Nuts & Volts

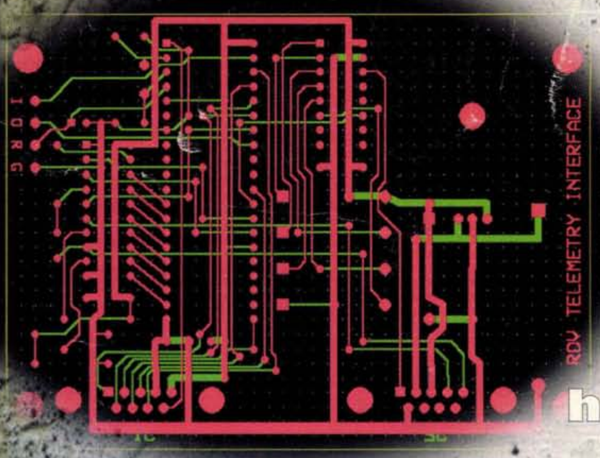
U.S. $3.50
CANADA $4.50

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 INTERFACES, TRANSLATOR, DRIVE MECHANIC, AND DRIVE DIAGNOSTIC TEST SOFTWARE WITH PRINTER PORT
P/N SDIPRO .... $995.

CSC

CORPORATE SYSTEMS CENTER
www.corpsys.com

ORDER FACTORY DIRECT:

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, hall-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

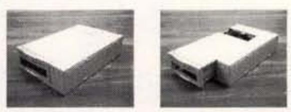
- Bargain case for 5.25" drives, brand new!
- 7" x 4.5" x 10.5" overall size
- 50-pin SCSI connectors
- SCSI ID switch
- 65W Power supply (lots of power for hard drives, etc.)
- Fan-cooled, uses standard IEC Power cord (not included)

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**

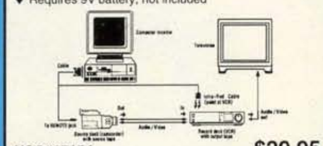
X-Windows Terminal!

- 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**

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**

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**

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

House that Equipment!

- Bargain on used, bench 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 SCSI2 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

A. **Now - $59.00**

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**

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 Cadnica 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**

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**

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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- 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 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.

New Product News

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

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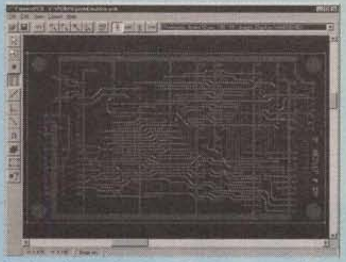
NEW PRODUCT EDITOR,
430 PRINCELAND CT., CORONA, CA 91719

EXPRESSPCB



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

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

CDT-4

A non-invasive tester (CDT-4) for CD 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. 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:

SOUNDSMITH
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

PAGEPRO

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

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
WEB: 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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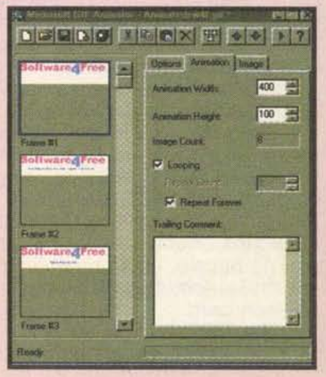

ON THE COVER ...
PCBs and ROBOTS, ROBOTS, ROBOTS ...

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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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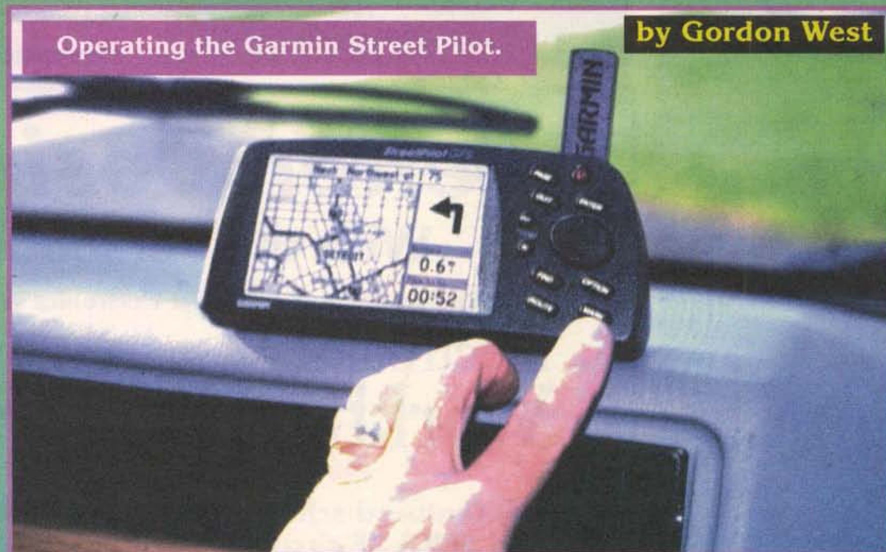
FREE RADIO SIGNALS FOR GPS ERROR CORRECTION

by Gordon West



Operating the Garmin Street Pilot.

