Sanyo Cadnicia cells.
- ◆ Built-in 19VDC power supply for battery charging
- ◆ Tiny piggy-back PC board seems to be a SCSI interface
- ◆ Case measures 18" x 14" x 7", with several compartments
- ◆ SCSI II to CEN50 SCSI cable, many great parts inside!
- ◆ Buy either the whole assembly, or just the parts you want!
- ◆ Not guaranteed to function with laptops -- for parts only!

HSC#17180 Complete Laptop Case \$49.95

HSC#17182 Empty Hardshell Case \$29.95

HSC#17181 Nicad Pack, 12.5VDC, 5AH \$17.50

HSC#17179 SCSI II Cable, 1 ft. long \$12.50

## Extra-long Cord Outlets!

- ◆ Don't daisy-chain those outlet strips to get power where you need it! (The fire department doesn't approve!)
- ◆ Multi-outlet SG/Waber outlet strips have extra-long cords
- ◆ UL Approved, metal housings, 15 Amp circuit breaker
- ◆ Brand new, two lengths to choose from!
- ◆ Hurry, these won't last long, especially the 50-footers!
- HSC#17172 4-Outlet strip w/ 15' cord \$9.95
- HSC#94148 3-Outlet strip w/ 50' cord \$17.50

## Quick, Cheap, Easy IDE!

- ◆ What more could you want in an IDE controller?
- ◆ Creative Technology CT1871 Plug and Play card
- ◆ Perfect for CD-ROM's, other non-bootable SCSI devices
- ◆ 16 bit short ISA card has minimum parts count
- ◆ Supports up to two CD-ROM drives
- ◆ All settings are PnP settable, supports all ATAPI drives
- ◆ New, OEM bag with spec. sheet, 90-day warranty

HSC#17358 \$3.95

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specialties co.

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Supply

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FAX your orders to:  
(408) 732-6428



## Visit HSC's Website!

- ◆ Pay us a virtual visit on the World Wide Web!
- ◆ Simply point your browser to <http://www.halted.com>
- ◆ Site is constantly being revised, please visit often!
- ◆ Check out the amazing "Gizmo of the Week" feature!

## HSC Catalog online!

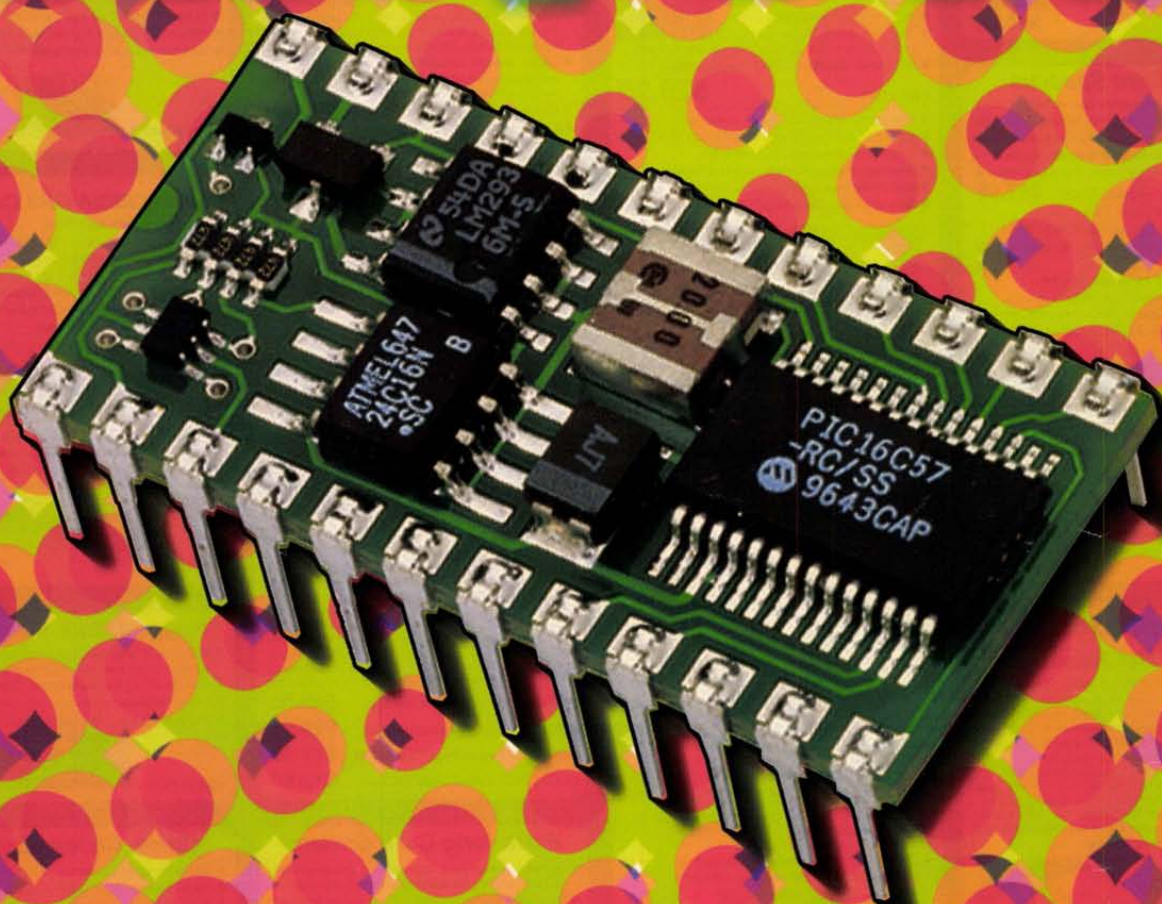
- ◆ That's right, get HSC's catalog on the World-Wide Web!
- ◆ Simply go to [www.halted.com](http://www.halted.com) and follow the big red link.
- ◆ Adobe .PDF files are available for download and viewing.
- ◆ Or drop on by and pick one up...we'd love to see you!

Terms: Some quantities limited; all items subject to prior sale. Minimum order: \$10.00 plus shipping. Orders under \$20.00 subject to \$2.00 handling fee, in addition to shipping. All orders shipped FOB Santa Clara, CA (this means you pay freight!) by UPS Surface (no P.O. Boxes) unless otherwise specified, in which case prevailing carrier rate plus \$5.00 handling fee applies. Prepaid orders that don't include shipping charges will be shipped freight COD. There is a \$4.75 UPS charge added to shipping charges for COD shipments. If you have questions about your order, please call Customer Service at (408) 732-1854 M-F 9AM to 5PM PST.



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when they***

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generate sine waves***

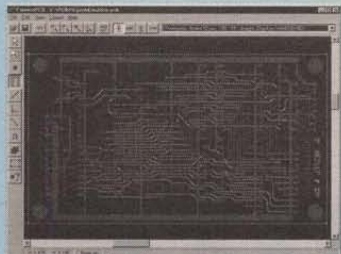
**PARALLAX** 

<http://www.parallaxinc.com>

916.624.8333

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registered trademarks of Parallax, Inc.





Engineering Express has recently unveiled its new ExpressPCB layout software and ExpressPCB manufacturing service for fast turnaround/low-cost printed circuit boards. Together they provide an integrated solution for professionally prototyping electronics very quickly and economically.

The ExpressPCB layout editor is available for Windows95 and WindowsNT. The strength of the layout package comes from its intuitive design and ease of use. The standard Windows user interface makes it simple to master PC board design in a single evening. The editor includes a large library of stock components, many components reference the manufacturer's part numbers. The software is available at no cost and can be downloaded from [www.expresspcb.com](http://www.expresspcb.com)

To complement the layout editor, Engineering Express has an integrated PC board fabrication service that manufactures very high-quality, double-sided printed circuit boards with plated-through holes. This integrated solution allows the user to instantly get quotes for PC boards, and place orders directly from the layout program. Once an order is placed, the software automatically transmits the layout over the Internet to the ExpressPCB manufacturing service.

For more information, contact:

**ENGINEERING EXPRESS**  
56 CONCORD AVE., #33  
DEPT. NV  
CAMBRIDGE, MA 02138  
617-441-9497  
E-MAIL:  
[reifel@expresspcb.com](mailto:reifel@expresspcb.com)

#### CDT-4



A non-invasive tester (CDT-4) for ACD players, DVD, Laser disc players, CD-ROMs, computers, preamplifiers, amplifiers, tuners, DATs, VCRs, and tape decks is introduced by SoundSmith.

The CDT-4 tests for intermittent signal level change, CD skips, noise distortion, or loss of signal.

# New Product

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

# News

Errors are logged for up to five days or more in non-volatile memory and are displayed on large numeric LEDs. Error information can also be fed via an RS232 port to a computer or printer for complete error printout.

The CDT-4 comes with a specially designed audio CD, and may be used for automated integrity testing of any analog signal path. It runs on either the supplied 13-volt AC transformer, or on 12 volts DC for automotive stereo testing.

Users for the tester include audio servicers, custom home installers, audio retailers, engineers, and service personnel in the radio and television broadcast industries, computer sales and service people, audio manufacturers, and automotive stereo dealers and servicers.

The CDT-4 features a multi-segmented display on the front of the instrument to indicate the number of tests, and number and type of failures, and when during the testing they occurred. A computer interface is provided to allow the user to view, store, or create a print-out of the results. This information is invaluable in allowing the technician to pinpoint the nature of the problem, and to then effectively solve the problem.

Model CDT-4 is available for \$749.00 (includes power supply, test CD, and manual). Replacement CDs are \$29.95.

For more information, contact:

**SOUND SMITH**  
8 JOHN WALSH BLVD.  
STE. 417 DEPT. NV  
PEEKSKILL, NY 10566  
1-800-942-8009  
914-739-2885  
FAX: 914-739-5204  
WEB: [www.sound-smith.com](http://www.sound-smith.com)

#### PAGEPRO



RF Neulink announces PagePro, its new line of synthesized digital paging transmitters with built-in PCSAG paging encoder.

PagePro comes with paging software that runs in a Windows 95 or Windows NT environment. Generating numeric, alphanumeric, and tone pages is as easy as a mouse click.

Although designed to handle the demands of wide area paging, the PagePro is equally well-suited for in-house and local area paging.

The PagePro series is fully synthesized and can be easily field programmed in 10 or 12.5 KHz increments via a built-in RS 232 port.

Several models are available covering the 134-174 MHz, 218-230 MHz, and 260-280 MHz ranges.

Output power is adjustable with a nominal maximum output of five watts in the 136-174 MHz range and two watts in the 218-230 MHz and 260-280 MHz ranges.

For more information, contact:

**RF NEULINK**  
7610 MIRAMAR RD., DEPT. NV  
SAN DIEGO, CA 92126  
619-549-6340  
FAX: 619-549-6345  
1-800-233-1728  
[rfneulink@rfindustries.com](mailto:rfneulink@rfindustries.com)

#### NAVIFINDER-200™



Precision Navigation, Inc. introduces the Navifinder-200™ electronic compass module, which is ideal for use in RVs, snowmobiles, motorcycles, boats, and van/truck conversions. It can easily be mounted in a dash or enclosed in a housing.

The Navifinder-200 uses advanced calibration algorithms that discriminate between the earth's magnetic field and those generated externally, such as from the metal and electronics in a vehicle. By electronically compensating for these external factors, the Navifinder-200 is able to provide highly accurate compass readings in all vehicle environments.

The Navifinder-200 is much easier to set-up than a floating ball compass, taking less than two minutes to calibrate. Plus it is simpler to use because it continuously displays your exact heading, eliminating the guesswork involved in reading an unstable floating ball, which is necessary with most other vehicle compasses.

The Navifinder-200 compass is priced at \$75.00 in single units for the avid hobbyist and, for OEMs, the 1,000 unit price drops to \$32.00.

For more information, contact:

**PRECISION NAVIGATION, INC.**  
1235 PEAR AVE., STE. 111  
DEPT. NV  
MOUNTAIN VIEW, CA 94043  
650-962-8777 FAX: 650-962-8776  
E-MAIL:  
[sales@precisionnav.com](mailto:sales@precisionnav.com)  
WEB: [www.precisionnav.com](http://www.precisionnav.com)

#### NEW FM LOW-PASS FILTERS



Progressive Concepts announces three new low-pass filters Model LPF7000, LPF7002, and LPF7003.

These highly efficient Chebyshev design filters have a bandpass of 0-108 MHz and offer up to 75 dB of attenuation to harmonic energy in the range of 120-500 MHz. With an insertion loss of less than .01 dB, these filters are well-suited for use on power levels as low as 100 milliwatts on up to 300 watts. Input and output impedances are both 50 ohms and they are available with SO-239 or "N" type connectors.

Prices start at \$69.00.

For more information, contact:

**PROGRESSIVE CONCEPTS**  
P.O. BOX 586, DEPT. NV  
STREAMWOOD, IL 60107  
630-736-9822  
FAX: 630-736-0353

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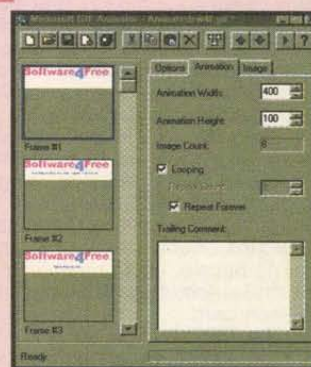


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### EDITORIAL CONTRIBUTIONS

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 two weeks prior to the 1st of the month for the next month's issue.



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Talk is cheap. Give your BASIC Stamp projects a voice with the SP0256-AL2 allophone speech processor from General Instruments.		

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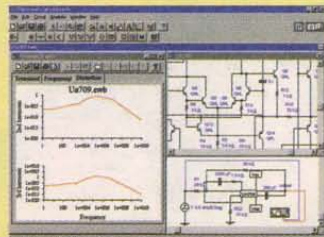
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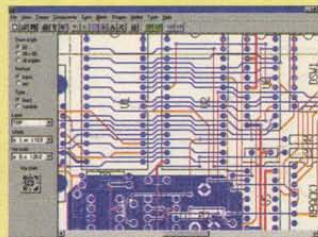
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# FREE RADIO SIGNALS FOR GPS ERROR CORRECTION

**Y**ou may have thought that the old boater's beacon band from 200 KHz-500 KHz has been abandoned. Not so! The United States Coast Guard, plus the Department of Transportation for highway and railroad positioning, will provide us free low-frequency correction signals for sub-meter accuracy ...

The Department of Defense global positioning system has achieved such widespread positive response in its capabilities that almost everyone, every single day, benefits from it.

Boaters navigate with GPS. Pilots stay on track. Backpackers can carry a \$99.00 Magellan Pioneer GPS to safely guide them back down the trail. Paramedics and police keep track of their response vehicles with GPS. Surveyors use GPS for centimeter and millimeter accurate benchmarks.

The flower delivery you received this morning was guided by GPS to your doorstep. Pizza Man is tracked on GPS to keep your cheese and anchovies piping hot as they direct him to the next stop.

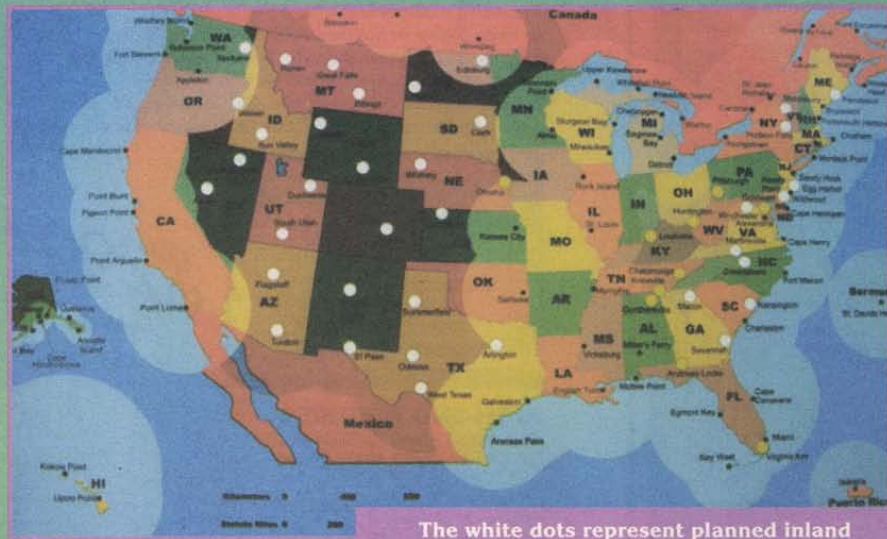
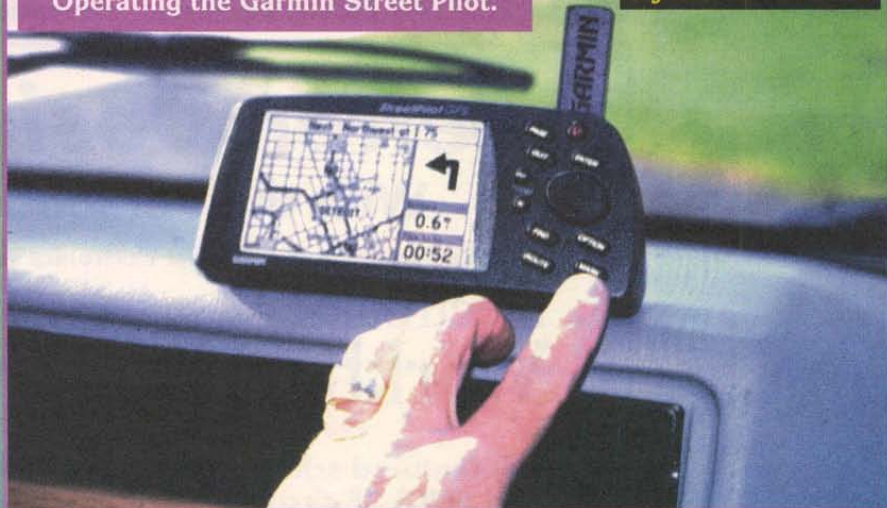
Many high-end vehicle manufacturers may offer global positioning system car-navigation systems as an option. Hertz Corporation — the world's largest car rental company — has expanded the availability of its "NeverLost" navigation system, manufactured by Magellan, to more than 50 rental locations in 35 US cities, equipping 8,000 rental vehicles.

"Businessmen depend on the global positioning system to voice-instruct them exactly how to get to their client's location in a strange city," comments Jim White of Magellan. "Travelers can also find it extremely useful for navigating their way around unfamiliar towns and finding hotels, restaurants, and points of interest," adds White. Consumers can buy this system as "PathMaster" for a retail price of \$1,995.00, and this includes one regional data base cartridge and the installation of that cartridge in their set-up.

There is also the cellular phone GPS system from Bartizan Communications, nicknamed "Bart," that does not necessarily have the big

Operating the Garmin Street Pilot.

by Gordon West



The white dots represent planned inland DGPS beacon stations.

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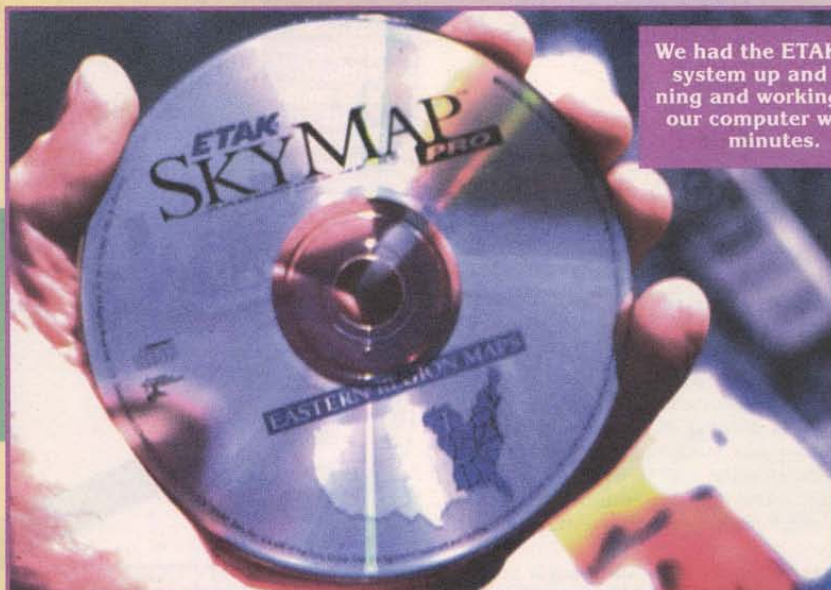
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street map on the dash, but constantly keeps track of your whereabouts out on the highways and byways, and allows for instant contact to a dispatcher who can send help or the medics to the position they see on their screen via cellular.

There is also the BEACON from EX2 Company (1-800-392-7686) that offers a color touch-screen readout of every street, highway, one-way road, and alley in the United States, Canada, and Alaska. "There is even a wireless infrared keyboard that may allow this system to do double-duty as an office work station," comments Wayne Bagrowsky at EX2. "We also have the professional car-navigation capabilities of voice prompts that will tell the driver when to turn left, go back, or hang a right," adds EX2.

### BUT HOW ACCURATE?

The global positioning system transmits two signals for "precise" positioning — Channel L1 is a spread-spectrum signal on a carrier frequency of 1575.42 MHz, and Channel L2 — reserved for authorized users only — transmits on

1227.60 MHz spread-spectrum.

Civilian equipment like the \$99.00 Magellan, or the \$350.00 Garmin GPS III mapping system, or the \$2,000-\$4,000 GPS chart and mapping systems, receive only the L1 channel leading to a 95 percent probability of position accuracy within the radius of a 300-foot circle.

### RADIUS

This means a potential error out to 300 feet

from your position in the center of a circle. This means you could mark a favorite scuba dive spot in error 295 feet due north, and then try to return to that same spot a few days later in error 295 feet south. This could put you two football fields away from the earlier position, and one football field away from where you actually are.

Hey, I thought this GPS business was "spot on" down to a manhole cover. Well, it CAN be, and read on because we're going to tell you how the United States government is giving us free signals to correct this potential of a 300-foot error from our true position.

### WHY THE ERRORS?

The biggest error is purposely induced by the Department of Defense to deny spot-on enemy missile accuracy by unfriendly forces. This error is called "selective availability," abbreviated S/A, and it means that we have been (as civilians) selected NOT to be available for decoding the secondary L2 precise military encrypted P-CODE.

There are also man-made errors that can throw off position accuracy using GPS, in addition to selective availability:

Selective availability	± 100 foot errors
Ionospheric errors	± 25 feet
Tropospheric errors	5 feet
Clock/ephemeris errors	15 feet
Multipath errors	5 feet
Noise	5 feet
Poor geometry errors	70 feet

If we could decode the restricted L2 frequency, we could minimize our atmospheric and ionospheric errors by 50 to 75 feet. This is because we could determine signal-path errors better by looking at the difference between two widely spread frequencies, rather than just one.

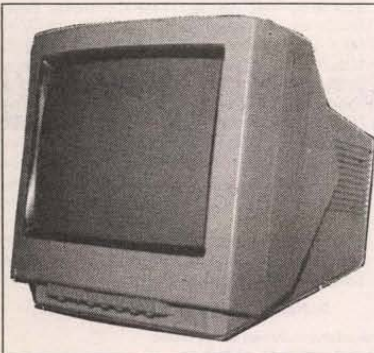
We can also minimize poor geometry errors by letting our GPS receiver sit in a specific position and self-calculate where the greatest number of position fixes take place on the screen. In fact, I do that regularly in our communications van, and can generally spot my REAL position down to 20 feet or so after letting the equipment "settle in" for a few minutes.

But the biggest error comes from the military — on purpose —



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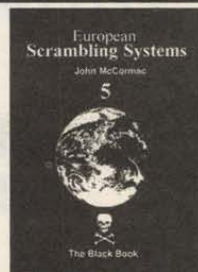
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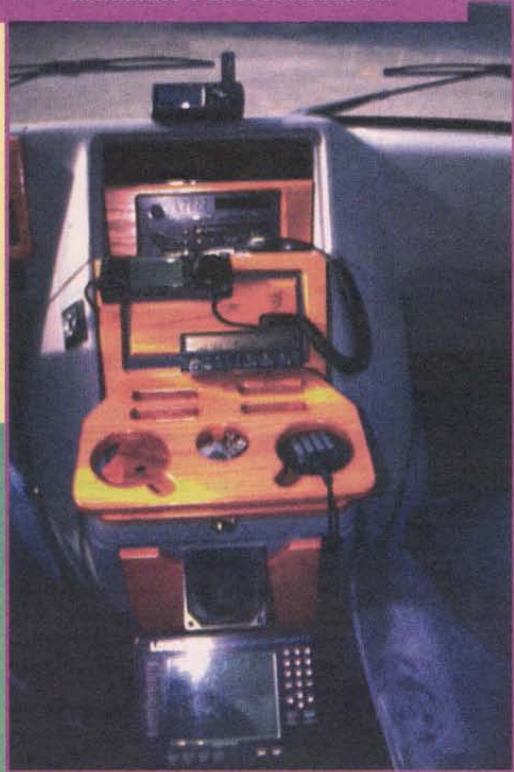
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and this is why your GPS may show you going one or two MPH in a certain direction, even though you are standing absolutely still. If you plot your track (even the little \$99.00 Magellan can do this), you will see that Uncle Sam is taking you for a phantom ride within the radius of a 300-foot circle; and if you sit still, you'll begin to see that you're at a specific spot within that circle because you constantly keep going through ground zero.

On the car navigation GPS systems, many contain a mapping algorithm that will not only keep track of your GPS position, but also keep track of roads around you. After you go straight, turn left, and then turn right, the expensive software begins to match your GPS position with known roadways, and then self-corrects so your automobile is now straight down the charted road. But the little handheld GPS sets might not have this comparison software, so occasionally you will see yourself going down the highway,

Here is some of the testing we did on portable GPS equipment that includes street maps and RV parks. This is inside the author's 21-foot Roadtrek.



and when you zoom in, see that you are slightly over on the right shoulder. But usually on a four-lane road, the little inexpensive Garmin Street Pilot GPS will clearly show you on one side of the road going north, and when you travel back, show you on the other side of the road.

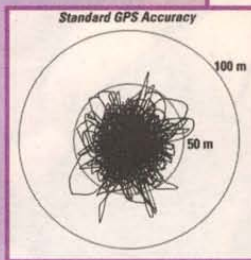
You are out on the desert on a camping trip, and your better half loses their gold one-carat diamond ring in the sand. The wind is blowing like mad, and you didn't bring your metal detector. Can you mark your position with GPS, drive home to get the metal detector, and then return to that exact same spot within a couple of feet?

If you let your mobile GPS "settle in" for about 20 minutes, then mark your spot, chances are you'll be able to get back to that same spot within about 20 to 30 feet. But for a surveyor, this is not close enough. For a large super-tanker coming into a narrow navigational channel, the probability of a 300-foot error is out of the question.

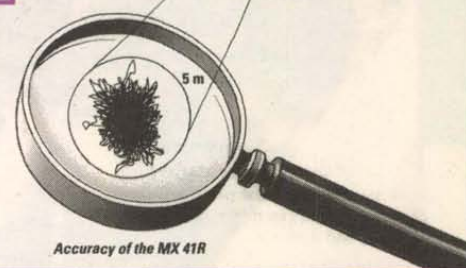
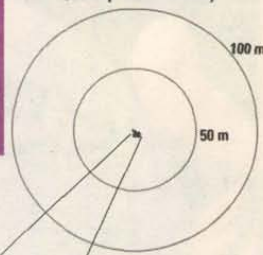
The way we achieve spot-on accuracy for those that need to get back within a meter or so of their pre-memorized position is through differential GPS correction methods. Differential GPS relies on a local receiver with a very expensive GPS inside taking position measurements, and comparing them to a surveyed benchmark. For boaters, the differential reference receiver is usually at the entrance looking over a big harbor or channel. For the aviation industry, it may be at the end of a runway. And soon for the railroad and automobile industry, these differential reference stations will be set on benchmarks throughout the country.

The differential beacon receiver compares its EXACT position to what is calculated by the global positioning system satellites. Every couple of seconds, an error correction message is sent out to all local GPS receivers in the area to add or subtract XX number of feet at a specific heading in order to calculate their own exact position. The differential transmitter, for surveyors, is usually up in the 400-MHz region, or higher.

Position accuracy without (left) and with differential corrections.



DGPS Improved Accuracy



Accuracy of the MX 41R

You can subscribe to differential corrections by a receiver that picks up the signals on commercial FM music station sub-carrier channels. You tie in your differential beacon receiver to your little GPS that accepts a differential correction signal via the NMEA (National Marine Electronics Association) input port, and the receiver self-corrects on the information provided. If you want millimeter accuracy, you might pay over \$100.00 a month. If you're looking for sub-meter accuracy, it could cost you about \$50.00 a month. If you're just looking for 10 to 30 feet accuracy, it might cost you *nothing* a month because these signals are already out there for EVERYONE to use.

The United States Coast Guard provides typical 10 to 15 foot correction accuracy signals for vessel harbor and harbor approach areas along the coastlines and rivers of the United States. The United States Coast Guard and other maritime authorities broadcast these differential signals on a discreet frequency between 283.5 KHz to 325.0 KHz.

"These beacon signals can be received hundreds of miles from the broadcast transmitters, including inland by motorists on the highways," comments Travis Gray, an applications engineer with CSI (Communications Systems International), in Calgary, Alberta. CSI manufactures and distributes 300-KHz differential GPS beacon receivers throughout the world (403-259-3311).

Unlike the pay-or-don't-get signals from cellular and FM sub-carriers, these powerful cor-

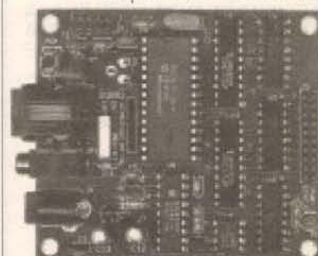
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rection signals are absolutely free.

Any simple GPS receiver that is marketed as "differential ready" or "differentially capable" can accept a selection of RTCM SC-104 messages from a marine beacon receiver. The differential message standard provides 64 messages related to GPS and marine navigation. Message types 1 and 9 provide the most relevant data to non-precision DGPS, and include the pseudo-range correction values, range rate correction parameters, and satellite health information. Messages types 18 through 21 provide data relevant to precision DGPS. All of the United States Coast Guard dif-

and a combination GPS/beacon antenna in a single enclosure.

And now more great news for the highway traveler wanting spot-on GPS accuracy, but not traveling down a road next to a Coast Guard differential beacon correction transmitting signal. The Department of Transportation and the railroad industry will soon be implementing abandoned government low-frequency GWEN transmitters throughout

the interior of the United States, and in a little over a year, additional signals will start popping up in the 283 KHz to 325 KHz band, now covering all US interior regions with solid differential correction signals.

### PORTABLES ARE OUT — FOR NOW

The little handheld portable GPS can sit in a bracket, and plug into differential beacon correction signals if they are designed (as most are) with DGPS capabilities. However, when you have one stuck in your backpack, the receiver and its

large antenna gets left behind, so your little handheld is now on its own. If you need spot-on DGPS capabilities, you'll need to drag along that extra board set and run it to a low-frequency loop or whip in order to obtain the correction signals down on the government beacon bands.

A few more problems. In downtown cities (where you could really use spot-on coverage), the weak incoming low-frequency MSK signals could get covered up by spark-plug noise and power-line noise. If you're trying to drive around town in a city more than 80 miles away from a local beacon transmitter, chances are your reception may be marginal and you'll notice your dash-mounted

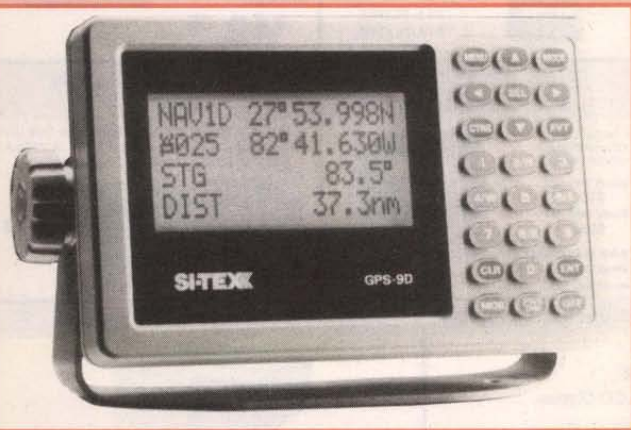
GPS constantly blinking the differential reception icon.

I suppose if you're real serious about downtown DGPS coverage, you could sport a large ham radio 160-meter whip, and pull in signals this way. Or maybe it's time to invest in FM sub-carrier commercial differential signals that are unaffected by noise and big buildings.

Will the Department of Defense ever turn off selective availability signal dithering? Probably so — but according to experts in the industry, not for another 5 to 10 years. And even if they did turn off selective availability, you would still have a circle of error of about a 100-foot radius.

Ultimately, we may see differential beacon receivers carried on one of the incoming GPS channels directly from the satellite. Aeronautical users anticipate WAAS (wide area augmentation system) as one way of having a portable-type GPS with differential capabilities. This is still many years away.

But right now FREE correction signals are coming in from the US Coast Guard, and just starting up inland by the GWEN transmitting antenna takeover. But even if you don't have differential correction, the global positioning system is just fine for car-navigation receivers that



**GPS equipment can also read out speed, mileage, sunrise and sunset, latitude and longitude, direction, and mapping coordinates.**

ferential GPS correction-sending stations are on the air, and for status updates, contact the US Coast Guard, Petaluma Control Center, at 707-765-7612 or 707-765-7613.

The correction message is sent on an existing Coast Guard radio beacon carrier frequency. In between the modulated CW dots and dashes for the radio beacon identifier, listen for the subtle modulation of the minimum shift-keying bit rate at 100 bps.

Board sets for the experimenter are available from CSI. One design that I like very well is their two independent receiver channel board — SBX-2 — which continuously monitors all beacon signals available for a particular location. The first channel tracks the primary station while the second channel continuously searches for other available beacons in the area. When the CSI SBX-2 board chip-set identifies a stronger signal, it will automatically switch to that station without operator intervention.

An HCMOS data interface level allows quick and easy integration with TTL and CMOS compatible GPS products. CSI also offers a wide selection of antennas for use with the SBX-2 engine. Options include an active E-field whip, or your choice of two H-field loop configurations,

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1-888-872-8768

### DeLorme

Freeport, ME  
1-800-452-5931

### EX2

West Chester, PA  
1-800-392-7686

**PRODUCTS IN THIS ARTICLE:** The car navigation and GPS equipment mentioned in this article represents only those systems that author Gordon West has personally reviewed and operated. *Nuts & Volts* encourages product manufacturers not mentioned in this article to contact Gordon West at Gordon West Radio School, Inc., 2414 College Drive, Costa Mesa, CA 92626; 714-549-5000.

will dead-reckon you back onto the highway. And if you're driving down city streets looking at your position on a lap-top computer, those ETAK and DeLorme under-\$300.00 GPS systems are wonderful, and your position on the street maps will certainly be close enough that you can almost get down to driveway level.

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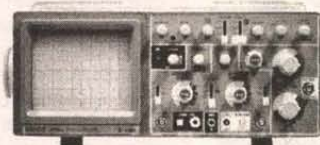
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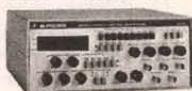
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# reader FeedBack

Dear Nuts & Volts:

The following refers to Tech Forum question #39816 - Mar. '98. Two answers to this question were printed in the May issue, however, they were both wrong.

The battery for the Metro Tel MT-911G is an Eveready 544A or equivalent, and is six volts.

Its purpose is to retain the stored phone number for the redial function. Since the memory is retained for 90 seconds after power is removed even when no battery is installed, and only works in rotary (pulse) mode, I have never installed one in mine. It also has a relatively short life unless the test set is always connected or the battery removed.

I have the original general description, specifications and maintenance manual for this unit, which I would be glad to copy and send if you provide a mailing address or fax number. It consists of three double-sided pages.

**Robert Glasure**  
Freeport, FL

Dear Nuts & Volts:

In the "Reader Feedback" section of the May '98 issue, Mr. G. Zomber refers to an article by Mr. Carr that appeared in the January issue.

Mr. Zomber finds fault with Mr. Carr's statement regarding the voltage gain of the preamp that was designed by Mr. Carr. Mr. Carr says that the gain formula is  $R2/R1+1$ . I say that Mr. Carr is correct and Mr. Zomber is wrong.

The simple voltage gain formula without the "+1" applies only when R1 is driven with the input signal.

When the non-inverting input point (+) on the op-amp receives the input signal, the pesky little "+1" has to be considered. This is because all of the input signal appears across R1 which then gets added into the output.

This latter configuration is the one that Mr. Carr used in his preamplifier, hence the "+1" part is correct.

Interestingly, if  $R1=R2$  the voltage gain is two —  $R2/R1+1$ .

Another bit of interesting trivia concerning this configuration is that there is no way to get a gain of one (sometimes called UNITY) or less than one. Try it.

**R. Schroeder**  
Walnut, CA

Dear Nuts & Volts:

In response to your reader's comments about the "SignaMail" units sold by Alltronics in the Apr. '98 issue. I

test all of the units before they are shipped. All units go out the door fully tested and working properly.

First, out of the hundreds of receivers I have checked, only two have had music module or 4001 chip problems and were rejected.

Second, the units are very dependable and stable. Owing to the use of crystal-controlled FM transmitter and receiver, plus tone encoding, they are not prone to false signals and have a maximum range of about 500 feet.

The original price of these units was \$79.95 each. We still have refurbished units available at \$14.95 each. This is a unique device with lots of experimenter uses.

Alltronics does have a return policy.

**Ken Terteling**  
Bench Technician  
Alltronics

Correction:

*I've become aware of an error in my April '98 article "Build A 'Super' Etching Tank."*

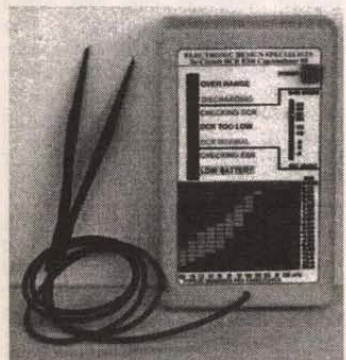
The diameter of the PCB support pin pictured in the middle right area of Figure 7 on page 100 should be 3/16 inch (it's incorrectly shown as 3/8 inch). The drill holes shown in the figure are correct, as is the description of the support pins in the parts list.

*I apologize for any inconvenience this may have caused.*

**Larry Ball**

## New Product News

### THE CAPANALYZER 88



Electronic Design Specialists introduces an in-circuit electrolytic capacitor checker that is guaranteed 100% accurate in circuit, with a money back guarantee.

The The CapAnalyzer 88 automatically discharges the cap, measures DCR, checks for shorts, and measures ESR in circuit, all in one step.

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uF can be measured with 100% accuracy. Only 2.5 seconds is required for each cap, so that an entire PC board can be checked in just minutes.

All signals are under 50 millivolts with a 5-ohm test impedance to prevent semiconductors, resistors, or coils from causing false readings.

A slider control sets the value of DCR for the alarm beeper to warn the technician. The state-of-the-art design uses a microprocessor and a two-color 20 segment LED meter to read ESR with a resolution down to 0.1 ohm. A beeper allows eyes-off use by beeping from one to five beeps depending on the ESR reading and quality of the capacitor.

Included is a one-handed, gold-plated tweezer probe that can check both conventional and surface-mounted capacitors, and a handy three-color chart on the front panel that shows typical ESR readings for good and bad capaci-

tors in reference to their capacity.

It is battery-operated (AAA batteries) and handheld to make it easier to use, either in the shop or in the field. A three minute warning beeper alerts the technician that the unit is on if no testing is detected.

The CapAnalyzer 88 is available at most electronics distributors, as well as from EDS directly, for \$169.00.

For more information, contact:

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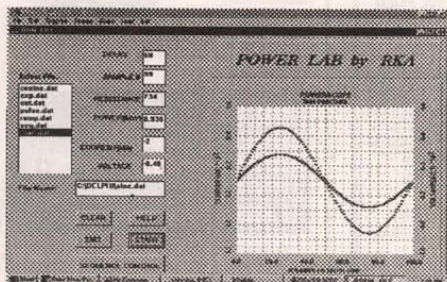
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# Open Channel

by Joseph J. Carr

## Some Practical Matters

**W**ow! Did I get a lot of letters and E-Mail when I discussed the things they don't teach in school (or is that "teach in school anymore")! It seems that I've touched a hot button. Apparently, a lot of people are concerned with what engineers and electronic technicians are learning in schools today ... or not learning. What I did not get was even one letter that told I'm full of bullfeathers. One expects some big changes, because technologies change, but some things are a bit ridiculous.

One fellow told me that he has seen both mechanical and electrical engineers hired at his company recently that could write software in five or six different software languages, but could not read a mechanical drawing for the product they were building. That would be fine if all of a product was software, without any mechanical or electrical

stuff. My new car contains a heckuva lot of software, but it also contains tires, an engine, and a couple dozen electronic boxes — including a CD player which lets me listen to my pre-1965 hillbilly music (I know, I know ... I'm a musical antediluvian).

A friend of mine is the director of a biomedical engineering laboratory in a major hospital. When I did that kind of work in the 1970s, every technician you hired could troubleshoot to the component level. Even a kid right out of the community college could learn the art of troubleshooting in short order. But my friend tells me that he has to go through a large number of applicants to find a component-level troubleshooter. And even then sometimes his positions have to be filled with less than desirable applicants who seem trainable.

It can be argued that printed circuit board swapping is the way to go

today. And that is often true, especially on equipment that has such intense post-repair testing protocols that a "certified" board from the original equipment manufacturer is the best solution. However, even an up-to-date institution like my friend's hospital will have a large collection of equipment of mixed ages up to 20 years old or so. Try buying a printed circuit board for a 20-year-old scientific or medical electronic device!

At one time, I was a pretty hot shot troubleshooter (I made my living in electronic repair for 16 years before getting my college degree). Sometimes, troubleshooting boils down to experience driven instinct. For example, one time when I was repairing a DC power supply in a piece of medical equipment, with my boss (a Ph.D. engineer) looking over my shoulder, I surprised the boss with seemingly magic ability.

The comparison amplifier was an older style op-amp made with seven PNP and NPN silicon transistors. It was a genuine ambiguity group because they were DC coupled with hefty doses of feedback. I looked at the situation, pointed to one transistor, and told the boss, "it's that one!"

It was, indeed, "that one!" The boss was mystified as to how I knew it was "that one!" Actually, I didn't know it for sure. But knowledge is often probabilistic. There were seven transistors in the circuit. Six of them were metal can TO-5 devices, and one was the equivalent device, but in a plastic package. At that time (in the

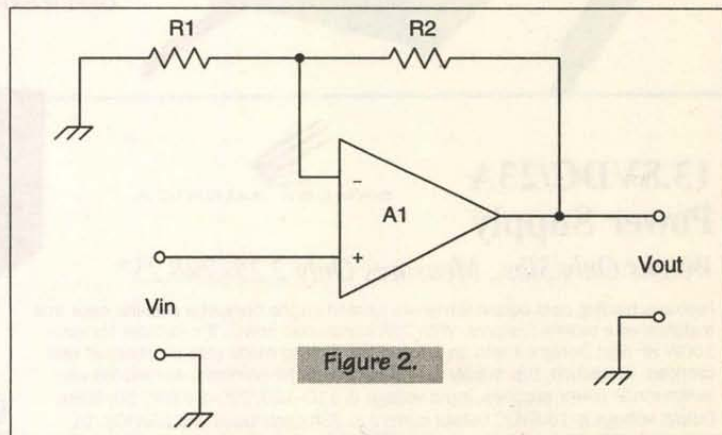
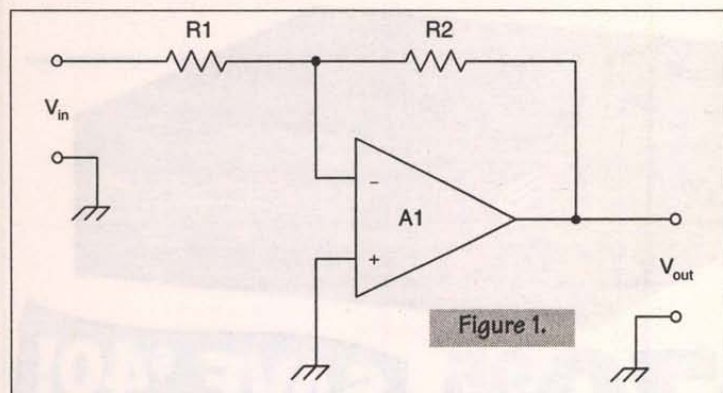
1970s), plastic transistors had a failure rate well over 10 times that of the same device in metal cans. Why? Dunno. But my experience bore out what all the other technicians believed (DoD would not permit plastic transistors in its electronics because of the reliability problem).

Brilliant, huh? No, not really. Any two-bit technician could do the same after having replaced about a gazillion plastic transistors and only a few TO-5 metal devices.

### A Bit About Op-Amps

The operational amplifier is an interesting device. As a means of illustrating some practical electronics matters, let's take a look at this popular IC amplifier. It can produce high-voltage gains by setting two resistors. It is the ratio of the two resistors that sets the overall gain, so the circuit designer can exercise a great deal of control over things. Figure 1 shows the basic inverting configuration for the op-amp. Notice that the op-amp has two inputs. The inverting input ("IN" or "-") produces an output signal that is 180 degrees out of phase with the input signal. In other words, a positive going input signal will produce a negative going output signal. The non-inverting input ("IN" or "+") has exactly the same amount of gain as the inverting input, but produces an output signal that is in-phase with the input signal.

An implication of this arrangement is that the output will be zero



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when exactly the same signal is applied to both inputs simultaneously. This has tremendous impact on the usefulness of the op-amp in certain electronic instrumentation situations, such as amplifying a Wheatstone bridge output or suppressing noise signals.

The ideal op-amp has an infinite open loop (i.e. no feedback) voltage gain, although making that claim for real devices is ludicrous. It is true, however, that modern devices have gains in excess of 1,000,000 and even cheapies can offer 250,000. An implication of this feature of the op-amp is that the closed loop gain can be set solely by the ratio of two resistors in a resistive voltage divider feedback network. In Figure 1 those resistors are R1 and R2. The gain of this circuit is found from:

$$A_v = \frac{-R2}{R1}$$

where:  $A_v$  is the closed loop voltage gain, and R1 and R2 are the values of the two resistors. The negative sign is used to indicate that a phase reversal takes place between input and output terminals (which is why they call it an "inverting follower amplifier").

Let's say we want to make a voltage amplifier with a gain of, say, 100. That means we can use a 100-ohm resistor for R1 and a 1,000-ohm resistor for R2. The ratio is 1,000/100 = 10, so everything is all right. Right? No, not by a long shot. Let's take a look at why.

But first, let me digress a bit. More than 20 years ago, I built a small amplifier for a physiologist to use with a Wheatstone bridge gram-force transducer. He actually wanted me to write a technical description for a physiology journal article he was writing ("publish or perish" looms large to young scientists). One of the "peer review" critics, who knew nothing about operational amplifiers, insisted that the amplifier would not work because "everyone knows" that op-amps have an infinite, or at least very, very high input impedance, so would be subject to a lot of noise." At the request of my scientist friend, I wrote a rebuttal that discussed the concept of "virtual ground."

This brain teaser causes some consternation with newcomers, but it quite logically follows from one of the properties of the ideal op-amp: both inputs stick together. That is, whatever you do to one input, it's the same as if you had done it to both. Thus, if you apply a potential, say one volt, to the non-inverting input, then you will measure the same potential on the inverting input. Note in Figure 1 that the non-inverting input is grounded, so is at zero volts potential. That means, by this property, that the inverting input will also be at zero voltage potential. Thus, it will behave as if it were physically grounded!

So what's wrong with our scenario in which R1 = 100 ohms? Nothing, if the source impedance is minuscule. The input impedance of this circuit is essentially the parallel combination of R1 and R2, or since R2 >> R1, it is dominated by R1. We

thus can claim that  $R_{IN} = R1$ . Let's say our input signal source is a voltage source that has an inherent internal resistance of 25 ohms (not an unreasonable number). It could be very much higher if a photoresistor or thermistor circuit were the source. If we place a 1 volt input signal at  $V_{IN}$ , then we would expect the output voltage to be  $V_O = V_{IN} \times (R2/R1) = (1V)(10) = 10V$ . But it won't be 10 volts with the scenario concocted. The actual input voltage seen by the op-amp is reduced by the amount calculated from the voltage divider equation:

$$V_{IN(ACTUAL)} = V_{IN} \times \frac{R1}{R1 + R_s} = (1V) \times \left( \frac{100 \Omega}{(100 + 25) \Omega} \right) = (1V)(0.8) = 0.8 \text{ volts}$$

Thus, the actual output voltage will be  $(-0.8V)(10) = -8 \text{ volts}$  — a 20 percent error. What the designer of our 100-ohm input amplifier failed to do was consider the minimum allowable value for R1 to prevent a serious error from voltage divider action. The general rule of thumb is that  $R1 > 10R_s$  for sloppy circuits, and  $R1 > 100R_s$  for more reasonable circuits. Thus, for a source resistance of 25 ohms,  $R1 > 2,500 \text{ ohms}$ . That would make the minimum design for a gain of 10 amplifier  $R1 = 2,500 \text{ ohms}$  and  $R2 = 25,000 \text{ ohms}$ . As a practical matter, since 2.7K and 27K are standard resistor values, those would normally be selected.

It's also possible to pick input resistors that are too high. The reason is that the nice little op-amp does not have an infinite input impedance (as the books claim), but in fact has a finite input impedance. One can expect an input bias current to flow out of the input, rather than zero current. The ideal op-amp input will neither sink nor source current, but the real op-amp might produce anywhere from a few nanoamperes to a couple milliamperes. That current will

flow in both R1 and R2, creating a voltage drop that is seen by the op-amp as a spurious voltage input. If the values of R1 and R2 are high, then that DC offset signal can be substantial. As a result, some designers place a compensating resistance between the non-inverting input and ground that has a value equal to the parallel combination of R1 and R2.

Figure 2 shows a different form of op-amp circuit. This one uses the same operational amplifier, but is a non-inverting amplifier. In other words, the output signal is in-phase with the input signal. The feedback

network is similar, except that one end of resistor R1 is grounded, rather than being connected to the signal source. The signal is, instead, applied to the non-inverting input. The gain of this circuit is found from:

$$A_v = \frac{R2}{R1} + 1$$

Note there is no negative sign, which indicates that this circuit does not invert the input signal.

What kind of problems might exist when this circuit is used as shown? One problem is that the input is open any time the amplifier is not connected to a signal source. In some cases, this means the amplifier will oscillate at some frequency or another. In other cases, it can mean the output voltage will snap to a high value DC voltage close to one of the power supply rails. To prevent this requires a resistor from the non-inverting input to ground. Keep in mind the input resistance restrictions given above for the inverting follower. In reality, however, because the

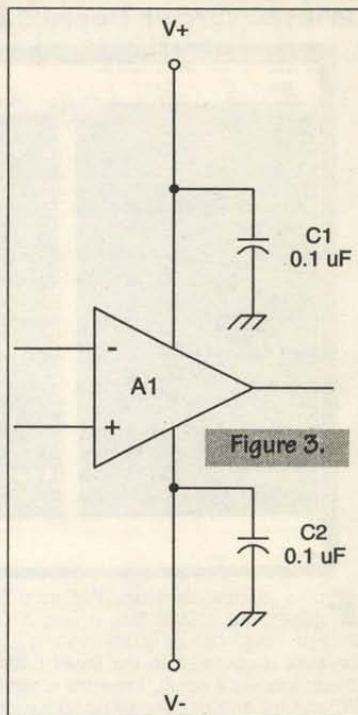


Figure 3.

input resistor is not used for setting gain, it can be almost any high value. It is not uncommon to find resistors between 100 Kohms and 10

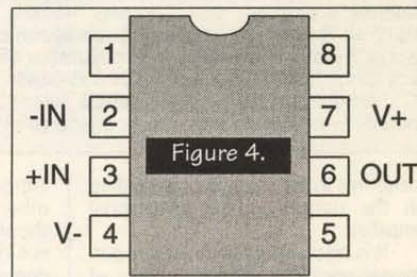


Figure 4.

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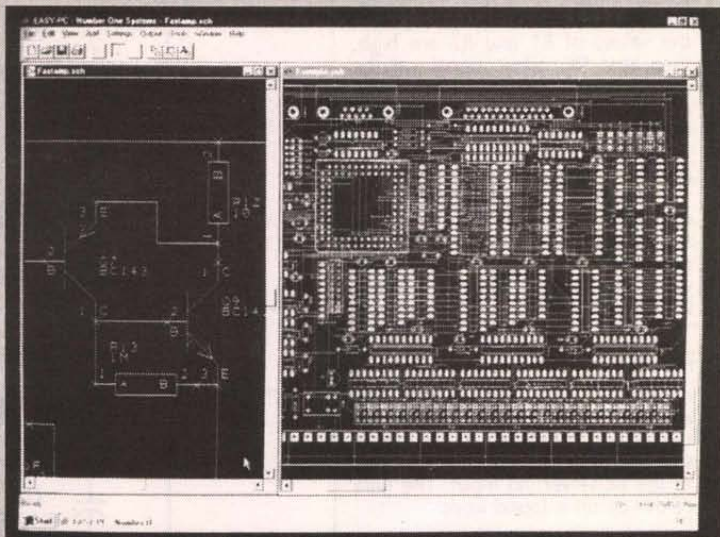
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Now the producers of Easy-PC (Number One Systems in England) has a Windows-compatible version. Figure 5 shows an example of the Easy-PC for Windows graphical user interface. And it isn't merely the DOS program with a Visual Basic shell for Windows. It's an all new product. You can see the product at the web site, which has the URL <http://www.numberone.com>. In the UK, the address is **Number One Systems**, Harding Way, St. Ives, Huntingdon, Cambs. PE17 4WR, UK. E-Mail to [sales@numberone.com](mailto:sales@numberone.com). In the United States, the product is available from a distributor: **Number One Systems**, 126 Smith Creek Drive, Los Gatos, CA 95030; phone 408-395-0249.

Another product is **ExpressPCB**, which also has a service that produces the boards from your designs. Check their web site at <http://www.expresspcb.com>.

megohms in this position, depending on the nature of the operational amplifier.

It is relatively easy to make operational amplifiers oscillate instead of amplify. Sometimes the oscillation shows up as a high-frequency oscillation that dominates the output signal with its high amplitude. Often, however, the signal is more subtle than that. It will show up as a whispy oscillation on top of the regular output signal. One of the most common problems that causes oscillation is that the builder failed to provide bypass capacitors at the DC power supply terminals (Figure 3).

Two bypass capacitors are needed because there are two DC power supplies. The V- power supply is negative with respect to common or ground, while the V+ power supply is positive with respect to common or ground. Note, however, that the op-amp itself does not have a ground terminal. The input and output signal common or ground for the amplifier is taken from the common or ground of the two DC power supplies.

The capacitors used for decoupling the amplifier should be mounted as close to the body of the device as possible. Typically mylar or some other small, modern form of 0.1 uF capacitors are used.

Most modern op-amps are sold in the eight-pin mini-DIP package (Figure 4). The pin-outs shown in Figure 4 are the "industry standard" or "741-family" connections. Most single op-amps follow this protocol,

although some devices follow some other pin-out scheme. The pins not shown labeled will be either offset null or frequency compensation pins, depending upon the device (see data

sheets).

Now let's assume that you have built an operational amplifier circuit, and it doesn't work. What do you do? The first step is to take a DC voltmeter and find out what voltages are present on the pins. First, check that the V- and V+ voltages are present. If one or both of those voltages are missing, then the circuit will not work.

Next check the output terminal and read the voltage present. It should be near zero. The trick is to find out whether or not the input terminals are capable of controlling the output. Short the two input pins (-IN and +IN, or 2-3 in Figure 4) together and note any change of the output voltage. If the output voltage drops to zero (as it should if the amplifier device is working), then the IC is capable of working. If the output voltage is some other voltage, then one must determine just why. Several things come to mind. First, are the DC power supply voltages present and of proper value? If not, find out why. Next, make sure that any null circuit is set to zero volts potential, or is disconnected. If the output voltage still remains high, then consider whether or not the device is bad (replace it and see).

Another indication of a bad device is a DC offset voltage (it doesn't have to be close to the DC power supply rail). If there is, say, a 2.5 volt DC level on the output terminal even when the inputs are shorted together, and the null circuit (if any) is either disconnected or set to

## For Further Reading

Several of my books deal with operational amplifier circuits. They can be ordered through any book store, most electronics parts distributors, or through Amazon Books on-line (<http://www.amazon.com>).

Joseph J. Carr. *Electronic Circuit Guidebook Volume 3: Op-Amps*. ISBN 0-7906-1131-7. Howard W. Sams/PROMPT Publishing.

Joseph J. Carr. *Linear IC Applications: A Designer's Handbook*. ISBN 0-7506-3370-0. Butterworth-Heinemann/Newnes.

Joseph J. Carr. *Linear Integrated Circuits*. ISBN 0-7506-2591-0. Butterworth-Heinemann/Newnes.

zero, then the device is probably bad.

In future columns, we will take some more looks at analog electronics circuits from both the design-and-build and troubleshooting perspectives. If there are any particular topics you would like to see, then contact me at the address shown elsewhere. **NV**

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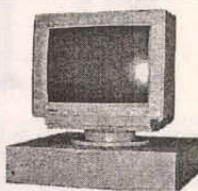
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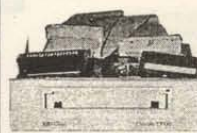
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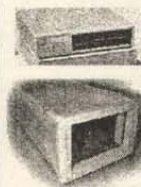


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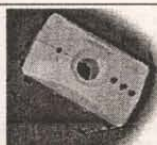
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**JUNE 5-6**

**MI - MT. CLEMENS** - Computer & Technology Show, Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

**TX - ARLINGTON** - West Gulf Division Convention, Tom Green K5VOU, 972-442-1721

**JUNE 6**

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet, Santee Drive-in. 619-561-0052

**CANADA - QUEBEC - MONTREAL** - ARC Hamfest, James Hay VE2VE, 514-697-7205. E-Mail: jrhay@haya.qc.ca

**ME - HERMON** - Pine State ARC Hamfest, Hermon High School, 8am-1pm. Roger Dole KA1TKS, 207-848-3846

**MI - GRAND RAPIDS** - Annual Hamfest, Hudsonville Fairgrounds, off I-96 x-way. Randy N8KQX, 616-532-5450

**MI - TAYLOR** - Super Computer Sales, Democratic Club Hall, 23400 Wick Rd. 10am-3pm. Computers And You 734-283-1754. Web: www.gatecom.com

**NC - CHARLOTTE** - Hamfest & Computer Fair, Roll-A-Round Skate Ctr., 8830 E. Harris Blvd., 7:30am-12:30pm. Charlotte ARC, PO Box 33582, Charlotte, NC 28233. E-Mail: w4cql@qsl.net. Web: http://members.aol.com/w4cql/w4cql

**TN - NASHVILLE** - ARC Hamfest, TN State Fairgrounds, 8am-5pm. Bob Malone WB5ZDS, 615-865-6225

**JUNE 6-7**

**CA - SACRAMENTO** - Computer Show, Cal Expo, MarketPro 415-456-6730. Web: http://marketpro.com

**FL - ORLANDO** - Computer Show, Central FL Fairgrounds, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**KY - LOUISVILLE** - Computer Show, KY Fair & Expo Ctr. 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**MD - TIMONIUM** - Computer Show, MD State Fairgrounds, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**NY - WHITE PLAINS** - Computer Show, Westchester County Ctr. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

**PA - KING OF PRUSSIA** - Computer Show, Valley Forge Convention Ctr. 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**TN - MEMPHIS** - Computer Show, Agricenter Int'l., 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**WA - DRYDEN** - Apple City ARC Hamfest, Greg Johnson WATTS, 509-663-1081. E-Mail: g.c.johnson@mail.sprint.com

**JUNE 7**

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.

**CA - LIVERMORE** - Swapmeet, Las Positas College, Noel Anklam 510-447-3857

**CA - SAN DIEGO** - Computer Show, Scottish Rite Center, MarketPro 415-456-6730. Web: http://marketpro.com

**CT - NEWINGTON** - AR League Hamfest, Newington High School, Willard Ave. Rte. 173, 9am-1pm. Ralph Borriello N1VIM, 860-828-1695. E-Mail: rborriello@snet.net

**IL - PRINCETON** - Starved Rock Rock Hamfest, Debbie Burton N9DRU, 815-795-2201. E-Mail: dbkatz@mtco.com

**IN - WABASH** - County ARC Hamfest, 4-H Fairgrounds, State Rd. 13N, Don Spangler W9HNO, 219-563-8487. Web: http://www.netusa.net/~qrziota/

**MA - TAUNTON** - Computer Show, Holiday Inn, Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**MI - MADISON HEIGHTS** - Super Computer Sales, U.F. & C.W. Hall, 876 Horace Brown Dr. 10am-4pm. Computers And You 734-283-1754. Web: www.gatecom.com

**NY - QUEENS** - Hamfest, NY Hall of Science Parking Lot, Flushing Meadow Corona Park, 47-01 111th St. Stephen Greenbaum WB2KDG, 718-898-5599 night only. E-Mail: WB2KDG@bigfoot.com

**OH - MEDINA** - Two Meter Group Hamfest, Medina County Fairgrounds Community Center, 735 Lafayette Rd. 8am-3pm. Mike Rubaszewski N8TZY, 330-273-1519. E-Mail: N8TZY@aol.com

**PA - ALLENTOWN** - Computer Show, Days Inn Conference Ctr. 10am-3pm. Peter Trapp Shows 603-272-5008. Web: www.petertrapp.com

**PA - BUTLER** - Hamfest, Butler Farm Show Grounds, 8am-4pm. George Artnak N3FXW, 412-854-5593. Web: http://www.users.sgi.net/~wolfie/

**VA - MANASSAS** - Ole Virginia Hams ARC

Hamfest, Prince William County Fairgrounds, Rt. 234, Mary Lu Blasdel KB4EFP, 703-369-2877

**WI - JUNCTION CITY** - Swapfest & Auction, US Army Reserve Ctr. John Feltz W9JN, 715-457-2506. E-Mail: jfw9jn@tznnet.com

**JUNE 12-13**

**GA - ALBANY** - ARC Hamfest, Arthur Shipley N4GPJ, 912-439-7055

**JUNE 12-13-14-15**

**NY - ELLENVILLE** - Chavim Int'l Convention, Fallsview Hotel, Arnold Halpern W2GDS, 732-222-3009. E-Mail: w2gds@juno.com

**JUNE 13**

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet, A B Miller High School, Bill 909-822-4138 eves

**CANADA - ONTARIO - FERGUS** - Guelph & Kitchener-Waterloo ARCs Hamfest, Bill Smith VE3WHS, 519-821-6642. E-Mail: smith.ve3w@sympatico.ca

**ID - RATHDRUM** - Hamfest, Lions Club, Hwy 53, Jim Monroe 208-667-4915. E-Mail: jmonroe@dm.net

**KY - PADUCAH** - ARA Hamfest, Executive Inn Convention Ctr. 8am-3pm. Craig Martindale WA4WBU, 502-444-6822

**MA - DENNIS** - Cape Cod Tailgate Swapfest, 8am-3pm. Don Haaker WA1AIC, 508-760-1571

**MI - LIVONIA** - Super Computer Sales, Livonia Elks Lodge Hall, 31117 Plymouth Rd. 10am-3pm. Computers And You 734-283-1754. Web: www.gatecom.com

**NH - SEABROOK** - Computer Show, Greyhound Racetrack, Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**NY - BUFFALO** - Computer Show, Hamburg Fairgrounds, 9:30am-4pm. MarketPro 201-825-2229.

All listing information should be sent to:

**Nuts & Volts Magazine**

**Events Calendar**

430 Princland Court

Corona, CA 91719

Phone 909-371-8497

Fax 909-371-3052

E-mail events@nutsvolts.com

Web: http://www.marketpro.com

**NY - CORTLAND** - Skyline ARC Hamfest,

Andrew Slaugh KB2LJV, 607-753-0597.

E-Mail: sany@sanyips.com

**PA - HARRISBURG** - Computer Show, PA Farm Show Complex, East Bldg. 10am-3pm. Peter Trapp Shows 603-272-5008. Web: www.petertrapp.com

**VA - ANNANDALE** - Computer Show, Northern VA Community College, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**JUNE 13-14**

**GA - DALTON** - Computer show, North GA Fairgrounds, Georgia Mountain Productions 706-838-4827

**FL - TAMPA** - Computer Show, FL State Fairgrounds, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**IN - FT. WAYNE** - Computer Show, Memorial Coliseum, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**NY - LAKE GROVE** - Computer Show, Sports Plus, 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

**OH - COLUMBUS** - Computer Show, OH Expo Ctr. 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**PA - ALLENTOWN** - Computer Show, Allentown Fairgrounds, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**VA - VIRGINIA BEACH** - Computer Show, Virginia Beach Pavilion, 9:30am-4pm. MarketPro 301-984-0880. Web: www.marketproshows.com

**JUNE 14**

**IL - WHEATON** - Six Meter Club of Chicago Hamfest, DuPage County Fairgrounds, 2015 Manchester Rd. Joseph Gutwein WA9RIJ, 630-963-4922

## BLUE LEDS ARE HERE

**HURRY!** We have just received a quantity of brilliant blue LEDs. These are sold by others for much more. We have stocked blue LEDs before, but these are the brightest and best that we have ever seen. Each has a diffused light blue case. Produces very nice blue light! Very hard to find item.

**T1 Case (3 mm)** G9493 \$2.25 ea. 10 for \$20 100 for \$180  
**T1-3/4 Case (5 mm)** G9494 \$2.50 ea. 10 for \$23 100 for \$210

## POWERFUL KNF HEAVY-DUTY DC LIQUID PUMP

Very high quality pump has a membrane pump mechanism to allow for a variety of different liquids to be pumped. These precision pumps were made for laboratory or industrial use. The original costs of these were probably in the \$150 to \$300 neighborhood. These are used excellent condition and can be powered from 12V solar panels, batteries etc. Voltage range is 12VDC up to 28VDC. At 12 VDC we pumped a quart of water in 90 seconds. At 24VDC we pumped it in 45 seconds. Self priming type with fittings for 1/4" tubing on input. Size about 5" x 5". Has rubber cushioned mounting base. These are used excellent condition. [Sale expires 8-15-98] **G9414 \$24.95**

## DIGITAL DISPLAY PEN TYPE AC/DC VOLTAGE DETECTOR

This amazing device can detect AC volts, even through insulation, and can also be used as a handy continuity tester. It is very unusual in that it does not use batteries, yet provides indications on a small LCD display. As the probe tip is brought near a live wire, which is plugged into 120VAC, a "V" symbol is displayed on the LCD display (no need to touch the probe tip to a live wire as it can detect the presence of AC through insulation). Will also measure approximate AC or DC voltage level from 12V - 220V AC or DC and will display a digital approximation (12V, 30V, 55V, 110V, 220V) if probe tip is touched to a "hot" wire. Can also identify blown fuses, circuit breakers, faulty insulation, etc. Very handy brand new in retail blister package. **G9569 \$2.98**

## HEAVY DUTY AIRPAX SERVO MOTOR

Airpax Model C82902-M2 is 2 1/16" dia. with mounting ears on 3" centers. Features 2.7V operation and with ohms/coil .97, step angle 7.5°. Has 5/8" L x 1/4" dia. "D" shaft. Standard four lead type with 2 ft. long flexible leads. Brand new! No other data available. **G9547 \$4.95**

## 1 FARAD SUPER CAP

Giant capacity in a small size! This cap is only 1 1/8" dia x 7/16" H but is rated a whopping 1 Farad @ 5.5VDC. Use this to store the energy from solar cells to run motors, light LEDs, power radios. You'll be amazed at how long the charge on these lasts before you need to re-charge them. They are like a super compact, high capacity rechargeable battery! Brand new with metal post leads and vinyl wrap. **G9439 \$2.49**

## SMALL DC MOTOR WITH WORM GEAR

These are type FF-180PH Mabuchi motors with a plastic worm gear with gear brace. Size of motor 1 1/4" L x 13/16" x 9/16". Operates from 1.5VDC up to 12VDC. Great for hundreds of applications including robotics. Worm gear is 3/8" L x 5/16" dia. Has solder terminals. **G9558 \$1.59**

## HONEYWELL MOTION ACTIVATED SECURITY CONTROL

Turns lights or appliances on when you enter a room and off when you leave, without touching a switch. Now you don't need to fumble around looking for light switches. This motion activated control senses you entering the room, turns on a lamp or small appliance, and then turns it off when you leave. Adds a measure of safety and security to any room in your home. Small 4 1/2" x 2 1/2" almond and grey unit sits on any surface and controls lamps and small appliances (up to 400 watts). Maximum range 15 ft. Lights can be operated manually at any time. No installation required. Brand new in sealed retail blister pack. Model # CL850D-1002. **G9497 \$8.95**

## COMPLETE WIRELESS VIDEO SECURITY SYSTEM

Consists of a high quality 900 MHz wireless B/W TV camera, which can operate from 7 AA batteries (not included) or an AC adapter (included), also a special 900 MHz wireless B/W receiver unit with adapter which can be used with any standard TV, VCR or monitor you have. No need to buy a monitor—just connect the output of the receiver ("F") type to your TV or VCR antenna input. One of the easiest to use and best quality picture and sound units around. Range is stated as 120 ft., but we found a maximum of 60 ft. your best. Camera Transmits audio and video, has a built in microphone, a 1/3" CCD image sensor with 78° fixed wide-angle lens, an "LED" on indicator, a mounting base and base and 2 channel output so you can use 2 cameras in same vicinity without interference. Receiver has 2 channel capability, plus an auto switch function that displays one camera output for a while and then the second camera (if you have one) output. Complete ready to go system consisting of one dual channel camera, one receiver, AC adapters and hardware for a ridiculously low price. Note: these were dealer demos or returns from customers that did not know how to hook them up (very simple), so they may have a slight case scratch (most do not). We 100% test each system to make sure it works perfectly. Hurry, don't be the only one! **G9486 \$109.00 COMPLETE SYSTEM G9324 \$79.95 EXTRA CAMERA/ADAPTER**

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## AMPLIFIED JAZZ STEREO SPEAKERS

Great for computers, CD players, headphone radios, tape players, etc. These compact amplified speakers produce high quality room filling sound from almost any sound source. Features volume control, on/off switch and AC adapter. Will also run on 3 "C" batteries (not included). With 3.5MM stereo plug and flexible cable. White color Model # J-201. Brand new in box. **G9499 \$9.95**

## LARGE GEARED MOTOR

Looks like this could be used in robot applications or anywhere a high torque forward motion is needed. Consists of a 3 1/2" L x 1 3/8" dia. motor that has a bridge rectifier attached to its power input leads. The bridge allows for operation from 12V up to 120V AC or DC. The shaft of the motor is a worm gear connected to a rotating 3/4" dia. white plastic gear. The arrangement provides a tremendous forward movement. However, the motor shaft itself cannot be reversed, because the worm gear only operates in one direction (that's why the bridge rectifier is attached). Brand new! **G9485 \$3.95**



# Events CALENDAR

**KY - ERLANGER** - Ham-O-Rama '98. Lions Park. 8am-3pm. Robert Blocher N8JMV, 513-797-7252  
E-Mail: krod@iso.cin.tx.net

**MD - NEW CARROLLTON** - Computer Show. Ramada Conference & Exhibition Ctr. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988

**MI - GRAND RAPIDS** - Super Computer Sales. Crowne Plaza, 5700 28th St. S.E. 10am-4pm. Computers And You 734-283-1754.  
Web: www.gatecom.com

**NH - MANCHESTER** - Computer Show. Holiday Inn Expo Center. Northern Computers Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**NY - BETHPAGE** - Hamfest. Briarcliffe College, 1055 Stewart Ave. 9am-2pm. Richie Selzer N2WJL, 516-520-9311. E-Mail: N2WJL@juno.com  
Web: http://www.limarc.org

**NY - BINGHAMTON** - Computer Show. The Showplace. 10am-3pm. Peter Trapp Shows 603-272-5008. Web: www.petertrapp.com

**NY - ROCHESTER** - Computer Show. The Dome Ctr. 9:30am-4pm. MarketPro 201-825-2229.  
Web: http://www.marketpro.com

**OH - SUFFIELD** - Hamfest. Wingfoot Lake Park, 10 miles east of Akron. Ken Phillips K8CHE, 330-733-5795.

**TN - KNOXVILLE** - Hamfest & Electronics Flea Market. National Guard Armory, 3330 Sutherland Ave. 9am-4pm. David Bower K4PZT, 423-974-5064. E-Mail: d.bower@ieee.org  
Web: http://www.kornet.org/rack

**JUNE 19-20-21**  
**GA - ATLANTA** - Hamfestival '98. Greg Barrett N5BDJ, 770-649-1467.  
E-Mail: gbjb@mindspring.com  
Web: http://www.saf.com/arc

**JUNE 20**  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**MI - DEARBORN** - Super Computer Sales. Dearborn Civic Center, 15801 Michigan Ave. 10am-3pm. Computers And You 734-283-1754.  
Web: www.gatecom.com

**MI - MIDLAND** - Hamfest. Midland County Fairgrounds, 8am-1pm. Jeff Weinberg 517-636-0643 (w) 517-839-9371 (h). E-Mail: w8cq@bytethis.com

**NH - NASHUA** - Computer Show. Sheraton Tara. Northern Computer Shows 978-744-8440.  
E-Mail: inquiries@ncshows.com

**NJ - DUNELLEN** - Raritan Valley RC Hamfest. Columbia Park. 7am-2pm. Bob Pearson WB2CVL, 908-846-2056. RWPEARSON@WB2CVL@WORLDNET.ATT.NET

**OH - AKRON** - Computer Show. Summit Co. Fairgrounds, 10am-3pm. Peter Trapp Shows 603-272-5008. Web: www.petertrapp.com

**VA - BLUEFIELD** - Hamfest. Brushfork Armory. Don Williams WA4K, 540-326-3338.  
E-Mail: wa4k@sera.org  
Web: http://www.inetone.net/erarc/hamfest/

**WV - BLUEFIELD** - Hamfest. Brushfork Armory.

Don Williams WA4K, 540-326-3338.  
E-Mail: wa4k@sera.org  
Web: http://www.inetone.net/erarc/hamfest/

**JUNE 20-21**  
**FL - WEST PALM BEACH** - Computer Show. South FL Fairgrounds. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**GA - KENNESAW** - Computer Show. Outlet Mall, I-75 @ Exit 117. Georgia Mountain Productions 706-838-4827

**MD - GAITHERSBURG** - Computer Show. Montgomery Co. Fairgrounds. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**NJ - SECAUCUS** - Computer Show. Meadowlands Exposition Ctr. 9:30am-4pm. MarketPro 201-825-2229.  
Web: http://www.marketpro.com

**PA - HARRISBURG** - Computer Show. Farm Show Complex. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**PA - MONROEVILLE** - Computer Show. Pittsburgh Expo Mart. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**WV - CHARLESTON** - Computer Show. Charleston Civic Ctr. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**JUNE 21**  
**IN - CROWN POINT** - Lake Co. ARC Hamfest. Lake Co. Fairgrounds. Malcolm Lunsford W9MAL, 219-769-3925. E-Mail: w9mal@cris.com

**MA - CAMBRIDGE** - Flea Market. Kendall Square area. MIT. Nick Altemberd K1M1QX, 617-253-3776.  
http://web.mit.edu/wlmx/www/swapfest.html

**MD - FREDERICK** - ARC Hamfest. Eric Gammeter N8AAV, 301-865-0865

**MI - LANSING** - Super Computer Sales. Holiday Inn South Convention Ctr., 6820 S. Cedar St. 10am-4pm. Computers And You 734-283-1754.  
Web: www.gatecom.com

**MI - MONROE** - Monroe Co. Radio Comm. Assn. Hamfest. Fred VanDaele KA8EBI, 313-242-9487

**OH - CLEVELAND** - Computer show. Cuyahoga Co. Fairgrounds. 10am-3pm. Peter Trapp Shows 603-272-5008. Web: www.petertrapp.com

**OH - MACEDONIA** - Cuyahoga ARS Hamfest. Rich James N8FIL, 1-800-404-2282.  
http://www.cars.org

**JUNE 26-27-28**  
**MI - TAYLOR** - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 734-287-2000

**JUNE 27**  
**DE - NEWARK** - Computer Show. University of DE. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**FL - FT. MCCOY** - Hamfest. Tom Bench KT4VF, 352-546-3967. E-Mail: w4frc@qsl.net  
Web: http://www.qsl.net/w4frc

**MI - KALAMAZOO** - Super Computer Sales. Kalamazoo Co. Fairgrounds, 2900 Lake St. 10am-3pm. Computers And You 734-283-1754.  
Web: www.gatecom.com

**VA - CHANTILLY** - Computer Show. Capital Expo

Ctr. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**VA - RICHMOND** - Computer Show. The Showplace. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**JUNE 27-28**  
**FL - JACKSONVILLE** - Computer Show. Morocco Shrine Auditorium. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**NJ - SOMERSET** - Computer Show. Garden State Exhibit Ctr. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

**OH - SHARONVILLE** - Computer Show. Sharonville Convention Ctr. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**TN - KNOXVILLE** - Computer Show. TN Valley Fairgrounds. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**JUNE 28**  
**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. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**MI - FARMINGTON HILLS** - Super Computer Sales. Farmington Hills Activity Ctr., 28600 Eleven Mile Rd. 10am-3pm. Computers And You 734-283-1754. Web: www.gatecom.com

**PA - WILKES-BARRE** - Computer Show. Genetti's Best Western. 9:30am-4pm. MarketPro 301-984-0880 Web: www.marketproshows.com

**VA - ROANOKE** - Computer Show. Roanoke Civic Ctr. 9:30am-4pm. MarketPro 301-984-0880  
Web: www.marketproshows.com

**JULY 1998**

**JULY 3-4-5**  
**MI - MT. CLEMENS** - Computer & Technology Show. Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

**JULY 4**  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**PA - DILLSBURG** - Harrisburg RAC Hamfest. Monaghan Fire Hall, 245 W. Siddonsburg Rd. Michael Kaibach N3HLK, 717-232-6087.  
fabinfo@fabral.com n3hjb@juno.com

**JULY 5**  
**MI - GRAND RAPIDS** - Super Computer Sales. Crowne Plaza, 5700 28th St. S.E. 10am-4pm. Computers And You 734-283-1754.  
Web: www.gatecom.com

**OH - LISBON** - Hamfest & Computer Show. Columbiana County Fairgrounds. 8am-3pm. Dick Sisley K3JKB, 330-385-1245

**PA - WILKES-BARRE** - Murgas ARC Hamfest. Robert J. Michael WB3FAA, 717-288-3532

**JULY 10-11-12**  
**ND - DUNSEITH** - Int'l Hamfest. Int'l Peace Garden. Rt. 1 Box 116. Dave Syndal VE4XN, Canada 204-728-2463. Lynn Nelson W0CQ, USA 701-839-8200

**JULY 11**  
**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

**IN - INDIANAPOLIS** - Central Division Convention. Rick Ogan N9LRR, 317-251-4407

**KY - TOMPKINSVILLE** - Hamfest. National Guard Armory, Hwy 163. J. Bunch 502-678-5784. E-Mail: dwelch@glasgow-ky.com

**MI - PETOSKEY** - Swap & Shop. Emmet Co. Fairgrounds. 8am-1pm. Clark Rouse KA8TIL, 616-582-6455

**MO - KANSAS CITY** - PHD ARA Hamfest. Bob Roske WA0CLR, 816-436-0069.  
E-Mail: wa0clr@juno.com

**NC - SALISBURY** - NC Alligator Group Hamfest. Civic Center. 8am-1pm. Walter Bastow N4KVF, 704-279-3391. E-Mail: alligator@juno.com

**OK - ALTUS** - Altus Area ARA Hamfest. Ronald Hughes KB5UVC, 580-482-7994

**WA - KENNEWICK** - Tri Cities ARC Hamfest. Dick N7WLD, 509-783-3479.  
E-Mail: dick.goranson@kcc-computers.com

**WI - OAK CREEK** - Swapfest. American Legion Post 434, 9327 S. Shepard Ave. 7am-2pm. 414-762-3235

**JULY 12**  
**IL - PEOTONE** - Kankakee ARS Hamfest. Don Keroac K9NR, 815-939-7548. E-Mail: K9nr@juno.com  
Web: http://www.geocities.com/CapeCana/veral/Hangar/5711/

**MA - SWANSEA** - Computer Show. Venus DeMilo. Northern Computers Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988

**NJ - AUGUSTA** - Sussex Co. ARC Hamfest. Dan Carter N2ERH, 973-948-6999. E-Mail: scarncj@qsl.net  
Web: http://www.qsl.net/scarncj/

**NY - ALEXANDER** - Genesee Radio Amateurs Hamfest. David Carlson KA2OQZ, 716-786-3622. E-Mail: carlson@frontiernet.net  
Web: http://www.frontiernet.net/~wittman/wittman/GRAM

**OH - BOWLING GREEN** - Ham-O-Rama & Computer Show. Wood Co. Fairgrounds. 8am-1pm. 419-354-1811. E-Mail: sjhudson@wcnnet.org

**PA - KIMBERTON** - Valley Forge Hamfest. Kimberton Fire Company Fairgrounds. Bob Haase W3SA, 610-293-1919.  
E-Mail: wb3joe@voicenet.com

**PA - PITTSBURGH** - North Hills ARC Hamfest. Northland Public Library, 300 Cumberland Rd., 8am-3pm. Bob Ferrey, Jr. N3DOK, 412-367-2393. E-Mail: n3dok@pgb.net  
Web: http://nharc.pgb.pa.us

**JULY 17-18-19**  
**MT - EAST GLACIER** - MT State Convention. Gerry Leach VE6BVZ, 403-285-5547. E-Mail:

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# Events CALENDAR

leachg@cadvision.com

JULY 18

**CA - ANGELS CAMP** - Flea Market. Utica Park. 7am-2pm. Stephen Barnett KD6CNU, 209-878-3829

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052

**NC - CARY** - Swapfest. Cary Community Ctr., 404 N. Academy. Cary ARC, PO Box 53, Cary, NC 27512

**NH - SEABROOK** - Computer Show. Greyhound Racetrack. Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**OH - WELLINGTON** - Noarsfest. Lorain County Fairgrounds, 8am-3pm. Clark Beckman NB2PD, 216-671-8795

**PA - SALEM TOWNSHIP** - Computer & Hamfest. Beach Haven Carnival Grounds. Charlie AD3L, 717-864-2571

**TX - TEXAS CITY** - Tidelands ARS Hamfest. Carl W. Steele Jr. WA5WVP, 409-948-0308

JULY 19

**IL - SUGAR GROVE** - Fox River Radio League Hamfest. Wauaubsee Community College. James Von Olmhausen 630-897-3042. E-Mail: n9uzc@amsat.org

**MA - CAMBRIDGE** - Flea Market. Kendall Square area. MIT. Nick Altenbernd KA1MQX, 617-253-3776  
http://web.mit.edu/w1mx/www/swapfest.html

**MA - WORCESTER** - Computer Show. Worcester Centrum Center. Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**MO - WASHINGTON** - Zero Beaters ARC Hamfest. Bernie E. Hillerman Park. 6am-2pm. Keith Wilson KO2H, 314-629-2264. E-Mail: n0mfd@amsat.org  
URL: http://zbarc.usmo.com

**NY - FARMINGVILLE** - Radio Central ARC Hamfest. Jo Ann Colletti N2IME, 516-399-1877. Web: http://www.li.net/~n2mqd

**OH - VAN WERT** - Hamfest. County Fairgrounds, US 127 S. Louie Thomas WD8LLO, 419-238-2812. E-Mail: barnesr@bright.net  
Web: http://www.bright.net/~barnesr/w8fy.htm

JULY 24-25

**FL - MILTON** - Milton ARC Hamfest. Mark McAnally KE4QKN, 850-626-7686. E-Mail: KE4QKN@AOL.COM

**OK - OKLAHOMA CITY** - OK State Convention. Harold Miller KB1ZQ, 405-672-7735. E-Mail: n1lpm@swbell.net

JULY 24-25-26

**AZ - FLAGSTAFF** - AZ State Convention. Mark Kesauer N7KKQ, 602-440-2039. E-Mail: arcathill@aol.com

**MI - TAYLOR** - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 734-287-2000

JULY 25

**IN - HUNTINGTON** - Huntington Co. ARC Hamfest. Ray Tackett 219-786-0029. E-Mail: rtackett@huntington.in.us

**NC - ASHEVILLE** - Hamfest. Haywood Co. Fairgrounds. 8am-4pm. Thomas Queen K4BNP, 828-258-2639. E-Mail: k4bnp@aol.com

**OH - CINCINNATI** - OH-KY-IN ARC Hamfest. Dana Laurie WB8M, 513-761-7388. E-Mail: rdl@one.net

JULY 25-26

**OK - OKLAHOMA CITY** - Ham Holiday. OK State Fair Park (Hobbies, Arts & Crafts Bldg.) Sat: 5-8pm, Sun: 8am-5pm. Thomas Webb 405-732-7110. Web: www.geocities.com/heartland/7332. E-Mail: n1lpm@swbell.net

JULY 26

**CA - SANTA ANA** - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

**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 - TIMONIKON** - Hamfest. York Rd. Bob Koblish N3HAT, 410-467-4634. E-Mail: n3hat@erols.com  
Web: http://www.smart.net/~brats

**ME - PORTLAND/WESTBROOK** - Computer Show. Verrillo's Convention Center. Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**OH - PAULDING** - Hamfest. Park Lane Center, Fairgrounds RD. Jerry KB8MAF, 419-399-4507. E-Mail: JLRHOD@BRIGHT.NET

JULY 31-AUGUST 1

**TX - AUSTIN** - State Convention. Joe Makeever W5HS, 512-345-0800

JULY 31-AUGUST 1-2

**MI - MT. CLEMENS** - Computer & Technology Show. Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

AUGUST 1998

AUGUST 1

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052

**KY - BOWLING GREEN** - KY Colonels ARC Hamfest. Leon Garrett K4CIT, 502-842-5307

**MO - SPRINGFIELD** - State Convention. Karen Thorpe N0TDW, 417-889-6775

**NC - HIGH POINT** - Hamfest. National Guard Armory, 8am-1pm. 336-887-3039. E-Mail: RAHam@infoave.net

**NY - WEEDSPORT** - Hamfest. Weedsport Speedway/Fairgrounds, Rt. 31. Joe Kahler WA2NGX, 315-364-5135

**OH - COLUMBUS** - Voice of Aladdin ARC Hamfest. Jim Morton KB8KJP, 614-846-7790

**OR - Bandon** - Coos Co. RC Hamfest. Brian Howard W7MLT, 541-572-5623

AUGUST 1-2

**FL - JACKSONVILLE** - Hamfest & Computer Show. Prime Osborn Convention Ctr. Sat: 9am-5pm, Sun: 9am-3pm. 336-887-3039. Web: http://www.pbbox.com/~w4ue/hamfest.html

AUGUST 2

**IL - PEOTONE** - Hamfest. Dave Brasel NF9N, 708-448-0580

**IN - ANGOLA** - Land of Lakes ARC Hamfest. Theresa J. Limestahl KB9NNR, 219-495-5403. E-Mail: tjlimestahl@dmci.net

**NH - PORTSMOUTH** - Computer Show. Yoken's. Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

**OH - RANDOLPH** - ARC Hamfair. Portage County Fairgrounds, St. Rt. 44. 8am-4pm. Joanne Solak KJ3O, 330-274-8240

**VA - BERRYVILLE** - Hamfest & Computer Show. Clarke Co. Runtan Fairgrounds. Tom Martin KF4TIX, 540-539-4301. E-Mail: hamfest@vvalley.com  
Web: http://www.vvalley.com/svarc.hamfest

AUGUST 8

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

**IL - QUINCY** - Western IL ARC Hamfest. Jim Funk N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: http://scribers.mid-west.net/bcrocket/swapfest.htm

**WV - HUNTINGTON** - Tri-State ARA Hamfest. Bernard Mays WB8ZER, 304-743-5459. E-Mail: wb8zer@juno.com

AUGUST 9

**IA - AMANA** - Cedar Valley ARC Hamfest. Wayne Kolosik K10FE, 319-393-4224. E-Mail: k10fe@usa.net

**KY - FRANKFORT** - Hamfest. Western Hills High School. John R. Barnes KS4GL, 606-253-1178 eves. E-Mail: ks4gl@juno.com

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AUGUST 14-15

**LA - NEW ORLEANS** - Int'l DX Convention. Don Boudreau W5FKX, 504-737-9733

AUGUST 14-15-16

**CA - SAN DIEGO** - ARRL Southwestern Division Convention. Town & Country Hotel, Mission Ballroom, 500 Hotel Cir. N. Cybil Albright 619-728-4284

AUGUST 15

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052

**GA - ALBANY** - Computer & Elect. Expo. Hasan Temple, 1822 Palmyra Rd. 9am-5pm. Sandy Rabb 912-888-9393. E-Mail: GODS@SURFSOUTH.COM

**KS - CHANGUTE** - Chanute Area ARC Hamfest. Charlie Ward W0DAKU, 316-431-6402

**NH - SEABROOK** - Computer Show. Greyhound Racetrack. Northern Computer Shows 978-744-8440. E-Mail: inquiries@ncshows.com

AUGUST 15-16

**AL - HUNTSVILLE** - Hamfest. Von Braun Civic Ctr. Sat: 9am-4:30pm, Sun: 9am-2:30pm. Art Davis WB4KKA, 256-883-0477  
Web: www.hamfest.org

**MN - WASECA** - Hamfest & Craftfair. Waseca Co. Fairgrounds. Lloyd L. Schlaak 507-465-8619. E-Mail: n0vfv@smig.net

AUGUST 16

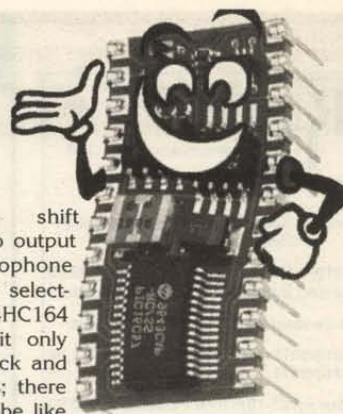
**IN - LAFAYETTE** - Tippecanoe ARA Hamfest. James Canarecci WA9TGO, 765-474-6570

**KS - SALINA** - Central KS ARC Hamfest. Ron Tremblay WA0PSF, 785-827-8149. E-Mail: tremblay@midusa.net



# STAMP APPLICATIONS

by Jon Williams



## Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

### Talk Is Cheap!

As far as output devices go, LEDs are okay, character LCDs are nice, and graphical LCDs are pretty cool. But a voice? Now you're talking — literally. With a couple of chips, a little time with your soldering iron, and just a bit of code, you can give your BASIC Stamp projects a voice and an unlimited English vocabulary to go along with it.

### The SP0256-AL2

The heart of this project is the General Instrument SP0256-AL2 allophone speech processor. I'm sure that somebody will question the logic of doing a project with a chip that went out of production quite some time ago, especially when there are other devices available. I went with the SP0256-AL2 because they're still easy to come by (from B.G. Micro; see Sources), they're inexpensive, they're easy to interface, and I like

the idea of the unlimited (English) vocabulary.

Being a simple guy, I'm going to keep things simple (if you want the gory technical details, you can read them in the GI docs). The SP0256-AL2 is a specialized processor that contains 64 digitally-encoded speech sounds — called allophones — and the software to convert the digital allophone data to an audible sound. By linking allophones, we can create speech.

Selecting an allophone is a simple matter of placing its address on the SP0256-AL2 bus and strobing (high to low) the ALD line. If the address buffer is full, the LRQ line will go high, so we should check it before loading another allophone address.

### Making The Connection

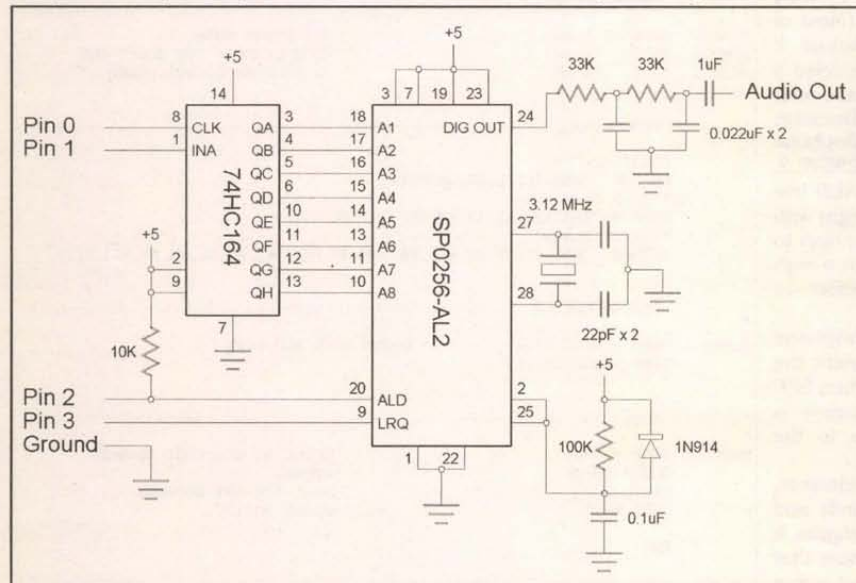
To make a straightforward connection to the SP0256-AL2, we need eight lines: six for the allophone address, and one each for ALD and LRQ. You could, of course, connect direct, but this chews up a lot of pins and leaves nothing left if

74HC164 shift register to output the allophone address. I selected the 74HC164 because it only needs clock and data lines; there is no strobe like on the 75HC595. What this means, however, is that the outputs ripple with the clock. This presents no problem for our project since the SP0256-AL2 address lines are ignored until ALD is pulsed low.

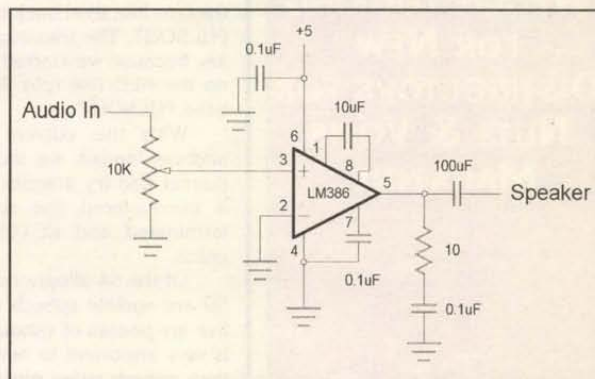
Figure 1 shows the schematic for the circuit. You'll notice that I used all of the address lines on the SP0256-AL2. Technically, I could have tied A7 and A8 to ground, but I figured it was just as easy to connect them to the 74HC164. This also makes my circuit compatible with the SP0256, provided I connect an external speech ROM to the appropriate pins on the SP0256.