You 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.

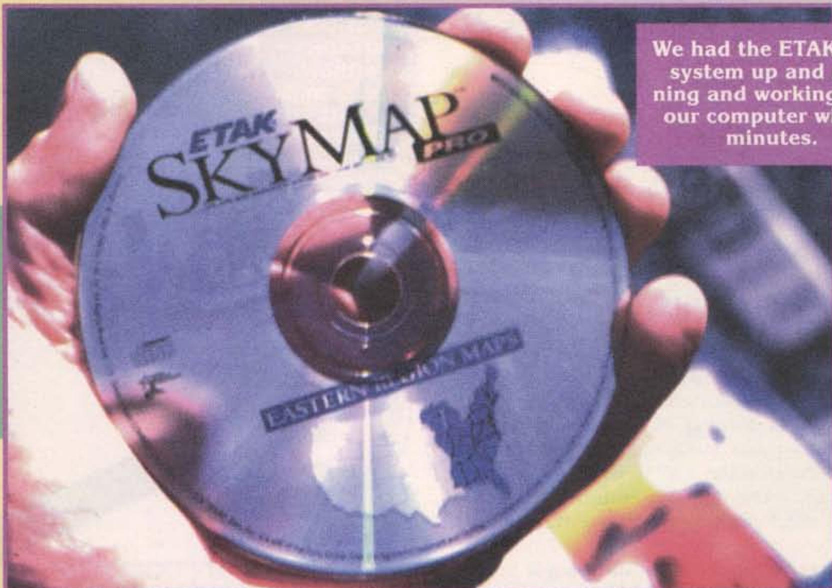
The flower delivery you received this morning was guided by GPS to your doorstep. Pizza Man is tracked on GPS to keep your cheese and anchovies piping hot as they direct him to the next stop.

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

The white dots represent planned inland DGPS beacon stations.



We had the ETAK GPS system up and running and working with our computer within minutes.

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

MAGELLAN GPS MAP'N TRACK

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.

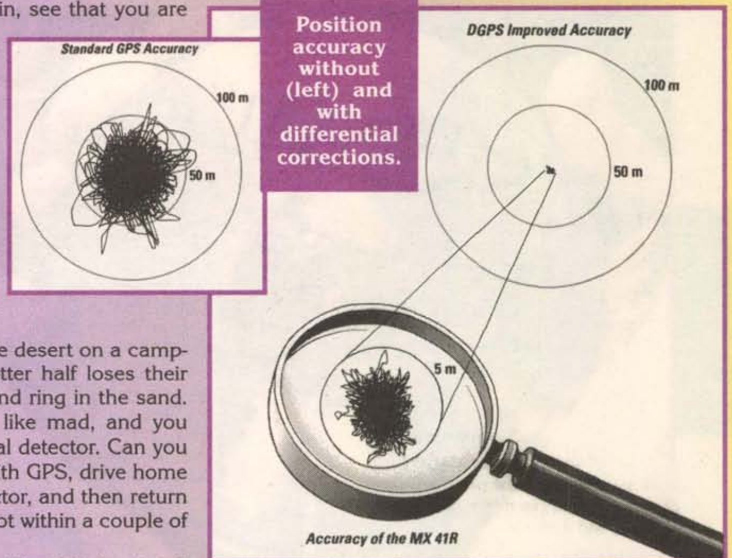
But the biggest error comes from the military — on purpose —

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.



Position accuracy without (left) and with differential corrections.

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.

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-

Furuno differential beacon receiver (DBR) for improved GPS accuracy. Works with almost all GPS equipment.

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-

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, 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 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.

Have you tried GPS? If you're really looking for a powerful portable entry-level GPS that has embedded highway cartography, check out the $360.00 Garmin GPS III. It's quite a unit, and is the little brother to the Garmin Street Pilot that is now the hit of most RV operators.