I also elected to use an external amplifier. If you'd like to have an onboard audio amp, Figure 2 shows an appropriate circuit. Just keep your wiring tight around the op-amp to prevent it from oscillating.

Wiring up the circuit will be the most time-consuming task of this project. There are really too many connections to try to put this on a solderless breadboard, so point-to-point wiring (my choice) or wire-wrapping is called for. Of course, if you have the tools and know-how to make your own PC boards, that would be even nicer. Take your time. You certainly don't want to screw



you're using a BS1. I cut the pin count down to four by using a



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# STAMP APPLICATIONS

things up by rushing through your wiring. You'll be rewarded for your patience.

## The Software

BASIC Stamp software really doesn't get any easier than this, folks. After last month (remember the graphing thermometer and all the trouble I had squeezing it into the BS1?), this one's a breeze. Please refer to Listing 1 for analysis.

My strategy goes like this: I store speech strings in the Stamp's EEPROM. Each string ends with the marker byte \$FF. To say a particular string, I load its EEPROM address into the variable called addr and call the subroutine called Speak. Nothing to it.

Speak reads the data stored at the current value of addr. If it is not \$FF (the end of the speech marker), we send it to the SP0256-AL2. But first we have to make sure that the SP0256-AL2 address buffer is not full. If it is, we wait for the LRQ line to go low.

When the speech processor is ready, we output an allophone address via the 74HC164 (Most of you have seen this code before. If you're new, or haven't connected a BS1 to a shift register, please refer to the section titled "Shifty Business For Beginners.") With the allophone address placed on the SP0256-AL2, we load it by pulsing the ALD line (high to low, then back to high) with PULSOUT. The transition is high to low because we started with a high on the ALD line (pin 2) before we used PULSOUT.

With the current allophone address loaded, we increment the pointer and try it again. When \$FF is encountered, the subroutine is terminated and RETURNS to the caller.

Of the 64 allophone addresses, 59 are audible speech sounds and five are pauses of various lengths. It is very important to remember that your speech string must end with a pause. Otherwise, the last allophone will continue to play.

As always, I've made heavy use of SYMBOLS to make the code more readable. This includes all of the allophones. There is one allophone — OR — that collides with a PBASIC keyword. The problem is solved with the addition of an underscore. You'll see "\_OR\_" in the allophone table (Listing 2).

## Talk, Talk, Talk

Once you're all wired up, the fun begins: creating speech data. This is not quite as easy as it might seem, because there is no direct correlation between the spelling of a given word and the allophones used to produce it. Things get even

### Listing 1

Nuts & Volts: Stamp Applications, June 1998

-----[ Title ]-----

File..... TALKER.BAS  
Purpose... BASIC Stamp -> SP0256-AL2 Allophone Speech Processor  
Author.... Jon Williams  
E-mail.... jonwms@aol.com  
WWW..... <http://members.aol.com/jonwms>  
Started... 03 MAY 98  
Updated... 03 MAY 98

-----[ Program Description ]-----

This program enables the BASIC Stamp to talk by interfacing with the GI SP0256-AL2 Allophone Speech Processor.

A 74HC164 parallel output shift register is used to provide the allophone address to the SP0256-AL2. Four I/O lines are used:

Pin 0 (Out) Clock to 74HC164 (can be shared)  
Pin 1 (Out) Data to 74HC164 (can be shared)  
Pin 2 (Out) ALD - pulsed low causes allophone address to be loaded  
Pin 3 (In) LRQ - goes high when the SP0256-AL2 address buffer is full

-----[ Revision History ]-----

03 MAY 98 : Version 1

-----[ Constants ]-----

SYMBOL Clk = 0  
SYMBOL Dio = Pin1  
SYMBOL ALD = 2 ' Address Load  
SYMBOL LRQ = Pin3 ' Load Request

' Copy and Paste "ALLOPHON.BAS" here

-----[ Variables ]-----

SYMBOL data = B0 ' allophone data  
SYMBOL shift = B2 ' loop counter for shift out  
SYMBOL addr = B3 ' EE address of allophone

-----[ EEPROM Data ]-----

' Hello,  
EEPROM (HH1,EH,LL,AX,OW,PA4)  
' I am the  
EEPROM (AA,AY,PA2,AE,MM,PA2,DH1,AX,PA2)  
' BASIC Stamp  
EEPROM (BB2,EY,SS,IH,KK2,PA3,SS,SS,PA1,TT2,AE,AE,MM,PP,PA1,\$FF)

-----[ Initialization ]-----

Init: Pins = %00000100 ' begin with ALD high  
Dirs = %00000111

-----[ Main Code ]-----

Main: addr = \$00 ' point to start of speech  
GOSUB Speak ' speak!  
PAUSE 2000 ' wait for two seconds  
GOTO Main ' speak again...  
  
END

-----[ Subroutines ]-----

Speak: READ addr, data ' get allophone from EE table  
IF data = \$FF THEN Done ' if \$FF, we're done  
Busy: IF LRQ = 1 THEN Busy ' wait if SP0256-AL2 buffer full  
FOR shift = 1 TO 8 ' shift out the allophone address  
Dio = Bit7 ' get a bit  
PULSOUT Clk, 10 ' clock it out  
data = data \* 2 ' left-shift the byte  
NEXT  
PULSOUT ALD, 10 ' load the allophone  
addr = addr + 1 ' point to next allophone address  
GOTO Speak  
Done: RETURN

trickier when one considers that the same allophone can have a bit of a different sound based on its position in the word. It won't take too long to get the hang of concatenating allophones to create speech. What I found is that I started listening very carefully to the way I say words. Diphthongs (vowel sounds

that glide together) are the trickiest part of the encoding. And don't worry, you don't have to figure everything out from scratch.

Please download TALKER.ZIP from my FTP directory. Along with the source code for this project, you'll find a couple of PDF documents that I located on the Internet.



# STAMP APPLICATIONS

## Listing 2

Nuts & Volts: Stamp Applications, June 1998

### Allophone constants for "TALKER.BAS"

SYMBOL PA1	= \$00	10 ms pause (before BB, DD, GG and JH)
SYMBOL PA2	= \$01	30 ms pause (before BB, DD, GG and JH)
SYMBOL PA3	= \$02	50 ms pause (before PP, TT, KK and CH)
		(and between words)
SYMBOL PA4	= \$03	100 ms pause (between clauses and sentences)
SYMBOL PA5	= \$04	200 ms pause (between clauses and sentences)

### sample word

SYMBOL OY	= \$05	boy
SYMBOL AY	= \$06	sky
SYMBOL EH	= \$07	End
SYMBOL KK3	= \$08	Comb
SYMBOL PP	= \$09	Pow
SYMBOL JH	= \$0A	doDge
SYMBOL NN1	= \$0B	thin
SYMBOL IH	= \$0C	sIt
SYMBOL TT2	= \$0D	To
SYMBOL RR1	= \$0E	Rural
SYMBOL AX	= \$0F	sUcceed

SYMBOL MM	= \$10	Milk
SYMBOL TT1	= \$11	parT
SYMBOL DH1	= \$12	They
SYMBOL IY	= \$13	sEE
SYMBOL EY	= \$14	bEige
SYMBOL DD1	= \$15	could
SYMBOL UW1	= \$16	to
SYMBOL AO	= \$17	AUght
SYMBOL AA	= \$18	hOt
SYMBOL YY2	= \$19	Yes
SYMBOL AE	= \$1A	hAt
SYMBOL HH1	= \$1B	He
SYMBOL BB1	= \$1C	Business
SYMBOL TH	= \$1D	THin
SYMBOL UH	= \$1E	boOk
SYMBOL UW2	= \$1F	fOod

SYMBOL AW	= \$20	Out
SYMBOL DD2	= \$21	Do
SYMBOL GG3	= \$22	wiG
SYMBOL VV	= \$23	Vest
SYMBOL GG1	= \$24	Got
SYMBOL SH	= \$25	SHip
SYMBOL ZH	= \$26	aZure
SYMBOL RR2	= \$27	bRain
SYMBOL FF	= \$28	Food
SYMBOL KK2	= \$29	sKy
SYMBOL KK1	= \$2A	Can't
SYMBOL ZZ	= \$2B	Zoo
SYMBOL NG	= \$2C	aNchor
SYMBOL LL	= \$2D	Lake
SYMBOL WW	= \$2E	Wool
SYMBOL XR	= \$2F	repaIr

SYMBOL WH	= \$30	WHig
SYMBOL YY1	= \$31	Yes
SYMBOL CH	= \$32	CHurCH
SYMBOL ER1	= \$33	fIR
SYMBOL ER2	= \$34	fIR
SYMBOL OW	= \$35	bEAU
SYMBOL DH2	= \$36	They
SYMBOL SS	= \$37	veSt
SYMBOL NN2	= \$38	No
SYMBOL HH2	= \$39	Hoe
SYMBOL _OR	= \$3A	stORE
SYMBOL AR	= \$3B	alARm
SYMBOL YR	= \$3C	cleaR
SYMBOL GG2	= \$3D	Guest
SYMBOL EL	= \$3E	saddLE
SYMBOL BB2	= \$3F	Business

(note leading underscore)

' end of Allophone table

Both are scans of SP0256-AL2 documentation. One is from GI, the other from Radio Shack. The Radio Shack document contains a lot of application information — good stuff that you'll find extremely helpful when you start working with the SP0256-AL2. There's information about the chip and how it works, as well as a nice library of common words, numbers, names of months, and the days of the week.

## Applications

If you consider that we proba-

bly get most of our information through spoken words, the applications for this technology are limitless. Here are a couple of ideas that come to mind: a talking thermometer (I told you I had a thing for thermometers!), a talking clock, a talking alarm system, and various devices for the blind. Heck, you could even make your own annoying "Your door is ajar ..." alarm for the family automobile. Another obvious application is giving your Stamp-controlled pet robot a voice.

Have fun. If there's enough interest in this and other voice-ori-

## Shifty Business For Beginners

Since the Stamp does not use a traditional address/data bus, beginners are often troubled with I/O expansion, especially with the BS1. Upon analysis, we'll find that we usually define pins as inputs or outputs, and rarely do we need to change the state of a pin mid-program. Since this is the case, we can expand our Stamp I/O with shift registers.

This project uses the 74HC164 serial-in, parallel-out shift register. With the 74HC164, we can turn two Stamp lines into eight. What we've effectively done is expanded the Stamp's outputs from eight to 14 (remember that two are used to control the shift register). If you need more outputs, you can use the 74HC595 because it's cascadable (you can link two or more together in a chain). Be aware that the '595 also requires a strobe line to transfer your data to the outputs. If your circuit requires more than eight (additional) outputs, or you don't want the outputs to ripple (change) with the clock line, the 74HC595 is the way to go.

For the sake of discussion, let's stick with the '164. When the clock line is pulsed high, the state of the input pin (high or low) is transferred to output A. At the same time, what was on output A is transferred to output B, and so on down the line. The content of output H, the last bit, is transferred into bit-oblivion — it's gone forever. By doing eight such transfers, we can output an eight-bit byte with two pins.

Back in August, I made the comment that it is my habit to reserve variables B0 and B1 for bit-level access. Here's where we'll use bit-level access.

Take a look at the FOR-NEXT loop embedded in the Speak subroutine. This loop runs eight times; enough to shift out a byte. The first thing we do is grab Bit7 and output it to the data pin. Bit7 is the MSB (most significant bit) of B0, the variable that holds our shifted data (it is SYMBOLically renamed data). We grab Bit7 because we want this bit to be present on 74HC164 output H when we're done with eight clock pulses.

After Bit7 is output, we want to do the same thing with Bit6, then Bit5, and so on, down to Bit0. We could do this in hard code, but that technique would be wasteful. It's more convenient to move Bit6 to Bit7 and repeat the same set of code. We call this a left shift since the bit values move to their left during this process. Since we're dealing with binary numbers, multiplying the current value of data by two causes a left shift. It's important to keep in mind that the value of data will change during this subroutine. If you need to save it for some reason, make a copy to another variable before calling Speak.

Okay, what about inputs? Not a problem. Go get a 74HC165: a parallel-input, serial output shift register. This chip complements the '164. With the ground we've just covered, you should be able to check out the specs and put together the code, so I will not deny you the opportunity to learn from the experience. I will, however, give you a hint. In order to share the data line with the '164, you'll need to change it from an output to input and back. For an example, take a look at last month's project — it used this technique.

ented projects, we'll put one together with one of the newer options. The call is yours. My E-Mail address is in the Sources section. Happy Stamping. NV

## 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>

### Scott Edwards Electronics, Inc.

2700 E. Fry Blvd. Suite A4  
Sierra Vista, AZ 85635  
phone 520-459-4802  
fax 520-459-0623  
[www.seetron.com](http://www.seetron.com)  
[info@seetron.com](mailto:info@seetron.com)

### B.G. Micro

P.O. Box 280298  
Dallas, TX 75228  
Orders: 800-276-2206  
<http://www.bgmicro.com>

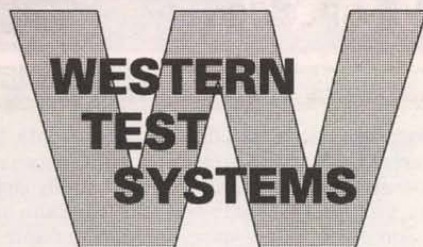
### Jon Williams

1505 Grande Blvd., #1602  
Tyler, TX 75703  
(903) 509-1691  
[jonwms@aol.com](mailto:jonwms@aol.com)

Internet:

<http://members.aol.com/jonwms>  
<http://members.aol.com/jonwms/stamps>





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TEK 7104 1 GHz Oscilloscope	\$4,500.00
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TEK 7844 400 MHz Dual Beam Oscilloscope frame	\$600.00
TEK 7844 400 MHz Dual Beam Oscilloscope	\$1,000.00
with 7A24, 7A26, 7B80, 7B85	
TEK 7904A 500 MHz System	\$1,250.00
with 7A24, 7A26, 7B80, 7B85	
TEK 7A13 105 MHz Differential Comparator	\$225.00
TEK 7A19 600 MHz Single Trace Amplifier	\$150.00
TEK 7A24 400 MHz Dual Trace Amplifier	\$300.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$175.00
TEK 7B15 1 GHz Delaying Time Base	\$450.00
TEK 7B80 400 MHz Delayed Time Base	\$175.00
TEK 7B85 400 MHz Delayed Time Base	\$175.00
TEK 7B92A 500 MHz Dual Time Base	\$275.00

### STORAGE

TEK 7633 100 MHz Storage Oscilloscope frame	\$600.00
TEK 7633 100 MHz Storage Oscilloscope	\$900.00
with (2) 7A26, (1) 7B92A	

### PROBES

HP 1122A Probe Power Supply	\$200.00
TEK 1101 Accessory Power Supply, for FET probes	\$250.00
TEK P6046 100 MHz Differential Probe	\$750.00
TEK P6201 800 MHz 1X/10X/100X FET Probe	\$450.00
TEK P6202A 500 MHz 10X FET Probe	\$300.00
TEK P6701-opt.02 O/E Converter,	\$675.00
450-1050 nm/0-1 mV; DC-700 MHz, ST conn.	

### CALIBRATION

TEK 067-0587-01 Signal Standardizer	\$300.00
Calibration Fixture, 7000 series	
TEK CG5001-opt.01/TM5006 Programmable	\$6,000.00
Oscilloscope Calibrator, with power module	
TEK SG503 Level Generator,	\$600.00
250 kHz-250 MHz, TM500 series	

## WAVEFORM GENERATORS

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HP 3310A 5 MHz Function Generator	\$250.00
HP 3310B 5 MHz Function Generator,	\$325.00
monocycle & var.phase trigger	
TEK DD501 Digital Delay & Burst Gen.,	\$275.00
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TEK FG501 1 MHz Function Generator, TM500 series	\$225.00
TEK FG503 3 MHz Function Generator, TM500 series	\$250.00
TEK RG501 Ramp Generator, TM500 series	\$225.00

### PULSE

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Digital Delay Generator, 0-100 mS, 1 nS res., 5 Hz-5 MHz	
HP 214B-001 10 MHz Pulse Generator,	\$1,750.00
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HP 8005B 20 MHz Dual Output Pulse Generator	\$400.00
HP 8007B 100 MHz Pulse Generator	\$650.00
HP 8012B 50 MHz Pulse Generator,	\$600.00
variable transition time	
HP 8015A 50 MHz Dual Output Pulse Generator	\$750.00
HP 8080A/81A/83A/84A 300 MHz Word Generator	\$800.00
HP 8080A/91A/92A/93A 1 GHz Single	\$950.00
Channel Pulse Generator	
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$600.00
TEK PG505 100 kHz Pulse Generator,	\$275.00
80 V peak, TM500 series	

### PROGRAMMABLE

HP 3325A 21 MHz Synthesized Function Generator, HP1B	\$1,650.00
HP 3325A-002 Synthesized Function	\$1,750.00
Generator, High Voltage Output opt	
HP 8161A-020 100 MHz Programmable	\$3,500.00
Pulse Generator, dual channel opt.	
HP 8165A-002,003 Prog. Signal Source,	\$2,000.00
1 mHz-50 MHz, log sweep, rear out	
TEK AWG5102 Arb. Waveform Gen.,	\$1,400.00
20 MS/s, 12 bits, 50ppm synthesis <1MHz	
TEK AWG5105-opt.02 Arbitrary Waveform	\$1,900.00
Generator, dual channel option	
WAVETEK 288 20 MHz Synthesized	\$1,000.00
Function Generator, GPIB	

## VOLTAGE & CURRENT

### VOLTMETERS

HIPOTRONICS KVM200D 3-1/2 digit	\$1,000.00
DVM / HV Divider, 0-200 kV, 2000:1 division	
HP 3456A 6-1/2 Digit Voltmeter	\$750.00
HP 3468A 5-1/2 digit Multimeter	\$300.00
HP 3478A 5-1/2 digit Multimeter, HP1B	\$700.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter,	\$1,000.00
10 nV sensitivity, GPIB	
SOLARTRON 7081 8-1/2 digit Voltmeter	\$3,900.00
TEK DM501A 4-1/2 digit Multimeter, TM500 series plug-in	\$225.00

### CALIBRATION

FLUKE 5100B-03,05 Calibrator,	\$3,500.00
wideband AC & GPIB options	

FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA	\$450.00
FLUKE 515A Portable Calibrator,	\$1,000.00
DC/AC/Ohms, line & battery power	
FLUKE 5220A Transconductance	\$3,000.00
Amplifier, DC-5 kHz, 0-20 A	
FLUKE 720A 7-decade Kelvin-Varley Voltage Divider	\$1,250.00
FLUKE 731B DC Reference Standard	\$400.00
FLUKE 732A DC Voltage Standard	\$2,000.00
FLUKE A55-series AC Thermal Converters	\$300.00
HOLT 11 AC Thermal Converter Set,	\$3,000.00
0.5-1200 V, 20 Hz-30 MHz	
VALHALLA 2703 AC Volt.Std., 0-120V/10	\$2,250.00
Hz-100 kHz; 120-1200V/10 Hz-1 kHz	

### VOLTAGE SOURCES

HP 6114A Precision Dual Range Power	\$850.00
Supply, 25V 2A / 40V 1A	
HP 6115A Precision Dual Range Power	\$850.00
Supply, 50V 0.8A / 100V 0.4A	

### CURRENT METERS & SOURCES

HP 4140B Picoammeter / DC Voltage Source,	\$2,500.00
without 16055A fixture	
HP 6177C DC Current Source, to 50V, 500mA	\$500.00
HP 6181C DC Current Source, to 100 V, 250 mA	\$500.00
HP 6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 225 Current Source,	\$500.00
0.1 uA-100 mA, 10-100 V compliance	
KEITHLEY 227 Current Source,	\$800.00
1 uA-1 A, 0-50 V compliance	
KEITHLEY 228 Programmable Voltage/Current Source	\$2,500.00
KEITHLEY 261 Picoampere Source	\$375.00
KEITHLEY 614 Electrometer	\$800.00
KEITHLEY 642 Electrometer	\$2,900.00
TEK AM503/A6302/TM501 AC/DC Current Probe System	\$1,000.00
TEK CT-5 opt.05 High Current	\$500.00
Transformer for P6021/A6302, to 1000A	
VALHALLA 2301 Programmable	\$1,250.00
Single Phase Power Analyzer	
VALHALLA 2575A AC/DC Wideband Current	\$950.00
Shunt, 20 mA-100 A, DC-10 kHz	

## IMPEDANCE & COMPONENT TEST

### L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
BOONTON 72B 1 MHz Capacitance Meter	\$600.00
ESI 2160 LCR Bridge, 20 Hz-150 kHz, GPIB	\$2,000.00
HP 4282A-101 3-1/2 digit LCR Meter,	\$2,250.00
120 Hz / 1 kHz / 10 kHz test, HP1B	
HP 4275A-001 5-1/2 digit LCR Meter,	\$6,000.00
10 kHz-10 MHz, 0-35 V int. bias	

### STANDARDS

E.S.I. DB62-11K 6-Decade Resistor,	\$300.00
0-11,111.0 Ohms, 0.01 Ohm res.	
E.S.I. SR1010 Resistance Transfer	\$550.00
Standards, 1 Ohm-100 K/step	
E.S.I. SR1050-1M Resistance Transfer	\$2,000.00
Standard, 1 Megohm/step	
E.S.I. SR1-set Set of eight Standard	\$900.00
Resistors, 1 Ohm - 10 Megohms	
GR 1404-A 1000 pF Reference Standard Capacitor	\$700.00
GR 1406 Standard Air Capacitors,	\$375.00
GR900 connector, 0.1% acc.	
GR 1412-BC Decade Capacitor, 50 pF - 1.11115 uF	\$350.00
GR 1432-U 4-Decade Resistor,	\$125.00
0-11.110 Ohms, 0.01 Ohm resolution	
GR 1433-J 4-Decade Resistor,	\$350.00
0-1.110 Ohms, 1 Ohm resolution	
GR 1433-N 5-Decade Resistor,	\$400.00
0-11.111 Ohms, 0.1 Ohm resolution	
GR 1433-U 4-Decade Resistor,	\$350.00
0-111.0 Ohms, 0.01 Ohm resolution	
GR 1433-X 6-Decade Resistor,	\$450.00
to 111,111.0 Ohms, 0.1 Ohm res.	
GR 1482-series Standard Inductors	\$275.00
VALHALLA 2724A Programmable	\$1,675.00
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### HI & LO RESISTANCE

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### CURVE TRACERS

TEK 577D1/177 Storage Curve	\$2,250.00
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TEK 577D2/177 Curve Tracer, with standard test fixture	\$1,850.00

### T.D.R.

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0-50,000 feet/chart recorder	

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HP 6201B 0-20 V 0-1.5 A CV/CC Power Supply	\$175.00
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply	\$300.00
HP 6260B-027 0-10 V 0-100 A CV/CC	\$675.00
Power Supply; 208 VAC line	
HP 6261B-027 0-20 V 0-50 A CV/CC	\$675.00
Power Supply; 208 VAC line	
HP 6263B 0-20 V 0-10 A CV/CC Power Supply	\$400.00
HP 6266B 0-40 V 0-5 A CV/CC Power Supply	\$400.00

HP 6267B 0-40 V 0-10 A CV/CC Power Supply	\$550.00
HP 6269B-028 0-40 V 0-50 A CV/CC	\$950.00
Power Supply; 230 VAC line	
HP 6281A 0-7.5 V 0-5 A CV/CC Power Supply	\$175.00
HP 6284A 0-20 V 0-3 A CV/CC Power Supply	\$225.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply	\$225.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply	\$125.00
HP/HARRISON 6443B	\$375.00
0-120 V 0-2.5 A CV/CC Power Supply	
KEPCO ATE 100-10M 0-100 V	\$900.00
0-10 A CV/CC Power Supply, 120 VAC 20 A line	
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply	\$375.00
SORENSEN DCR 20-25B 0-20 V	\$550.00
0-25 A CV/CC Power Supply	
SORENSEN DCR 300-1.5B 0-300 V	\$600.00
0-1.5 A CV/CC Power Supply	
SORENSEN DCR 600-0.75B	\$600.00
0-600 V 0-750 mA CV/CC Power Supply	
SORENSEN SRL 20-12 0-20 V	\$400.00
0-12 A CV/CC Power Supply	
SORENSEN SRL 60-8 0-60 V	\$650.00
0-8 A CV/CC Power Supply	
TEK PS501-1 Power Supply	\$175.00
0-20 V, 2 mV res., 400 mA, TM500 series	

### MULTIPLE OUTPUT

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HP 6227B Dual 0-25 V 0-2 A CV/CC Power Supply	\$600.00
HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply	\$600.00
HP 6237B Triple Output Supply, +/- 0-20 V 0.5 A, 0-18 V 1 A	\$550.00
HP 6239A Dual Output 0-20 V 0-3 A CV/CC Power Supply	\$550.00
TEK PS5010 Programmable	\$750.00
Triple Power Supply, TM5000 series	
TEK PS503A Dual Power Supply, TM500 series	\$200.00

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ACME PS2L-500 Programmable Load,	\$400.00
0-75 V / 0-75 A / 500 Watts max.	
HP 59501B HP1B Isolated DAC/Power Supply Programmer	\$175.00
KEPCO BOP 50-2M/488 Bipolar	\$900.00
Op Amp/Power Supply, to 50 V 2 A; GPIB	
TRANSISTOR DEVICES DAL-50-15-100	\$200.00
Programmable Load, 0-50 V, 0-15 A, 100 Watts max.	
TRANSISTOR DEVICES DVL-50-300-3000	\$1,200.00
Programmable Load, 0-60 V / 0-360 A / 3000 Watts max.	

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HP 5315A-002,003 100 MHz/100 nS	\$650.00
Univ. Counter, battery power, 1 GHz C-ch	
HP 5315B 100 MHz/ 100 nS Universal Counter	\$500.00
HP 5316A 100 MHz/100 nS Universal Counter, HP1B	\$600.00
HP 5316B 100 MHz/ 100 nS Universal Counter, HP1B	\$1,000.00
HP 5334A 100 MHz Universal Counter, HP1B	\$850.00
HP 5334A-010,030,050 100 MHz	\$1,000.00
Univ.Counter; OCXO, DVM, 1.3 GHz C-ch., rear in	
HP 5334B-010,060 100 MHz	\$1,000.00
Universal Counter, HP1B, OCXO	
HP 5335A 200 MHz Universal / Statistical Counter	\$1,200.00
RACAL-DANA 1992-04 100 MHz/1 nS	\$750.00
Univ. Counter, 1.3 GHz C-channel, OCXO	
TEK DC5004 Programmable	\$250.00
100 MHz/100nS Counter/Timer, TM5000 series	
TEK DC5009 Programmable 135 MHz Univ.	\$500.00
Counter/Timer, TM5000 series	
TEK DC5010 350 MHz / 3.125 nS Universal	\$1,200.00
Counter, TM5000 series	
TEK DC503A 125 MHz/ 100 nS	\$275.00
Universal Counter, TM500 series	

### FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB	\$2,500.00
EIP 578-opt.02,05 26.5 GHz Source	\$5,000.00
Locking Counter; power meas., OCXO	
HP 5340A 18 GHz Frequency Counter	\$1,200.00
HP 5342A 18 GHz Frequency Counter	\$2,400.00
HP 5342A-001 18 GHz Frequency	\$2,500.00
Counter, OCXO reference	
HP 5342A-003 18 GHz Freq.Counter,	\$2,400.00
+22 dBm, -20 dBm dynamic range	
HP 5342A-01,04,05 24 GHz Frequency	\$3,250.00
Counter, OCXO, DAC	
HP 5343A-opt.26.5 GHz Frequency	\$4,500.00
Counter, OCXO reference	
HP 5345A/5355A/5356B 26.5 GHz	\$4,000.00
CW/Pulse Frequency Counter	
TEK DP501 1.3 GHz Prescaler, divide by 16, TM500 series	\$225.00

### STANDARDS

HP 105A Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz	\$750.00
HP 105B Quartz Oscillator,	\$1,500.00
0.1/ 1.0/ 5.0 MHz, battery power	
HP 5087A-opt.033 Distribution Amplifier;	\$1,750.00
12 outputs at 10 MHz	

## AUDIO & BASEBAND

### SPECTRUM ANALYSIS

HP 3586C Selective Level Meter,	\$1,500.00
50 Hz-32.5 MHz 50 & 75 ohms	
TEK 7L5L/3R7803 Spectrum Analyzer,	\$1,500.00
20 Hz-5 MHz, 10 Hz min. res., w/fmz	





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HP 338A Distortion Analyzer, built-in low distortion osc.	\$1,500.00
HP 8903A-001 Audio Analyzer, 20 Hz-100 kHz; rear panel input	\$2,600.00
HP 8903B-001, 0.13, 0.51 Audio Analyzer, 20 Hz-100 kHz; C-message, CCITT	\$3,750.00
TEK DA084 Programmable Distortion Analyzer	\$1,000.00

## RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz	\$500.00
FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz	\$500.00

## 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
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 option	\$850.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal.	\$175.00
HP 461A Amplifier, 20/40 dB, 1 kHz-150 MHz, 0.5 V/50 Ohms	\$125.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave	\$400.00
KROHN-HITE 3202R Dual HP/LP/BR Filter, 20 Hz-2 MHz, 24 dB/octave	\$500.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
KROHN-HITE 3750 LP/HP/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 AF501 Tunable Bandpass Filter / Amplifier, 3 Hz-35 kHz	\$300.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$475.00

## RF & MICROWAVE

### SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A	\$600.00
HP 11970A WFT28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970Q WFT28 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 8444A-052 Tracking Generator, 0.5-1500 MHz, for 8554/8568, etc.	\$1,250.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A	\$650.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res.	\$4,500.00
HP 8566B Spectrum An., 100 Hz-22 GHz, HP calibration certificate	\$37,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. bw.	\$8,500.00
TEK 119-0098-00 WR42 Single Ended Mixer, 18.0-26.5 GHz, for Tek 491	\$200.00
TEK 119-0099-00 WR28 Single Ended Mixer, 26.5-40 GHz, for Tek 491	\$200.00
TEK 492-1.2, 3 Spectrum Analyzer, 50 kHz-21 GHz, 100 Hz min. res.	\$6,500.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492A/5/6	\$1,375.00
TEK WM490A WR28 Harmonic Mixer, 26.5-40 GHz	\$850.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz	\$2,000.00

### NETWORK ANALYZERS

HP 11665B Modulator, 0.15-18.0 GHz, N(m/f)	\$325.00
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### SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB	\$2,750.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res., GPIB	\$2,000.00
FLUKE 6062A Signal Generator, 0.1-2100 MHz, 10 Hz resolution	\$5,500.00
FLUKE 6070A Synthesized Signal Generator, 0.2-520 MHz, 1 Hz res.	\$2,000.00
GIGATRONICS 605/10-18 Synthesized Source, 10-18 GHz, 1 kHz res., GPIB	\$3,000.00
GIGATRONICS 605/2-8 Synthesized Signal Gen., 2-8 GHz, 1 kHz res., GPIB	\$3,000.00
GIGATRONICS 840-01 Freq. Doubler, 26.5-40 GHz (WR28) out, 13-20 GHz in	\$3,500.00
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, 18 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO	\$3,500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio	\$750.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP 8640B-001, 002 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc.	\$2,200.00
HP 8660C/86602B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod, w/86635A	\$3,250.00
HP 8660C/86603A/86633B Synthesizer, 1-2600 MHz, AM, FM	\$3,750.00

### SWEEP GENERATORS

HP 8350B/83592C-004 Sweep Oscillator, 10 MHz-20 GHz, +10 dBm levelled	\$18,500.00
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, HP1B programmable	\$675.00
HP 86222A RF Plug-in, 10-2400 MHz, +13 dBm levelled	\$1,250.00

HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten.	\$1,750.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$675.00
HP 86235A-001, 002 RF Plug-in, 1.7-4.3 GHz, +14 dBm levelled, 70 dB atten.	\$1,000.00
HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled	\$1,000.00
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	\$2,000.00
WAVETEK 2002A Sweep Generator, 1-2500 MHz, +13 dBm levelled	\$1,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld.	\$1,500.00
WILTRON 6617A-40 Sweep Generator, 10 MHz-8 GHz, +16 dBm levelled	\$3,000.00

### POWER METERS

ANRITSU MA72B Power Sensor, -20 to +20 dBm, 0.01-18 GHz	\$300.00
ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm	\$2,500.00
BOONTON 4200-01A, 03/8-4A x2 Dual Channel Microwattmeter, w/2) 1 MHz-7 GHz sensors	\$1,500.00
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	\$300.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$900.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -10 to +34 dBm	\$950.00
HP 435B-001/8482H Power Meter, 0.1-4200 MHz, AC or battery power	\$1,200.00
HP 8477A Power Meter Calibrator, for HP 432 series	\$500.00
HP 08486A Power Sensor, 33.0-50.0 GHz, WR22, for 435B/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series	\$350.00

### RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00
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### AMPLIFIERS, MISCELLANEOUS

BOONTON 82AD-opt.01A Modulation Meter, AM, FM, 10-1200 MHz, GPIB	\$900.00
HP 11715A AM/FM Test Source	\$1,600.00
HP 415E SWR Meter	\$300.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms	\$125.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz	\$450.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output	\$750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz	\$3,000.00
HP 8901B-1.2, 3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO	\$4,500.00
HP 8970A Noise Figure Meter	\$6,000.00
HUGHES 1177H01F000 TWT Amplifier, 2.0-4.0 GHz, 10 Watts output	\$1,500.00
HUGHES 1177H02F000 TWT Amplifier, 4.0-8.0 GHz, 10 Watts output	\$1,500.00
HUGHES 1277H02F000 TWT Amplifier, 4.0-8.0 GHz, 20 Watts output	\$2,500.00
HUGHES 8020H02F000 TWT Amplifier, 4.0-8.0 GHz, 20 Watts output	\$2,750.00
MICROWAVE SEMI-CORP. MC5112 Noise Source, 25.5 dB ENR, 10-12.4 GHz, N(m), +28 VDC	\$275.00
ROHDE & SCHWARTZ ES2H Test Receiver, 9 kHz-30 MHz	\$6,000.00

## COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00
BIRD 8329-310 30 dB Attenuator, 2000 Watts, DC-1 GHz, LC(f)/N(f)	\$650.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$400.00
GR 900-Q GR900 14mm Interseries Adapters	\$125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11612A Bias Network, 45 MHz-26.5 GHz, APC3.5	\$550.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz	\$450.00
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 Crystal Detector, 10 MHz-18 GHz, neg. pol., APC7	\$250.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA	\$150.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA	\$400.00
HP 8495G-002 Programmable Step Attenuator, 0-70 dB, DC-4 GHz, SMA	\$300.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA	\$400.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz	\$750.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HP K532A WR42 Frequency Meter, 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	\$350.00
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 GHz	\$500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz	\$450.00
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
HP X870A WR90 Slide Screw Tuner	\$150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz	\$450.00

HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz	\$900.00
HUGHES 45721H-2000 WR28 Precision Rotary Vane Atten., 0-50 dB, 26.5-40 GHz	\$1,200.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz	\$250.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity	\$600.00
HUGHES 47323H-1211 WR19 Flat Broadband Detector, negative, 40-80 GHz	\$650.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-82 GHz response	\$375.00
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC	\$100.00
KRYTAR 1818 Directional Coupler, 20 dB, 2-18 GHz, SMA(f)	\$200.00
MA-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
MIDWEST MICROWAVE 3537 DC Block, 0.1-12.4 GHz, SMA(m/f) "NEW"	\$40.00
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)	\$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 368BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f)	\$325.00
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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 792F Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz	\$375.00
OMNI-SPECTRA 2085-6010 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)	\$50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
SONOMA ENG. S-4901 WR15 Junction Isolator, 57-59 GHz, 30 dB isolation	\$125.00
SONOMA ENG. S-4906 WR15 Junction Isolator, 60-62 GHz, 30 dB isolation	\$125.00
SONOMA ENG. S-4907 WR15 Junction Isolator, 62-64 GHz, 30 dB isolation	\$125.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$75.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz	\$400.00
SPACEK LABS K-2X Frequency Doubler, 8.0-13.25 GHz in / 18.0-26.5 GHz out	\$350.00
SPACEK LABS KA-3X Frequency Tripler, 8.63-13.33 GHz in / 26.5-40.0 GHz out	\$350.00
TRG 8528 WR22 Direct Reading Phase Shifter, 0-360 deg., 33-50 GHz	\$1,250.00
TRG V551 WR15 Frequency Meter, 50-75 GHz	\$600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz	\$750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB	\$200.00
WEINSCHEL 1515 Power Divider, 2-Way, DC-18 GHz, SMA(m/f)	\$125.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f)	\$150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f)	\$150.00

## COMMUNICATIONS

HP 59401A HP1B Bus Analyzer	\$700.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars	\$800.00
TEK 1411R PAL Gen., w/SPG12 sync; TSG11 color bars; TSG13 linearity	\$750.00
TEK 1411R PAL Test Gen., w/SPG12, TSG11, TSG13, TSG15, TSG16	\$1,000.00
TEK 1411R PAL Test Gen., w/SPG12, TSG11, TSG12, TSG13, TSG15, TSG16	\$1,100.00
TEK 1411R opt.04 PAL Test Gen., w/SPG12, TSG11, TSG13, TSG15, TSG16	\$1,400.00
TEK 1420 NTSC Vectorscope	\$600.00
TEK 147A NTSC Test Signal Generator, with noise test signal	\$800.00
TEK 148 PAL Insertion Test Signal Generator	\$700.00
TEK 1750 NTSC Waveform / Vector Monitor	\$2,250.00
TEK 5200A NTSC Vectorscope	\$750.00
TEK 521A PAL Vectorscope	\$750.00

## MISCELLANEOUS

P.A.R. 5101 Lock-In Amplifier, 5 Hz-100 kHz	\$650.00
P.A.R. 5206-95, 98 Two-Phase Lock-In Amp., 2 Hz-100 kHz, GPIB	\$1,500.00
P.A.R. 5209 Lock-In Amp., 0.5 Hz-120 kHz, 130 dB dynamic response	\$2,500.00
TEK TMS006 500-series 6-slit Programmable Power Module	\$600.00
TEK TMS04 500-series 4-slit Power Module	\$175.00
TEK TMS06 500-series 6-slit Power Module	\$250.00
TEK TMS15 500-series 5-slit Traveller Power Module	\$750.00



# SECURITY ELECTRONICS SYSTEMS AND CIRCUITS

## — Part 5

by Ray Marston

### IR LIGHT-BEAM ALARM BASICS

Last month's episode of this 'Security Electronics' series explained (among other things) the basic operating principles of visible light-beam alarm circuits, and ended by explaining that virtually all modern light-beam security systems, in fact, operate in the invisible infrared (rather than visible light) range. Use one or more pulse-driven IR LEDs to generate the transmitter's 'light-beam,' and use matching IR photodiodes or phototransistors to detect the beam at the receiver end of the system. The graph of Figure 1 conveys some useful information regarding the spectral response of the human eye, and of general-purpose and IR photodiodes and phototransistors.

Thus, the human eye is sensitive to a range of electromagnetic light radiation; it has a peak spectral response to the

color green, which has a wavelength of about 550nm, and has relatively low sensitivity to the color violet (400nm) at one end of the visible-light spectrum, and to dark red (700nm) at the other. The human eye is blind to electromagnetic light radiation beyond this narrow spectrum.

Optoelectronic semiconductor devices such as photodiodes and phototransistors have spectral responses that are determined by the chemistry of their semiconductor junction material.

General-purpose 'light sensi-

tive' types have (as shown in Figure 1) typical spectral responses that straddle the human visibility spectrum, but IR types operate at a peak wavelength of about 900nm and generate an output spectrum that is well beyond the range of normal human visibility. IR light-beams are thus invisible to human eyes.

A simple IR direct light-beam intrusion detector or alarm system can be made by connecting an IR light-beam transmitter and IR receiver in the basic way shown in Figure 2. Here, the transmitter feeds a coded pulse-type signal (often a simple squarewave) into an IR LED that has its output focused into a fairly narrow beam (via a molded-in lens in the LED casing) that is aimed at a matching IR photodetector (phototransistor or photodiode) in the remotely placed receiver.

The system action is such

Ray Marston looks at IR light-beam and PIR movement-detector circuits and systems in this month's episode of the series.

that the receiver output is 'off' while the light-beam reaches the receiver, but turns on and activates an external alarm or other mechanism if the beam is interrupted by a person or other object.

This basic type of system can be designed to give a useful detection range of up to 20 meters when used with additional optical focusing lenses, or up to five meters without extra lenses.

Note that the simple Figure 2 light-beam alarm system works on a strict line-of-sight principle between the Tx and Rx lenses, and the alarm may thus activate if any object with a diameter greater than the smaller of the two lenses enters the beam's line-of-sight.

Thus, a weakness of this simple system is that it can easily be false-triggered by relatively small insects entering the beam or resting on one of the lenses. The improved dual light-beam system shown in Figure 3 does not suffer from this defect.

The Figure 3 system is basically similar to that already described,

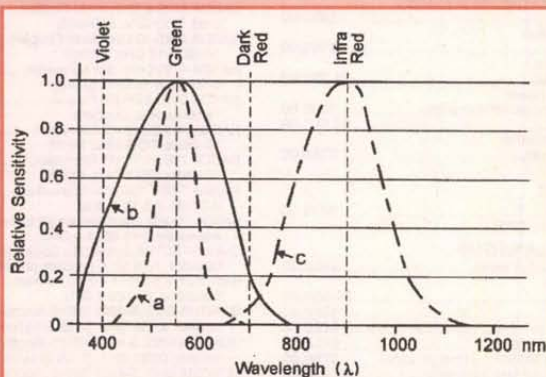


Figure 1. Typical spectral response curves of (a) the human eye and (b) general-purpose, and (c) IR photodiodes/transistors.

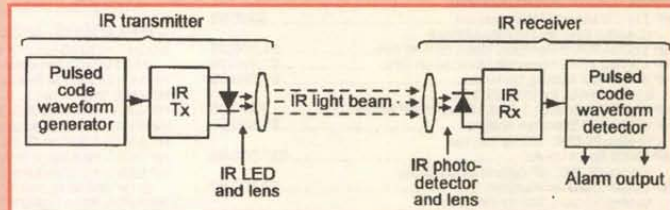


Figure 2. Simple IR direct light-beam alarm system.

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but transmits the IR beam via two series-connected LEDs that are spaced about 75mm apart, and receives the beam via two parallel-connected photo-detectors that are also spaced about 75mm apart.

Thus, each photodetector can detect the beam from either LED, and the receiver's alarm will thus activate only if *both* beams are broken simultaneously, and this will normally only occur if a large (greater than 75mm) object is placed within the composite beam. This system is thus virtually immune to false triggering by insects, etc.

Note that, as well as giving excellent false-alarm immunity, the dual light-beam system also gives (at any given LED drive-current value) double the effective detection range of the simple single-beam system, since it has twice as much effective IR transmitter output power and twice the receiver sensitivity.

### IR SYSTEM WAVEFORMS

IR light-beam systems are



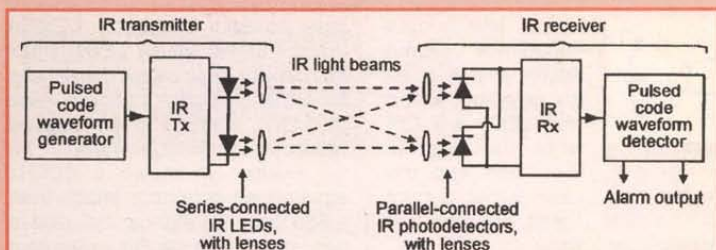


Figure 3. IR dual light-beam alarm system.

usually used in conditions in which high levels of ambient or background IR radiation (generated by natural or artificial heat sources) already exist. To enable the systems to differentiate against this background radiation, and give good effective detection ranges, the transmitter beams are invariably pulse-coded, and the receivers are fitted with matching pulse-code detection.

In practice, the transmitter beams usually use either a continuous-tone or a tone-burst type of pulse-coding, as shown in Figure 4.

IR LEDs and photodetectors are very fast-acting devices, and the effective range of an IR beam system is thus determined by the peak currents fed into the transmitting LED (or LEDs), rather than by the mean LED current.

Thus, if the waveforms of Figure 4 are used in IR transmitters giving peak LED currents of 100mA, both systems will give the same effective operating range, but the Figure 4(a) continuous-tone transmitter will consume a mean LED current of 50mA, while the tone-burst system of Figure 4(b) will consume a mean current of only 1mA (but will require a more complex circuit design).

The operating parameters of the tone-burst system require careful consideration, since this type of IR intrusion detecting system actually works on a 'sampling' principle and is usually intended to detect the presence of a human intruder.

Note that humans moving at normal walking speed take about 200mS to pass any given point, so IR light-beam systems do not need to be switched on continuously to detect a human intruder, but only need to be turned on for brief 'sampling' periods at repetition periods that are far shorter than 200mS (at, say, 50mS).

The actual sample period can be very short relative to the repetition period, but must be long relative to the tone frequency period. Thus, a good compromise is to use a 20KHz tone with a burst or 'sample' period of 1mS and a repetition period of 50mS, as shown in the waveform example of Figure 4(b).

## IR SYSTEM DESIGN

The first step in designing any electronic system is that of devising the system's block diagrams.

Figure 5 shows a suitable block diagram of a continuous-tone IR light-beam intrusion alarm/detector system, and Figure 6 shows the block diagram of a tone-burst version of the system. Note that a number of blocks (such as the IR output stage, the tone pre-amp, and the output driver) are common to both systems.

The continuous-tone system (Figure 5) is very simple, with the transmitter comprising nothing more than a squarewave generator driving an IR output stage, and the receiver comprising a matching tone pre-amplifier and code waveform detector, followed by an output driver stage that can activate a device such as a relay or alarm, etc.

The tone-burst system (Figure 6) is rather more complex, with the transmitter comprising a free-running pulse generator (generating 1mS pulses at 50mS intervals) that drives a 20KHz squarewave generator which, in turn, drives the IR output stage that generates the final tone-burst IR light beam.

In the receiver, the beam signals are picked up and passed through a matching pre-amplifier and then passed on to a code waveform detector/expander block, which ensures that the alarm does

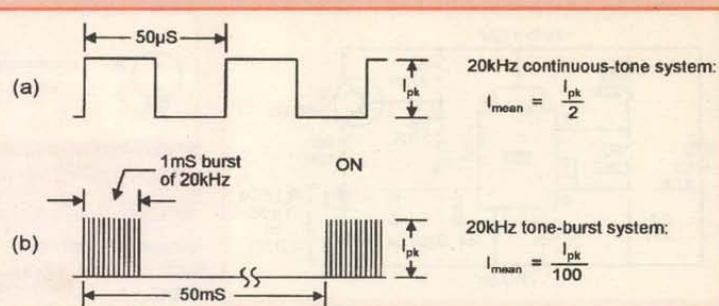


Figure 4. Alternative types of IR light-beam pulse-code waveforms, with typical parameter values.

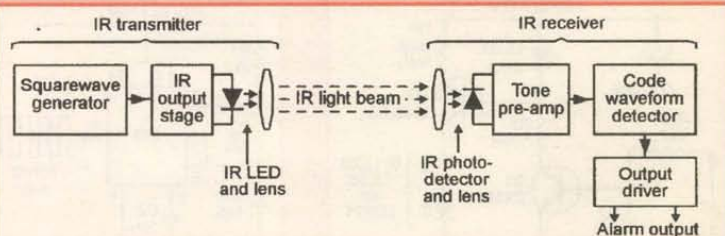


Figure 5. Block diagram of a continuous-tone IR light-beam intruder alarm/detector system.

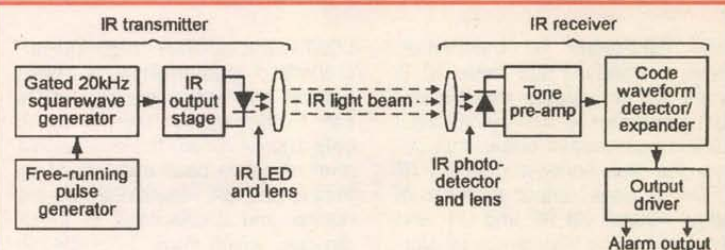


Figure 6. Block diagram of a tone-burst IR light-beam intruder alarm/detector system.

not activate during the 'blank' parts of the IR waveform. The output of the expander stage is fed to the output driver.

## IR LIGHT-BEAM TRANSMITTER CIRCUITS

Figure 7 shows the practical circuit of a simple continuous-tone

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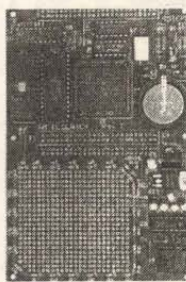
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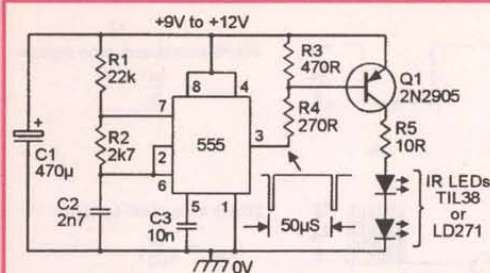


Figure 7. Simple continuous-tone IR light-beam transmitter.

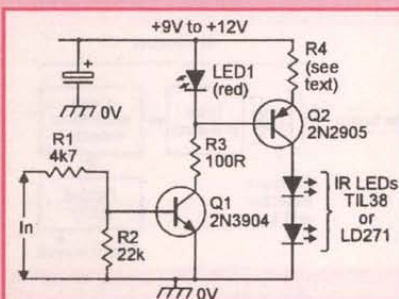


Figure 9. 'Universal' IR transmitter output stage.

dual light-beam IR transmitter. Here, a standard 555 'timer' IC is wired as an astable multivibrator that generates a non-symmetrical 20KHz squarewave output that drives the two series-connected IR LEDs at peak output currents of about 400mA via R5 and Q1, and the low source impedance of storage capacitor C1.

The circuit's timing action is such that the ON period of the LEDs is controlled by C2 and R2, and the OFF period by C2 and (R1+R2), i.e., so that the LEDs are ON for only about one-eighth of each cycle; the circuit thus con-

sumes a mean current of only about 50mA. The Figure 7 circuit can use either TIL38 or LD271 (or similar) 'high power' (100mW or greater) IR LEDs. These popular and widely-available LEDs can handle mean currents up to only 100mA or so, but can handle brief repetitive peak currents of up to at least 2.5A. Figure 8 shows the outline and connections of these devices, which have a molded-in lens that focuses the output into a radiating beam of about 60° width; at the edges of the beam, the IR signal strength is half of that at the beam's center.

Minor weaknesses of the IR output stage (Q1 and R3 to R5) of the Figure 7 circuit are that it has a

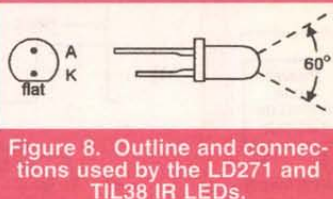


Figure 8. Outline and connections used by the LD271 and TIL38 IR LEDs.

very low input impedance (about 300R), that it gives an inverting action (the LEDs are ON when the input is low), and that the LED output current varies with the circuit's supply voltage.

Figure 9 shows an alternative universal IR transmitter output stage that suffers from none of these defects. Here, the base drive current of output transistor Q2 is

derived from Q1 collector, and the Q1 circuit has an input impedance of about 5kΩ (determined mainly by the R1 value).

Thus, when the circuit's input is low, Q1 is off, so Q2 and the two IR LEDs are also off, but when the input is high, Q1 is driven to saturation via R3, thus driving LED1 (a standard red LED) and Q2 and the two IR LEDs on.

Under this latter condition, about 1.8V is developed across LED1, and about 0.6V less than this (= 1.2V) is thus developed across R4, causing Q2 to act as a constant-current generator that feeds a

peak collector current of 1.2V/R4 amps into the two IR LEDs. Thus, this circuit's peak output current can be set by giving R4 an ohm's value of 1.2V/I, where I is the desired peak output current in amps.

Figure 10 shows a 20KHz squarewave generator (made from a 555 timer IC) that can be used in conjunction with the Figure 9 output circuit to make a continuous-tone IR beam transmitter. In this case, the Figure 9 circuit's R4 value should be at least 6R8, to limit the peak IR LED currents to less than

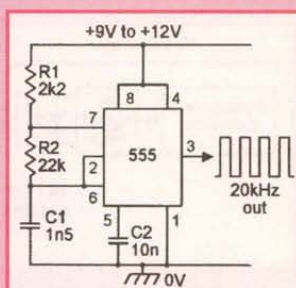


Figure 10. 20KHz square-wave 'tone' generator.

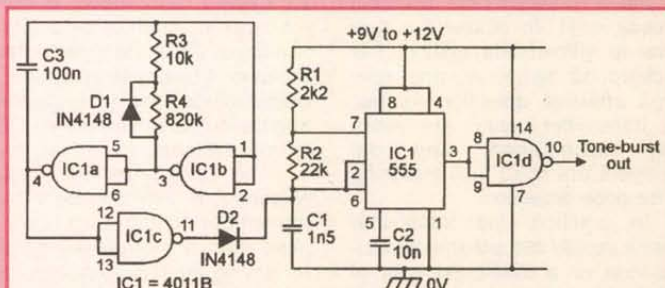


Figure 11. Tone-burst (1mS burst of 20KHz at 50mS intervals) waveform generator.

200mA.

Alternatively, Figure 11 shows the circuit of a tone-burst generator that gives 1mS bursts of 20KHz at 50mS intervals, and which can be used in conjunction with the Figure 9 output stage to make an IR tone-bursts transmitter.

Here, the IC1a and IC1b sections of a 4011B CMOS quad two-input NAND gate IC are wired as a free-running asymmetrical astable multivibrator that produces 1mS and 49mS periods; this waveform is inverted and buffered by IC1c and used to gate a 20KHz 555-type squarewave generator via D2, and this squarewave is then buffered and inverted by the final 4011B stage (IC1d), ready for feeding to the input of the Figure 9 output stage.

Note when using the Figure 11 circuit that R4 in the Figure 9 output stage can be given a value as low as 2R2, to give peak output currents of up to 550mA, but that, under this condition, the transmitter will consume a mean current of little more than 6mA.

## IR RECEIVER PRE-AMP DESIGN

The basic IR input signal to an IR light-beam receiver can be picked up and converted into a proportional current by either an IR photodiode or an IR phototransistor. If a photodiode is used, it can be connected in series with a load resistor (with a typical value in the range 10K to 100K), and can be used in either of the reverse-biased configurations shown in Figure 12.

The diode's basic action is such that its reverse-biased leakage current is proportional to the IR light intensity on its junction, being

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very low under dark conditions and relatively high when brightly illuminated; this current is converted into a proportional output voltage by R1.

An IR phototransistor can be used by connecting it in either of the basic ways shown in Figure 13(a) or (b), in which load resistor R1 has a typical value in the range 1K0 to 33K. Most phototransistors have only two externally-accessible leads (collector and emitter), but a few are three-lead types with an accessible base lead; a three-lead

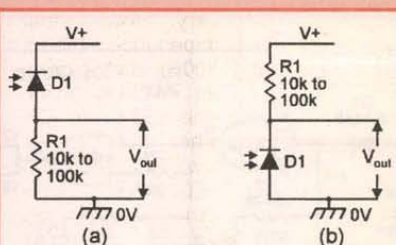


Figure 12. Alternative ways of using a photodiode as a light-to-voltage converter.

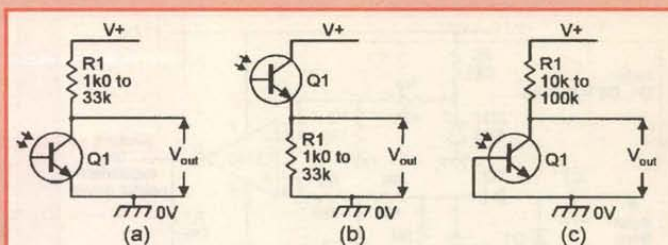


Figure 13. (a) and (b); alternative phototransistor configurations. (c); a three-lead phototransistor use as a photodiode.

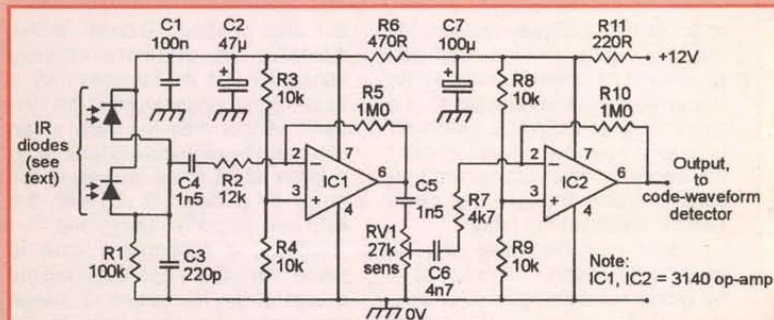


Figure 14. IR receiver pre-amplifier circuit.

device can be used as a photo-transistor by connecting it in either of the basic ways already shown, or it can be used as a photodiode by wiring it in the way shown in Figure 13(c).

Note that a phototransistor's sensitivity is typically 100 times greater than that of a photodiode, but its maximum operating frequency (typically a few hundred KHz) is proportionally lower than that of a photodiode (typically 10s of MHz). Also note in Figures 12 and 13 that the photosensor exhibits a high sensitivity but a low cut-off frequency if R1 has a high value, and a low sensitivity but high cut-off frequency if R1 has a low value.

Figure 14 shows the practical circuit of an IR light-beam receiver that is designed for use with 20KHz continuous-tone or tone-burst single-beam or dual-beam systems, and uses IR photodiodes as signal converters. Here, the two IR diodes are connected in parallel and wired in series with R1, so that the converted IR signal is developed across R1 (note that one of these diodes can be removed if the unit is used with a single-beam IR system).

The converted R1 signal is amplified by cascaded op-amps IC1 and IC2, which can provide a maximum signal gain of about x17,680 (= x83 via IC1 and x213 via IC2), but have the gain made variable via RV1.

These two amplifier stages have their frequency responses centered on 20KHz, with third-order low-frequency roll-off provided via C4-C5-C6, and with third-order high-frequency roll-off provided by C3 and the internal capacitors of the two op-amps.

The Figure 14 receiver pre-amp

circuit can be used with a variety of IR detector diode types, which ideally should be housed in black (rather than clear) infrared transmissive moldings, which greatly reduce unwanted pick-up from visible light sources. Figure 15 shows the case outline and IR-sensitive face positions of three popular IR photodiodes of this type.

The output of the Figure 14 pre-amplifier can be taken from IC2 and fed directly to a suitable code-waveform detector circuit, such as that shown in Figure 16. Note, however, that if the IR Tx-Rx light-beam system is to be used over ranges less

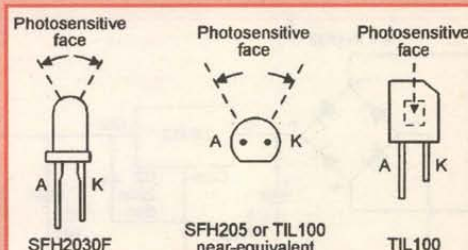


Figure 15. Case outline and IR-sensitive face positions of three popular types of IR photodiode.

than two meters or so, the pre-amp output can be taken directly from IC1, and all the RV1 and IC2 circuitry can be omitted from the pre-amp design.

## A CODE WAVEFORM DETECTOR

In the Figure 16 code waveform detector circuit, the 20KHz tone waveforms (from the pre-amp output) are converted into DC via D1-D2-C2-R5-C3 and fed (via R6) to the non-inverting input of the 3140 op-amp voltage comparator, which has its inverting input connected to a thermally-stable 1V0 DC reference point.

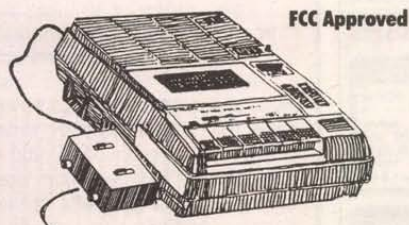
the output follows the pulse-modulation envelope of the original transmitter signal.

The detector output can be made to activate a relay in the absence of a beam signal by using the expander/output driver circuit of Figure 17.

## AN EXPANDER/OUTPUT DRIVER

The operating theory of the Figure 17 circuit is fairly simple. When the input signal from the detector circuit switches high, C1 charges rapidly via D1, but when the input switches low, C1 discharges slowly via R1 and RV1; C1

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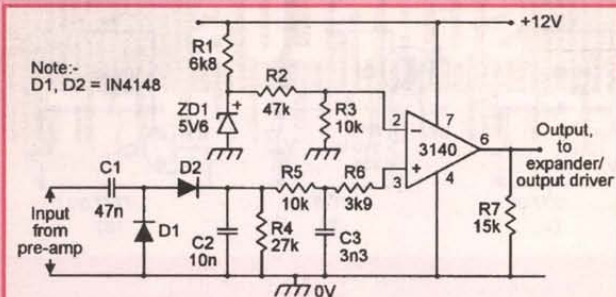


Figure 16. Code-waveform detector circuit.

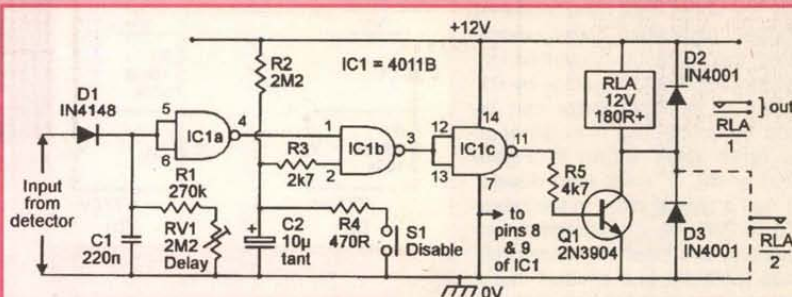


Figure 17. Expander/output driver circuit.

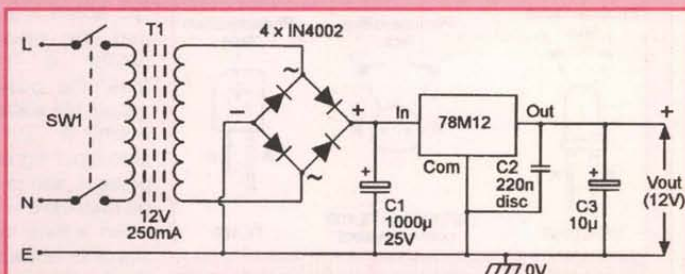


Figure 18. Line-powered regulated 12V, 250mA supply.

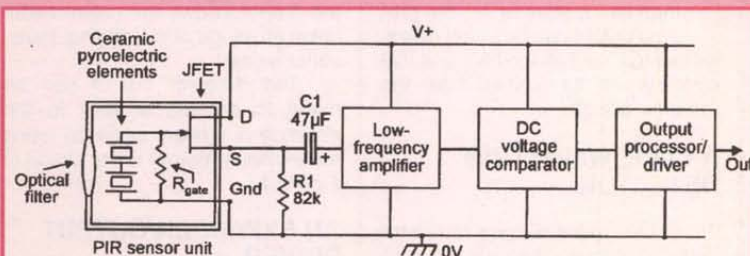


Figure 19. Basic PIR detector usage circuit.

thus provides a DC output voltage that is a 'time-expanded' version (with expansion presettable via RV1) of the DC input voltage.

This DC output voltage is buffered and inverted via IC1a, and used to activate relay RLA via Q1 and an AND gate made from IC1b and IC1c.

Normally, the other (pin 2) input of this AND gate is biased high via

R2, and the circuit action is such that (when used in a complete IR light-beam system) the relay is off when the beam is present, but is driven on when the beam is absent for more than 100ms or so. This action does not occur, however, when pin 2 of the AND gate is pulled low; under this condition the relay is effectively disabled.

The R2-C2 network's purpose

is to disable the relay network via the AND gate (in the way just described) for several seconds after power is initially connected to the circuit or after DISABLE switch S1 is briefly operated, thus enabling the owner or other authorized persons to pass through the beam without activating the relay.

Note that the relay can be made self-latching — if required — by wiring normally-open relay contacts RLA/2 between Q1 emitter and collector, as shown dotted in Figure 17.

## IR LIGHT-BEAM SYSTEM RANGES

The circuits of Figures 14, 16, and 17 can be directly interconnected to make a complete IR light-beam receiver that can respond to either tone-burst or continuous-tone signals; the receiver must be powered from a well-regulated 12V DC supply unit, such as that shown in Figure 18.

The practical maximum operating range of a complete IR light-beam security system of this type is greatly affected by the types of lenses used in the system. If additional lenses are *not* used, but the Tx and Rx are carefully aimed at each other, and the Rx diodes are screened from the effects of visible light by mounting them deep inside aimed tubing, the maximum range should be at least five meters, and may be as high as seven meters.

This range can be vastly increased with the help of additional focusing lenses and/or reflectors.

At the Tx end of the system, most of the optical output power of each IR LED is typically radiated over an arc of about 60°, and thus has a fairly low radiation density value. The Tx signal's radiation density value can easily be increased by a factor of four (thus doubling the system's effective range) by mounting each IR LED at the focal point of a simple torch-type optical reflector that is aimed at the receiver unit.

At the Rx end of the light-beam system, each IR photodiode has an integral lens that focuses the received IR light on to the diode's photosensitive area.

On 5mm detectors such as the SFH2030F, this lens has a collec-

tion area of about 19.6mm<sup>2</sup>; in this example, the detector's effective sensitivity can be increased by a factor of four (thus doubling the system's range) with the help of an external 10mm<sup>2</sup> focusing lens, or by a factor of 36 (thus increasing the range by a factor of six) with the help of a 30mm<sup>2</sup> focusing lens.

Thus, if reasonable care is taken in the opto-mechanical design of the IR system, its range can easily be increased to 20 meters, and possibly to 60 meters or more.

## PIR MOVEMENT-DETECTING SYSTEMS

IR light-beam alarms are 'active' IR units that react to an artificially-generated source of IR radiation. Passive IR (PIR) alarms, on the other hand, react to naturally-generated IR radiation such as the heat-generated IR energy radiated by the human body, and are widely used in modern security systems.

Most PIR security systems are designed to activate an alarm or floodlight, or open a door or activate some other mechanism, when a human or other large warm-blooded animal moves about within the sensing range of a PIR detector unit, and use a pyroelectric IR detector of the type shown in Figure 19 as their basic IR-sensing element.

The basic Figure 19 pyroelectric IR detector relies on the fact that some special ceramics generate electrical charges when subjected to thermal variations or uneven heating.

Modern pyroelectric IR detectors such as the popular PIS201S and E600STO types incorporate two small opposite-polarity series-connected ceramic elements of this type, with their combined output buffered via a JFET source-follower, and have the IR input signals focused onto the ceramic elements by a simple filtering lens, as shown in the basic PIR detector usage circuit of Figure 19.

It is important to note at this point that the detector's final output voltage is proportional to the *difference* between the output voltages of the two ceramic elements.

The basic action of the Figure 19 PIR detector is such that, when a human body is within the visual

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field of the pyroelectric elements, part of that body's radiated IR energy falls on the surfaces of the elements and is converted into small, but detectable, variation in surface temperature and corresponding variation in the output voltage of each element.

If the human body (or other source of IR radiation) is stationary in front of the detector's lens under this condition, the two elements generate identical output voltages and the unit's final 'difference' output is thus zero. But, if the body is moving while in front of the lens, the two elements generate different output voltages and the unit produces a varying output voltage.

Thus, when the PIR unit is wired as shown in the Figure 19 basic usage circuit, this movement-inspired voltage variation is made externally available via the buffering JFET and DC-blocking capacitor C1 and can, when suitably amplified and filtered, be used to activate an alarm or other mechanism when a human body movement is detected.

In practice, pyroelectric IR detectors of the simple type just described have — because of the small size (usually about 20mm<sup>2</sup>) and simple design of the detector's IR-gathering lens — maximum useful detection ranges of roughly one meter.

In modern commercial PIR movement detecting security units, however, this range is greatly extended (usually to well over 10 meters) with the aid of a large (about 2000mm<sup>2</sup>) multi-faceted external IR-gathering/focusing plastic lens, which splits the visual field into a number of parallel strips and focuses them onto the two sensing areas of the PIR unit.

Figure 20 shows the typical PIR sensing pattern of a commercial 'intrusion detector' unit designed to protect a normal-sized room in domestic-type applications. In this example, the unit is mounted on a wall at a height of seven feet and is aimed downwards at a shallow angle, and the multi-faceted plastic lens splits the visual field into a large number of vertical and horizontal segments.

Any person moving through a single segment will activate a single trigger signal within the PIR sensor; a person moving through the entire visual field will thus produce numerous triggering signals,

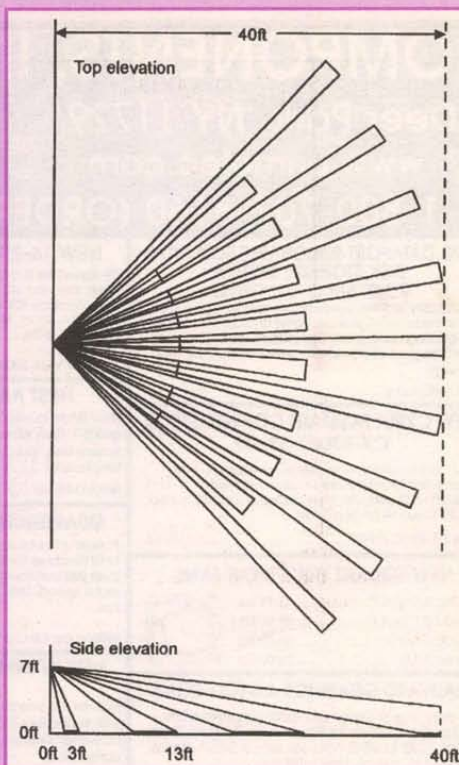


Figure 20. Typical PIR sensing pattern of a commercial 'intrusion detector' unit designed for normal domestic-type applications.

but a stationary IR source will produce no signals.

Most intrusion detectors of this type incorporate 'event counting' circuitry that will only generate an alarm-activating output if three or more trigger signal are detected within a few seconds, thus minimizing the chances of a false alarm due to sudden changes in temperature caused by the auto-activation of time-switched security lights, etc.

The lens-generated PIR sensor pattern shown in Figure 20 is the type that is often used in burglar-alarm systems to protect a single room in a medium-sized house. Alternative (and usually interchangeable) plastic lens types, offering different ranges and coverage patterns for various special types of application, are available at low cost from many commercial PIR-unit suppliers.

Among the most important of these are the 'pet' type, in which the field's vertical span is restricted to 2.5 to 6.6 feet above ground level to avoid activation by domestic pets while giving good sensitivity to normal humans, and the 'corridor' type, in which the field's horizontal span is restricted to about 20° to give long-distance coverage (typically about 30 meters) of narrow corridors and passageways.

Note that, because high-quality commercial PIR security units of this basic type are widely available at comparatively low cost, it is not practicable (on aesthetic and economic grounds) to try to build similar units on a DIY basis. NV

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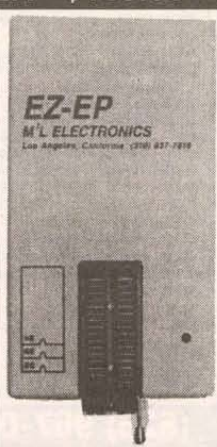
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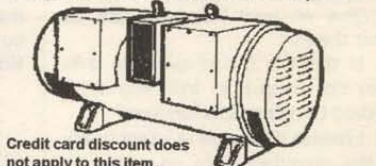


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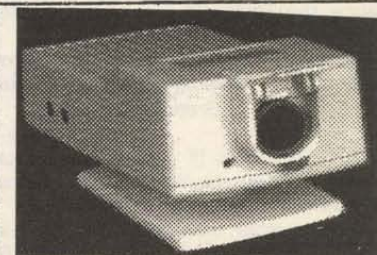
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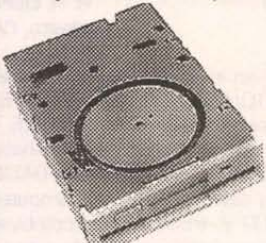
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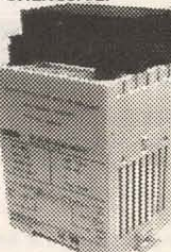
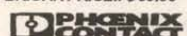


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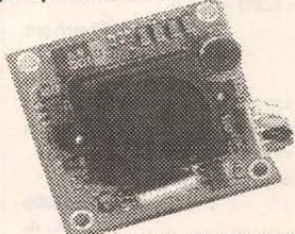
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# TECH FORUM

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

All the commercial "PIR" motion detectors that I can find will turn on and stay on if the supply voltage is quickly turned off and on. The problem with this is that when I get a momentary power failure, the controlled lights or the other device remains on until I am present to reset the PIR.

Is there a model available that does not behave in this way or a method to defeat this function?

I realize this is done intentionally by the manufacturers as a way to activate the lights via the supply switch. An external turn-off timer is undesirable.

**6981 Coleman Bovender  
Greensboro, NC**

What problems (if any) will be encountered in substituting a Si transistor for a GE transistor of similar type/specs. other than base/emitter voltage drop?

Can this be done without major modifications?

**6982 John Pinto  
Morgan Hill, CA**

I am interested in building a Theremin. It's a musical instrument. Does anyone have ideas?

**6983 Michael  
via Internet**

I have a Magellan 2000 GPS unit. It's had a rough life. All the functions work on it except for the display.

Some of the pixels are not functioning and I was wondering if there is a way to take the system apart in order to do repairs on it myself? (I'm too cheap to pay to get it fixed.)

I have looked everywhere to find some kind of tech manual on it or some clue as to how to take it apart, but all to no avail.

Can anyone help me?

**6984 Darren Moorhouse  
via Internet**

I am interested in building a couple of high-power (6 KW) switching power supplies.

The output is variable in the 25- to 40-volt range and the input is from the 230-volt line.

I expect to rectify and filter the AC to provide a  $\pm$  DC supply and drive a toroidal transformer with power

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MOSFETs or IGBTs.

The secondary needs to be isolated from the primary.

I need information on selecting the proper core and the primary winding to keep the losses reasonable. The switching frequency is estimated to be 200 KHz and controlled by Pulse Width Modulation.

**6985 Mike Beaver  
Los Altos, CA**

I want a feedback circuit to "tickle" ordinary quartz crystals at their resonant frequency.

The crystals will range in size from 1/2 of a little finger to 2x the size of a thumb.

I don't even know where or how to hook wires to the crystals. If necessary, I could hang them in water to "connect" them to the power source.

Is there a frequency doubler or quadrupler circuit?

**6986 Dan Martin  
North Egremont, MA**

I am a die-hard user of a Commodore 64 computer and have several spare back-ups.

It is all I need for what I do, and I'm still trying to learn all its capabilities.

What I would like to know is how to add a hard drive.

**6987 Anthony Eberhart  
Chicago, IL**

My computer screen-saver kicks the screen on and powers it down instead of a sleep mode.

What is the problem?

**6988 E. J. Wells  
Joliet, IL**

I am searching for hard/software compatible to the Yamaha CX5M music computer, specifically related to its musical functions.

**6989 M. Reese  
Chicago, IL**

I need an analog-digital converter (not a kit or project) that isn't very expensive for radio astronomy applications. Any suggestions?

**69810 Wayne L. Truax  
Presidio of San Francisco, CA**

I have come into possession of an impressive looking piece of test

equipment called a Model 505 Waveform Analyzer.

This unit is a model 505-488 manufactured by AUTEK Systems Corp., Santa Clara, CA.

It was surplus from National Semiconductor Co. I do not have the probes nor the manual. I have tried to obtain information on this unit and have not been able to find out anything. The company AUTEK apparently no longer exists.

Does anyone know what it is? Is it something that could be useful to an electronics hobbyist like me? Does anyone know what happened to AUTEK Systems Corp.? Where can I obtain a manual?

**69811 R. R. Dunn  
Modesto, CA**

When in GW-BASIC, Alt-A prints out AUTO, Alt-B prints BSAVE, and so on. Looking inside GWBASIC.EXE, I cannot find an occurrence of those strings; yet when I use GW-BASIC with my new Windows 95 computer with DOS 7, those Alt key combinations all work the same as they do on my DOS 3.30 computer.

This is unlike the Alt-nnn keypad trick, because it works only when in BASIC. (What is the source of the Alt-nnn keypad trick in terms of software? It works in DOS, DEBUG, EDLIN, GW-BASIC, QBASIC, etc.)

The real question is: what is the source of those strings: AUTO, BSAVE, and so on? If it's not inside GW-BASIC, or inside COMMAND.COM, is it inside the BIOS? Why does it all still work with DOS 7, even though the source is not inside GW-BASIC?

**69812 Homer B. Tilton  
Tucson, AZ**

I am looking for a circuit for a 0-30V @ 20A power supply, using 2N3055 output transistors (six) and using a 62.5V @ 20.5A power transformer (not center tapped).

**69813 M. Jobe  
Marion, IL**

I need a circuit diagram and/or component descriptions suitable in a wide band (100 KHz to 75 MHz  $\pm$  3 dB) amplifier with a gain of +20 dB.

The input impedance is 10 megohms and the output impedance is

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- 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.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

## QUESTION INFO

### TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

- 1) Circuit Design
- 2) Electronic Theory
- 3) Problem Solving
- 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.

50 ohms.

I've tried several J-FET and Com-linear amplifiers. I am getting 500+ microvolts of white noise at the 50-ohm output when my input is terminated only with 10 megohms and the input cable and device are disconnected to remove the noise generated from the device I want to amplify.

I am looking for methods which will result in less than 100 microvolts of white noise as seen at the output of the +20 dB amplifier.

The noise is primarily in the first stage and is then amplified resulting



# TECH FORUM

in the 500+ microvolts of noise which I want to reduce.

I've read Comlinear's noise analysis application notes. Does anyone have any tips on wide band width, high- input impedance, low-noise methods and/or devices? I am using low-noise metal film resistors.

69814 David R. Howland  
Santa Cruz, CA

## ANSWERS

### ANSWER TO #4987 - APR. 1998

The 80287 math coprocessor chip needs no programming — just plug it in and it should be recognized.

You can run MSD.EXE (Microsoft's diagnostic program) to verify that it is recognized.

If it is not automatically recognized, you may have to configure a math coprocessor enable jumper on the motherboard and/or as a BIOS setting.

John McMichael  
Laramie, WY

### ANSWERS TO #49814 - APR. 1998

Op-amps aren't very good at driving high-power loads like LEDs,

relays, and such. What you want to use is a bipolar transistor like a 2N2222 to drive the LED.

Depending upon the forward current rating of the LED and the supply voltage available, you will need to put a resistor in series with the LED and the transistor.

To calculate this resistor, take the supply voltage, subtract the LED forward voltage, and subtract 0.3. Divide this result by the maximum forward current (in mA) times 0.9 to get the series resistor value in Kilohms. Multiply this resistor value by the square of the LED current to find the power rating necessary (round up to the nearest 1/4, 1/2, etc).

You will also need a resistor between the base of the transistor and the circuit driving the transistor. Calculate its value by the following: subtract .7 from the maximum voltage put out by the driving circuit (probably close to the power supply voltage) and divide by the LED current used in the previous calculation (in mA). Then multiply this result by 100 to get the resistor value in Kilohms.

The circuit is then wired like this: the series resistor (first one calculat-

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Eaton 380K11, Synthesizer, 1-2000MHz Opt. 01, 03, 183	\$2,500	Marconi 2022A, Signal Generator, 10KHz-1GHz	\$1,800
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Fluke 515A, Portable Calibrator	\$800	Racal Dana 1515, Delay Pulse Generator	\$500
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General Radio 1433G, Decade Resistor	\$350	Secore TF30, Super Cricket Transistor Tester	\$200
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# TECH FORUM

## ANSWER TO #49817 - APR. 1998

There are a large number of people programming and hacking the TI-85, because of its cheap cost, ease-of-use, and ease-of-availability.

Researching on the Internet can lead to hundreds, if not thousands, of web pages dedicated to third-party hardware and software for the TI-85 calculator.

Visiting <http://www.ticalc.org> (your Internet headquarters for Texas Instruments graphing calculators) would be a good starting point. This web page consists of product information, third-party software, reviews, message forums, and many, many links to other TI-85 related web sites.

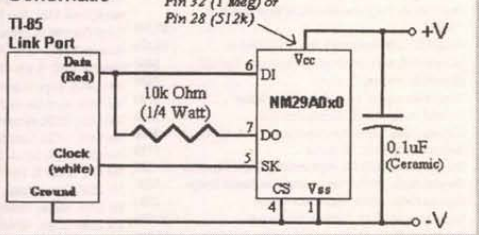
There are also a number of E-Mail mailing lists available on the Internet. As far as adding more memory to your TI-85, a modification has been done that increases the amount of RAM to either 512K or 1024K. The device is known as "The Expander SF" and connects to the 2.5 mm female stereo "link connector" on the bottom of the TI-85.

Detailed construction information, schematics, software, etc., can be found at: <http://www.egr.msu.edu/~tsaimelv/expander.htm>

The schematics for the device, designed by Melvin Tsai (tsaimelv@pilot.msu.edu), can be seen below:

Joe Grand

### Expander SF Schematic



ed) is wired between the power supply positive and the anode of the LED (usually the long lead). The cathode of the LED connects to the collector of the transistor (identify the leads with the flat side of the part facing you and the leads down — from left to right — emitter, base, collector). Connect the second resistor to the base of the

transistor and the other end to the driving circuit. Connect the emitter of the transistor to the return lead of the power supply.

Some additional notes: you should optically shield your IR receiver and the transmitter LED to avoid oscillations in your circuit.

Also, you should be aware that

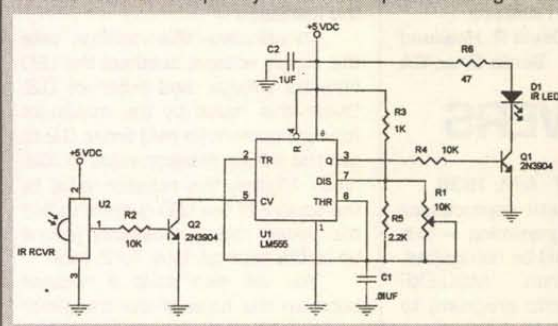
## ANSWERS TO #49814 - APR. 1998

I made the same mistake you did in my first attempt in building an IR repeater.

As it turns out, the binary data from the IR transmitter modulates a 40-KHz carrier frequency which is

removed by the IR receiver. You end up with only the binary command data. You have to re-modulate the binary command data if you want to re-transmit it.

Fortunately, this is easily accomplished using a 555



timer IC configured to oscillate at 40 KHz. With an o'scope or frequency counter on pin 3 of U1, adjust R10 for 40 KHz. See the schematic for construction details.

Kevin Goodwin  
Oceanside, CA

the input and output of your repeater must be in phase in order for this method to work. If it still doesn't, repeat, and check to be sure that the LED is off (no voltage drop across the LED resistor) when there is no IR source on the receiver. If it is on when it should be off, then you need to invert the driving signal to the transistor. You can do this by inserting a second transistor and base resistor between the driving circuit and the transistor driving the LED.

Put a 4.7K resistor between the power supply and the collector of the

first transistor and connect the base resistor of the LED transistor to the collector of the first transistor.

Vinny Worley  
Fenelon, PA

## ANSWER TO #4985 - APR. 1998

The terms "pull-up" and "pull-down" refer to external load resistors that will "pull up" the output of a logic gate or other amplifier output to some desired voltage (i.e., +5 VDC), or "pull down" the signal to somewhere near ground" (i.e., 0 VDC).

Pull-ups are typically found in dig-

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# TECH FORUM

## ANSWERS TO #49814 - APR. 1998

There are a couple of ways to handle this situation depending on the characteristics of the IR signal that you want to repeat.

Most IR signals are modulated with a 40 to 50KHz squarewave signal. The high-frequency squarewave signal is turned off and on to convey the binary data. The most common way to repeat these signals is to demodulate the signal to base band then use the resulting binary code to key another IR transmitter, usually consisting of something like a 555

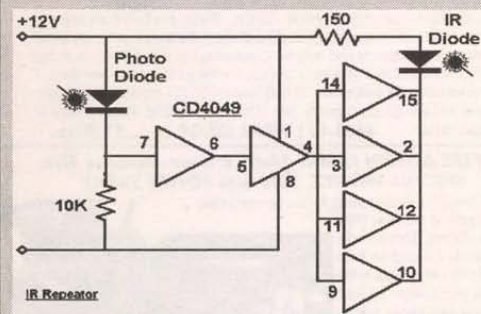
oscillator driving an IR diode. The 555 must be set to the same frequency as the incoming signal.

However, a much simpler way is to simply amplify the incoming signal, complete with the 40 to 50KHz modulation and use it to directly drive another IR diode. This allows any IR signal to be repeated regardless of the modulating frequency. This can be done by using a CMOS CD4049 hex inverter.

Feel free to play with the 10K resistor to adjust the sensitivity. The 150-ohm resistor can be adjusted to set the current into the transmitting IR diode.

Note that four gates are connected in parallel to drive the transmitting IR diode. This will allow long runs of two-conductor cables between the CD4049 and the IR diode as indicated in your original drawing.

John K3PGP  
via internet



ital circuits where you want the input of a logic gate to always be at a logic high:

+Vcc (typically +5 VDC)  
R (typically 1K to 4.7K)  
— gate input

They are also seen on the outputs of gates for "noise immunity," especially where you need to guarantee the output is at a "logic high" until it switches to a logic low. In these cases, the resistor will be around 4.7K to 10K to ensure the driving gate can drop the voltage level to a good "logic low" (<0.8 VDC) when necessary.

"Pull-down" resistors are similarly used to ensure an input is "held to ground:"

— gate input  
R (typically 220 ohms)  
GND

There is a special situation where both resistors are used in a receiver configuration to terminate a long signal run from a driver chip:

+Vcc (typically +5 VDC)  
R (typically 330 ohms)  
from driver — gate input  
R (typically 220 ohms)  
GND

This configuration reduces noise on the driver line and ensures distinct logic level changes from the driver.

In terms of calculating pull-up and pull-down values, simply apply Ohm's Law for a voltage divider. Note: make sure your driver can source the necessary current for a pull-down or sink the amount of current with a pull-up.

The typical pull-up values in TTL

digital circuits are 1K to 10K, depending on how "hard" you want the pull-up to be.

For pull-downs, 150 to 330 ohms is what is typically seen. Remember, a pull-down has to do more work than a pull-up because you have a direct path to signal ground with a pull-down, so make sure your driver circuit can handle the current draw across the pull-down resistor.

Ken Simmons  
Auburn, WA

## ANSWER TO #5982 - MAY 1998

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Continued on page 62

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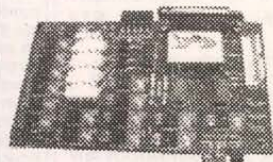
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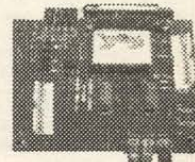
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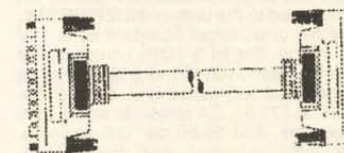
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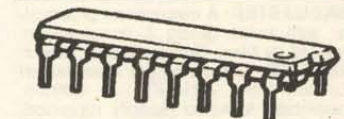
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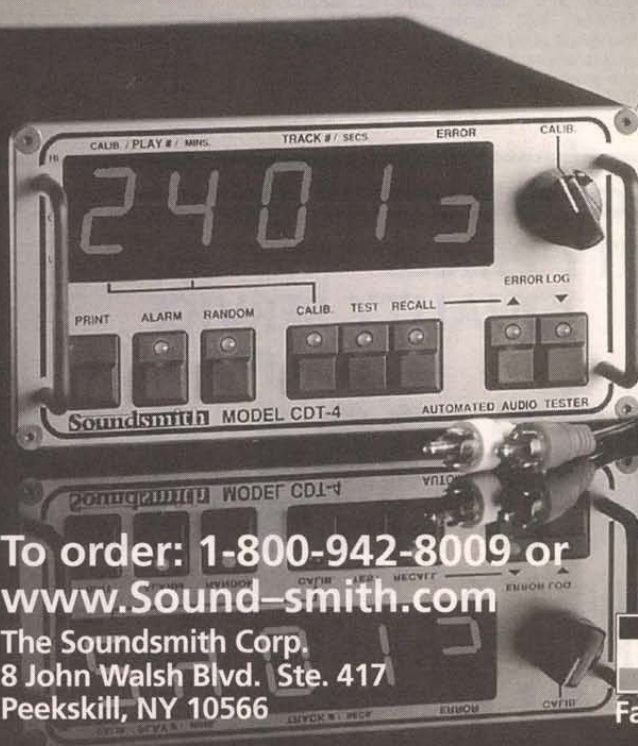
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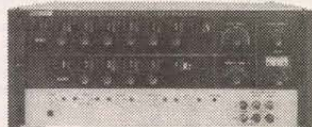
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## Fluke 5215A

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## Fluke 5440A

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## Fluke 8012A

Digital Multimeter, 3.5 digits, seven functions, 0.1% basic accuracy, true-rms ac, from 45 Hz to 50 kHz, 10A range, 2 $\Omega$  and 20 $\Omega$  range.

**\$175.00**

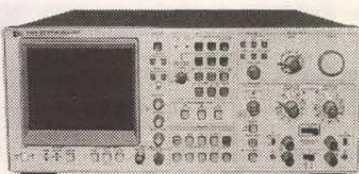
## Hewlett-Packard 8657A Opt 002

Signal Generator, 100 kHz to 1040 MHz, 10 Hz resolution, output power +13 to -143.5 dBm into 50 $\Omega$ . Opt 002, RF connectors on rear panel.

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## Hewlett-Packard 3582A

Spectrum Analyzer, .02 to 25.5 kHz, 0.02 Hz resolution, 70 dB dynamic range, transfer function, coherent function, phase spectrum, and frequency domain analysis, internal noise source, HP-IB.



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## EIP Microwave 548A Opt W-36

Microwave Frequency Counter, 10 Hz to 26.5 GHz, 12 digit LED display, sensitivity 25 mV rms (10 Hz to 100 MHz) -15dBm (22 to 26 GHz). Opt W-36 includes the following options and modifications: Opt. 05, oven stabilized time-base, opt. 06, extended frequency capability, opt. 08 GPIB, W-11, 50/60 to 400 Hz operation, EMI/RFI shielding.

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## Hewlett-Packard 8901B

Modulation Analyzer, 150 kHz to 1300 MHz, measures AM and FM to 1% accuracy, measures RF frequency, measures power, low internal noise, completely automatic. Options available.

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## Hewlett-Packard 8903B

Audio Analyzer, 20 Hz to 100 kHz, combines the functionality of a low distortion audio source, frequency counter, high performance distortion analyzer, SINAD meter, and a ac/dc voltmeter.

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## Hewlett-Packard 5350B

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## Hewlett-Packard 8640B

Signal Generator, 0.5 to 512 MHz, -149 to +19 dBm RF output, phase locking and counter.

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## Hewlett-Packard 8350A/83545A

Sweep Oscillator Mainframe with Sweep Oscillator plug-in. Plug-in capabilities; 5.9 to 12.4 GHz frequency range, 50 mW max leveled power, complete HP-IB programmability.

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## Hewlett-Packard 5335A

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Manual, dc to 18.0 GHz, 0 to 11 dB in 1 dB steps.

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Signal Generator, provides a leveled output amplitude that is variable 245 to 1050 MHz in 2 bands. Amplitude range is 0.5 V to at least 4 V p-p.

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## Tektronix 465B

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## Tektronix 466

100 MHz Storage Oscilloscope, dual trace, 5 mV/div, stored writing speed of 3000 div/ps variable persistence. Includes 2 probes.

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350 MHz Oscilloscope, dual trace, 5 mV/div sensitivity, 1 ns/div sweep rate, 3.0 div/ns writing speed, selectable input impedance. Includes 2 probes.

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**HP CALCULATORS** wanted: models 10, 70, calculator watch, others for private collection. Cash paid. Bob Morrow, 765-855-2348, [rbmorrow@aol.com](mailto:rbmorrow@aol.com)

## TEST EQUIPMENT

**STANDARDS, CALIBRATORS:** Fluke C41 shunt kit \$1,999, 332B \$750, 760 \$600, 760 \$350, 721A \$595, 80E-10 \$225, 873A, 883A, 885A, 887/887AB, 895A, 931B, new and used boards & cables for 7505B, 1100A, etc. L & N: 4035-B 1,000 ohm, unused, orig. box, papers, \$450. Rubicon 91396 10 ohm primary \$325. Gray: 30215 0.001 ohm ABS \$450. L & N 8163 platinum thermometer (huge) \$1,495. Honeywell 1407/1507 universal direct reading ratio set \$350. Recard Jahre primary coaxials D62 2MF \$125, D63 3MF \$125. HP 738A voltmeter calibrator (AC/DC) \$475. HP 745A/746A, books, \$750, 3420B \$450. Eaton/Ailtech 7009 hot/cold noise, two coax adapters, \$475. CEC force-balance transducers. MKS pressure M & C systems. Military F-258-1 universal tester, temperature control \$495. G-R 1652A limit bridge, 7-decade \$295. ESI 830-120-876 \$2,600. Eaton 3161-2K loadcell \$325. Cohu 303B-R \$320. Eppley 1963 standard cell \$125. General Mills/BUORD T-3028 electronic analyzer of calibrator (AC/DC) \$440. Atlantic Research PPC-1 pressure pulse calibrator \$220. Kintel M10A-10 meter calib. (tubes) \$150. List of other t & m. [aklinger@flash.net](mailto:aklinger@flash.net) 817-370-2575.

**HP 8405A** vector voltmeter, \$800, HP 3455A, \$500; HP 3456A, \$800; HP 6111A 0-20V precision power supply, \$200; HP 4815A vector Z meter, \$1,500; HP 5328A counter, \$400; HP 5326B counter, \$200; EIP source locking counter, 18GHz, \$1,000; HP 3580A, LED spec. ana., 10Hz-50KHz, \$1,000; Collins URC32/KWT-6 HF transceiver, \$1,500; Tektronix 7633 100MHz storage frame, \$350; HP 1600A logic ana., with probes, \$300; HP 3570A network ana., \$400; HP 8690B sweeper frame, \$300; HP 8698B, sweeper plug-in 4-110MHz, \$400; HP 8601A sweeper, 4-110MHz, \$450; HP 8697A sweep plug-in 26.5-40GHz, \$500; HP 432A, 468A power meter, \$350; HP 432B, 8468A, power meter, 10MHz-18GHz, \$500. A-Comm Electronics 303-290-8012.