Got GPS? NV

RESOURCES

Magellan Systems Corp.
San Dimas, CA
909-394-5000

Garmin Int'l
Olathe, KS
913-397-8200

C-Map Technology
Mashpee, MA
508-477-8010

Ultra Data Systems Travel Star
St. Louis, MO
1-800-747-2605

BEACON, Dave Carter & Associates
219-522-2857

Trimble Navigation
Sunnyvale, CA
1-800-827-8000

Lowrance/Eagle
Catoosa, OK
918-438-8645

Etak, Inc.
Menlo Park, CA
1-800-765-0555

Bart, Bartizan American Communications
Sarasota, FL
941-955-7818

Navigation Technologies
Silicon Valley, CA
408-617-5000

Jeppesen Chart Cartridges
Aurora, OR
503-678-1431

Alpine Electronics
Torrance, CA
310-326-8000

Travroute Software
Princeton, NJ
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.

Write in 111 on Reader Service Card.

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."

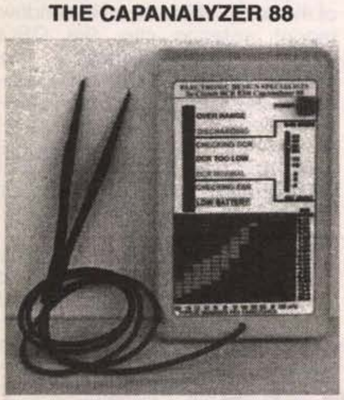
The diameter of the PCB support pin pictured in the middle right area of Figure 7 on page 100 should be 3/16 inch (it's incorrectly shown as 3/8 inch). The drill holes shown in the figure are correct, as is the description of the support pins in the parts list.

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 or shorts, and measures ESR in circuit, all in one step.

Values from 0.47 uF to 2200 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 capacitors 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:

ELECTRONIC DESIGN SPECIALISTS
4647 APPALACHIAN ST.
DEPT. NV
BOCA RATON, FL 33428
561-487-6103

THE WIRELESS CONTROLGATE™

Emge Industries, Inc., announces the introduction of a new line of industrial radio remote controller modem systems designed to interface with electrically operated machinery and equipment. These systems are available in either simplex (one-way communication) or duplex (two-way communication) versions. A variety of analog, digital, RS-232, and RS-485 inputs and outputs are available for tailoring the system to the customer requirements.

The ControlGate™ ACE-928 utilizes state-of-the-art frequency hopping spread spectrum radio technology. Operating in the 902 to 928 MHz band, the ControlGate ACE-928 design offers unmatched noise immunity for the most stringent applications where communication reliability is of prime concern.

Electrical equipment or machinery controlled by a 0-5 VDC or 4-20 mA analog signal command can be safely and easily operated by the ControlGate ACE-928.

Eliminated by the ControlGate ACE-928 are the traditional wiring costs associated with long runs of control wiring and conduit to such devices as potentiometers, flowmeters, temperature sensors, pressure sensors, displacement sensors, velocity sensors, machine controllers, PLCs, and PCs.

The ControlGate ACE-928 systems also offer digital contact closures for simple ON-OFF commands. In addition, RS-232 and RS-485 ports are available on some models for easy computer interface. The duplex version offers standard two-way communication and the ability to setup a MODBUS network with master/slave units. Closed loop control is easily facilitated with the ControlGate products. All units are conveniently powered by low-voltage DC.

For more information, contact:

EMGE INDUSTRIES, INC.
1060 WINGFOOT ST., DEPT. NV
PLACENTIA, CA 92870-4444
714-996-5777
FAX: 714-996-5748

FIVE NEW ACCESSORY HEADS FOR PMM-1

Amprobe Instrument announces the release of their five new interchangeable accessory heads to expand the capabilities of their pen multimeter, model PMM-1. The accessory heads were designed with the HVAC Technician in mind.

The complete series extends the PMM-1's existing testing capabilities from AC and DC volts and resistance to now measure capacitance (start/run capacitor testing), DC microamps (flame rod and flame sensor testing), relative humidity, carbon monoxide (IAQ testing), and single or differential temperature (compressor efficiency testing).

AC amps to 300A is accomplished with the existing accessory, model PMM-C.

Each new accessory head is designed to output imVDC per unit measured. The unique mechanical design allows each head to slide onto the PMM-1, but may be used with any DMM with a DC millivolt resolution in conjunction with the appropriate test lead, model TL-10S.

For more information, contact:

AMPROBE INSTRUMENT
630 MERRICK RD.
P.O. BOX 329
DEPT. NV
LYNBROOK, NY 11563
516-593-5600
FAX: 516-593-5682

MFJ-310 HT ANTENNA

MFJ Enterprises, Inc. announces the new MFJ-310 HT antenna ... only $14.95.