**HEWLETT PACKARD:** 3722A noise generator, \$100; 427A multimeter, manual, \$60; 400E AC voltmeter, \$45; H04-400EL AC voltmeter, \$35; 1602A logic analyzer, \$40; 3440A/3442A DVM, \$40. **General Radio:** 1394A high rate pulse generator, \$125; 1551B sound level meter, \$75; 1208B unit oscillator, \$40. **Tektronix:** 3L5 spectrum analyzer plug-in, \$125; 528A waveform monitor, 1420 vectorscope, rack mount, \$575. **Fluke:** 1722A instrument controller, \$225; 8520A 5-1/2 digit multimeter, HP1B, \$200. **Nicolet:** UA-500A spectrum analyzer, manual, \$75. Kent, 515-232-7528.

**HP 334A**, \$500; HP 339A, \$1,500; HP 5340A, \$1,200; HP 3325A, synthesizer, \$1,600; HP 8640B sig. gen. 5-1200MHz, \$2,000; HP 3330B, synthesizer, \$500; HP 6012A power supply 0-60V 0-50A, \$1,200; HP 3586B, \$1,000; Fluke 6160B synthesizer, \$500; Fluke 6160B opt 2, \$800; Fluke 750A reference divider, \$600; Fluke 5200A AC calibrator, \$1,200; Fluke 5215A AC amplifier, \$1,200; HP 141T, 8553B, 8552A, \$1,200; HP 141T, 8553B, 8552B, \$1,800; HP 141T, 8555A, 8552B, \$2,000; A-Comm Electronics 303-290-8012.

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Digital Display 8210/8300 \$199.95, 30V/3A

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8108 \$549.95, 60V/3A.

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with Parallel (30V/6A) and Series (60V/3A) Mode operation.

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CPG-1366A \$159.95, VHF NTSC.

Freq.: 45.75, 175.25, 187.25 MHz.

RF Output: 10mV, Impedance: 75 $\Omega$ ;

Video Output: BNC, 1V<sub>p</sub>;

Power: 9VDC, 9V AC adapter (\$6).

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310 \$89.95, 1.8-150MHz, RF

Power: 0-4W/20W/200W 3 ranges;

SWR Measurement: 1.0- $\infty$ , 4W min.

Accuracy:  $\pm 10\%$ ; Overload: 3dB

In/Output Imp.: 50 $\Omega$ ; 20-239 plug.

320 \$89.95, 130-520MHz. Spec. see 310.

SWR-3P \$26.95, 1.7-150MHz;

RF Power: 0.5-10W, 0.5W-100W.

SWR-2P \$22.95, 1.7-30MHz; RF Power: 0.5-10W.

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Power: 20mW/200mW/2W 3 ranges; Imped.: 50 $\Omega$ ; Accuracy:

$\pm 10\%$  full scale; SWR  $\leq 1.5$ ; N-type connector; BNC type output

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AG-3011A \$549.00

RF SECTION:

Carrier: 98MHz  $\pm 2$ MHz;

Output: 10mV, 1mV & 0.1mV

COMPOSITE SIGNALS:

Pilot: 19KHz  $\pm 2$ Hz, 0.8Vrms

INT. MODULATION: 400KHz;

1KHz  $\pm 1\%$ , 1Vrms, distortion  $< 5\%$ ; L-R Separation:  $> 50$ dB.

EXT. MODULATION: Freq.: 50Hz-15KHz

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1/8" flat screwdriver, self-hold tweezers, metal tweezers, part

twist, soldering iron, solder, crimping tool, long-nose plier, cutting

plier, zipper vinyl case. Bits include: Phillips: #0/00/0/1/2/3/4/5/6/7/8/9/10/11/12/13/14/15/16/17/18/19/20/21/22/23/24/25/26/27/28/29/30/31/32/33/34/35/36/37/38/39/40/41/42/43/44/45/46/47/48/49/50/51/52/53/54/55/56/57/58/59/60/61/62/63/64/65/66/67/68/69/70/71/72/73/74/75/76/77/78/79/80/81/82/83/84/85/86/87/88/89/90/91/92/93/94/95/96/97/98/99/100/101/102/103/104/105/106/107/108/109/110/111/112/113/114/115/116/117/118/119/120/121/122/123/124/125/126/127/128/129/130/131/132/133/134/135/136/137/138/139/140/141/142/143/144/145/146/147/148/149/150/151/152/153/154/155/156/157/158/159/160/161/162/163/164/165/166/167/168/169/170/171/172/173/174/175/176/177/178/179/180/181/182/183/184/185/186/187/188/189/190/191/192/193/194/195/196/197/198/199/200/201/202/203/204/205/206/207/208/209/210/211/212/213/214/215/216/217/218/219/220/221/222/223/224/225/226/227/228/229/230/231/232/233/234/235/236/237/238/239/240/241/242/243/244/245/246/247/248/249/250/251/252/253/254/255/256/257/258/259/260/261/262/263/264/265/266/267/268/269/270/271/272/273/274/275/276/277/278/279/280/281/282/283/284/285/286/287/288/289/290/291/292/293/294/295/296/297/298/299/300/301/302/303/304/305/306/307/308/309/310/311/312/313/314/315/316/317/318/319/320/321/322/323/324/325/326/327/328/329/330/331/332/333/334/335/336/337/338/339/340/341/342/343/344/345/346/347/348/349/350/351/352/353/354/355/356/357/358/359/360/361/362/363/364/365/366/367/368/369/370/371/372/373/374/375/376/377/378/379/380/381/382/383/384/385/386/387/388/389/390/391/392/393/394/395/396/397/398/399/400/401/402/403/404/405/406/407/408/409/410/411/412/413/414/415/416/417/418/419/420/421/422/423/424/425/426/427/428/429/430/431/432/433/434/435/436/437/438/439/440/441/442/443/444/445/446/447/448/449/450/451/452/453/454/455/456/457/458/459/460/461/462/463/464/465/466/467/468/469/470/471/472/473/474/475/476/477/478/479/480/481/482/483/484/485/486/487/488/489/490/491/492/493/494/495/496/497/498/499/500/501/502/503/504/505/506/507/508/509/510/511/512/513/514/515/516/517/518/519/520/521/522/523/524/525/526/527/528/529/530/531/532/533/534/535/536/537/538/539/540/541/542/543/544/545/546/547/548/549/550/551/552/553/554/555/556/557/558/559/560/561/562/563/564/565/566/567/568/569/570/571/572/573/574/575/576/577/578/579/580/581/582/583/584/585/586/587/588/589/590/591/592/593/594/595/596/597/598/599/600/601/602/603/604/605/606/607/608/609/610/611/612/613/614/615/616/617/618/619/620/621/622/623/624/625/626/627/628/629/630/631/632/633/634/635/636/637/638/639/640/641/642/643/644/645/646/647/648/649/650/651/652/653/654/655/656/657/658/659/660/661/662/663/664/665/666/667/668/669/670/671/672/673/674/675/676/677/678/679/680/681/682/683/684/685/686/687/688/689/690/691/692/693/694/695/696/697/698/699/700/701/702/703/704/705/706/707/708/709/710/711/712/713/714/715/716/717/718/719/720/721/722/723/724/725/726/727/728/729/730/731/732/733/734/735/736/737/738/739/740/741/742/743/744/745/746/747/748/749/750/751/752/753/754/755/756/757/758/759/760/761/762/763/764/765/766/767/768/769/770/771/772/773/774/775/776/777/778/779/780/781/782/783/784/785/786/787/788/789/790/791/792/793/794/795/796/797/798/799/800/801/802/803/804/805/806/807/808/809/810/811/812/813/814/815/816/817/818/819/820/821/822/823/824/825/826/827/828/829/830/831/832/833/834/835/836/837/838/839/840/841/842/843/844/845/846/847/848/849/850/851/852/853/854/855/856/857/858/859/860/861/862/863/864/865/866/867/868/869/870/871/872/873/874/875/876/877/878/879/880/881/882/883/884/885/886/887/888/889/890/891/892/893/894/895/896/897/898/899/900/901/902/903/904/905/906/907/908/909/910/911/912/913/914/915/916/917/918/919/920/921/922/923/924/925/926/927/928/929/930/931/932/933/934/935/936/937/938/939/940/941/942/943/944/945/946/947/948/949/950/951/952/953/954/955/956/957/958/959/960/961/962/963/964/965/966/967/968/969/970/971/972/973/974/975/976/977/978/979/980/981/982/983/984/985/986/987/988/989/990/991/992/993/994/995/996/997/998/999/1000/1001/1002/1003/1004/1005/1006/1007/1008/1009/1010/1011/1012/1013/1014/1015/1016/1017/1018/1019/1020/1021/1022/1023/1024/1025/1026/1027/1028/1029/1030/1031/1032/1033/1034/1035/1036/1037/1038/1039/1040/1041/1042/1043/1044/1045/1046/1047/1048/1049/1050/1051/1052/1053/1054/1055/1056/1057/1058/1059/1060/1061/1062/1063/1064/1065/1066/1067/1068/1069/1070/1071/1072/1073/1074/1075/1076/1077/1078/1079/1080/1081/1082/1083/1084/1085/1086/1087/1088/1089/1090/1091/1092/1093/1094/1095/1096/1097/1098/1099/1100/1101/1102/1103/1104/1105/1106/1107/1108/1109/1110/1111/1112/1113/1114/1115/1116/1117/1118/1119/1120/1121/1122/1123/1124/1125/1126/1127/1128/1129/1130/1131/1132/1133/1134/1135/1136/1137/1138/1139/1140/1141/1142/1143/1144/1145/1146/1147/1148/1149/1150/1151/1152/1153/1154/1155/1156/1157/1158/1159/1160/1161/1162/1163/1164/1165/1166/1167/1168/1169/1170/1171/1172/1173/1174/1175/1176/1177/1178/1179/1180/1181/1182/1183/1184/1185/1186/1187/1188/1189/1190/1191/1192/1193/1194/1195/1196/1197/1198/1199/1200/1201/1202/1203/1204/1205/1206/1207/1208/1209/1210/1211/1212/1213/1214/1215/1216/1217/1218/1219/1220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**NEW HEWLETT-PACKARD 141T CRTs. \$195 EACH.** We have quantities available. These are double boxed, unopened with late 80s date code, guaranteed. Fits all 141T spectrum analyzers. Contact Brian at Kentronix. 732-681-3229 or FAX 732-681-3312. Mailing: Kentronix, PO Box 2444, Farmingdale, NJ 07727 or E-Mail [brian@kentronix.com](mailto:brian@kentronix.com)

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Many of our kits are available completely built!

### PIC RELAY CONTROLLER

This is a good companion for any kit that need additional amperage or a micro-controlled relay function.

- Relay functions listed below are preset.
- ON / OFF toggle mode
- ON / RESET mode
- Fixed delay .5 second pulse stretch
- Fixed delay 10 second pulse stretch
- Variable time 1.5 to 14 sec.
- Variable time 11 to 24 sec.
- 3 Amp. total output
- Input and reset signal can be Active HI or LO
- Wall transformer included

Voltage requirements 7.5 to 15VDC Size: 1.75" x 2.7"  
PRC-1 KIT \$24.95  
PRC-C Case \$12.95

### CALLER ID DEFEATER

The kit that brings back the privacy in phone calling. I know you can defeat CALLER ID if you dial \*67, but how often do you remember to do that? This kit dials \*67 automatically. Now nobody can identify you as the caller. Easily modified for Centrex telephone systems. We supply a DC wall transformer. PCB size: 2.75" x 2.25" Case Included

CID-1 BUILT \$69.95 KIT \$49.95



### A Cricket, gets in your house and runs you crazy till you find it

Well this is no different, sneak this little NIGHT CRICKET into someone's bedroom, or cozy little nook, when night falls the fun begins. It's like a bad dream the lights go out and the cricket start chirping, turn the lights on to find the yammit and the chirping stops. It drives you nuts! Operates on a 9V battery. Small enough to hide most anywhere 2" x 3". You may want to get more than one. How many friends do you want to lose?

NC-1 KIT \$14.95

### 10 in 1 ULTIMATE LASER POINTER

The next generation of laser pointers is here! Project 10 different patterns from this unique new design without changing the lenses. This laser is so small it can be concealed in the palm of your hand. Keep people guessing where it is coming from! Dot has over 1,600 ft. range. Comes with Deluxe Key Chain Powered by 3 LR44 batteries (included) Size: 1.78" dia x 5/16" BUILT \$29.95

### LASER CHALLENGE

Great game for the Laser Pointer Set your target across the room or pin it to your chest. You can set it anywhere up to 25 yards. Use the laser pointer to shoot the target and the alarm goes off. Fun for kids and adults, great for laser tag fun. Power requirement: 9V battery PCB size: 1.5" x 1.2"

LAS-1 TARGET INCLUDED KIT \$14.95

### FAN CONTROLLER

Use this kit to control cooling fans. It senses heat and turns on a fan. The fan can be a ceiling fan or a fan in your computer, anything that needs cooled. Output is 100mA. Use the Relay kit RP-1 or the new Micro-controlled Relay PRC-1 kit for 3 amp. operation. Complete with temperature probe. Operating voltage: 7.5 to 18V DC Size: 1.5" x 1.2" FC-1 KIT \$14.95

**SUPER SNOOPER BIG EAR** Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to 12V DC. SIZE: 1.75" x 1" AA-1 BUILT \$29.95 KIT \$10.95

## LASER LIGHT SHOW

Club Effect Lighting  
Portable  
Red Laser

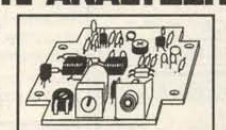


12 preset built-in rotating patterns  
Auto mode: Adjustable Music mode: Controlled by microphone On/Off switch and autotune switch Includes 4 "AAA" batteries  
3mW laser diode  
LASHW-1 BUILT \$69.95

## THE MIGHTY WIZARD

You can throw your old Ouija board away and come into the computer age. Use your inner feelings to control THE MIGHTY WIZARD. Touch your fingers to the pads and the 4 jumbo leds flash randomly till you release your fingers. One of the leds will stay lit. We supply 6 overlays, each a different game. Let your Bio-rhythm control your destiny. Fun to build and play for the whole family. Power requirements 9V battery PCB size: 2" x 3" Game size: 5.5" x 7.75" MW-1 KIT \$18.95

## RF ANALYZER



Want to know the code of your car alarm transmitter, your garage door opener or any other digitally transmitted RF signal? This kit will extract the code from the air through the antenna input, send the signal to the computer and display it on the screen. This is all done through the parallel port. Information can be stored to the hard drive for future reference. The RF Analyzer comes complete with Dos software. You can operate this kit from a 9V battery or from a wall transformer. We supply a wall transformer with your kit. Operating voltage 7.5 to 15V DC PCB size: 2.25" x 2.75" RFA-1 KIT \$99.95  
RFA-C Case \$12.95

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DF-222 KIT \$14.95

Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels (2 thru 22) only.

NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.



This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.  
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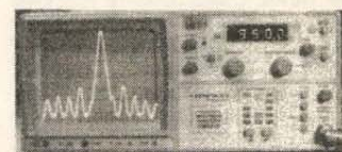
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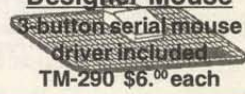
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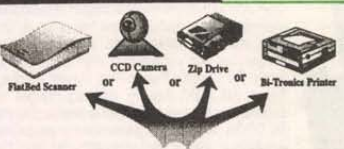
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300 Channels • 10 banks • Trunk Scan and Scan Lists Trunk Lockout • Trunk Delay • Extra battery & charger 10 Priority Channels • Programmed Service Search Size: 2-1/2" Wide x 1-3/4" Deep x 6" High  
Frequency Coverage: 29.000-54.000 MHz, 106-174 MHz, 406-512 MHz, 806-823.995 MHz, 849.0125-868.995 MHz, 894.0125-956.000 MHz.  
The Bearcat TrunkTracker BC235XLT, is the world's first scanner capable of tracking a selected radio transmission as it moves across a trunked radio system. Now it's easy to monitor fleets and subfleets in analog trunked radio systems. The BC235XLT can also work as a conventional scanner. This 300-channel, programmable handheld scanner provides scanner users with uninterrupted monitoring capabilities of Type I, II, and hybrid trunking systems. One of the biggest obstacles in the scanner industry has been the increasing use of trunking radio systems in business and public service agencies throughout the U.S. and Canada. This makes it nearly impossible to track a conversation as it moves within a trunk system from frequency to frequency. According to Ken Ascher, WB8LIT, Chairman & CEO of CEI, "the Bearcat 235XLT is a revolutionary breakthrough in scanner technology. Now it's easy to continuously monitor conversations even though the message is switching frequencies." The BC235XLT comes with AC adapter, CRX120 battery charger, two rechargeable long life ni-cad battery packs, belt clip, flexible rubber antenna, earphone, owner's manual and one year limited Under warranty. Not compatible with AGEIS, ASTRO, EDACS, ESAS and LTR systems. Call 1-800-USA-SCAN to order your scanner.

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The Bearcat 895XLT is superb for intercepting trunked communications transmissions (see BC235XLT description) with features like TurboScan™ to search VHF channels at 100 steps per second. This base and mobile scanner is also ideal for intelligence professionals because it has a Signal Strength Meter, RS232C Port to allow computer control of your scanner via optional hardware and 30 trunking channel indicator annunciators to show you real-time trunking activity for an entire trunking system. Other features include Auto Store - Automatically stores all active frequencies within the specified bank(s). Auto Recording - This feature lets you record channel activity from the scanner onto a tape recorder. CTCSS Tone Board (Continuous Tone Control Squelch System) which allows the squelch to be broken during scanning only when a correct CTCSS tone is received. For maximum scanning enjoyment, order the following optional accessories: PS001 Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter \$14.95; PS002 DC power cord - enables permanent operation from your vehicle's fuse box \$14.95; MB001 Mobile mounting bracket \$14.95; EX711 External speaker with mounting bracket & 10 feet of cable with plug attached \$19.95. Comes with AC adapter, telescopic antenna, owner's manual and one year limited Under warranty.

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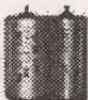
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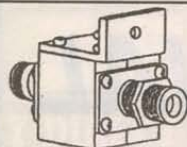
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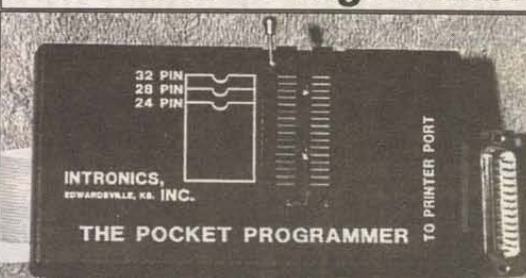


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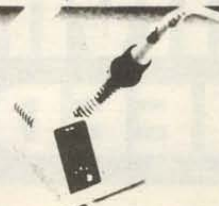
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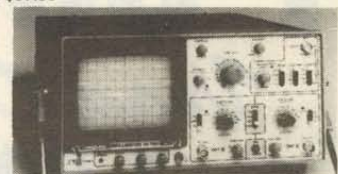
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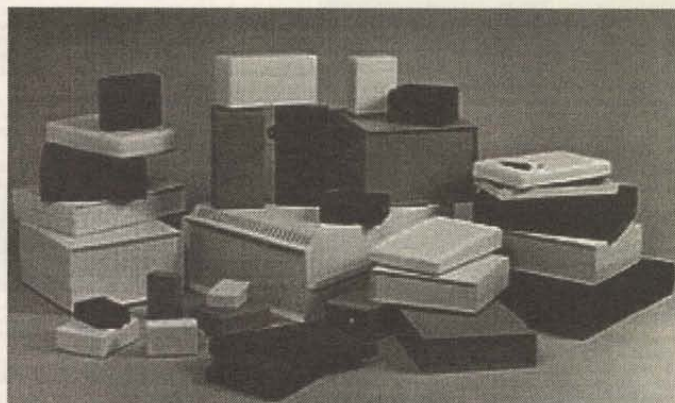
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FM-25, Synthesized FM Stereo Transmitter Kit.....\$129.95



## 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.

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LPA-1, Power Booster Amplifier Kit.....\$39.95

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LPA-1WT, Fully Wired LPA-1 with Case.....\$99.95



## Micro FM Wireless Mike

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

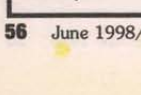


## Crystal Controlled Wireless Mike

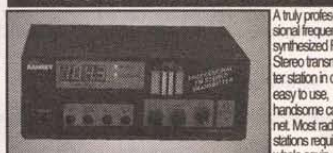
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FM-6WT Fully Wired FM-6.....\$69.95



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FM-100, Professional FM Stereo Transmitter Kit.....\$299.95

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## AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, "pro" version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper settable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded whip antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25 Professional AM Transmitter Kit.....\$129.95

AM-1 Entry level AM Radio Transmitter Kit.....\$29.95

Cam Matching Case Set for AM-1.....\$14.95

## Tone-Grabber Touch Tone Decoder / Reader

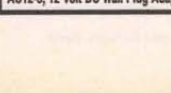
Diald phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode 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

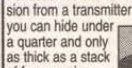
TG-1WT, Fully Wired Tone Grabber with Case.....\$149.95

AC12-5, 12 Volt DC Wall Plug Adapter.....\$9.95



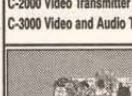
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C-2000 Video Transmitter Cube.....\$89.95

C-3000 Video and Audio Transmitter Cube.....\$149.95



## CCD Camera Interface Board

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IB-1 Interface Board Kit.....\$14.95



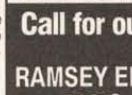
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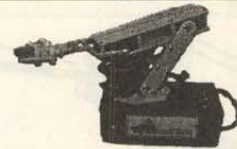
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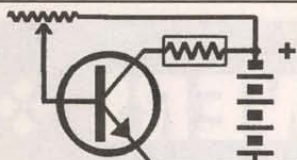
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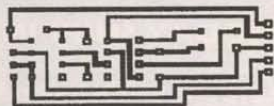
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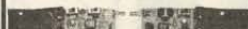
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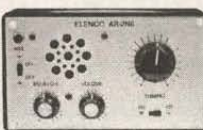
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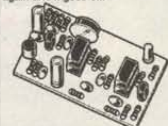
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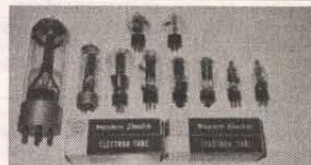
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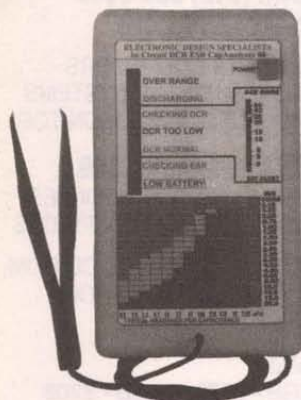
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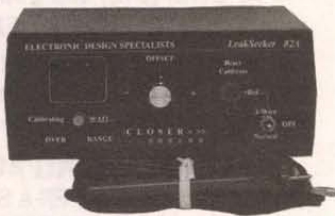
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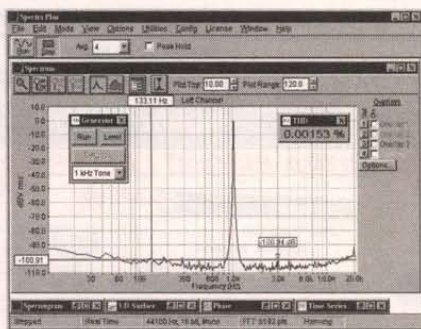
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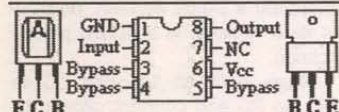
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ing handle that can be used as a tilting base.  
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amps. Torque constant is 9.1 oz-in per amp. Rotor inertia 0.0007 oz-in-sec<sup>2</sup>. Terminal  
resistance 0.89 ohm. Optical encoder is similar to "HEDS 6000" series. Encoder has  
1024 counts per revolution, two channel quadrature output. Outputs are TTL compatible.  
Encoder requires 5 VDC input at less than 50 mA input current. Dual shafts: front shaft is  
3/8" dia. x 3/4" long. This shaft is tapped on the end 8X32 tpi. Rear shaft is 1/4" dia. x 7/16" long. This shaft has dual  
flats that measure approx 3/16" across. Motor has four 8X32 tpi tapped mounting holes on front. A 3-3/16" dia. center-  
ing pilot is also provided on the front face. Dimensions: 4" dia. x 5-1/2" long (excluding shafts.)

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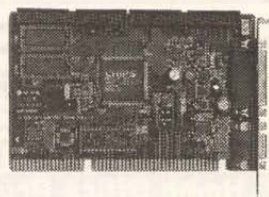
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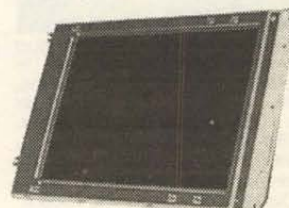
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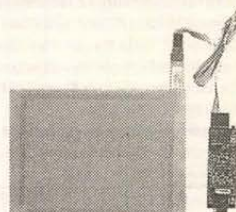
## LCD CONTROLLERS



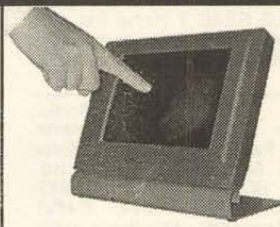
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Continued from page 39

## TECH FORUM

are available for \$25.00. Both  
PCLINK and MACLINK are available  
for \$47.00. *Z88 Source Book*, with  
three PC format disks of PD and  
shareware programs for the Z88  
are available for \$9.00. Prices  
include shipping.

Above all are available from  
**FWD Computing**, Frank Davis, P.O.  
Box 17, Mexico, IN 46958 USA.  
**317-473-8031**, Tuesday-Saturday  
only, 6pm-9pm. Fax **317-472-0783**,  
6pm-11am. E-Mail: [fdavis@quest.net](mailto:fdavis@quest.net).

I have two Z88s, but no PC of  
MAC. I have the *Source Book* (20  
pages), but no disks, and it gives  
some information not in the Z88  
manual.

The Z88 can be expanded to  
more memory. All my Z88 stuff  
came from Frank Davis.

**Donald S. Lambert**  
Auburn, IN

### ANSWER TO #4984 - APR. 1998

I am not aware of an existing pro-  
gram to read the serial ports of two

Radio Shack digital multimeters and plot  
the related data. However, it could be  
accomplished by breaking the problem  
into two steps.

First, connect each meter to a dif-  
ferent serial port on the computer. The  
manual for the multimeter shows a  
sample BASIC program for reading the  
meter values. Modify that program to  
read one meter then the other, and  
write each value separated by tabs to a  
file.

Now import that file into Microsoft  
Excel or some other spreadsheet pro-  
gram and use the built-in charting tools  
to produce your plots.

**Doug Smith**  
Roscoe, IL

### ANSWER TO #5981 - MAY 1998

Since each octave is a frequency  
ratio of 2:1, and each octave con-  
tains 12 equal half-steps, a half-step  
has the ratio of  $2^{1/12}$  or 1.0594631:1 — roughly 6%. To tune  
your turntable a half-step flat, it would  
need to run at roughly 31.33 RPM.

To tune it a half-step sharp, it would  
need to run at roughly 35.33 RPM.

Changing speed on a CD player  
is not quite so easy because of all the  
digital timing circuits involved.  
However, there are a few CD players  
built with this feature.

**J & R Music World 1-800-221-  
8180** [www.jandr.com](http://www.jandr.com) advertises  
the Technics SL-PD988 CD changer,  
among others.

**Sam Ash Music Store 732-  
572-0263** advertises the Denon  
DN600F CD Player (which is rack-  
mountable); they also have some  
larger dual-CD players with this fea-  
ture.

In general, CD players made for  
"DJ" use have variable pitch, the DJs  
often use this to match the TEMPO of  
two songs when they're cross-fading  
from one to the other, it doesn't  
seem to bother them that they're  
playing the song in the wrong key. But  
if the singer ends up a few steps  
sharp and sounds like Mickey Mouse,  
so what? Look how popular the Bee

Gees were!

**Greg Miller**  
via Internet

### ANSWER TO #5988 - MAY 1998

The National Semiconductor  
MM5450 "LED display driver" is  
essentially a 34-bit serial-in, parallel-  
out data register in a 40-pin plastic  
package.

Apply 4.75 to 11 volts DC to  
VDD pin 20 and connect ground to  
VSS pin 1. Take data enable pin 23  
low, set a data bit on DATA IN pin 22,  
then take the CLOCK IN line high and  
then low.

The data format calls for a  
"start" bit of logical "1" followed by 34  
bits of data. At the 36th clock a  
LOAD signal is generated synchro-  
nously with the high state of the  
clock, which loads the bits in the shift  
registers into the latches that control  
the output buffers. Each output  
can sink up to 15 mA.

So you see, the assignment of  
data bits to the a, b, c, d, e, f, and g



## TECH FORUM

segments of your seven-segment display device is entirely up to you.

The MM5450 is simply a big wide serial-in parallel-out data register with output buffers that can sink lots of current. It doesn't know anything about layout of seven-segment displays. It's probably the start bit shifting out the far end of the shift register that resets the shift register, because there must be a complete set of 36 clocks or the shift register will not clear.

Bit 1 is the first bit following the start bit and it will appear (when latched out) at pin 18. A logical '1' at the input will turn on the appropriate LED. Bit 2 appears at pin 17, and so on going clockwise around the 40-pin package (skipping pin 1, of course), bit 18 is on pin 40 and bit 34 is on pin 24.

Jack Dennon  
Warrenton, OR

### ANSWER TO #5987 - MAY 1998

When burning out "whiskers" in a NiCd cell, the "zapping" capacitor should be connected to the cell positive-to-positive. If you connect it with polarity reversed, you will have a high current flow through the cell which may cause damage, and you may also reverse-charge the cell.

I have typically used a "zapping" voltage of around 12 VDC, connected to a single NiCd cell which is nom-

inally around 1.2 VDC. You want to keep the "zapping" pulse fairly short in duration, to avoid over-charging and/or over-heating the cell.

The pulse duration can be controlled by using a capacitor with reasonably low capacitance, or else just use a momentary-contact switch between the capacitor and the cell, and close the switch just for a fraction of a second.

The fellow who taught me this trick suggested putting the NiCd cells under the desk before zapping them, just in case. I have never seen it happen, but in theory, if a cell is over-heated in the process (by excess current and/or pulse duration), it could explode.

Greg Miller  
via Internet

### ANSWER TO #5984 - MAY 1998

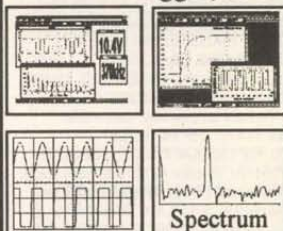
Well, I read and re-read this one about six or seven times, before I could make sense of it. Then it finally hit me, Arnaud was saying "SCAN" and meant "SWR" then it made sense. SWR is an acronym for standing wave ratio. SWR is the ratio of forward to reflected power.

The radio is working like it was designed. The antenna is working like it was designed. The problem is the radio covers a larger frequency span than the antenna is designed for. The antenna is "resonant" at 27 or so

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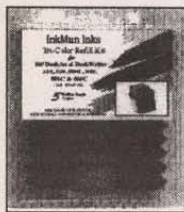
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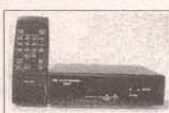
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## TECH FORUM

### ANSWERS TO #49814 - APR. 1998

Most late model appliances use a sophisticated IR remote system designed for across-the-room range with no false responses. The IR emitter in the control box is driven by coded digital pulses modulating a 40-KHz carrier. The detector is well filtered, so it responds only to 40-KHz signals from the control box, not other ambient sources of light and heat.

Fortunately, you don't have to build a well-filtered detector for your repeater, because the work has already been done. A module containing a sensitive 40-KHz IR detector and filter is available at Radio Shack stores, part number 276-137. Output is a TTL-compatible digital data stream with the 40-KHz carrier removed.

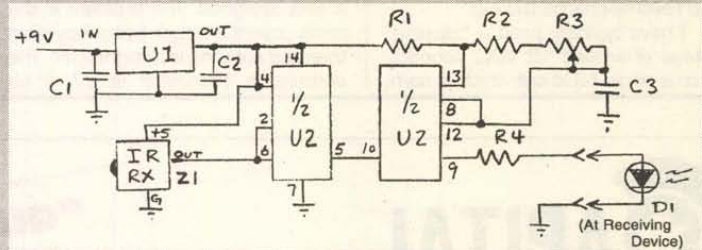
The schematic shows how I have incorporated that detector into a repeater. The detector gates a 40-KHz oscillator, made from half of a 556 timer. [The other half works as a logic inverter.] The oscillator drives an infrared LED which can be at the end of a cable that goes to the device to be remote-controlled. The circuit draws 18 mA. I powered mine from a nine-volt "wall wart" supply. The Radio Shack 273-1552 or 273-1432 nine-volt battery eliminator should work fine.

Construction and alignment of the repeater is easy with an oscilloscope. When you fire it up for the first time, leave the lead from the IR detector to U2-6 and U2-2 disconnected. Check the five-volt supply regulator output first. Then look for the five-volt digital stream at the detector output with a scope as you zap the repeater with your remote control.

Ground U2-6 and U2-2 and you'll get a continuous squarewave at pin 9. Adjust R3 to set the square-wave frequency to 40 KHz, using a frequency counter or well-calibrated scope time base. Now connect the wire from the detector to U2-6 and U2-2 and the repeater should be ready to go.

C1, C2	0.47 tantalum
C3	390 pF MICA
D1	IR emitter [RS 276-143]
R1	1K
R2	33K
R3	20K trimpot [RS 271-340]
R4	820
U1	7805 5V regulator [RS 276-1770]
U2	556 dual timer [RS 276-1728]
Z1	IR receiver assembly [RS 276-137]

Joseph D. Moell, P.E.  
Fullerton, CA



MHz, approximately the center of the CB band. So at that frequency, the reflected power, or standing wave ratio is minimum. So the reading of 1.5:1 ± .3 when used on the CB frequencies.

This is the design frequency of the antenna, and the maximum efficiency is obtained when the antenna is resonant at the desired frequency. When the radio is moved out of the CB bands into the Ham bands, the antenna is too low in frequency for the new higher transmit frequency, and the SWR goes up.

The antenna could be retuned to the new frequency by cutting the stainless steel rod shorter to accommodate a higher resonant frequency. However, doing so will make the SWR go up at the CB frequencies. And for legalities IE transmitting out of band it is probably best left as-is.

I just got an E-Mail about FCC busting New York cabbies for using CB radios out of band. So get a frequency chart of the CB frequencies, and stay on them. There are some frequencies within the band that fall between the 40-channels allocated by the FCC that are considered illegal frequencies. This is between channel



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1, and channel 40.

The radio you have will go below channel 1, and considerably above channel 40. Many of those frequencies are allocated to government use, and if you cause interference on one of those frequencies, you can expect a visit from the feds in short order. They do not take kindly to operation on unauthorized frequencies.

Anything between 28.000 MHz and 29.70 MHz is allocated to amateur use, and amateurs are very protective of those allocated frequencies. Consider getting an amateur license.

Arnaud also mentions when he adds 50' of RG 80 coax to the antenna, the SWR goes down. I assume he means RG-8(D) and would add more cable help. Well the answer to that is yes and no. Yes it will make the SWR read lower. The reason it will read lower is the additional cable adds additional loss, and the forward power sent to the antenna is lowered by this loss, and the reflected power from the antenna is lower first because less is reaching the antenna, and the reflected power is attenuated as well. So a lower SWR reading with additional cable is normal.

This loss introduced by the additional cable will be seen as lower power transferred to the antenna, than without it, and lower received signal coming into the receiver from that distant station you are trying to work. So the no answer is, it is decreasing your effective range so it will not help.

Ed Pruitt  
Keller, TX

#### ANSWER TO #5983 - MAY 1998

The only sure-fire way to extract the regulator board/components is to carefully "grind-out" the epoxy with a Dremel tool or similar.

Alternately, if you don't mind damaging the case, carefully drive a thin-blade chisel through the

epoxy/case seal around the edge. Chances are you will only have to gain a fraction of an inch to get past the epoxy "cap."

When you do remove the epoxy, you will most likely find the circuit board resting on a bed of dark-colored "grainy stuff" (non-conductive). You should then be able to carefully lift out the board for examination, etc.

If the board, etc. is "stubborn," carefully dig out the "grainy stuff" to expose/dislodge the internal board/components. It will take time and patience, but you will be able to "get inside" that sealed regulator module.

Ken Simmons  
Auburn, WA

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# 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 send your questions to me by E-Mail at [q&a@nutsvolts.com](mailto:q&a@nutsvolts.com), or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

### What's Up:

Piezo coaxial cable update, alpha wave stimulator, and an AC-line monitor. **Computer topics:** old monitor conversions and CMOS set-up questions answered.

### Piezo Coaxial Sensors ... Again

**Q.** I'm very interested in your solution to the driveway sensor problem in the Feb. '98 issue. The piezo coaxial cable you mentioned sure seems like the answer to my problem. However, I'm not on the Web, so I'd like a snail mail address of the company that sells the piezo cable. A schematic of the control unit would be nice, too.

**B. L. "Frenchy" Mestayer**  
Brazoria, TX

**Q.** Please expound on the subject of piezo coaxial cables. I am very interested in its use and the control circuitry needed to detect the presence of automotive traffic.

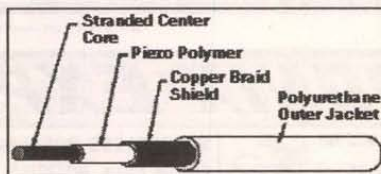
**Steve Craddock**  
via Internet

**A.** Boy, has the mention of this product raised a lot of response. First, the contacts.

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**Pete Smith**  
172 Big Valley Road  
Folsom, CA 95630  
Tel: 916 983-8644  
FAX: 916 983-0479  
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Now, the dialog. The AMP piezo coaxial cable has the appearance and characteristics of standard coaxial cable, but is constructed with a piezoelectric polymer insulator between the inner copper conductor and the outer braid shield.



The cable can be buried for perimeter fence security, traffic sensors with vehicle classification, and other safety and security applications. Other applications include sensors for floor mats, touch pads, and door edges. The piezo cables feature the same piezoelectric properties that are characteristic of piezo film sensors — the kind used in piezo buzzers. In its normal, relaxed state, the piezo cable behaves like a regular coaxial cable with the normal impedance/capacitance restrictions that you'd expect from a typical RG58A/U (20 AWG) coaxial cable. But if you bend, twist, or physically distort the cable in any way, the piezoelectric insulator produces a "lightning bolt" spark between the inner conductor and the outer shield. The electrical output is proportional to the stress imparted to the cable.

Parameter	Units	Value
Capacitance @ 1kHz	pF/m	600
Tensile Strength	MPa	60
Young's Modulus	GPa	2.3
Density	kg/m <sup>3</sup>	1890
Acoustic Impedance	MRayl	4.0
Relative Permittivity	@1kHz	9
tan $\delta_e$	@1kHz	0.017
Hydrostatic Piezo Coefficient	pC/N	15
Longitudinal Piezo Coefficient	Vm/N	250 x 10 <sup>-3</sup>
Hydrostatic Piezo Coefficient	Vm/N	150 x 10 <sup>-3</sup>
Electromechanical Coupling	%	20
Energy Output	mJ/Strain (%)	10
Voltage Output	kV/Strain (%)	5

### Kynar® Piezo Cable Typical Properties

The linear dynamic range of the cable is about 200 dB, which spans the range from a rain drop to an 18-wheeler. Herein lies the con-

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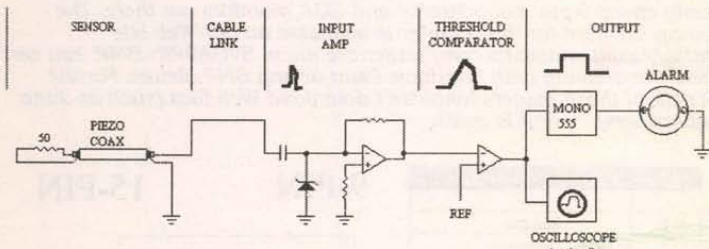


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trol circuitry design problem. A truck generates a lot higher voltage spike than does a rain drop — and the input amplifier must react accordingly. Typically, the amplifier is designed for a specific range. Let's say foot steps on a carpet, with over-voltage protection should a wheel chair come across the path. Because of this wide dynamic range, I can't give you the exact values for an amplifier that can cope with your specific stress pressures. However, I can block out a circuit for you. I've broken it into five stages.



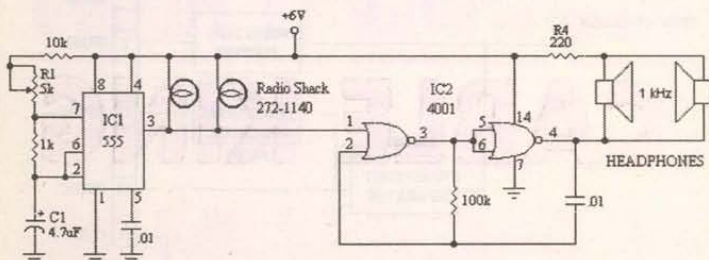
The first stage is the piezo coax cable itself. While the cable can pass a signal (such as an audio message between a gate speaker and your home), it's most likely you'll want to use it just to alert the passage of an object, like a car, across your parameter. If you don't have a signal source, a termination resistor is needed at the head end. The next step, stage 2, is the link between the piezo coax sensor and the controller (which consists of stages 3 through 5). Because it is coaxial, you can run the piezo cable right up to the input amp. Unfortunately, piezo cable isn't cheap. The price is \$16.50 per meter, about \$5.00 a foot (part # 0-1002399-0), so for long runs it would be wise to use only as much piezo sensor as you need and splice it to a cheaper standard coax cable to finish the link. The AC-coupled input amp is any op amp that's responsive to voltage spikes of various amplitude. The gain of the op amp is adjusted so that the signal from the piezo sensor exceeds the limit of the comparator (stage 4); a zener across the input clamps the spike and prevents damage to the op amp. The amplified signal is then run through a comparator which prevents under-voltage events from triggering the 555 monostable alarm. AMP also sells a piezo cable experimenter's kit that contains about 10 feet of piezo cable, coaxial splices, a user's manual, and a whitesheet of typical applications. The cost is \$100.00.

## Alpha Wave Generator

**Q.** A few years ago, I frequented a place in New York that provided "SynchroEnergizing," a form of hypnotic relaxation using sight and sound. Essentially, their SynchroEnergizers were safety goggles with small lightbulbs attached to headphones. The lights would flash while the headphones sounded a syncopated beep. The idea is that the light and sound frequency would, let's say, "smooth out your brainwaves." Apparently, certain frequencies put you into an alpha state ... kinda like slumberland. I won't rave about its results, but I enjoyed it and it certainly relaxed me. Do you know of any kits available for such devices? I suppose I could just build a simple 555-based oscillator, but how would I accurately control the frequency? How could I drive lightbulbs instead of LEDs?

Simon Gouldstone  
via Internet

**A.** Been there and done that, but let me put up the warning flags before I answer this. Yes, 9 Hz to 13 Hz can be relaxing. HOWEVER, if you're prone to epilepsy or related disorders, this is not the toy for you! It can send you into a seizure within seconds. It's the alpha wave that most enjoy so much that sends some persons to the emergency room. I'm sure you had to sign your life away before this club would let you participate in the pleasures. Well, in the same way, I'm not responsible for the use of the following circuit, nor is Nuts & Volts Magazine. With that said, here's the circuit.



As you correctly assumed, a simple 555 chip is all that's needed. Well, actually we need two chips, one for sight and one for sound. IC1 is the clock chip and lamp driver. The values shown produce a 10 Hz

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Dranetz PA6024B, Plug-in Harmonic Analyzer	\$300	HP 8013B, Pulse Generator, 1Hz-50MHz	\$275
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Fluke 8502A, DMM 5-1/2 Digit Opt. 0210/05/07/08A		Kepco JOE 36-15MPT, Power Supply, 0-36 @ 15A (metered)	\$275
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HP 3400A, True RMS Voltmeter, 10Hz-10MHz, 1mV-300V	\$200	Tek TB82A, Plug-in (500MHz), Dual Time Base	\$200
HP 3403C, True RMS Meter, AC/DC/DB 100MHz	\$325	Tek TD11, Plug-in Digital Delay	\$175
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HP 5328A, Counter, 500MHz	\$350	Tek 760A, Scope Mainframe (100MHz)	\$200
HP 5345A, Counter, 500MHz, HP-IB	\$450	Tek 7704A, Scope Mainframe (250MHz)	\$325
HP 6104A, Precision Power Supply, 20V @ 3A, 20-40V @ 1A (metered)	\$175	Tek 7854, Scope (400MHz), Dual Beam w/ Waveform Calculator	\$625
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flash rate with a 20% duty cycle — which, when used with an incandescent lamp, will tickle your alpha waves. R1 adjusts the flash rate between 9 Hz and 15 Hz. The 555 chip can output 300 mA of current, which is enough to light any of the mini lamps sold by Radio Shack. I recommend two or four 272-1140 bulbs glued into the sides of a pair of cheap plastic safety glasses (the kind you can find at any hardware store). You can parallel as many of these bulbs as you — and the 555 chip — can stand. Because these glasses are clear, either paint the lens with a reflective color or do your tripping in a darkened room. The sound comes from a 4001 logic chip (IC2) that's configured as a gated tone source. When the 555's output goes low, and the bulbs flash, the tone source sounds. Any headphone will work. Too loud? Increase the size of R4 to 470 ohms. The circuit draws very little current and can be powered by four AA batteries.

## Flash BIOS

**Q.** Could you explain to me what a "flash" BIOS is? Also, how do you do it?

**Joe Spinola**  
via Internet

**A.** Basically, there are two types of BIOS (Basic Input/Output System) chips used in computers. The first is the ROM, which stands for Read-Only Memory. This type of BIOS is programmed at the factory using a logic "mask" and its instructions are forever carved in stone, literally. A flash BIOS, on the other hand, is an EEPROM (Electrically Erasable Programmable Read-Only Memory) that is programmed at the time the PC is shipped. This type of BIOS can be erased and programmed with a different set of instructions. Generally this is done by downloading a routine from the vendor's Web site, or by a diskette that you can order (usually just for the cost of shipping and handling) from the vendor. Before you update, though, compare your current version number to the one being offered, because the EEPROM is good for only 100 erasures. Given the life of a PC, this is plenty, but if you do it frequently you could end up with a Ronny Reagan PC — one with no memory. I certainly wouldn't upgrade from 2.01.01 to 2.01.02. I'd wait for the 2.5 version unless there's a major bug fix.

## Old Monitors Still Live!

**Q.** I have an old MultiSync monitor with an analog/digital switch that I'd

like to use with a VGA card. I understand you showed a schematic of an adapter cable that will do this in your May '97 column. Can you give me the pinout for this 9- to 15-pin adapter, and have there been any modifications since it was published?

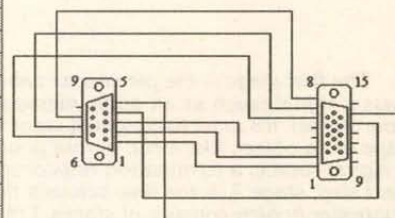
**Evert Anderson**  
via Internet

**A.** Just today a friend called and asked if I could solder up this very cable for him. Why is this fix so popular? Because there are a lot of really cheap 9-pin monochrome and EGA monitors out there. The wiring diagram for this adapter is available on our Web site (<http://www.nutsvolts.com>) under the name SVGA9PIN.BMP. You can view the drawing with Windows Paint or any BMP viewer. For the benefit of those readers who can't download Web files (such as Juno subscribers), here it is again.

15-Pin	9-Pin	Description
1	1	Red gun
2	2	Green gun
3	3	Blue gun
4	--	Monitor ID bit 2
5	--	no connection
6	6	GND (red return)
7	7	GND (green return)
8	8	GND (blue return)
9	--	no connection
10	--	GND
11	--	Monitor ID bit 0
12	--	Monitor ID bit 1
13	4	Horizontal sync
14	5	Vertical sync
15	--	no connection

## 9-PIN

## 15-PIN

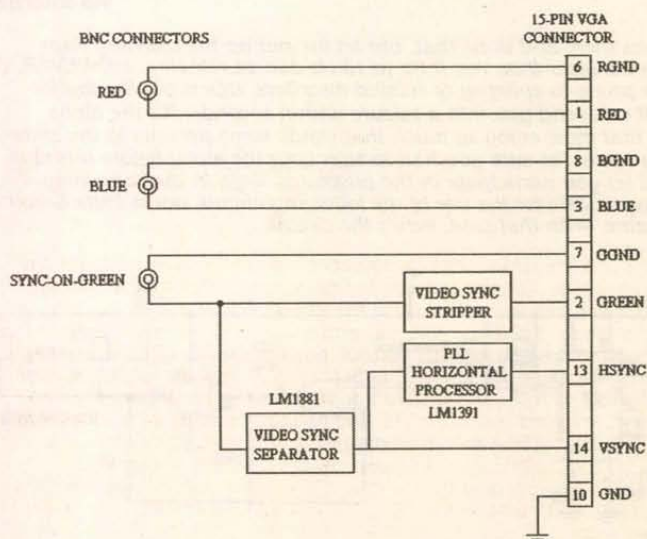


## RGB to SVGA Converter

**Q.** I have an old Hewlett-Packard UNIX computer with three BNC video outputs (RGB) that I wish to use with my SVGA monitor. Is there an interface available or a circuit that I can build to accomplish this?

**Chuck Karbginisky**  
via Internet

**A.** This is tricky because the sync signals are buried in the green output. Let me explain. All color video displays — including your TV — require five signals: red video, green video, blue video, horizontal sync, and vertical sync. All PCs, including your HP, have these signals in one form or another. In a VGA monitor they are five separate signals with five dedicated pins or five BNC connectors. A monitor with four BNC connectors combines the horizontal and vertical syncs into a composite signal. Other computers, like your HP and Macintosh systems, reduce the number of connections to three by combining the composite sync with the green video, called sync-on-green (the red and blue remain separate). So what you have to do is strip the composite sync from the green output then untangle the horizontal from the vertical and route them to separate outputs. While it's a complex process, it's been simplified with the advent of IC chips called sync separators, like the LM1881. Okay, how do you do it? Like this.



In this circuit the video sync separator strips the green video from the composite signal and outputs a composite sync (horizontal and

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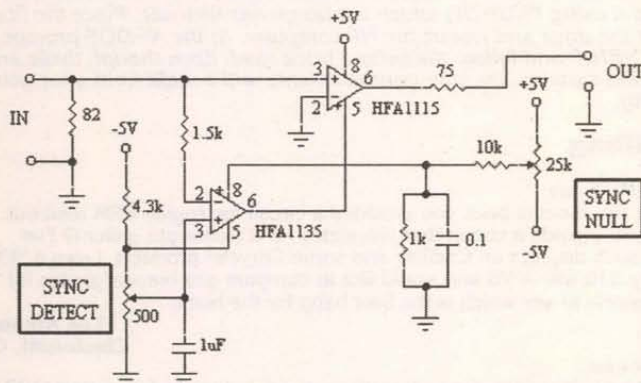
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vertical) and a separate vertical sync. The horizontal processor is an LM1391 phase-lock loop (PLL) that separates the horizontal sync from the vertical sync. Finally, the sync signals are removed from the green video using a video sync separator to restore the original green video signal. From there, the signals go to their respective VGA pins. What's missing in this block diagram are the various "glue" components surrounding the LM1881 sync separator and LM1391 PLL chips. You can find the external parts needed for the two chips by downloading their datasheets from National Semiconductor's Web site at <http://www.national.com>. The video sync separator can be made using discrete components; there's a good assortment of sync strippers in the ARRL handbook. For your convenience, here's a simple video sync stripper built around a couple Harris Semiconductor (<http://www.semi.harris.com/>) op amps.



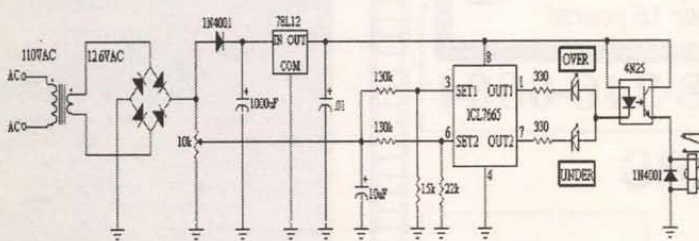
BTW, the LM1881 chip is an industry staple that's cloned by several vendors, including Elantec and Philips. Now let's hope your SVGA monitor has the right capture range to support the HP's scan rates. Can you buy a commercial unit that converts RGB video to VGA video? Not that I can find. Virtually all commercial video converters take the five separate signals, mix them, and output them as composite video.

## AC Power Monitor

**Q.** Hola, I live in Mexico City where we have a lot of AC-line power problems with what you call "brown-out." Sometimes the voltage drops so low that the lights look like a candle, but that's not the worst of it. It plays hell with the refrigerator and my computer. I'd like to know if you've recently published an article that can be used to turn off the power line to the whole house (within 10 seconds) if the line voltage is too high or too low.

**Oscar Trejo Rubio**  
Mexico D.F.

**A.** Thanks to battery-powered notebook computers, voltage monitoring ICs are plentiful and cheap. The AC-line monitor below is built around an ICL7665 Under/Over Voltage Detector. The chip is made by Harris and Maxim, and is available from Digi-Key (800-344-4539; <http://www.digikey.com>) for \$2.75.



A 12-volt transformer both powers the detector and provides the reference signal. The AC voltage is first rectified. Part of the voltage goes to a 10K pot and is used for the signal, the rest is isolated by a blocking diode (1N4001), filtered, and reduced to 12 volts using a 78L12 voltage regulator; this voltage powers the IC, LEDs and relay. The sensor's over-voltage input is Set1 (pin 3) and the under-voltage input is Set2 (pin 6). The resistors to these two pins are selected so that the IC triggers when the AC line voltage exceeds 125 volts or falls below 90 volts. When the line voltage hits these limits, one or the other LED will light which, in turn, causes the LED in the 4N25 optoisolator to glow and turn on the light-coupled transistor and pull-in the relay. You can use the relay contacts to control other relays (such as a contactor) that will disconnect power to the house. To calibrate the detector, use a Variac to adjust the AC line voltage to 91 volts and turn the 10K pot to the point where the "Under" LED just goes off.

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## Electronics Q & A

### AT Setup Diskette

**Q.** I have several HP Vectra ES computers, with a 286 CPU and 20 MB hard disk, that were just given to me, no strings attached. Unfortunately, the hard disks have been wiped clean, and I don't have the floppy that contains the CMOS setup routine, so they are unusable at the moment. I plan on donating these machines to persons who otherwise could not afford one, but first I have to get them up and running. Where can I find a copy of the setup disk?

**Herman O. Darr III**  
Auburn, IL

**A.** On our Web site (<http://www.nutsvolts.com>) under the name GSETUP31.ZIP. Download this program to a bootable 5 1/4-inch floppy (one that's been formatted with the FORMAT /S command) and unzip it using PKUNZIP, which is also on our Web site. Place the floppy in the drive and restart the HP computer. At the A> DOS prompt, type SETUP and follow the yellow brick road. Even though these are very old systems, I'm sure your recipients will benefit from your generosity.

### Mailbag

Dear Mr. Byers:

A few months back you provided a circuit for engine RPM read out. Can you provide a circuit that calculates MPG (miles per gallon)? I've seen such displays on Cadillac and some Chrysler products. I own a '93 Chevy S10 with a V6 and would like to compare gas brands/grades for my vehicle to see which is the best bang for the buck.

**Lee Amanns**  
Cincinnati, OH

**Response:**

About 20 years ago, when the gas crisis was in full swing (1974), my father bought a Buick that had this gadget. I drove it a few times, and remember that the readout only gave an instantaneous reading of what's going on. That is, if you put the pedal to the metal, it read zero MPG. Coasting to a stop with your foot on the brake, it read 150 MPG. The reading is derived from a sensor in the fuel feed line to the carburetor. It's a paddlewheel vane that spins when the gas flows, and the faster it spins the faster the gas is guzzled. So this is the first modification you have to make to your engine: the addition of a sensor. If you get that far, then you have to convert the sensor's revolutions into a voltage or current for display. If you want to have an average MPG reading, as you indicate, this signal needs to be integrated with the odometer, which requires another modification to the vehicle. Obviously, this isn't a simple project because it involves a lot more than a soldering iron. If you can surmount these hurdles, write me again and I'll give you a circuit that'll tie the two sensors together.

**TJ Byers**  
Q & A Editor

### Q & A or Tech Forum?

If you have questions about any aspect of electronics, from circuit design to theory explanations, or just need to be pointed in the right direction to get that project started (or finished), WE CAN HELP!

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The Tech Forum will get your question looked at by thousands of readers. Sometimes several answers might be published giving different approaches to solving your problem.

The Q & A column generally offers a quicker response from noted electronics author TJ Byers. Follow-up or spin-off questions and/or discussions might also appear in this column.

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630 San Antonio Rd.  
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1600 Broadway  
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5950 Florin Rd.  
Sacramento 95823

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Emeryville 94608

5611 Blackstone  
Fresno 93710

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6310 E. Pacific Coast Hwy.  
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### Muir Communications Ltd.

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### Norlink Communications & Consulting

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Thunder Bay, Ontario P7C 1A5

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Local 258, Bogota

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# AMATEUR ROBOTICS

# NOTEBOOK

by Robert Nansel

Welcome to the Amateur Robotics Notebook — the first of a series of articles on low-cost tools, materials, and techniques useful in the robotic art.

Homebrew robots have been my passion for over 25 years. I've been a member of the Seattle Robotics Society since '84, and edited their newsletter from '91 to '94, though now I live in Pittsburgh.

Over the years, I've traveled all over North America giving talks on robotics to groups in British Columbia, Massachusetts, Connecticut, Georgia, Ontario,

their own ways, and have taught me much.

## My philosophy

I want to emphasize tools, materials, and components that are inexpensive and widely available — from multiple sources where possible — so everybody can duplicate projects I present. I'll use surplus components on occasion, but only when they are also available outside of surplus channels (my budget is not unlimited, after all). Finally, so I won't leave out folks who *don't* breathe solder smoke as a sacrament, I want to point toward robot

absolute minimum outlay of time and money.

Let's get started on the mechanics.

## Preparing the breadboard

Breadbot's chassis and main circuit board are made from a modified solderless breadboard. The particular breadboard I used is the GSP GB2-120, available from Future/Active Electronics. This breadboard measures 6.5" long by 2.16" wide. Serendipitously, this width is a perfect fit for mounting two Futaba S148 servos laying side-by-side, and it also matches the

knife to cut through the backing paper and double-sticky foam, and scrape the foam and adhesive away. You should now see the ends of the first two rows of metal contacts and a hole between them molded in the plastic (Figure 1).

With a 5/64" bit, drill the hole the rest of the way through the board. The exit hole should end up perfectly centered in the groove that runs the length of the component side. Check that the 0.075" music wire can turn freely in this hole. Cut a 5/16" square of 1/32" thick scrap plastic to fit in the gap you've made in the double-sticky foam (plastic bread wrapper clips

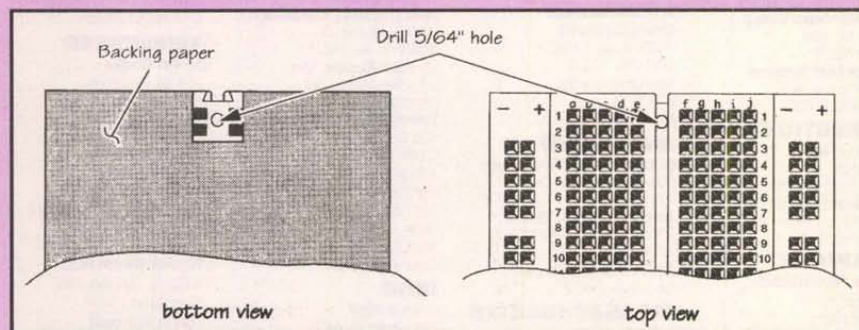


Figure 1. Breadboard modifications.

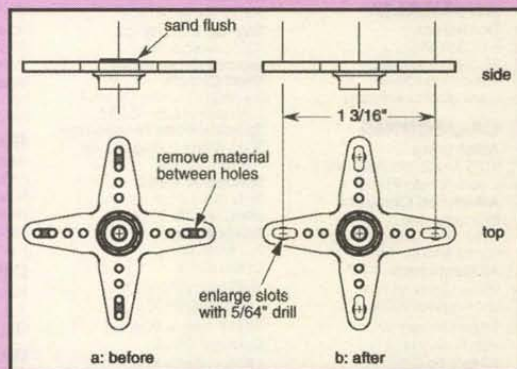


Figure 2. Servo control horn modifications.

Texas, Northern and Southern California, Oregon, and Washington state. I've attended robotics competitions: robot sumo tournaments, the BEAM Robot Olympics, the Trinity Robot Firefighting Contest, and others, too numerous to mention.

## It takes a village ...

The most important thing I've learned about robots and those who build them is the need for a community. Just as it takes a village to raise a child, it takes a community sharing resources to build working robots. Robotics is inherently a multi-disciplinary art, the confluence of esthetics, sensing, motion, and computing, and no one person can hope to master every field involved in it. Despite this, I've met quite a few fellow gearheads who share my passion for (and frustration with) these cybernetic creatures. Many of these folks have mastered enough parts of the disparate disciplines that they build robots that fly, swim, climb, hop, burrow, and — occasionally — make accurate 90-degree turns in a maze. These people have all advanced the Robotic Arts in

kits and modules. There are new companies with robot kits appearing every day; several advertise in this magazine.

The village of robot builders is still small, but we are well-networked and, together, we will do amazing things.

## Breadbot — a minimalist table-top robot

### Overview

Breadbot is a simple, easily customizable robot that will serve in this initial series of articles as a platform for experiments in basic robot control, sensing, and navigation. It uses readily available, low-cost components. Also, because of its low cost and simplicity, it is ideal for construction by students in a classroom environment.

In its simplest version, Breadbot uses the Parallax BASIC Stamp as its on-board controller, but it is not limited to the BASIC Stamp. Any microcontroller that can be plugged into a solderless breadboard is a candidate for a Breadbot controller. I use the BASIC Stamp first, though, to get the Breadbot rolling with the

length of a four AA-cell battery holder, the kind where all four batteries lay flat in a row.

The breadboard is really three pieces: a single 630-tiepoint terminal strip combined with two 100-tiepoint bus strips, one on each side. All three pieces are held together by molded-in dovetails on the sides and a sheet of double-sticky foam on the bottom. It is this double-sticky foam that makes building Breadbot so easy; you just cut and peel away portions of the backing paper and stick the battery holder and the servos in place. The GSP even has molded-in mounting bosses, one of which is used for mounting the trailing caster wheel. What could be simpler?

The first step is to drill a hole through the breadboard for the caster strut. Locate the end of the breadboard with the dovetail slot (for the GSP breadboard, this is the end where the first row of tie points is marked "1" on the component side). This end will be the rear of the robot. On the backing paper on the bottom side, mark in pencil a 5/16" square centered and flush with this end, then use a hobby

knife to cut through the backing paper and double-sticky foam, and scrape the foam and adhesive away. You should now see the ends of the first two rows of metal contacts and a hole between them molded in the plastic (Figure 1).

On the backing paper, mark off in pencil where the servos and the battery holder go. Measuring from the opposite end of the breadboard from the hole you just drilled, make marks at 0.5", 2.125", 3.0", and 5.5". Using a trisquare, strike lines across the width of the board at each mark.

Next, lightly cut the backing paper with a hobby knife, using a straight-edge on the pencil lines as a guide. Be careful this time to cut only the backing paper, not the sticky foam beneath.

## Mounting the servos and battery holder

Before you mount the servos, you must first modify them for continuous rotation. This procedure, as well as other basics of robotics, is explained very well in the Seattle Robotics Society webpage. If you are unfamiliar with modifying ser-







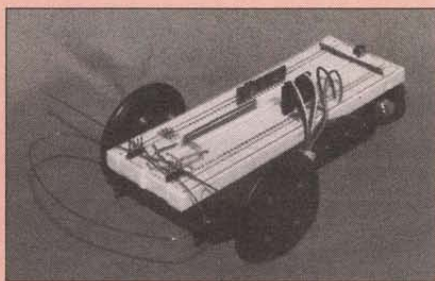


Photo 1. Breadbot with "bow tie" front bumper and side whiskers.

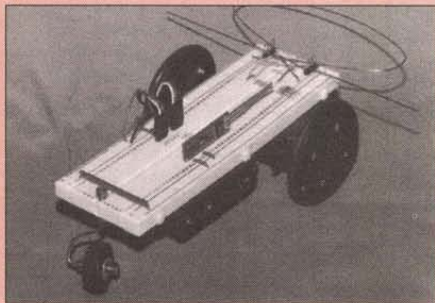


Photo 2. Reverse angle shot. Notice the jumper wires tying together the left and right power and ground distribution busses; both jumpers must be far enough forward that the setscrew in the top shaft collar can clear the jumpers when the caster turns.

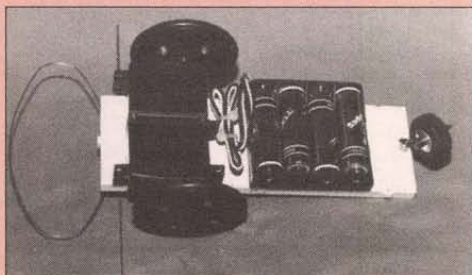


Photo 3. Breadbot's underside. I used nylon cable ties to hold the servo cables neatly in place between the battery holder and the servos.

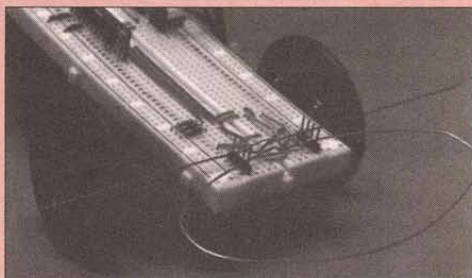


Photo 4. Close-up of Breadbot's whiskers and "bow tie" bumper.

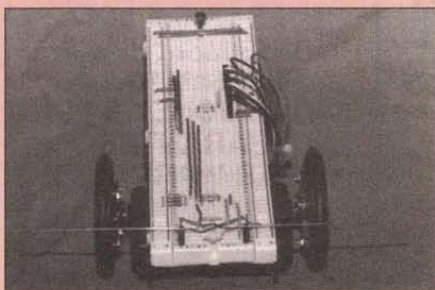


Photo 5. View of Breadbot with "bow tie" bumper removed.

with their tires, and attach their respective wheel mounts with the 2-56 screws and hex nuts (Photo 7).

When you tighten the nuts, make sure the wheel hubs and wheel mounts remain centered to each other. The wheel mount arms will bend to conform to the slight curve of the wheel disk. Attach the completed wheel/hub assemblies to the servos with the screws they come with.

### Making the caster

The caster consists of a strut, a wheel, and four shaft collars to hold everything in alignment.

Figure 3 shows the bends required to make the caster strut. You'll need two pairs of pliers and a bending jig to make the first three bends, and pliers and a bench vise to make the last bend.

The bending jig is just a piece of two-by-four with two #18 round head wood screws screwed in about half an inch apart. The screws should be the kind with an unthreaded shank near the head. Screw them vertically into the wood block until there is just enough clearance between their heads and the block to slide in the 0.075" music wire.

With the block clamped to your workbench, use one screw as a brace and the other as a post to bend the wire around.

Begin with a 12" straight length of music wire. Place the wire diagonally between and against the screw posts and mark a pencil line on the wood along the wire starting at the bending post; this is the zero degree line. Then use a protractor to mark off 66 and 90 degrees on the wood block relative to the zero line, and

draw tangent lines from the bending post to the angle marks.

In the middle of the wire, make the first 66-degree bend (see Figure 3a). You will actually need to bend the wire a little further than the mark because it will spring back some when you let go; bend it just enough past the mark so that when it springs back it lines up with the line.

Quan.	Unit	Description	Vender	P/N
1	ea.	1" tail wheel	Tower Hobbies	GPMQ4241
4	ea.	1/16" wheel collars	Tower Hobbies	GPMQ4300
2	ea.	Futaba S148 servos, modified (see text)	Tower Hobbies	FUTM0710
12	in.	0.075" dia. music wire	(local hobby shop)	
24	in.	1/32" dia. brass wire	(local hobby shop)	
1	ea.	BASIC Stamp I module	Parallax	BS1-IC
2	ea.	Stream Line 2 1/4" wheels	NW Model Dist.	NWMM100BLACK
1	ea.	4 AA-cell batt. holder	Radio Shack	270-391
3	ea.	1 Kohm, 1/4W resistor	Radio Shack	271-1321
1	ea.	36-pin male header	Digi-Key	929647-02-36-ND
1	ea.	GSP breadboard	Future/Active	GB2-120
8	ea.	2-56 1/2" flathead screws		
8	ea.	2-56 hex nuts		
1	ea.	5/16"x5/16"x1/32" plastic (see text)		

Make the second 66-degree bend about 11/32" away from the first bend, and the 90-degree bend about 9/16" from that bend. All three bends should lie in the same plane. Compare the dimensions of your work against Figure 3. Don't trim the ends to length until you have the angles and dimensions correct. You may have to try a couple times to get it just right.

The final bend is made with the "hook" of the strut clamped in a vise with the "bb" end vertical and pointing up, and the "aa" end of the hook pointing left. Bend the "bb" end away from you until it's 30 degrees off vertical.

It's important to come as close to the shape in the drawing as you can because there is only about an eighth of an inch clearance between the caster wheel and the battery holder.

Figure 4 shows how the wheel is held in place on the strut. The 1/16" shaft collar holes first have to be drilled out to 5/64" (don't forget to remove the setscrews before drilling!). Slide the collars and the caster wheel onto the music wire shaft at "aa," and adjust the collars so the wheel is centered with the caster spindle "bb" and is free to rotate. I align the setscrews so they all face the same direction for ease of setup.

Next, slide a shaft collar and the 5/16" plastic square (remember?) onto the caster spindle and loosely tighten the collar. Slip the whole assembly up into the hole in the breadboard and install the final shaft collar on top. Adjust the bottom collar up or down until the breadbot chassis is level, and tighten it in place, then adjust and tighten the top collar so that the caster wheel assembly is free to rotate 360 degrees. Check especially that the wheel clears the rear edge of the

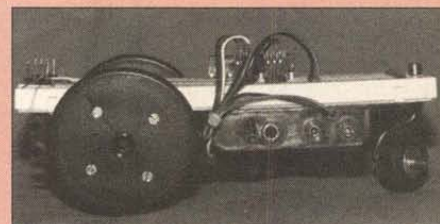


Photo 6. Side view showing the battery holder. Another cable tie secures the battery holder wires to the servo cables.

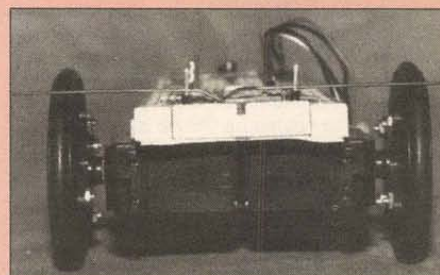


Photo 7. Head-on close-up of servos and whiskers ("bow tie" bumper removed for clarity).

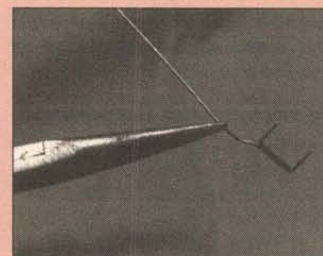


Photo 8. Close-up of the left whisker.

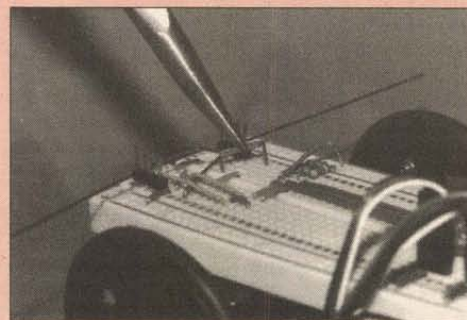


Photo 9. Installing the left whisker. The jumper wire visible to the right of the whisker is shown unconnected; in its final position, it lays over the left whisker lead to connect to the strip-line header for the right whisker.

battery holder when batteries are in place.



## Suppliers Mentioned:

### Digi-Key Corp.

701 Brooks Ave. South  
Thief River Falls, MN 56701-0677  
1-800-344-4539  
<http://www.digikey.com>

### Future/Active Electronics

Dept. FAC 4  
41 Main St.  
Bolton, MA 0170  
1-800-655-0006

### Northwest Model Distributing

21527 N.E. 227th Ave.  
Battleground, WA 98604  
1-360-687-9452

### Parallax, Inc.

3805 Atherton Road #102  
Rocklin, CA 95765  
1-888-512-1024  
<http://www.parallaxinc.com>

### Radio Shack

1-800-THE-SHACK  
<http://www.radioshack.com>

### Tower Hobbies

P.O. Box 9078  
Champaign, IL 61826-9078  
1-800-637-4989  
<http://www.towerhobbies.com/>

## Fabricating the whiskers

I'll finish off with more wire bending, this time for the left and right whisker sensors (the "bow tie" bumper will have to wait until next month). Fortunately, bending 1/32" brass wire is much easier than bending music wire.

Breadbot's whiskers solve the tricky engineering problem of how to make a cheap, sensitive, yet reliable bumper contact sensor. Usually this sort of thing is done with microswitches, which cost several dollars each, but these whiskers will cost only pennies to make.

The whiskers are designed to plug directly into the breadboard where they are connected to ground (see Photo 9). Each whisker is situated between the two rear-most pins of a four-pin header.

These pins serve both as mechanical stops and electrical contacts; their associated pull-up resistors are the only electronic parts on the breadboard aside from the BASIC Stamp controller. When a whisker touches something and deflects, contact is made, and the

pin is pulled low, signalling the controller that the whisker has sensed an obstacle. The "bow tie" bumper works in a similar fashion, though it uses the front two pins of the four-pin headers for its contacts.

Start by cutting two 6" and two 1" lengths of 1/32" brass wire. Bend the two 1" lengths into 90-degree L-shapes as shown in Figure 5. Leave them untrimmed for the time being.

For the 6" pieces, make the 90-degree bends first (leave at least 1/8" extra on the tails), and make the rest of the bends to match Figure 5. All of these bends should be coplanar.

Now trim the L-shapes so that when you solder them to the whiskers the pins are separated by 0.45" (this is the approximate diagonal distance between holes on the breadboard, two holes down, and four across).

Now comes soldering. Onto a piece of scrap wood, tape the L-shapes and the whiskers in the orientation shown in Figure 5. Dab the joint with a little rosin paste flux (not acid flux), and solder with silver solder to make nice strong joints. After the joints cool enough to handle, flip them over and repeat the process if needed to get a smooth joint. Trim the leads to their finished dimensions.

With the whiskers in the orientation shown, the final bends are made up from the figure. Make the bends (about 27 degrees) 13/16" from the ends with the solder joints. The headers plug into the last four rows of contacts (columns "a" and "f," rows 60-63, on the GSP board); the right whisker plugs into f-59 and j-57, and the left whisker plugs into a-57 and e-59. Adjust the bends until both whiskers are centered between their respective header pins and are horizontal and square with the breadboard.

### Next time

Well, I'm out of space. Next month, I'll finish up the mechanical details of Breadbot and show how to install the brain and program it. I'll also give some higher-performance alternatives to the BASIC Stamp controller. **NV**

Other breadboards than the GSP should also work fine to make a Breadbot. The Jameco JE23 (#20722) should work, as should the JDR PDS70 when combined with two PSD30 distribution strips. I haven't used either of these, but from catalog photos they appear to be the same breadboard. Just be sure they come with double-sticky foam on the underside, or be prepared to provide your own.

One commonly available breadboard that won't work as well, though, is the Radio Shack breadboard (#276-174). Its dimensions are different (it's shorter), it doesn't come with double-sticky foam, and it has only a single distribution bus on each side, which makes wiring more complicated. In contrast, the GSP breadboard has two distribution busses on each bus strip. Then, too, the GSP has the molded-in mounting boss for mounting the trailing cast wheel.

I may build a version of Breadbot using the Radio Shack breadboard in the future because it has the advantage that Radio Shack also carries a matching PCB that would allow me to directly transfer the design from the solderless breadboard to the PCB for a more permanent 'bot. This would be really handy for making a fleet of these machines to investigate group behavior among robots, and it would save money, too, since the PCBs cost \$2.99 each — one-third the cost of the solderless breadboards.

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2764-25	4.49	4.27	3.84
2764A-20	3.49	3.32	2.99
2764A-25	2.99	2.84	2.56
27C64-15	2.99	2.84	2.56
27256-15	4.79	4.55	4.10
27C256-15	2.99	2.84	2.56
27512-25	3.09	2.94	2.65
27C512-25	2.99	2.84	2.56
27C010-15	3.79	3.60	3.24
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7404	.29	.28	.25
7406	.27	.26	.23
7407	.33	.31	.28
7408	.33	.31	.28
7410	.19	.18	.16
7411	.55	.52	.47
7414	.27	.26	.23
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7473	.79	.75	.68
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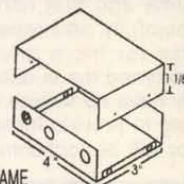
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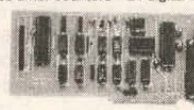
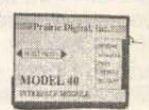
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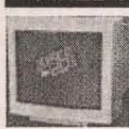
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# RESOURCE BIN

number seventy seven

## A look at accessing offshore electronics.

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### Offshore Electronics

Nearly all electronic parts are a lot cheaper from the Far East. Sometimes ridiculously so. Especially when you are buying, say, 100 or more custom double-sided and plated-through circuit boards. Where your costs can be one-third to one-fifth as much as purchasing locally. With worldwide express services, delivery might actually be faster than waiting around forever on an old line US parts distributor or on some uncaring local manufacturer.

How can you tap these sources? Is foreign involvement for you?

Firstoff, let's start off with some obvious warnings. If you do not know what you are doing, you are going to get eaten alive.

You probably do know enough to avoid those tiny "Make big money in import/export ads." Most of these old come-ons look exactly like the scams they almost certainly are. And the big time

stuff like those "Nigerian Bank Account" ripoffs seem only to fool the extremely greedy or the very gullible. This one is making the rounds once again, so it does seem to be working.

Often, foreign involvement will not be for you. I learned a long time ago that non-US response painfully and repeatedly caused me far more grief than it ever returned me in dollars. I personally have no foreign sales. No funding to provide foreign support has or will be forthcoming. Foreign E-

**NEXT MONTH:**  
Don shows us some star-tup secrets for your own web site.

Mail is ignored and any letters are returned unopened. My own view is that if you are a success here, you do not need any foreign sales. If you are not, the foreign sales will not help you in the least. Either way, I don't see any point in my seeking these out. Especially after the hassles and grief they have caused me in the past.

If you are genuinely serious about offshore electronics, it will be super important that you learn to speak the language and understand the local customs. Ferinstance, the word "yes" in Japan often does appear to mean something like "I have heard what you said and I understand where

you are coming from." In no manner does it mean anything even remotely like "I will definitely and quickly do what you ask." How something gets done seems more important than *what* is actually getting accomplished. Simple acts such as exchanging of business cards in the proper manner can be of profound and long-lasting importance.

In some other Pacific Rim nations, negotiations are *certain* to slowly grind you into oblivion. Taking forever and leaving absolutely nothing for you on the table. As far as bribery, *bakeesh*, or *mordita* go, the question is not if, but just when, how much, and in what manner. And directed only in those places that will do you the most good.

If you do have the opportunity to travel, the place to stop by is Japan's northeastern *Akihabara* district. This is your ultimate world class "radio row" of all time. Consumer electronic and computer bargains abound. One nice site is 203.141.89.34/japantravel. Even maps are included here.

At any rate, your 500-pound gorilla for finding offshore electronic parts and assemblies is ...

### Asian Sources Electronic Components

*Asian Sources* are a Philippine-based group of a dozen highly successful magazines on Pacific Rim suppliers for products and services. The mag you'd be most likely to want to look at initially is known as *Asian Sources Electronic Components*.

This one is an ongoing fat monthly mostly-ads magazine 600 pages or so. It is usually Japanese, Korean, and Hong Kong offerings for electronic parts. Since the technical content itself is pretty much vapid surveys and a "boom-rah" boosterism, all your real value here lies in the ads and the contacts they provide for you.

Typical recent editorial coverage was on clock radios, RDS receivers (a somewhat languishing method to add digital time, weather, song, artist, call letters, and emergency alerts to FM broadcasts), oversize television sets, language translators, handheld mikes, speakers, and child monitors.

These people also do offer several free finder services. These include a *SourcesFAX* form, a 3-in-1 inquiry form, online support, CDROM, and their personal customer feedback.

One way or another, you tell them what components you are looking for, and they will come up with sources. Not surprisingly, all their magazine advertisers appear

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**Asian Sources**  
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**Audio Amateur**  
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(603) 924-9464

**Bentley Auctioneers**  
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**CMP Publishing**  
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**Compliance Engineering**  
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**CRC Press**  
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Boca Raton FL 33431  
(800) 272-7737

**EE Times**  
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**Electronic Components**  
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(847) 475-1900

**Electronic News**  
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Southeastern PA 19398  
(215) 630-0951

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**Heathkit**  
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**Oxbridge**  
150 5th Ave #202  
New York NY 10011  
(212) 741-0231

**Panel Components**  
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(800) 662-2290

**SW Auction Weekly**  
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(602) 994-4512

**Synergetics**  
Box 809  
Thatcher AZ 85552  
(520) 428-4073

**TTA Communications**  
12 Falcon Gate Dean Rd  
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44 (0) 1454 318 722

**Ulrich's Dictionary**  
121 Charlton Rd  
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**Wireless World/EW**  
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you can find an existing copy of an Asian Source pub, there may be a card or two for a free sample of another title in it. By being patient enough and by carefully using these cards, you can scan all their mags.

Web site is [www.asiansources.com](http://www.asiansources.com).

### Related Pubs

Actually, *Asian Sources* consists of a bunch of different magazines. You might find some of their other titles of interest as well ...

**Computer Products**  
**Electronic Components**  
**Electronics**  
**Fashion Accessories**  
**Gifts & Home Products**  
**Hardwares**  
**Multimedia Products**  
**Telecom Sources**  
**Timepieces**  
**Trade & Travel**

The main difference between their electronic titles is that *Electronics* is whole systems such as TV sets, DVD players, boom boxes, and whatever, while *Electronic Components* are all the bits and pieces of circuit boards and individual components and minor assemblies. Their "hardwares" title is for drill presses and hinges and the rest of the stuff you'd expect to find at your local hardware store.

Their newest *Trade & Travel* mag bills itself as "The business and travel magazine for international traders," despite its still skimpy size, this one does appear to have bunches of useful content. Of particular interest is their ongoing *Asian Trade Show Calendar*.

### Some Directories

Those CRC press folks have been around for a long time. They are the ones who bring you the *Handbook of Chemistry and Physics* and companion standard reference titles. Their latest free *Everything in Electrical Engineering* flyer lists all sorts of titles. Including offshore access directories ...

**Singapore and Malaysia Electronics Industry**, by Michael Pecht, Donald Beane, and Anand Shukla. 1997, 128 pages \$39.95.

**Electronics Industry in Taiwan**, by Chung-Shing Lee and Michael Pect. 1997, 176 pages \$39.95.

**The Korean Electronics Industry**, by Joseph Bernstein, Damion Searls, and Martin Peckerar. 144 pages \$39.95.

I have added access links for these titles to [www.tinaja.com/amlink01.html](http://www.tinaja.com/amlink01.html).

### International Magazines

Most technically-oriented countries offer at least a few of the electronic magazines. For years and years, the best anyplace ever was the British *Wireless World*. Which long ago did get combined into *Electronics World*. While a shadow of its former self, this one still features its useful mix of understandable and useful hands-on construction projects intelligently combined with more advanced, yet clearly explained topics.

The Dutch have *Elektor Electronics* which does remain a great hobby construction mag. A few years back, there was a US version, but

this mag apparently folded for lack of enough advertising support. Possibly the *Audio Amateur* still does have a few odd copies remaining.

The *CMP Publishing* folks are well known here for their *E.E. Times* and *Computer Reseller* trade journals, plus many others. It turns out they also have a lot of international titles ...

**Cabling & Networking** (Italy)  
**Design & Elektronik** (Germany)  
**E.E. Times Taiwan** (Taiwan)  
**Electronic Engineering** (England)  
**Electronic Times** (England)  
**Elektronik i Norden** (Scandinavia)  
**Markt & Technik** (Germany)  
**Micro Electronics** (Taiwan)  
**Mundo Electronico** (Spain)

**Nikkei Electronics** (Japan)  
**PCB International** (EEC)  
**PCB Magazine** (Italy)  
**Productronica** (Spain)  
**Selezione Di Elettronica** (Italy)  
**Technologies Magazine** (Israel)  
**What's New in Electronics Europe**  
**What's New in Electronics UK**

Here's a listing of some of the other international technical trade journals from a stunning variety of worldwide publishers ...

**Asia Computer Weekly**  
**Audio-Video International**  
**Australian Electronics Engineering**  
**Asian Electronics Engineer**  
**Business Travel Asia Pacific**  
**Canadian Electronics**  
**Currency Alert: Asia**  
**Currency Alert: Latin America**  
**EDN Asia**  
**EDN China**  
**EDN Europe**  
**EIC Electronique**  
**Electronic Business Asia**  
**Electronic Commerce Report**  
**Electronics & Comm in Japan**  
**Electronics Foreign Trade**  
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# RESOURCE BIN

## Global Electronics Int'l Jnl of Electronic Commerce Japan Consumer Electronics Scan Pacific Telecommunications Test & Measurement Europe TWICE

Way over on the non-technical side, *International Business* can be a useful trade journal. Subtitled *Strategies for the Global Marketplace*. It is from *New Media Publications* and their website is at [www.internationalbusiness.com](http://www.internationalbusiness.com). And *Upside* is a Silicon Valley Yuppie tech management mag that occasionally has useful international info in it.

## Technical Support

A number of firms offer offshore assembly that gets combined with US engineering and technical support. These folks tend to advertise in such trade magazines as *Electronics News* or *Electronic Buyer's News*.

One random sample example is *All Shore Industries* at [www.allshore.com](http://www.allshore.com). Their specialties do appear to be PC boards and assemblies combined with global sourcing and procurement.

One resource for strong technical support on most anything involving international cord sets and connectors is *Panel Components Corporation*. These folks have a fat catalog chock-full of international power specs.

As usual, really fine information on international standards can be found in *Compliance Engineering*.

Most of the main package delivery services offer international services. Your obvious starting point here will be [www.ups.com](http://www.ups.com).

## Some Additional Web Sites

A nice collection of international web sites hosted by *Arizona Central* appears at

[www.azcentral.com/community/azmex/amcintweblinks.shtml](http://www.azcentral.com/community/azmex/amcintweblinks.shtml).

Some of their links include ...

Asia Development Bank  
Bureau of Export Administration  
Census Bureau  
Environmental Protection Agency  
Export Legal Assistance Network  
International Monetary Fund  
International Standards Org  
International Trade Administrations  
Japan External Trade Organization  
National Trade Data Bank  
Phoenix Export Assistance Center  
SCORE Program  
Trade Compass  
Trade Point USA's I-Trade  
Trade Port  
NABank  
NAFTA Small Business Information  
United Nations Trade Development  
US Agency for Int'l Development  
Virtual Africa

Arizona Central gets involved with that *Arizona-Mexico Commission* where you can find more information on the *Maquiladora* and its related twin-cities programs. These let you combine US engineering and "offshore" assembly.

They might also provide you with useful consultant referrals.

A potentially interesting web site that targets international telecomm is the *Open World Markets* site from *TTA Communications*. They bill themselves as the "world's first online technical information service for international telecommunications manufacturers." Their web site is [www.ttau.com](http://www.ttau.com). This one is a fee-based service.

Yet another useful resource is at [www.asia-inc.com](http://www.asia-inc.com). Their site includes Far East business news, along with a searchable data-

base plus an Asian Internet directory. For more personal business news, job hunting, and for extensive online links, you might also want to check [www.asiaville.com.sg](http://www.asiaville.com.sg).

The content at [www.chinabig.com](http://www.chinabig.com) is a comprehensive online Yellow Pages and bilingual resource.

Finally, look into [www.asiatrade.com](http://www.asiatrade.com) that claims to have everything in Asia from travel to insurance, import to export, conventions to banking. Even online betting.

## This Month's Contests

For our contests this month, just tell me about a useful foreign electronics access resource I don't already know about. Or tell me some horror story which involves you and an offshore whatever. Please skip the "Are you bringing anything back?" "I hope not." jokes. Or else add to our technical education dialog.

There should be a largish pile of my new *Incredible Secret Money Machine* 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.

To be fair to everyone, all entries must be written and submitted via snail mail. Send all your written entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial.

## Further Help

A reminder that one of the best ways to find info on any magazine anywhere in the world is by way of the *Oxbridge Media Finder* stashed at [www.mediafinder.com](http://www.mediafinder.com). If that one does not work, and if the usual web tools don't help, there's always good old *Ulrich's Periodicals Dictionary* on the reference shelf at your local library. I sure do hope that Ulrich's eventually gets freely on line. So far, they haven't the foggiest clue that they've already clearly been done in by an aggressive "free info" online stance at Oxbridge. To me, Ulrich's clearly seems about to become roadkill.

One good source for book info is *Amazon Books*, <http://www.amazon.com>. Once again, *Books in Print*, as your original horse's whatever source seems to be in dire jeopardy because of their lack of free online support.

I guess there's an obvious hidden message buried somewhere here. One of the big reasons that you have to even think about going offshore for electronics parts and products is the utterly abysmal lack of electronics education in the US.

Very few high schools offer anything at all in the way of electronics training. Trade schools largely have dried up as their federal subsidies vanished. Some that remain are of questionable quality. Quite a few community colleges are either discontinuing their electronics programs outright or sharply cutting back on them. Caused mostly by the aerospace downsizing a decade ago.

Lots of old-line distributors have now made it outrageously

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difficult to cheaply pick up a few parts. But new sources such as [www.questlink.com](http://www.questlink.com) do seem to be picking up on the slack. Heathkit is pretty much gone as a personal learning resource. Although they still do host quality educational electronics on a low profile basis.

Electronic kits in general are largely in disarray. For the simple reason that nobody knows how to solder any more. Other more informal technical education sources (such as ham radio clubs) have pretty much lost much of their relevance.

To me, all of this is shooting your seed corn in the foot. It also seems monumentally and incredibly short-sighted. One useful side effect: there are now mind-boggling great auction buys as the schools fold their classes. See the [www.auctionadvisory.com](http://www.auctionadvisory.com) link from Southwest Auction Weekly and others on [www.tinaja.com/beewb01.html](http://www.tinaja.com/beewb01.html) for the latest auction info. Or the great Bentley's Auctions link you'll find on [www.tinaja.com/dntkb01.html](http://www.tinaja.com/dntkb01.html). These fine people at Bentley can be your ultimate source for quality electronic test gear. Offered by the semi load.

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**M**icrocomputer pioneer and guru Don Lancaster is the author of 35 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 unique products and resource secrets. The best calling times are 8-5 on weekdays, Mountain Standard Time

Don is the webmaster of his Guru's Lair found at <http://www.tinaja.com/tinaja>. 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 [don@tinaja.com](mailto:don@tinaja.com).

the insider electronic auction secrets. Or do visit [www.barg01.html](http://www.barg01.html) for all of the goodies themselves.

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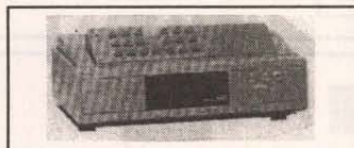
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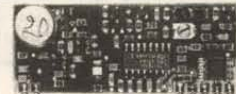
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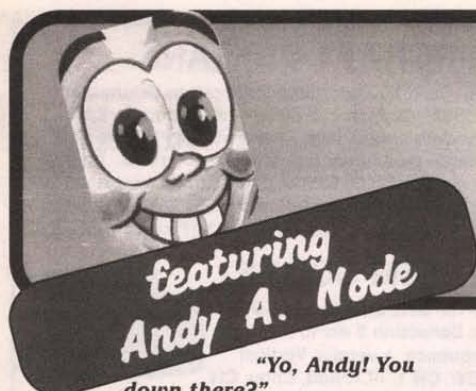
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featuring  
Andy A. Node

# THE WEEKEND WORKBENCH

## Andy Builds An IR Switch

Don't clap — zap that light on/off with your VCR remote

"Yeah, come on down. Wait, let me get the lights."

"How did you turn on the stairway light without getting up, and what's that beeping noise?"

"It's my latest project, an infrared 'clapper.'"

"But it sounds like beeping, not clapping."

"Not that kind of clapping. Instead of clapping my hands to activate a remote-controlled switch, I'm using infrared emissions from my VCR's remote control to turn the light off and on. Watch. Press the power button once, and the light comes on. Press it again, and the light goes off. The beeping sound you hear is a piezo buzzer that sounds off when the infrared light is detected — the same invisible light that triggers the switch."

"Can you use the channel buttons to control different lights?"

"I could, but I kept this project simple. No matter which VCR button I push, the results are the same. Once on, once off. By simply detecting the presence of an infrared beam, and not its embedded code, I can use my TV or stereo remote — or almost any handheld remote — to activate the switch, too. Here, try it. Decoding the keypad takes a lot more circuitry, which could turn this one-night project into a semester project. Maybe someday in my spare time ..."

## Construction

Hi everybody! It's good to be back. When I first started working on this project, I went to Radio Shack and bought up every IR (that's the handle the experts use when referring to infrared) item they had on the shelf. You know, phototransistors, LEDs, and matched optical devices. My intent was to start from scratch and build the ideal IR system.

Well, as Robert Burns (the Scottish poet) once said, 'The best laid schemes o' mice and men /Gang aft a-gley.' Loosely translated, it means that unforeseen factors often prevent us from attaining our goal. This was my case. Not only was the part count increasing at an alarming rate as the design progressed, but it was becoming increasingly unstable.

Back to the drawing board and my parts catalogs. Here's where I

discovered the elegant solution, the GP1U52X IR detector module. This little 40-KHz IR detector — available from nearly all mail-order outlets and Radio Shack — reduces the circuitry needed to detect IR signals to a single three-lead device. (The module actually comes in three different frequency ranges from 32 KHz to 40 KHz, so shop around for one that fits your IR remote.) I quickly plugged this module into my design and breathed a sigh of relief. A couple tweaks here and there to reduce interference from room lights, and voila! I was in business (Figure 1).

The printed circuit board for my project is hardly bigger than a Priority Mail (\$3.00) postage stamp and mounted on it are the tin-can IR module, two ICs, and a half-dozen smaller components. You can find a copy of my design on our Web site (<http://www.nutsvolts.com>) under the name IR\_RELAY.ZIP. The file contains a complete schematic, foil pattern, board layout, and a parts list.

You'll notice that I broke the design into three parts (that's because the plastic box held three circuit boards). This project consists of three well-defined stages (Figure 2). First,

**Kids and beginners** — be sure and have someone help you with the final installation of this project if you intend to hook it up to an AC light switch. This should *only* be done by a qualified person!!

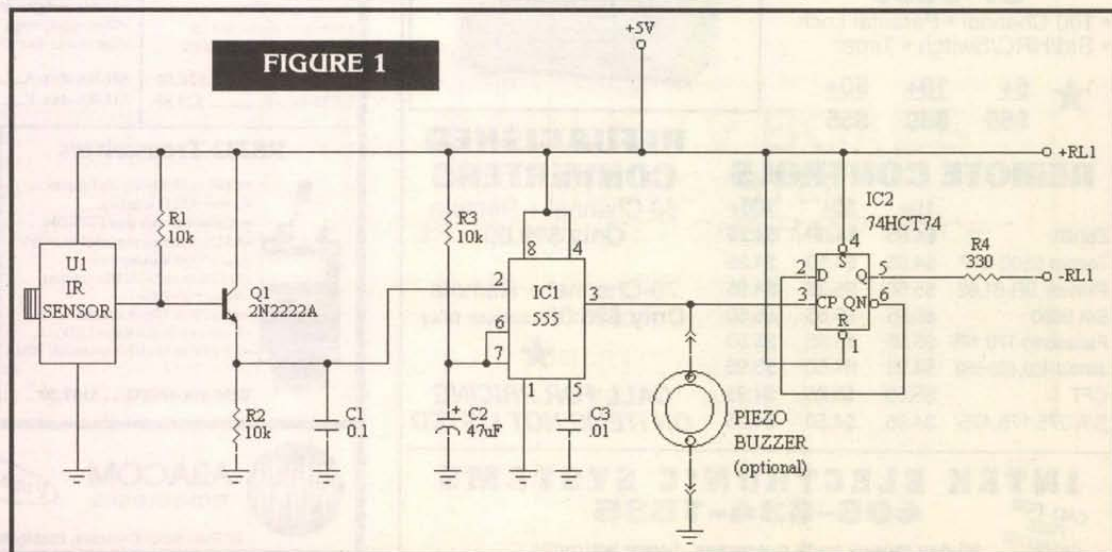
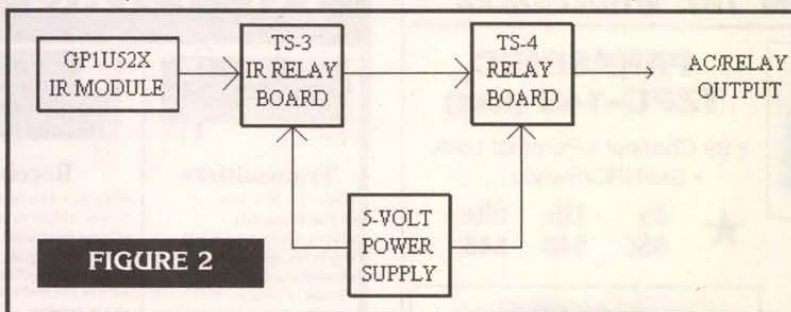
there's the sensor, followed by a relay and, of course, a power supply. You can build the IR switch using a separate board for each stage, as I did, or you can place all three side-by-side on one circuit board.

## Detector Module

The heart and soul of the switch is the GP1U52X IR receiver/demodulator (see "How It Works"). While using these detector modules seems straightforward, there are a few bumps along the way. The single most important construction detail involves the metal case, which must be grounded. If you don't tie the case to ground, you'll get extraneous signals that'll trigger the relay when you least expect it. If your controlled device is something like a light bulb, it's just an annoyance. But if you are controlling a motor or have incorporated the circuit into your latest robotics, these surprises are no fun.

I also noticed that the IR detector is quite sensitive and it can be easily overwhelmed by stray sunlight or room lights. Halogen lamps are especially offensive. While I've been able to filter out most of this unwanted interference using a simple RC filter, there are situations where ambient light reduces the sensor's range to mere inches.

The obvious solution is to





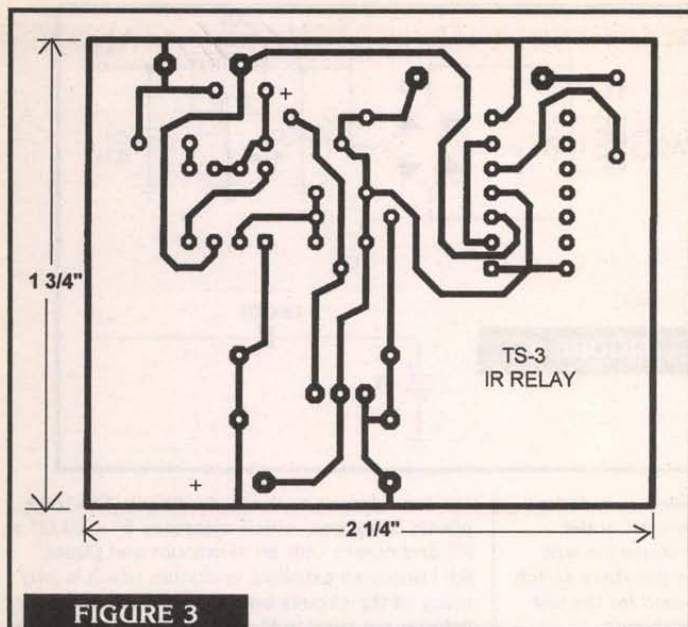


FIGURE 3

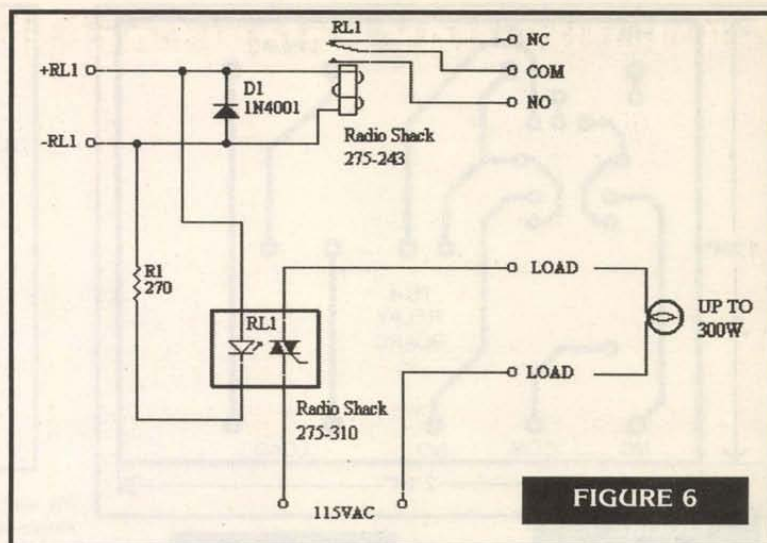


FIGURE 6

light a lot.

Another thing I noticed in my experiments is that the black plastic case you see here — the one I bought from Radio Shack — is also transparent to IR. I didn't realize it until I started positioning the circuit boards inside the box and aligned them so that the IR detector would face outward. When I put the cover on the box for fitting and zapped it with my VCR remote, I was shocked to hear the beeper chirping. I hadn't even cut out the window hole yet!

As it turns out, many products that we think are light tight are plate-glass windows to IR. Anyway, I toyed with this for a while and discovered the cabinet to be a perfect IR filter for short distances. The unshielded range of the detector is about 30 feet, give or take a couple feet depending on the power of the remote, whereas the range of the sealed

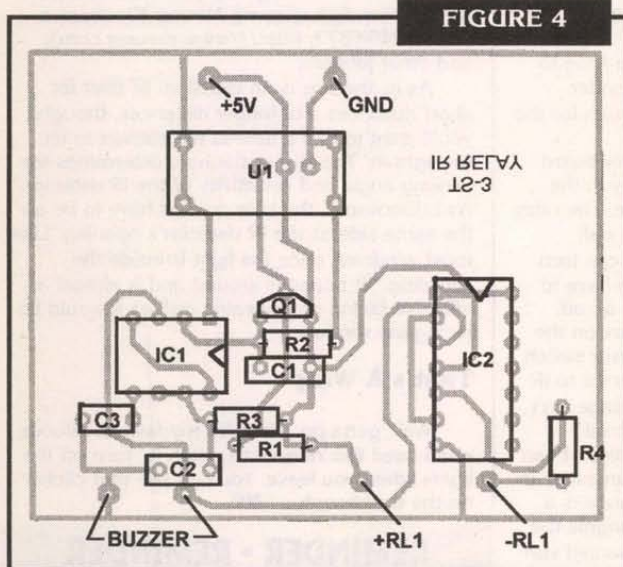


FIGURE 4

## Relay Output

You'll notice in my design, the relay is off the detector board. I did this to have a wider variety of switching options, as shown in Figure 5. The mechanical relay can handle 2A, while the solid-state relay and triac can handle 3A (300W) and 6A (600W), respectively.

R3 is a current-limiting resistor for use with the solid-state devices. When driving a coil relay, though, you need to short out R3 with a jumper wire and add a damping diode across the winding. Of course, you can use the open-collector TTL output to drive any load you wish up to about 10 mA.

I use relays in my designs so often that I've made a separate relay card. It's like a staple ... you know, flour and salt. I simply pull a relay board off the shelf and slide it into a slot in the cabinet. The card contains two relay devices. One is a five-volt mechanical single-pole, double-throw (SPDT) relay and the other is a single-pole (SPST) AC solid-state relay. Both are from Radio Shack.

You can duplicate my relay card (Figure 6) using the foil pattern and parts layout shown in Figure 7 and Figure 8. While my relay boards host both devices, you don't have to. The mechanical relay sells for \$2.99 and the solid-state relay sells for \$6.99. The cheaper relay works with both AC and DC at 2A, and the more-expensive solid-state relay can handle AC only. In my original design, there's a three-pin berg connector (the same kind used to set the CPU speed on motherboards) to select between the two relays. For my projects, I simply insert a jumper wire in place of J1.

## Power Supply

If you opt for the triac as a switch, pay attention to this caution: **This configuration connects to the AC power line, so you have to isolate the five-volt power supply to prevent sparks.** A small transformer-isolated power supply (Figure 9) is the logical choice. This circuit is nothing more than a full-wave rectifier housed in a small DIP chip, a 78L05 linear voltage regulator, and a couple capacitors. One of these days, I'll get around to putting this on a printed circuit board, too, but for now I have it on a perf board.

The alternative is a battery pack made up of four cells or a wall transformer. The current drain is just 3 mA, which means an alkaline "AA" cell will last about a 1,000 hours. That's equal to about 40 days and 40 nights. Four "C"

eliminate the unwanted light using an IR filter. You can make a cheap IR filter using exposed film leaders from old color negatives. While these black strips are opaque to ordinary light, they are nearly transparent to IR light. A couple layers of this film cut to size and placed over the grill of the IR detector tames the ambient

black box is five feet.

While I took the time to fabricate a printed circuit board (Figure 3 and Figure 4) for my IR detector, the circuit layout isn't critical and you can use any construction method you like. Just make sure to ground the GP1U52X's metal case.

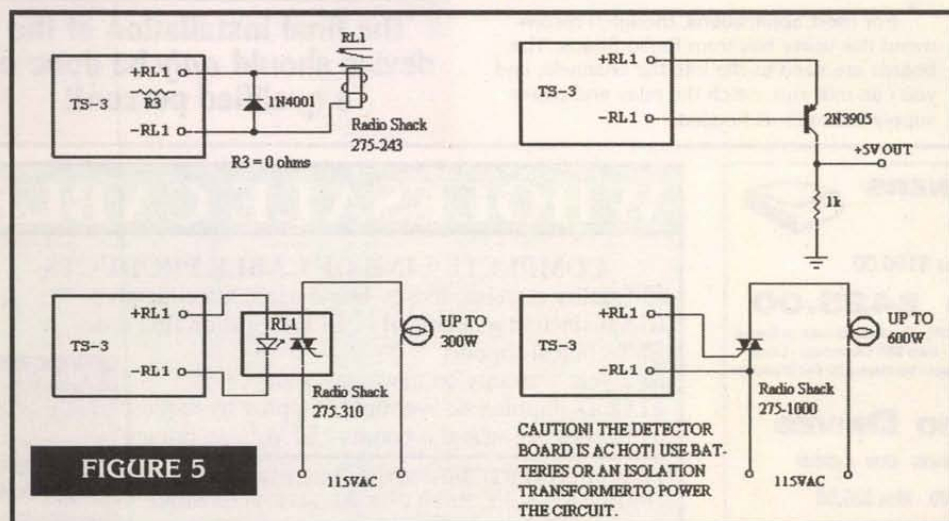


FIGURE 5



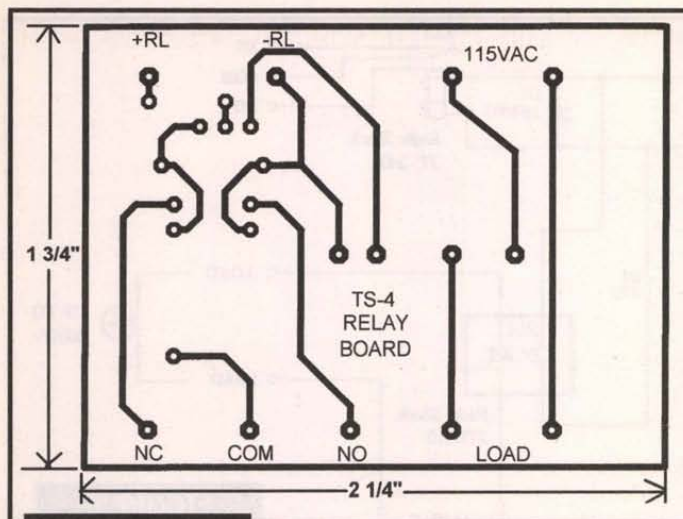


FIGURE 7

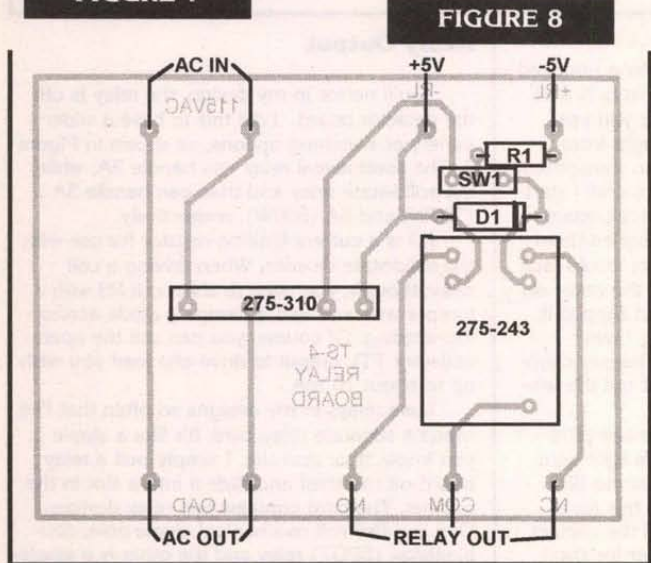


FIGURE 8

cells will tow the line for 100 days and "Ds" will get you from January to August. Should you decide to use a battery pack, you must insert a diode in series with the batteries (Figure 9 again). The diode has a 0.7-volt voltage drop across it, which reduces the 6.8 volts of a fresh battery pack to an acceptable 6.1 volts. (The  $V_{cc}$  limit of the IR detector module is 6.3 volts.) It would be wise to filter the output of a 5V, 300 mA wall transformer with a 470 uF capacitor.

easily turn on and off the light from anyplace in the workshop. Actually, the limited range is a plus because the VCR remote won't toggle the workshop lights when I'm upstairs channel surfing.

For most applications, though, I recommend this utility box from Radio Shack. The boards are sized to slip into the channels, and you can mix and match the relay and power supply modules as needed.

My wall switch included a single-socket AC outlet, which is why I chose the wall transformer for the stairs switch and the perf-board for the test unit on the workbench.

### Give Me A Home ...

The last thing we have to do is button it up. Wonder where I hid the IR switch for the stairs light?

I put the IR sensor board and a solid-state relay in the switch box over there. The relay is paralleled with the wall switch so that either can turn on the light, but both have to be off for the light to be off.

Like the black box on the bench, the plastic cover switch plate is fairly transparent to IR light, and while the range isn't as great as it would be if I drilled a hole in the plate, I can

I'm referring to the Radio Shack 270-1803 plastic utility box, which measures 5" x 2-1/2" x 2", and comes with an aluminum and plastic lid. I find it an excellent enclosure which is why many of the circuits boards you'll find in this column are sized to fit in this case. You can buy a similar box from Digi-Key (1-800-344-4539; <http://www.digikey.com>), Mouser Electronics (1-800-346-6873; <http://www.mouser.com>), and other jobbers.

As is, the box is an excellent IR filter for short distances. For longer distances, though, you'll want to drill a hole in the cabinet to let the light in. The size of the hole determines the viewing angle and sensitivity of the IR detector. As I discovered, the hole doesn't have to be on the same side as the IR detector's opening. Like most windows, once the light is inside the "building," it bounces around and is almost as effective facing an opposing wall as it would be facing the window.

### That's A Wrap

Well, gotta go. Time for my favorite sitcom, and I need this remote to watch it. Turn off the lights when you leave. You can use that clicker on the workbench ... NV

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**The final installation of the device should *only* be done by a qualified person!!**

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## How It Works

At the heart of our IR switch is a GP1U52X infrared receiver/demodulator module (Figure 10). This module is a hybrid IC designed for use as an IR detector for TVs, VCRs, and audio components. The GP1U52X uses a PIN photodiode that has a peak sensitivity in the near-infrared range (940 nm). Near-infrared means it's very near the visible spectrum and can be seen by some birds and bees, but is invisible to us.

A PIN diode differs from rectifier diodes in that there is an insulating layer between the P-doped and N-doped junctions. The thickness of this insulating layer is such that it's extremely sensitive to near-infrared light, and the stronger the light source, the less effective this layer is at insulating. The more intense the light source, the greater the current flow.

The output of the PIN diode is processed by a special integrating amplifier that separates the ambient light from the IR signal. Critical to the separation of ambient light and signal is a band-pass filter that rejects all signals outside the bandpass of 40 KHz. The cut-off points are 38 KHz and 42 KHz, which spans the range of the majority of handheld remote controls. Following the filter is a rectifier circuit — made up of a diode, integrator, and comparator — that turns the 40-KHz burst into a logic high output.

Most remotes have a code that identifies the button pressed. Well, we're not impressed. That is, we don't care which button is pressed, just the fact that a 40-KHz signal is present. This causes a lot more trouble than you'd first think. Unless this code is ignored, the switch has the equivalent of Tourette's Syndrome, with spastic changes in the controller caused by the logical equal of Morse code dots and dashes — and cursing. So I fed the output of the already heavily-filtered IR signal through another filter. This filter consists of two parts: R2 and C1, and IC1, a 555 monostable timer (Figure 1).

Normally the 555 is triggered by a negative-going pulse. What is little known is that the input of this chip is a voltage-triggered comparator — not an edge-triggered logic input. What I did was insert an RC filter driven by Q1 on the trigger (pin 2). When a 40-KHz signal is detected, the open-collector output of Q1 turns on and Q1 turns off, which causes C1 to discharge through R2. When the voltage reaches  $1/3 V_{cc}$ , the 555 triggers. This prevents false signals from the remote's coding.

The output of the 555 goes to a CMOS flip-flop. Tickle it once, and it's on; tickle it again, and it's off. Beyond this we have the relay, which can be any of many choices (Figure 5). The mechanical relay option switches both AC and DC currents up to two amps. The solid-state relay can handle three amps, but its triac switcher is an AC-only device. The triac version is tied to the AC line, so pay heed to the caution in the text.

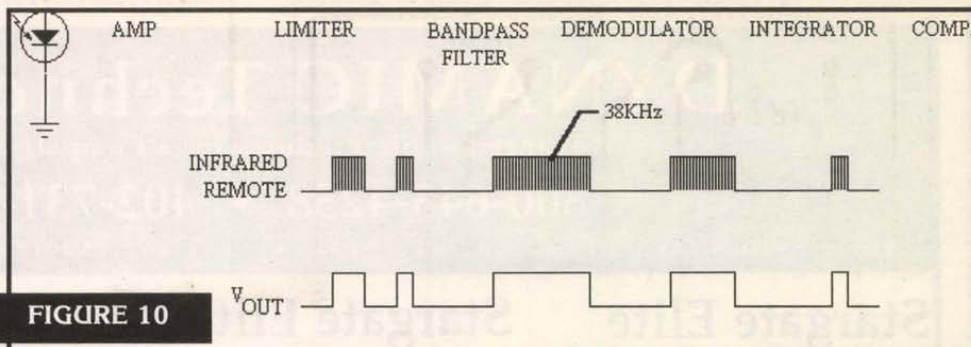


FIGURE 10

### Parts List: IR Detector

Reference	Description	Digi-Key	Radio Shack
<b>Semiconductors</b>			
IC1	LM555	LM555CN-ND	276-1723
IC2	74HCT74	MM74HCT74N-ND	276-2816
Q1	2N2222A	2N4401-ND	276-2058
<b>Resistors</b>			
R1,R2,R3	10K	10KQBK-ND	271-1335
R4	330	330QBK-ND	271-1315
<b>Capacitors</b>			
C1	0.1uF	EF1104-ND	272-1069
C2	47uF	P5230-ND	272-1027
C3	0.01uF	EF1103-ND	272-1065
<b>Misc.</b>			
U1	GP1U52X	LT1060-ND	276-137
Piezo buzzer	See text	P9966-ND	273-060
Cabinet	See text	HM104-ND	270-1803

Note: An etched and drilled printed circuit board is available from Circuit Design, P.O. Box 5415, Central Point, OR 97502 (541-664-7904; <http://www.cdsnet.net/Business/circuits/>). The price is \$6.00 plus \$1.00 S/H (\$3.00 for Priority Mail). Request part number TS-3.

### Parts List: Relay Board

Reference	Description	Digi-Key	Radio Shack
<b>Semiconductors</b>			
D1	1N4001	1N4001GICT-ND	276-1101
<b>Resistors</b>			
R1	270 ohms	270QBK-ND	271-1314
<b>Misc.</b>			
RL1	SS Relay	GH7002-ND	275-310
RL1	5V, SPDT relay	Z100-ND	275-243

Note: An etched and drilled printed circuit board is available from Circuit Design, P.O. Box 5415, Central Point, OR 97502 (541-664-7904; <http://www.cdsnet.net/Business/circuits/>). The price is \$6.00 plus \$1.00 S/H (\$3.00 for Priority Mail). Request part number TS-4.

### Parts List: Power Supply

Reference	Description	Digi-Key	Radio Shack
<b>Semiconductors</b>			
D1	FW rectifier	DF01M-ND	276-1161
IC1	78L05	NLM78L05FA-ND	276-1770
<b>Capacitors</b>			
C1	47uF	P5230-ND	272-1027
C2	0.1uF	EF1104-ND	272-1069
<b>Misc.</b>			
T1	12V, 300 mA	T309-ND (see text)	273-1385B

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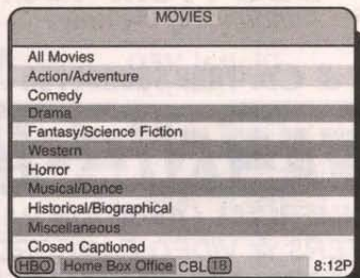
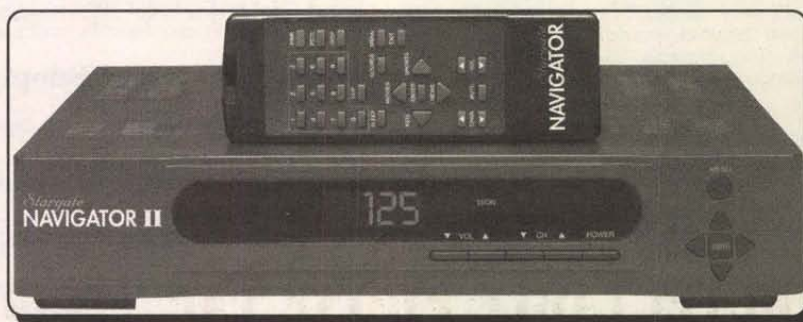
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# C Pointers and Linked Lists

This article helps you understand pointers and provides linked list code that you can use in your own applications.

by Jeff Stefan

**P**ointers, dynamic memory allocation, and linked lists can be confusing even to some advanced C programmers, and most beginning programmers avoid them at all costs (I know I did). There's some mental tricks you can use in order to understand these advanced concepts and use them to your advantage. In order to overcome these sometimes bewildering aspects of C, you have to learn to think like a compiler.

## Basic Pointers

You've probably heard it a thousand times: a pointer holds a memory address. Think of a memory address as a mailbox. The mailbox is at a fixed address, and never changes. What goes in the mailbox changes (new mail goes in and out). That's the data. Here's when it's convenient to think like a compiler.

When you declare a variable in your program, such as an integer variable `MyVar`, the compiler needs to put it somewhere. It has a lot of addresses to choose from, so it picks one and tags it with the name

`MyVar`. When the program runs, `MyVar` can hold many different values, but its address never

changes, as shown in Figure 1.

In our example, address `0xFFFF2` is the address that the compiler assigns to `MyVar`. Storage for variables like `MyVar` is reserved at compile time, which implies that the programmer knows how much storage the program needs when it runs. This is fine for single variables like `MyVar`, but what about situations where file data needs to be read, and you don't know in advance how many data elements are contained in the file? This is where pointers, dynamic memory allocation, and linked lists come into play.

	Address	Data
<code>0xFFFF2</code>	<code>MyVar</code>	
<code>0xFFFF0</code>		
<code>0xFFEE</code>		
<code>0xFFFF</code>		

Data goes in and out of `MyVar`, but the address of `MyVar` never changes.

FIGURE 1

`int *ptr1;` Step 1: the compiler finds the name `ptr1`

↑

`int *ptr1;` Step 2: the compiler finds a semicolon. This means it's at the end of the expression and can only move left.

↑

`int *ptr1;` Step 3: moving left, the compiler finds a `*`, indicating that `ptr1` is a pointer.

↑

`int *ptr1;` Step 4: the compiler moves right again and finds the semi-colon.

↑

`int *ptr1;` Step 5: moving left, the compiler finds `int`. The compiler now knows that `ptr1` is pointer to an integer.

FIGURE 2

So what are some of the things pointers are good for? For one, pointers allow you direct access to memory and require fewer machine instructions than non-pointer code. Look at the listing of the pointer code example, `cpoint.c`. The program declares three variables:

```
int MyVar1 = 0;
int MyVar2 = 0;
int MyVar3 = 0;
int *ptr1;
int *ptr2;
int *ptr3;
```

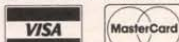
`MyVar1` through

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```

/*****
 * non-pointer method of accessing Buffer elements using
 * index variable.
 *****/
printf("\nBuffer access using index variable\n");
for(i=0;i<10;i++)
{
    printf("%c",Buffer[i]);
}

```

**FIGURE 3**

MyVar3 are declared in the usual way, but the pointer declarations \*ptr1 through \*ptr1 are different. The variable names have a star in front of them. This tells the compiler to reserve storage a pointer, and that's all. We declared the pointers to be of type int, but this does not mean that ptr1 through ptr3 are integers! We've just informed the compiler that we intend to have the pointers hold the addresses of integers. If we wanted the pointers to access characters, floats, or structures, we would have declared them as such.

What does the compiler do when it sees a declaration like \*ptr1? It applies what's called the right-left rule. Here's how it works. At compile time, the compiler first reads a line from your program text, encountering the line int \*ptr1;. Once it has the line of program text in memory, it looks for the variable name. It finds ptr1, and saves that in a data structure called a symbol table. Then it scans to the right, looking for any additional information regarding ptr1. It finds a semicolon, so now it moves to the left of ptr1 and finds a \*. The compiler now knows that ptr1 is a pointer, but it does not yet know what data type ptr1 will point to. It moves again to the right and finds the semicolon, then moves to the left again to find int. Now the compiler can complete the

entry in the symbol table for ptr1. The compiler now knows that ptr1 is a pointer to integers. Figure 2 illustrates the right-left rule for int \*ptr1. You can read any complex declaration by using the right-left rule.

The pointers are now declared, but they aren't pointing to anything useful.

In fact, the pointers are pointing to random locations in memory. An uninitialized pointer is probably the most dangerous thing in a C program. It's like having a loaded gun with a hair trigger and randomly pointing it into a crowd. That's why we initialize the pointers to the addresses of MyVar1, MyVar2, and MyVar3 right away. This is done by the lines:

```

ptr1 = &MyVar1;
ptr2 = &MyVar2;
ptr3 = &MyVar3;

```

The ampersand is called the "address of" operator, and gets the address of a variable. Now that the pointers point to the same addresses as the variables, we can easily get at the variable's data by using the star operator, denoted as \*. Pointers are so useful because you can get at a variable's data with very little code.

If you compile and run cpoint.c, you can see how the addresses and values are assigned to the pointers. The program then uses the pointers to swap the values held in the MyVar variables.

Here are the rules when using pointers

as shown in cpoint.c:

1. To declare a pointer, use the start operator, \*, as in int \*ptr1.
2. To assign an address to a pointer, use the & operator on the right hand side and don't use any operator on the pointer side, as in ptr1 = &MyVar.
3. To get the data the pointer points to, use the \* operator again, as in printf("the value of ptr is %d", \*ptr).

Single step through the code a few times to get a feel for how these simple pointers work.

## Pointers and Arrays

Pointers are especially useful when scanning an array or buffer. The program listing for bufscan.c illustrates two methods of scanning an array. The first method uses an index variable to access array elements, and the second method uses a pointer. As shown in Figure 3, the index variable i is used in a for loop. Think about what the compiler needs to do. To execute the for loop, the compiler must first access the address of i and increment its value in the for loop. To

```

/*****
 * Set pointer to start of buffer and print values
 *****/
printf("\nBuffer access using pointer\n");
ptr = Buffer;
while(*ptr)
{
    printf("%c",*ptr++);
}
printf("\n");

```

**FIGURE 4**

```

/*****
 * Filename: cpoint.c
 * Description: Simple C pointer demo program. This program
 *              shows how to swap values using pointers.
 * (c) 1997 Jeff Stefan
 *****/
#include <stdio.h>
#include <conio.h>

void main(void)
{
    int MyVar1 = 0;
    int MyVar2 = 0;
    int MyVar3 = 0;
    int *ptr1;
    int *ptr2;
    int *ptr3;

    clrscr();
    /*****
     * Right now, the pointers are pointing to random
     * locations in memory (uninitialized pointers). This is
     * the most dangerous state a pointer can be in. It's
     * like holding a loaded gun with the safety off!
     *****/
    printf("\nUninitialized pointer values are:\n \
    ptr1 = 0x%X\n ptr2 = 0x%X\n ptr3 = 0x%X\n",ptr1,ptr2,ptr3);

    /*****
     * assign vars and pointers and print results
     *****/
    MyVar1 = 1;
    ptr1 = &MyVar1;
    printf("\nAddress of MyVar1 is 0x%X ",&MyVar1);
    printf("Contents of MyVar1 is %d\n",MyVar1);

    MyVar2 = 2;
    ptr2 = &MyVar2;

```

```

printf("Address of MyVar2 is 0x%X ",&MyVar2);
printf("Contents of MyVar2 is %d\n",MyVar2);

```

```

MyVar3 = 3;
ptr3 = &MyVar3;
printf("Address of MyVar3 is 0x%X ",&MyVar3);
printf("Contents of MyVar3 is %d\n",MyVar3);

```

```

/*****
 * assign pointers to point to same location
 *****/
ptr1 = ptr2 = ptr3 = &MyVar1;
printf("\nAddress of ptr1 is 0x%X ",ptr1);
printf("Contents of ptr1 is %d\n",*ptr1);

```

```

printf("Address of ptr2 is 0x%X ",ptr2);
printf("Contents of ptr2 is %d\n",*ptr2);

```

```

printf("Address of ptr3 is 0x%X ",ptr3);
printf("Contents of ptr3 is %d\n",*ptr3);

```

```

/*****
 * Swap contents of MyVar1 in MyVar2. First, assign
 * pointers to point to the addresses of the variables.
 *****/
ptr1 = &MyVar1;
ptr2 = &MyVar2;
ptr3 = &MyVar3;

```

```

/*****
 * Next, move the contents of the pointers to swap values
 *****/
*ptr2 = *ptr1;
*ptr1 = *ptr3;
*ptr3 = *ptr2;

printf("\nMyVar1 and MyVar3 after swap is %d and %d\n",*ptr1,*ptr2);
}

```



find the index value of Buffer, the compiler must again find the address and value of i. That's a lot of work just to extract a character value out of a buffer or array!

Now, let's look at the pointer version, shown in Figure 4. First we assign ptr to point to the starting address of Buffer. In the while loop, the pointer is de-referenced. All this means is that we're getting the value that the pointer holds, or the contents of the pointer by using the star operator.

The printf statement in the while loop does all the work, specifically the expression \*ptr++. What does the compiler do when it sees this expression? First, it gets the contents of what ptr is pointing to. We already set the ptr to point to the first location of Buffer, so there is no reason to calculate Buffer's address, so the value we access is right where we're pointing, at Buffer[0]. We access the data stored at Buffer[0] by using the star operator. After the contents of ptr is printed, ptr is incremented to the next address by using the ++ operator, allowing us to access the next value in Buffer, which is Buffer[1]. With this simple construct, we can quickly traverse a large buffer with a lot more speed and efficiency than by using the static indexing method. Compile and single step through bufscan.c to see it in action.

## Dynamic Memory

After you get reasonably comfortable with pointers, the next big hurdle is understanding and manipulating dynamic memory allocation. A lot of C programmers shy away from dynamic memory allocation and rely on static arrays or arrays of structures for data storage. There are two disadvantages to storing data this way. The first disadvantage is that all storage must be reserved at compile time. Whether you need all of the storage when the program executes is beside the point. A programmer must consider the worst case storage scenario and must always allocate the maximum amount of memory needed.

The second disadvantage is that all of the storage for statically declared variables reside on the stack, and the heap goes to waste. The stack is where the compiler puts the variables declared at compile time along with function return addresses and other data. The heap is where dynamically allocated variables go, which are brought into existence when the program runs by

dynamic memory allocation.

If all of the variables are put on the stack, the stack may occasionally overflow while the program executes. In an embedded system, this is a disaster. You, the programmer, are left with a debugging nightmare while the heap resource goes untouched. It's like having a party and showing everyone into a broom closet and not letting them into the rest of the house. Remember, memory is there for you to use, not to ignore.

So how do you use the heap? Use the C standard library utility functions malloc( ), calloc( ), realloc( ), and free( ). The most commonly used function for memory allocation is malloc( ). When the compiler encounters a call to malloc( ), it winds up making a request to the operating system for a finite amount of storage for an object. The object can range from a single byte to an array of structures. If memory is available, a pointer is returned to the starting location of the newly available memory. If the requested memory is unavailable, a NULL is returned.

When the program is done with the object, a call to free( ) returns the memory to the operating system. Think of the advantages. Memory is used only when you need it in your program. It also puts you, not the compiler, in control over how memory is used. Here's how to allocate storage for a 20 byte buffer and load in the character 'a' into the first buffer byte:

```
char *Buffer;
Buffer = malloc((char ) 20);
if (Buffer == NULL)
{
    printf("Can't malloc buffer\n");
    exit(0);
}
*Buffer = 'a';
```

The variable Buffer now points to the starting

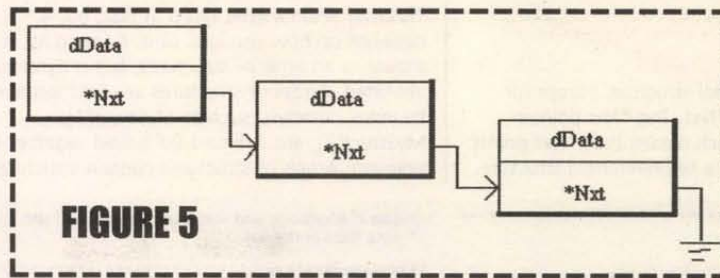


FIGURE 5

address of 20 bytes we asked for.

When the program is finished using the buffer, it returns it to the operating system memory using free( ), as follows:

```
if(Buffer)
    free(Buffer);
```

If you're confused about when to use the star operator, just remember this: to declare a pointer and to get at the data it holds, use the star, to get at the address of the pointer or to assign a pointer to a variable or data structure, don't use the star. Look at the call to malloc( ) and think about what we really want to do. We want to ask the operating system to reserve 20 bytes of storage and to let us know where we can get at the first of the 20 bytes. What we're after is the address of the start of the buffer, so we don't use the star. When we want to access or manipulate the data by loading an 'a' into the first position, we used the star.

## Linked Lists

Linked lists are pervasive in advanced programming, and if you want to bring your C skills to a professional level, you need to learn how to work with lists. Lists are a flexible and ubiquitous data structure, and you'll no doubt encounter them sometime in your programming career. The example program, linklist.c, shows how to create and use a simple linked list. You can use this program as a base for your own linked list projects. Here's how it works:

The header file, linklist.h, contains the linked list structure template, which is:

```
struct lst {
    double dData;
```

```
    strcpy(Buffer,"Hi There!!");
```

```

    /* non-pointer method of accessing Buffer elements using
    * index variable.
    *****/
    printf("\nBuffer access using index variable\n");
    for(i=0;i<10;i++)
    {
        printf("%c",Buffer[i]);
    }

    /* Set pointer to start of buffer and print values
    *****/
    printf("\nBuffer access using pointer\n");
    ptr = Buffer;
    while(*ptr)
    {
        printf("%c",*ptr++);
    }
    printf("\n");
}
```

```

/*****
* Filename: bufscan.c
* Description: using a pointer to scan for a character
*              in a buffer.
*
* Listing #2
*
* (c) 1997 Jeff Stefan
*****/
#include <stdio.h>
#include <conio.h>

void main(void)
{
    char Buffer[10];
    char *ptr;
    int i;

    clrscr();

    /*****
    * Copy string into Buffer
    *****/
}
```



```
struct lst *Nxt;
};
```

It looks like a normal structure, except for one item, the pointer \*Nxt. The \*Nxt pointer points to struct lst, which means that \*Nxt points to itself. This makes lst a self-referential structure.

This may seem a little weird at first, but it depends on how you look at it. A linked list is similar to an array of structures, but is dynamically allocated. Arrays of structures are held together by index numbers, such as MyStruct[1], MyStruct[2], etc. A linked list is held together by pointers. Arrays of structures contain structures of

the same type. In order for a list pointer to point to the same type of structure, the \*Nxt pointer needs to be of the same type as the structure, which is itself.

Figure 5 shows three example nodes of the simple linked list used in the program linklist.c. The dData field contains a double precision value,

```

/*****
 * Filename: LinkList.c
 * Description: Simple Linked List Demo
 * (c) 1998 Jeff Stefan
 *****/

#include <stdio.h>
#include <dos.h>
#include <math.h>
#include <malloc.h>
#include <memory.h>
#include <conio.h>
#include "linklist.h"

#define SUCCESS 0
#define FAILURE 1
#define MAX_FILE_NAME 45

void CreateLst(void);
void AddNode(double);
void SearchLst(int);

int OpenFile(char *);
void CloseFile(void);
void ReadFile(char *);
void CloseFile(void);
void CalcAve(void);

/*****
 * list declaration and pointers,
 * and global var to count number
 * of list nodes.
 *****/
struct lst *First, *Node, *SrcPtr;
int NumListEntries;

/*****
 * declare statistics structure
 *****/
struct stats Stat;

/*****
 * file pointer
 *****/
FILE *fp;

void main(int argc, char *argv[])
{
    int i;
    int Result;
    char Filename[MAX_FILE_NAME];

    /*****
     * Read filename from the command line then open file.
     *****/
    if (argc < 2)
    {
        printf("No filename specified.\n");
        exit(0);
    }
    strcpy(Filename, argv[1]);

    fp = fopen(Filename, "r");
    if (fp == NULL)
    {
        printf("Cannot open input file.\n");
        exit(0);
    }

    /*****
     * Create the linked list, read a data file into the list,
     * then close the data file.
     *****/
    CreateLst();
    ReadFile(Filename);
    CloseFile();

    /*****
     * Calc the average and standard deviation of the
     * data held in the list.
     *****/
    CalcAve();

    /*****
     * Print results
     *****/
    printf("Data file:  %s\n", Filename);
    printf("Average is:  %4.3f\n", Stat.Ave);
}

/*****
 * CreateLst: creates linked list
 *****/
void CreateLst()
{
    First = malloc(sizeof(struct lst));
    if (First == NULL)
    {
        printf("Can't malloc list\n");
        exit(0);
    }
    Node = First;
    Node->Nxt = NULL;

    /*****
     * AddNode: adds a node to the list
     *****/
    void AddNode(double nNewData)
    {
        Node->dData = nNewData;
        Node->Nxt = malloc(sizeof(struct lst));
        if (Node->Nxt == NULL)
        {
            printf("Malloc failure in AddNode()\n");
            exit(0);
        }
        Node = Node->Nxt;
        Node->Nxt = NULL;
    }

    /*****
     * SearchLst: searches list for data
     *****/
    void SearchLst(int SrcData)
    {
        /*****
         * point to first element of list
         *****/
        SrcPtr = First;
        while (SrcPtr)
        {
            if (SrcPtr->dData == SrcData)
            {
                printf("Data found\n");
                break;
            }
            SrcPtr = SrcPtr->Nxt;
        }
        if (SrcPtr == NULL)
        {
            printf("Data not found\n");
        }
    }

    /*****
     * OpenFile: opens data file from cmd line input
     *****/
    int OpenFile(char Fname[])
    {
        char TmpName[MAX_FILE_NAME];
        if (fp = fopen(Fname, "r") == NULL)
        {
            printf("Cannot open input file.\n");
            return (FAILURE);
        }
        else
        {
            return (SUCCESS);
        }
    }

    /*****
     * CloseFile: closes an opened file
     *****/
    void CloseFile()
    {
        if (fp)
        {
            close(fp);
        }
    }

    /*****
     * ReadFile: reads a data input file
     *****/
    void ReadFile(char *Fname)
    {
        char TmpVal[15];
        double DataVal;
        int Done = 0;

        NumListEntries = 0;
        while (!Done)
        {
            /*****
             * read data as string and convert to double
             *****/
            if (fscanf(fp, "%s", TmpVal) != EOF)
            {
                Done = 0;
                DataVal = atof(TmpVal);
                /*****
                 * load linked list
                 *****/
                AddNode(DataVal);
                NumListEntries++;
            }
            else
            {
                Done = 1;
            }
        }

        /*****
         * CalcAve: calculates average from data stored in
         * linked list and stores in Stat structure.
         *****/
        void CalcAve(void)
        {
            double TmpSum;
            double TmpAve;

            /*****
             * reset list ptr
             *****/
            Node = First;

            /*****
             * get sum of data in linked list
             *****/
            TmpSum = 0;
            while (Node->Nxt)
            {
                TmpSum = TmpSum + Node->dData;
                Node = Node->Nxt;
            }

            /*****
             * calculate average
             *****/
            TmpAve = TmpSum / NumListEntries;

            /*****
             * load in list structure
             *****/
            Stat.Ave = TmpAve;
        }
    }
}

```



and the \*Nxt pointer is used to link the list together. When the \*Nxt pointer is NULL, indicated by the electrical ground signal, there are no more elements in the list.

The first thing to be done in the main program linklist.c is to declare pointers to the list structure. Linklist.c uses three global pointers, \*First, \*Node, and \*SrcPtr. The pointer \*First will point to the first instance of the list structure, or first node. This first node acts as an anchor, so we give it an exclusive pointer and will not change its address. For each new node in the list, we use the \*Node pointer. If we want to search for a specific value that's in one of the list nodes, we use the \*SrcPtr.

The next thing to do is to create the list. The function CreateList() makes a call to malloc() to create a linked list. The call is:

```
First = malloc(sizeof (struct lst));
if (First == NULL)
{
    printf ("Can't malloc list\n");
    exit( 0);
}
Node = First;
Node->Nxt = NULL;
```

We simply ask the compiler for the number of bytes to store a list structure, no more, no less. That's why we use the sizeof operator. This tells the compiler to generate the instructions to calculate the exact number of bytes it takes to store the list structure. Now that the first node is allocated, we initialize the list pointers by pointing the current list element \*Node to \*First. Notice that we're dealing with addresses, not data, so there is no star operator attached to \*Node or \*First in the code. We then set the \*Nxt pointer to NULL, indicating there are no more nodes in the list (we've just allocated our first list element only).

The hard part is over after the first node is allocated. The first node is safely allocated in memory, the list pointers are initialized, and we're ready to add more nodes when we need to. To illustrate how lists are built, linklist.c reads a file of numbers, D1.dat, into the list,

then calculates the average of the numbers. The ReadFile() function makes a call to AddNode(). The code for AddNode() is:

```
AddNode(double nNewData)
{
    Node->dData = nNewData;
    Node->Nxt = malloc( sizeof (struct lst));
    if (Node->Nxt == NULL)
    {
        printf ("Malloc failure in AddNode( )\n");
        exit(0);
    }
    Node = Node->Nxt;
    Node->Nxt = Null;
}
```

AddNode() loads the data read from the file into the dData list field and allocates storage for the next node. The last two lines look confusing, but they're not, really! Think of the \*Nxt pointer as an agent that goes out and acquires new memory (this is the call to Node->Nxt = malloc()). If \*Nxt is successful, then the current node is set to the newly acquired memory, via Node = Node->Nxt. The \*Nxt pointer now needs to point to NULL, to let functions like SrcList() know where the end of the list is.

The function CalcAve() shows you how to reset and manipulate a linked list. The first thing that happens in CalcAve() is to set the current list element \*Node equal to the first element of the

list, \*First. We'll be traversing the list from beginning to end and adding the dData values, so we need to know where the list starts. When we first created the list, we allocated the base node called \*First and then left it alone. Remember, \*First acts as an anchor that always points to the beginning of the list. The next block of code traverses the list and adds the data values:

```
while (Node->Nxt)
{
    TmpSum = TmpSum + Node->dData;
    Node=Node->Nxt;
}
```

While the \*Nxt pointer isn't NULL (at the end of the list), we'll keep accessing the data field in the list and adding them together. That's why we set Node->Nxt equal to NULL whenever a new node is allocated. If the \*Nxt pointer wasn't set to NULL, then the while loop wouldn't know where the end of the list was and the program would either crash or hang up. After the list is read and the numbers are summed, their average is calculated and placed in the stats structure element Stat.Ave.

I know this is a lot to learn, and dealing with dynamic memory allocation and linked lists can be confusing and intimidating, but if you want to elevate your programming skills and gain complete control over your computer's resources, you need to master these two areas. Sometimes looking at things from a compiler's viewpoint helps. The code is yours to experiment with. I compiled it with Turbo C/C++ 3.0, but any ANSI C compiler should work. Add new pointers and variables to cpoint.c and see what happens. Try modifying linklist.c to make a call to SrcList() and single step through the code with a debugger to see what happens.

In programming, you learn by doing, not just reading through code listings. Use this code base to create lists you can use in your own programs. Above all, don't give up and revert back to using arrays and arrays of structures for everything. It's like driving a Pinto when you could be driving a Porsche. **NV**

```
/* *****
 * Filename: LinkList.h
 * Description: Linked list data structure for linklist.c
 * (c) 1998 Jeff Stefan
 * *****
 */
/* *****
 * Linked list structure
 * *****
 */
struct lst
{
    double dData;
    struct lst *Nxt;
};
/* *****
 * statistics structure
 * *****
 */
struct stats
{
    double Ave;
};
```



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UCN5804. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 timer, parallel port, etc. Build your own robot, anything that requires precision positioning.  
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## NIPPON PULSE MOTOR

7.5 deg./step, 48 s/rev, 5 V, stepper with brass gear mounted on shaft. NPM P/N PF42-48ES. With spec sheet.  
**92M010** **\$3.95 each**

## COMBO PACK!

One 93I002 IC and 92M010 motor (both shown above) with schematics.  
**93I003** **\$7.95/set**

## INFRARED KIT

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Copper braid, solid center conductor.  
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12VDC @ 15mA controls relay. Specs included.  
**98G001** **\$7.95 each**

## ULTRABRIGHT WHITE LED

T1-3/4, water clear, 1600 mCd. Docs included.  
**SE5082H** **\$4.95 each**

## LIGHT AMPLIFIER???

This clear 5/16" diameter plastic lens fits nicely on a T1 LED or the end of a fiberoptic cable and magnifies the output.  
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## 8Hy 300mA CHOKE

800 Ohms DCR, 3000V RMS insulation. Stancor #C-1722.  
**98N003** **\$9.95**

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#730-9/16" dia.  
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Separates stereo signals from the cable TV input, feeds RF signals to TV/VCR tuner and stereo signals to FM (either RF or fixed/variable level audio). Hundreds of useful parts which may be removed for audio/RF projects. Controller board has CPU and socketed EPROM as well as Mitsumi varactor tuner, cable/FM separator board, regulated power supply subassembly, channel select board, and stereo separation output board. Black metal case, 14" x 10" x 3". Sold for experimental purposes only. With documentation.  
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Unused unit from cable TV box takes channel 3, 4 or 5 signal and demodulates the audio. Comes with documentation and schematics, plus additional schematics to build add-on video demodulator board.  
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200-250VAC in. Plug & play, no minimum load. With docs.  
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\* Same as above, except 5V @ 192A out.  
**98E010** **\$24.95 each**

## MINI-SWITCHER

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**98E006** **\$7.95 each**

## PLUG & PLAY IDE CD-ROM INTERFACE CARD

Supports up to two ATAPI compliant IDE CD-ROM drives.  
**98C007** **Box of 20 for \$19.95**

## MULTI-OUTPUT TRANSFORMER

110V primary, two 18.2VAC secondaries, one center-tapped 20VAC secondary. With schematic.  
**98E002** **\$4.95 each**

## 9VDC 1A WALL WART

Input 120VAC, 60Hz, 16W. Class 2. Center negative coaxial connector.  
**98E004** **\$5.95**

## 16.5VCT 1.5A DESK POWER SUPPLY

115VAC in; AC output 16.5 VCT @ 1.5A.  
**97E009** **\$4.95 each**

## MINI TOWER POWER SUPPLY

Pulled from unused equipment.  
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## ATARI 1020 COLOR PRINTER

For all Atari 8-bit computers. (Not PC-compatible!) Package includes: printer, power supply, software, pens, paper and interface cable. These are new units in factory sealed boxes.  
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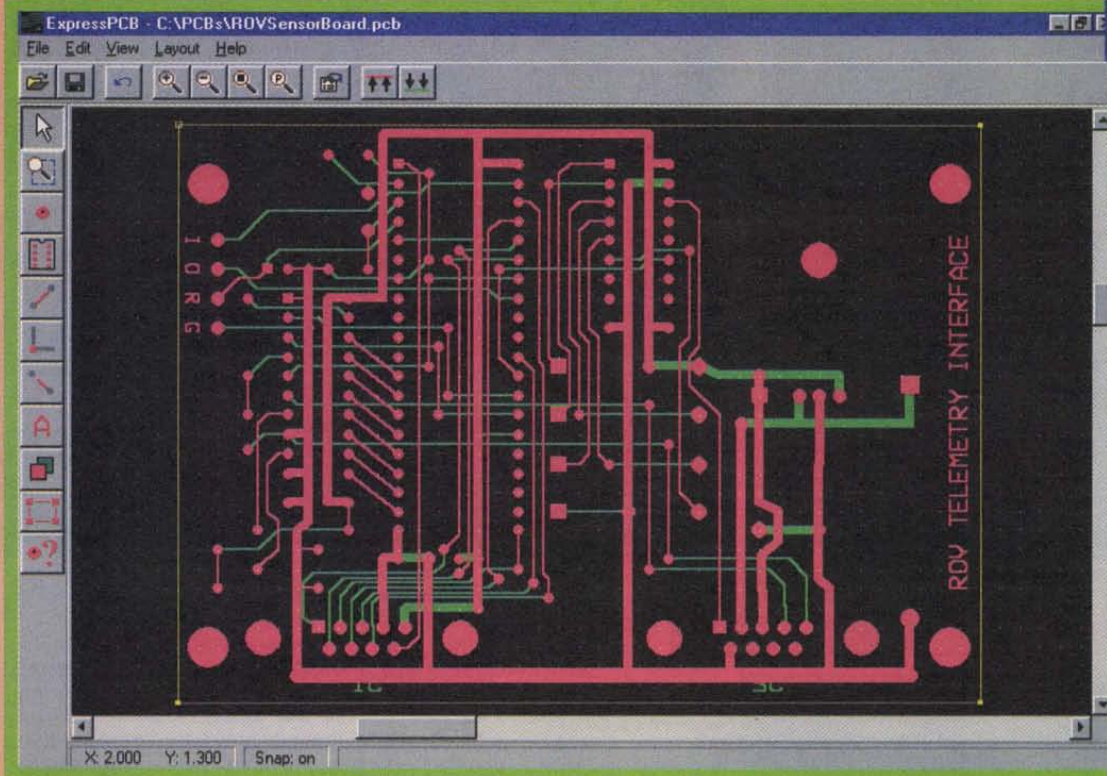
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**Figure 1. Graphical user interface for ExpressPCB's layout program.**

plated-through holes are clearly the ticket for prototyping modestly complicated circuits; the only other thing you need is a few tricks of PC board design.

### The Standard Recipe

The first step is easy enough: you launch the layout program (see Figure 1) and establish the physical outline of the board by dragging on

*Contrary to popular belief, prototyping with printed circuit boards can be inexpensive and hassle-free.*

the corner of the default rectangle displayed in the main window. That act automatically establishes two grids of fiducial points.

One of these sets makes up the so-called visible grid — helpful benchmarks arrayed a tenth of an inch (0.100") apart — which is, of course, a convenient spacing for

**M**ost hobbyists with an interest in electronics, and indeed many professionals who are not full-time electrical engineers, routinely use wire-wrapped boards to prototype circuits, even though these boards look rather messy and prove a nuisance when it comes time to make multiple copies. What to do? The obvious answer is to do what the pros do: use printed circuit boards.

Yet few follow this route, because they perceive too many barriers to making PC boards themselves. Creating the artwork for a board is the first roadblock.

Pre-printed stick-on pads and slim rolls of tape promise to be frustratingly tedious. General-purpose computer drawing programs are better; although they too prove rather inflexible and difficult to apply to the task.

Specialized "CAD" PC board layout programs are clearly the way to go, but this professional-quality software is usually expensive and hard to learn.

Cheaper programs are available for a few hundred dollars, but often they prove awkward to use. For example, many of the applications available for laying out PC boards still run under DOS rather than Windows.

If all these difficulties do not dissuade you from trying to design a sleek circuit board for your next project, the challenge of negotiating a reasonable price with your local PC board fabrication shop probably will.

So thank heaven for ExpressPCB. This combi-

**by David Schneider  
and Stanley Reifel**

## Printed Circuit Boards for Everyone

nation software provider and PC board manufacturer will help you avoid the problems that usually arise in prototyping. Not only can you download ExpressPCB's great little layout program from [www.expresspcb.com](http://www.expresspcb.com) for free, once you've designed your masterpiece with it, you can order the board over the Internet with a few clicks of the mouse. What is more, you receive the finished product within a few days — all for a price that is, typically, less than \$100.00. So one no longer has to be a professional electrical engineer (or have a professional's budget) to get high-quality PC boards on demand.

To test the promise of ExpressPCB, we decided to redesign a circuit we had previously built using wire-wrap for an unusual hobby project: a home-brew underwater robot (see sidebar). This circuit board seemed a particularly good candidate for replacement, because it is housed behind an acrylic dome along with the diminutive submarine's video camera, making the wire-wrapped board a visible eyesore in what otherwise was a reasonably spiffy gadget.

Although this particular circuit isn't very complex, the boards gen-

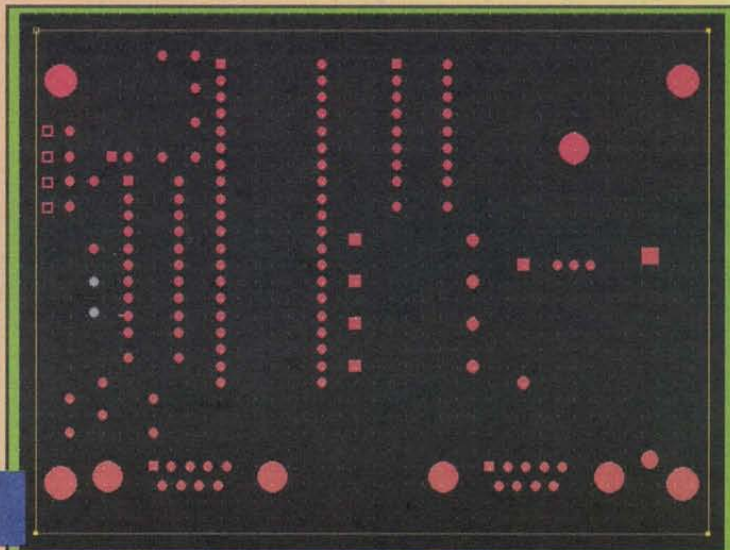
erated by ExpressPCB can handle far more complicated designs. The key is that the service manufactures custom boards with traces on both sides and so-called "plated-through" holes.

Designing boards with two layers is a good compromise between having just a single layer of copper for connections — which is often too limiting — and dealing with multiple layers, which would normally be hard to justify in a prototype and would be expensive to produce in any case. So two-layer boards with

many electronic components.

There is also an invisible "snap-to" grid to guide you when making interconnections. Although you can disable this feature, having the components and traces tied to this grid helps ensure that your design remains neat and orderly.

The software also provides a convenient library of standard components, many of which are listed directly by their Digi-Key catalog numbers. Groupings of pads for custom components are also simple to create.



**Figure 2a. Layout for telemetry controller board with components placed.**



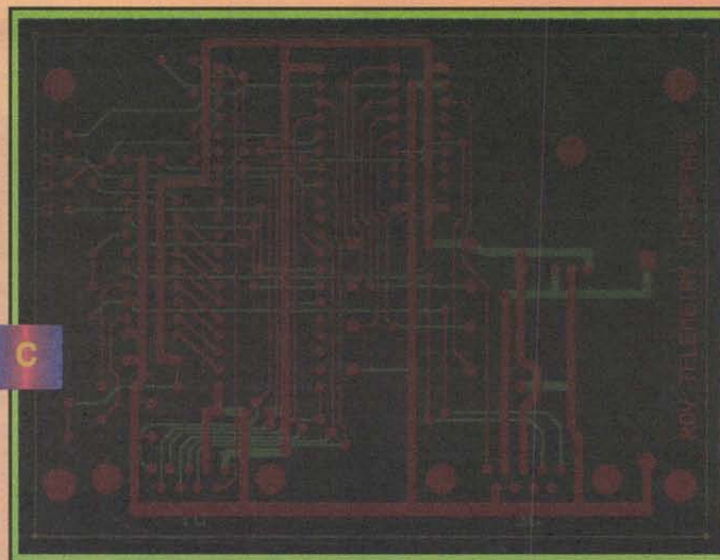
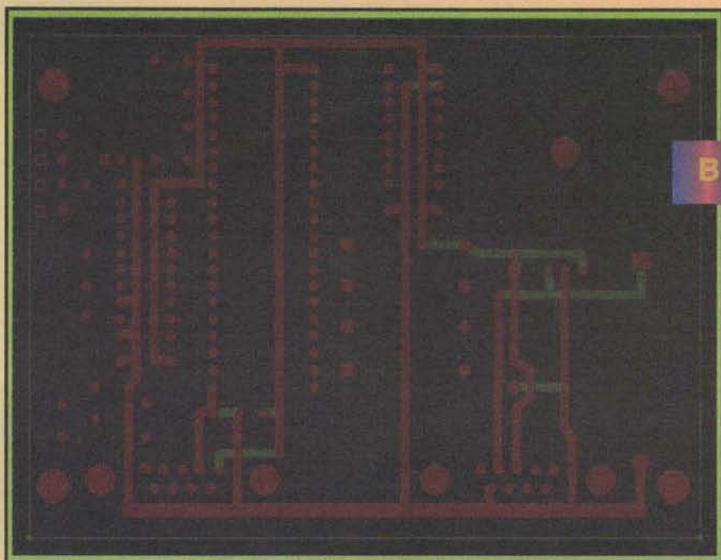


Figure 2b and 2c. Layout for telemetry controller board with components placed with power and ground traces added (b), and complete with signal traces (c).

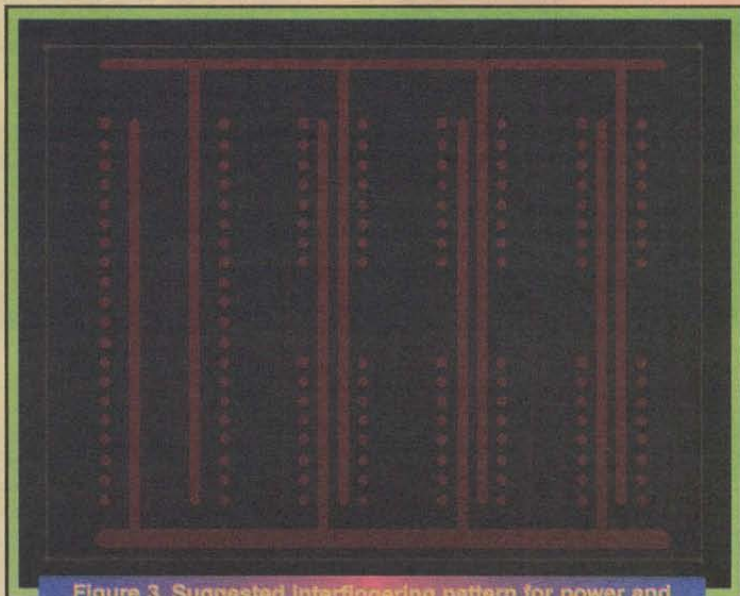


Figure 3. Suggested interfingering pattern for power and ground traces.

For example, non-standard ICs would typically require you to place a set of 0.056" holes at 0.100" spacings. And you can include other components easily enough by measuring the diameter of their leads and adding 0.008" to accommodate the copper plating that goes inside the holes.

Just don't forget to add the 0.008", or you'll be kicking yourself later when you get the board back and discover things don't fit.

With the software and a few simple guidelines, laying out the board is no big deal. You begin by considering any relevant physical constraints: What dimensions are reasonable? Where do the mounting holes go? And are there any special components, like potentiometers or connectors, that must face a certain direction?

The next task is to organize the other components, choosing to place functionally-related items

close together. But you also want to make sure you don't crowd things too much.

A good rule-of-thumb is to leave somewhere between 0.350" and 0.500" free around each of the chips. And your board will appear more professional if you keep components facing the same direction, say, with pin 1 of ICs and the positive lead of polarized capacitors always up or to the left on screen.

For our board, laying out the components took no time at all (see Figure 2a). It's a good idea to print a copy of your board at this early stage and put the components on the paper board, just to check that everything fits properly.

Once you've placed the components, the next job is to lay traces. Here is where you discover the beauty of two-

layer boards. With two layers, you can amass quite a few components and still manage to connect everything that needs to be connected. The trick is to reserve one layer for traces that run along the length of the board, the other layer for traces that run across the width. (On your computer screen, one set will go horizontally, the other vertically.)

Although this approach might seem limiting at first blush, it really isn't, because the two sides of the board can be easily connected using so-called "vias." These convenient bridges are formed by placing holes strategically: the holes are plated inside with copper, so they conduct between layers.

The combination of vias and perpendicular traces on opposite sides thus allows you to run connections as needed, all over the board.

Of course, you don't want to go putting down traces willy-nilly. Instead, start by establishing an organized set of paths for power and ground. For most digital circuits, you'll probably want to use moderately wide traces to handle the current: a 0.050" swath of cop-

per for power and at least as much, if not a bit more, for ground.

A good scheme is to run an interfingering pattern for power and ground traces (see Figure 3). Part of the network shown obviously breaks the rule about keeping traces running only in one direction on each side. But notice that the "wrong-way" traces appear only at the borders of the board, where they can't interfere with the routing of other traces.

After you have suitably distributed power and ground (Figure 2b), next connect the various signal traces. For that, a width of 0.012" should serve well.

Interconnecting signal traces between the two layers calls for a via with a pad of 0.056" (0.035" hole). Note also that these slim signal traces are apt to cause problems if you put in abrupt 90° turns: the manufacturing process tends to round corners slightly; so such traces would narrow too much while turning a sharp corner.

Avoid that possibility by substituting two closely-spaced 45° jogs where you want a signal trace to turn at right angles (see our completed layout in Figure 2c).

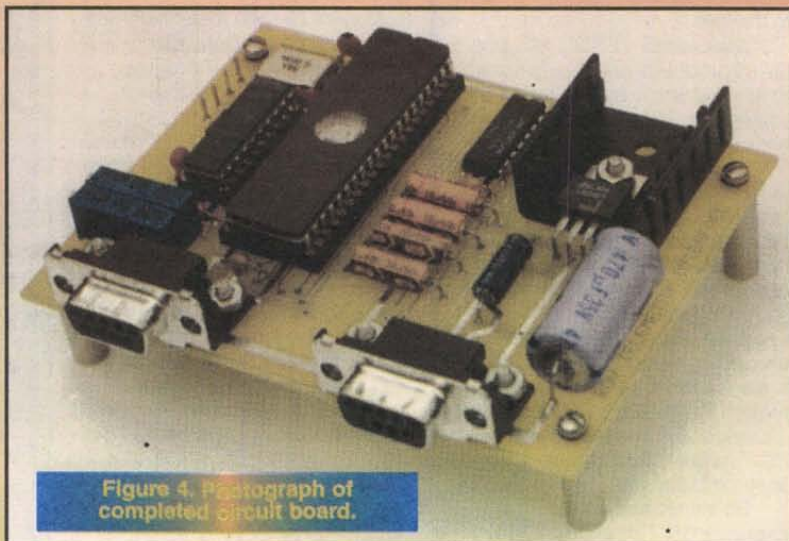


Figure 4. Photograph of completed circuit board.



**Show Itemized Costs**

The costs for ExpressPCB to manufacture and deliver this order will be:

Setup fee per order:	\$55.00
Setup fee for 2 boards:	\$1.00
Area cost for 24.00 square inches:	\$17.04
Shipping:	\$7.47
<b>Total cost of order:</b>	<b>\$80.51</b>

**Order Boards Via the Internet...**

The order form is now complete. If you place the order, your credit card will be billed \$80.51 (US dollars) by "Engineering Express" to manufacture and deliver these PC boards.

Press the "Show costs itemized" button to see the costs broken down.

Your order requires 1 full business day for manufacturing, and 2 business days for shipping. If the order is submitted after 6PM EST, or if submitted Friday night, Saturday or Sunday, then add one additional business day for manufacturing.

Before continuing, make sure your computer is connected to the Internet via your provider. Press the SEND button to place the order.

**Figure 5. Dialog box showing cost of finished PC board.**

see whether you can rework your design slightly to eliminate unnecessary vias. You may also want to add text to the board at this stage, which will be helpful later, if only to mark which side is the top.

Next, you should print out the top layer of your board to check for some common problems. For instance, you can check for missing vias, which will be obvious from any traces that seem to go nowhere. Look also for traces located where they really shouldn't be (for instance, right under a metal heatsink).

If all is well, make your final check of the connections by comparing the top and bottom layers on screen to your schematic. Going over the connections on the schematic with a red pen as you follow them around your screen is a handy way to document that you've checked each and every lead.

### Money Matters

ExpressPCB charges a fixed set-up fee of \$55.00 plus 71 cents for each square inch of board. (There's also a charge of 50 cents for trimming each board.) In rare instances, you may also incur an additional fee if your design involves more than 25 holes per square inch of board.

To take a concrete example,

the board we designed for the underwater robot measures three inches by four inches, and has 181 holes (see Figure 4). So having two copies of this 12-square-inch board manufactured cost \$55.00 (set-up), plus \$1.00 (trimming), plus \$17.04 (area charge), plus \$7.47 for shipping by two-day UPS. The total was just \$80.51. Although the calculation is not hard to do, a convenient feature of the software for ExpressPCB is its ability to determine the final cost to have the board made up and delivered (see Figure 5).

The software is also adept at communicating your design specifications and handling the financial transaction. All you need is a connection to the Internet. The program takes your design file and credit card information and sends this all off (encrypted) to ExpressPCB.

Within a few hours, you get confirmation of your order by E-Mail. Depending on whether you specify overnight or two-day delivery, the board will arrive at your home within two or three business days. So not only is this Internet-based service inexpensive; it's extraordinarily convenient.

If you want to give it a try for your next prototype, check out the World Wide Web Site [www.expresspcb.com](http://www.expresspcb.com), where you'll find an overview of the service and instructions to download the software. **NV**

Once you have completed all the necessary interconnections, pause to reflect on your work. And be duly critical at this stage. After all, you don't want to discover after the board is fabricated that you made a dumb mistake in the layout. Also, strive for a clean, minimalist design.

A good test is to ask yourself whether there are unnecessary vias. Blindly following the prescription to restrict a particular layer to traces running in one direction will force you to put in more vias than you really need or want. So now is the time to relax the rules somewhat. You should quickly be able to

## Diving without a Mask, Fins, or Snorkel

**H**aving collaborated on quite a few strange hobby projects over the years, the construction of an underwater remotely operated vehicle (ROV) seemed a natural way for us to get into diving — without getting wet.

Such ROVs can probe underwater sites that are too deep (or too dangerous) to explore in person. The fact that one of us had some experience with mobile robots and the other had worked with oceanographic gear also encouraged the undertaking.

The completion of the project also owes a great deal to the aid of a more serious robot designer and frequent contributor to these pages — Jeff Kerr — who lent advice, moral support and a garage filled with machine tools.

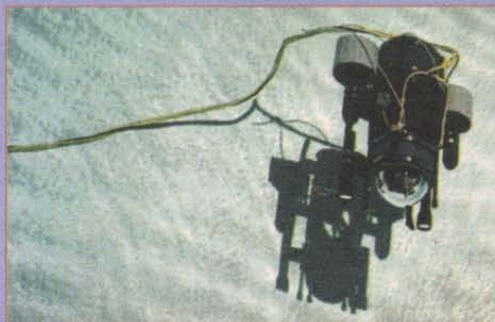
This robot sub is constructed — like many research-grade oceanographic instruments — primarily of PVC plastic, 6061

alloy aluminum, and stainless steel. The fore and aft pressure housings (fashioned from a pair of Schedule-80 PVC pipe end caps) are affixed to an anodized aluminum frame using stainless steel hose clamps.

Two underwater "thrusters" (modified trolling motors) are bolted outboard; a third hangs vertically between the two pressure housings. Skids, an acrylic dome, and a couple of pounds of lead ballast complete the basic vessel.

Although the sub's tether is 125 feet long, trials so far have been limited to swimming pools and one sheltered Atlantic inlet where the robot followed two scuba divers down about 20 feet.

Although most of the components should easily withstand the pressures at 10 times that depth, increasing friction on the seals around the motor shafts would progressively sap more and more power as the sub descends.







# "My TV reception is so clear, you'd think I had a 50-foot antenna on my roof!"

*Emerson's ingenious new antennas are hard to spot, easy to install and provide clear, powerful reception of broadcast signals...without rabbit ears.*

by Hope Chapman



Replace your unsightly "rabbit ears" today!

I'm amazed at the way technology has improved television. Developments in electronic circuitry have resulted in TV sets that have sharper pictures, brilliant colors and clearer sound. From the smallest portables to wide-screen home theater systems, televisions continue to work better and better as optical innovations are introduced. Unfortunately, a television's picture is only as good as the broadcast it's receiving, and even the world's best televisions cannot make up for a weak or distorted signal. Antenna technology has not kept pace with television design, and the rabbit ears from the 1950's are not far removed from what's available today. Well, there's finally been a quantum leap in the design of antennas, and it's the result of two patented components developed by scientists. These improvements are the secret behind Emerson's revolutionary new antennas.

**Picture imperfect.** Cable subscription solves the problem of getting the signal to your television, but storms and other factors can result in cable outages. If you prefer not to pay the rising monthly fees for cable or live in an area where it's not available, your picture is likely to be weak, undefined and distorted.

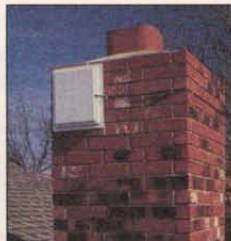
One way to improve your reception would be to mount a large antenna on your roof. Unfortunately, most roof antennas are not particularly pleasing to the eye and may even be prohibited in the area where you live. Rabbit ear antennas don't improve your picture to any great degree and make your room look like something from an earlier decade. Most antennas need to be aimed at the source of the broadcast and require turning mechanisms to pick up the signal clearly.

Whether you live miles out in the country or in a concrete building next door to a broadcast tower, bad reception can rob you of the definition and color you were intended to see. The Optima antenna gives you the signal-grabbing power of a large antenna in an inconspicuous, low-profile size.

**Stealth antenna.** In the past, creating an antenna with optimal reception meant making it big, with a large amount of surface area. This resulted in products that were large and unsightly or small and ineffective. Either way, the aesthetic look of your room or house suffered. Research and development tended to focus on the television, not on signal reception... until now.

Recently, a brilliant scientist in Colorado developed an antenna that would maximize reception without being overly conspicuous. Emerson, a leader in electronic technology, has now made this innovation available to the public.

At a lab in Colorado, they developed two patented design improvements that made the Optima antenna possible. First, they created a flexible circuit board with a serpentine antenna, resulting in a large surface area confined to a small space. Second, they developed a technique that converts the copper shielding on the attached cable to an additional signal receiver that results in an antenna almost 10 feet long. This greatly enhances the antenna's reception power and allows you to tune the antenna by simply moving the cable! The antenna



Your neighbors won't know it's there unless you tell them.



**Attention mini-dish owners.** If you own a mini-dish satellite system, you are aware of the off-air issue and are probably wondering how you can pick up local broadcasts. After all, what good are hundreds of channels if you can't find out who won the local city council race? The Dishmate™ harnesses the same technological innovations as the Optima TV antenna to give you a powerful omnidirectional antenna that is virtually invisible. It is compatible with a variety of systems and is easy to install.



works best at a range of up to 30 miles from the signal source. We recommend an amplifier for reception up to 45 miles away. Ask your representative for details.

The handmade assembly is encased in aircraft-grade plastic and high-density foam. The weather-resistant cover is a neutral white and can be painted to match the color of the house or room. Plus, the omnidirectional design allows you to mount the unit anywhere you please. The Optima's universal design makes it adaptable to any component, and installation is a snap. So sit back, relax and enjoy the clearest picture you can get from your television.

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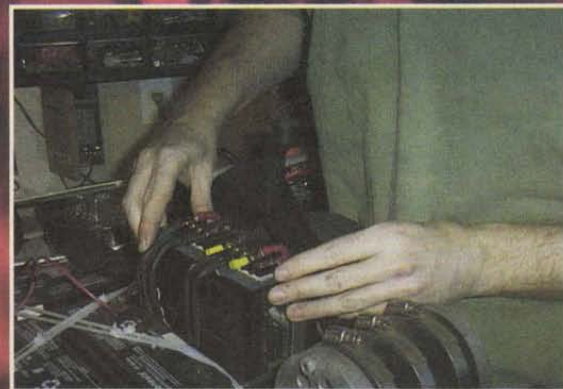
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"Look at all these people that spent all this money on stuff I get to break," laughs Greg Munson describing his thoughts upon arrival at Robot Wars 1997.

As he and Trey Roski unload their 170-lb. bruiser robot, the other competitors watch in painful anticipation. Behold: the third and latest version of La Machine, a name that chills the hearts of other heavyweight teams. "It's a car accident on wheels," summarizes Roski.

The original version of La Machine made its debut in RW'95 as an 80 lb. middleweight and, when the smoke cleared (literal-



powered steel ram sits menacingly atop the wedge-machine, waiting to whack any unfortunate adversary that climbs high enough on its forward moving edge. It certainly gives a new meaning to the phrase "angle of attack."

Radio-controlled robots for fun and destruction is the goal of

ers of a digital design group even doing at this event? Greg explains, "It's cool to be part of a story that isn't yet written." But the seeds of La Machine were sown long ago in summer projects between the two cousins. "We built prototypes of every idea, ran them into walls, and then investi-

gated what broke." Their motto: test everything.

# Robot Wars 1997: La Machine

by Dan Danknick

ly), it had wiped out the heavyweights in the melee round. "If it breaks, I feel we accomplished something," explains Roski and then, in a serious tone, "It's show-and-tell with an emphasis on 'show.'" That original design was \$600.00 worth of wood, aircraft aluminum, batteries, and motors. Eight relays controlled speed and direction. Not exactly the epitome of high-tech, but effective.

This year, it's a \$1,700.00 entry with a custom-welded aluminum shell, high-performance Hawker batteries, and rewind German drive motors. At its peak, it lays out 6HP to the wheels and reaches a sustained speed of 35MPH (during tests on an abandoned aircraft runway.) A CO2-

Robot Wars, an annual smash-fest held in San Francisco. Created and organized by artist Marc Thorpe, it has recently grown in international scope after a special made-for-TV series aired in Great Britain.

In its basic form, entrants fight opponents of like-weight, head-to-head in a protective plastic arena. Sold-out crowds yell and cheer as blows are delivered between the combatants. Allegiance frequently lies with the greater aggressor, but can switch as quickly as the relays running the motors in the arena.

As pioneers of the effective wedge design, Team La Machine has rained its share of destruction upon others. But it has not

emerged unscathed, at times breaking frame and casters, dealing with temperamental weapons, and smoking overheated motors.

"Things we didn't spend much time on are what failed." But this didn't impede La Machine's progress for the spirit of the team. "Our goal has always been to have *nothing* to bring home at the end of the day."

Then what are the co-own-



Even though this can become expensive, they feel it is vital for a robot that is designed to plow into opponents with maximum impact. "I love impact when things are going fast!" chimes in Trey.

Both Trey and Greg can be reached on the Internet at [impactmg@slip.net](mailto:impactmg@slip.net)

For more information on the event, you can visit the Robot Wars website at <http://www.robotwars.com/>

A comprehensive analysis of the last two events along with helpful building tips are available on competitor Andrew Lindsey's website at <http://www.cybercomm.net/~alindsey/>

Now in their early 30s, the principals of Team La Machine are no longer the hunters, but the hunted. Losing fights in both '96 and '97 to rival robot Biohazard was certainly not in the plan.

"This year we've built a scale model of Bio to try out some new technology," confides Trey, "we're gonna fight fire with fire." What mysteries that statement holds will certainly be revealed this August at RW'98. But winning or losing, "What is important is having a cool robot." NV





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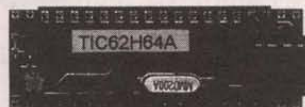
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# Getting Animated With Your Graphics



lain vanilla graphics just don't cut it anymore for many Web applications, especially for banner ads and other situations where

you want to grab a visitor's attention. Think of the Web pages that you visit and the graphics that you remember and click on - most of those are animated, right? And, if you're promoting your Web site through some sort of banner or link exchange, an animated banner is almost a necessity.

There are three main ways you can add animated graphics to your Web site, and it's much more simple to do so than you might think. In fact, no programming is usually needed. This month's column will show you how!

## How Animated Graphics Work

Like all moving images, animated graphics are composed of frames. A frame is a complete image that is part of a "stream" of related images. Like a motion picture, each frame is displayed in sequence to create the image of one continuously moving image. Animated Web graphics are

# Software Wizardry

By Harry L. Helms

**Figure 1**

**This is frame 1.**  
**This is frame 2.**  
**This is frame 3.**

sequences of .GIF (graphics interchange format) images. .GIF is the Web standard for line art (JPEG is the standard for photographic images).

Figure 1 shows a sequence of three frames. Notice that each frame is identical except for the number at the end of the line. When these frames are moved through a sequence, your eye will see what appears to be one image with a number that is constantly changing. The faster the images in the frame are moved through a sequence, the faster the number will appear to change. Each frame in the sequence must occupy the same amount of screen space (such as 250x100 pixels, for example), although the file size for each frame can vary.

The individual .GIFs in your animation can be created with any program that supports the .GIF format, such as Image Composer, PhotoShop, FreeHand, etc.

If you've done much Web surfing at all, you know how slowly some .GIF images download and display in your browser. This points to perhaps the biggest concern of using animated .GIFs on your web site: an animation with several "bulky" frames will take a long time to download and "play." If it takes too long, visitors to your site will probably not wait for it to download and surf elsewhere or stop the download of the graphic.

The keys to keeping your animated graphics "compact" is to use as few individual .GIFs as possible in the animation and to keep the size of the individual .GIFs small. You must carefully

plan your animation to determine how many individual .GIFs you really need. A larger number of individual .GIFs will let you get a "smoother" animation of moving objects (such as a ball that appears to roll across the image). However, you must decide how important "smoothness" and other factors are compared to small file sizes and rapid downloading. You may have to re-think your designs for an animation to eliminate some individual .GIFs.

Individual graphics should be created for minimum file size. The logical starting point is to keep the number of colors used to a minimum; instead of 24-bit color, use just the 216 colors in the standard Web image palette. Develop your animation so that the minimum possible screen area is used by the animations. Try to shave a few pixels in the horizontal and vertical planes; the difference in download time can be surprising.

If you're designing an animated graphic for use as a banner ad or other image that will appear on another Web site, be sure to check on the maximum file size allowed by that Web site. Many sites restrict banner ads and other graphics from outside sources to a total size (all individual .GIF frames and any supporting code) of no more than

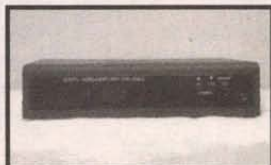
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# Software Wizardry

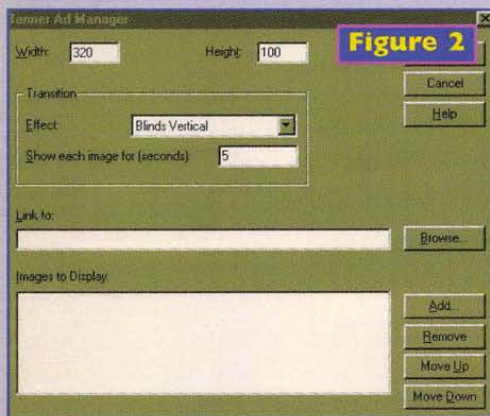


Figure 2

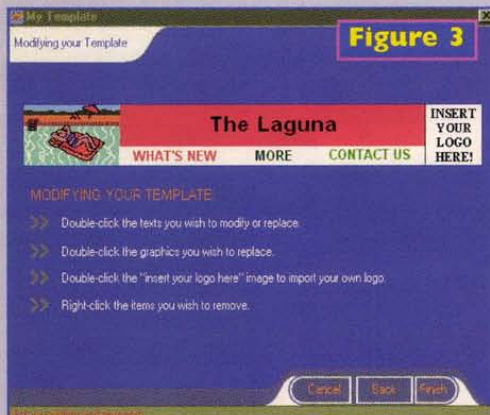


Figure 3

9 kilobytes. The "9K" limit is a good rule to follow even if the graphic will only appear on your site, as animations of that size or less download quickly.

Once you've created a series of .GIF frames, then comes the fun part: it's time to animate them!

## Animating With Perl

Perl was discussed in last month's column. It's the most widely used server-side programming language (the programs reside on a Web site's

server instead of being downloaded to the user's PC). It's mainly used for processing text and numerical data input sent from a PC to the server, but it can be used for other purposes, like moving the .GIF files in an animation sequence.

Since it is a true programming language, Perl lets you do some very interesting stuff with animated graphics. For example, you can alter the time sequence with which the individual frames are displayed. You can have the images displayed in a random sequence. And you can have the animation displayed in different locations on a Web page.

But using Perl-based animations has some drawbacks. Your Web server must be configured to use Perl, and your animation script must be written to the operating system (Unix, Windows NT, etc.) and Perl interpreter version

used by the server. Since Perl is a programming language, making some changes in your animation sequence will require some understanding of Perl.

As mentioned last month, however, numerous Perl scripts are available free via the Web, including several for animated graphics. Among the places to start looking for them are the Perl language home page ([www.perl.com](http://www.perl.com)) and Matt's Script Archive ([www.scriptarchive.com/scripts](http://www.scriptarchive.com/scripts)).

If you need some really spectacular animated graphics, Perl is probably

the best way to go. But working in Perl will take some knowledge and effort on your part. Unless you're working on a corporate or business site, you'll probably find that using Perl will be more trouble than its worth.

## Using Java For Animations

You may have been thinking that Java would be a terrific way to animate graphics. And indeed there are Java-based tools available to create animations.

Microsoft's FrontPage98 includes a Java applet known as the "banner ad manager" that is actually a .GIF animation applet. Figure 2 shows the control and setting window for this applet. The area in pixels occupied by the applet is set at the top of the window, and all .GIF files must be set to this same area. At the bottom of the window is a list of .GIF files in the order in which they will be displayed. .GIF files can be added from a hard drive or floppy, or removed from the list. The .GIFs can also be moved up and down the list. The resulting animation can also be linked to another page in the Web site or to another URL.

Figure 2 shows how Java can create some versatile effects not possible with any other method. This applet lets you choose how you want the transition between .GIF frames handled. The default is to simply switch between frames without a pause, but this applet lets you select options such as horizontal and vertical "blinds" (an effect similar to opening and closing window blinds), as well as "dissolves" from one image to another. You can also select how long you want each .GIF in the sequence to be displayed.

Other Java-based animation cre-

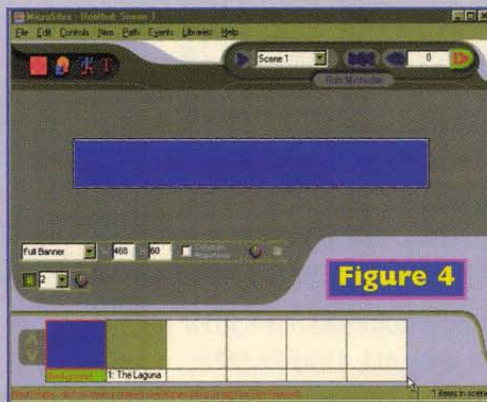


Figure 4

ation tools are available, such as MicroSites from Zapa Digital Arts. This software package is mainly intended for producing animated banner ads, although it can be used for other types of animated graphics. It includes a large amount of clip art, animations, and even sounds that can be added to your frames. Like many software packages today, MicroSites includes a wizard to help you set up the basic design of your animation. Figure 3 shows the template for a frame produced by the wizard; you can add graphics and text as desired to this frame template.

Figure 4 shows the workspace for creating an animation in MicroSites. MicroSites uses the term "scene" for an individual frame in an animation sequence. A scene can include one or more individual .GIF files plus other media elements, such as text and sound files. Scenes can be arranged and re-ordered in an animation sequence, as shown at the bottom on Figure 4.

Using Java — like MicroSites does — allows a high degree of control over how the different frames of an animation sequence are displayed. For example, the timing with which individual .GIF files are shown can be controlled, as can when other scene elements (like sounds) are displayed

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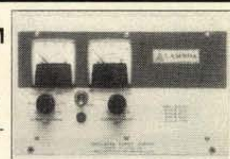
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The versatility and programmability of the Auto Remote makes it an excellent, easily integrated one-way paging device for use in areas of information management, security control, energy management, auto control, general control, data display, etc.

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The Auto Remote can have two distinct frequencies programmed via the serial interface. Each frequency is capable of supporting four capcode pager addresses. The frequencies can be the same.

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# Wizardry

or played. You can also give visitors to your Web site control which items are displayed, or the sequence in which they are displayed, through a mouse click on your animated graphics.

Perhaps the most powerful feature of MicroSites is that it allows you to define "animation paths" along which individual .GIF files or text can move across the area of a scene. The motion can be specified to stop at the end of a path, return to the starting position after reaching the end of a path, or to move back and forth along the path in a continuous loop. To get these sort of effects, you need to use a Java-based tool like MicroSites.

But Java-based animations suffer from the same problem as all Java applets: they're slow to download and slow in operation. I've used Java-based animations on my Web sites, and have found that typically the rest of the page, including large .GIF and JPEG files, download before the Java-based animation downloads and start to "run." Much of the impact of the animation is blunted because of this; site visitors see a "hole" in the page where the animation is located until the download is complete.

I think Java-based animations are the wave of the future in Web design, but I also feel that future will wait until Java becomes widely used as a server-side programming language instead of just a client-side interpreted language. My frustration with Java's slowness has led me to remove

all Java applets from my Web site and rely on Perl or JavaScript to provide interactivity. And for animated graphics, I'm now relying on animated .GIFs.

## Animated .GIFs

Animated .GIFs were first supported in Netscape 2.0 and were added to Internet Explorer 3.0. Both current versions of the Netscape and Microsoft browsers support animated .GIFs. Animated .GIFs are just a sequence of individual .GIF files displayed in sequence, as described earlier in this column. Because they are simple to create and modify, animated .GIFs are currently my choice for adding animated graphics to a Web site.

Many graphics and Web publishing programs include tools for creating animated .GIFs. Figure 5 shows the .GIF animator included as part of Microsoft's Image Composer graphics package. This tool is similar in features and functions to most other .GIF animators. As you can see in Figure 5, the individual .GIF files in each frame are displayed at the left side of the window. Note that the "Thumbnails Reflect Image Position Box" is checked. This means that the sequence of images at left will be the same sequence in which the images will be shown. Images can be added to the sequence by clicking on the appropriate box at the top of the window.

Figure 6 shows how the parameters of the animation are selected. All individual .GIFs in the sequence must be the same size selected for the animation. The image count changes automatically as new .GIF files are added or cut from the sequence. The check in the box next to "Looping" lets the sequence repeat; if this box is left blank, the sequence will play once and stop at the last frame. The box next to "Repeat Forever" is checked, and this causes the animation sequence to continuously repeat. If it is not checked, the exact number of repetitions can be selected immediately above this box.

You can determine how long each frame in the animation sequence is displayed. In Figure 7, notice the dark box around Frame #1. In this example, Frame #1 will be displayed for 100/100 of a second (that is, one second), although smaller and larger amounts of display time are easy to indicate. The "Undraw" selection

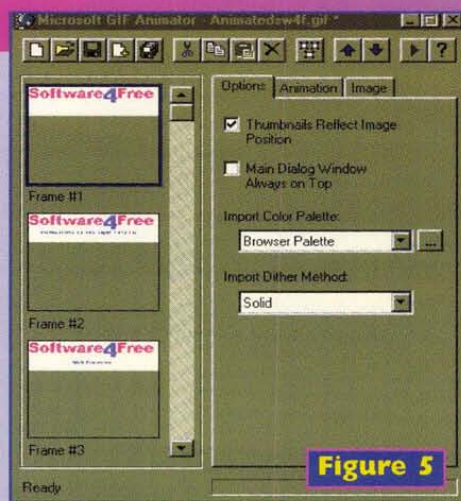


Figure 5

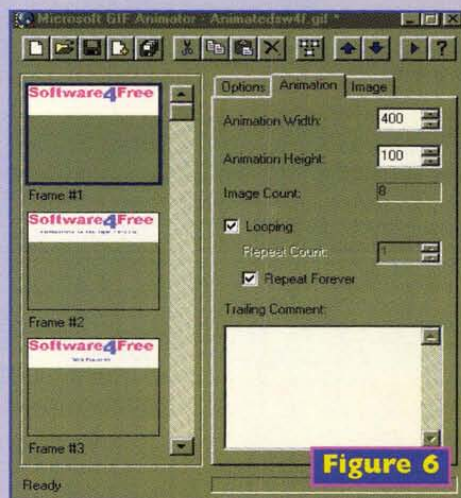


Figure 6

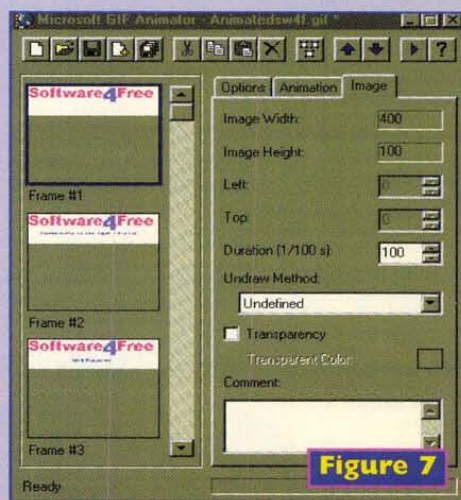


Figure 7

menu lets you decide whether you want a special effect — like briefly restoring the previous image — when leaving that frame in the animation sequence. And you can make the image in the frame transparent by clicking the indicated box.

Developing animated graphics is so easy and so much fun that it's easy to carry away with them. Like all Web publishing tools, they can get in the way of the message you're trying to convey and actually annoy visitors to your site. Be sure to plan how animations will fit into your total Web design before getting "overly creative!" NV



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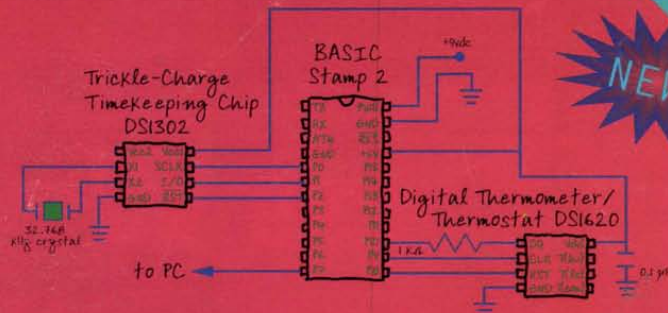
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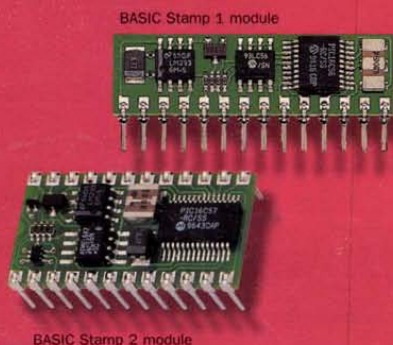


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