With your HT antenna outside of the car in MFJ's new HT window mount antenna clip, the QSO range is greatly extended. The window mount clip with BNC connector holds your antenna securely on the outside of your car's window where it can radiate freely. It's quick and easy to install and can be tucked away discreetly in your car's glove compartment to eliminate theft problems.

The MFJ-310 HT window mount clip comes with 10 feet of flexible low-cost mini-coaxial cable. It easily can be pushed into tiny crevices in your automobile to make a comfortable mobile QSO.

For more information, contact:

MFJ ENTERPRISES, INC.
P.O. BOX 494, DEPT. NV
MISSISSIPPI STATE, MS 39762
601-323-5869
FAX: 601-323-6551
1-800-647-1800
E-MAIL:
mfj@mfjenterprises.com
WEB:
http://www.mfjenterprises.com

Open Channel

by Joseph J. Carr

Some Practical Matters

Wow! 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 gozillion 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

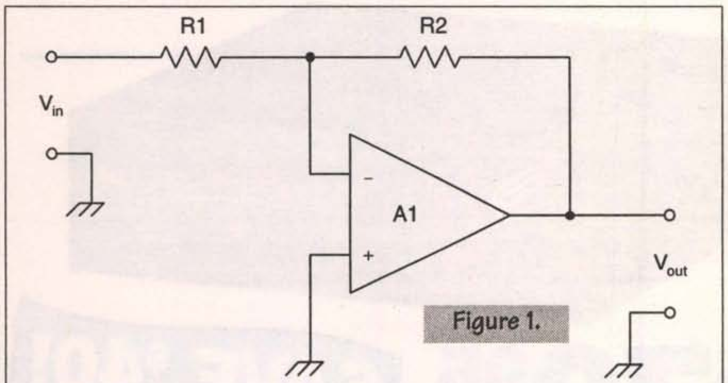


Figure 1.

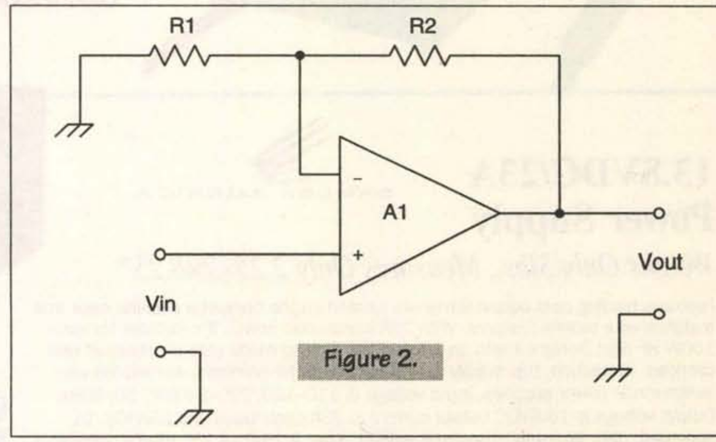


Figure 2.

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 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 ohms. That would make the minimum design for a gain of 10 amplifier R1 = 2,500 ohms and R2 = 25,000 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 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

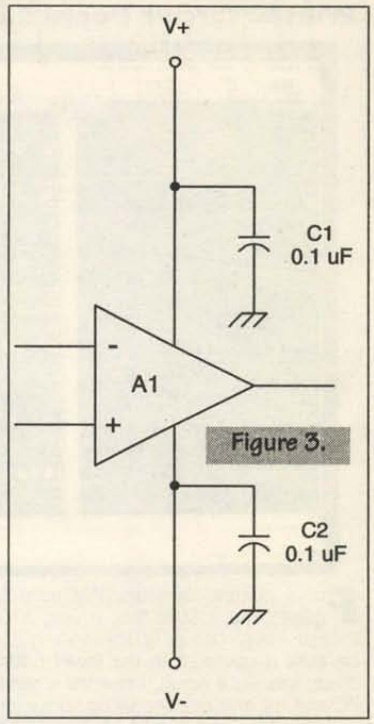


Figure 3.

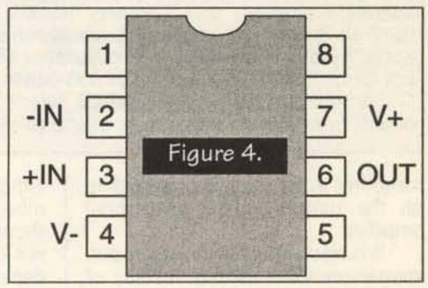
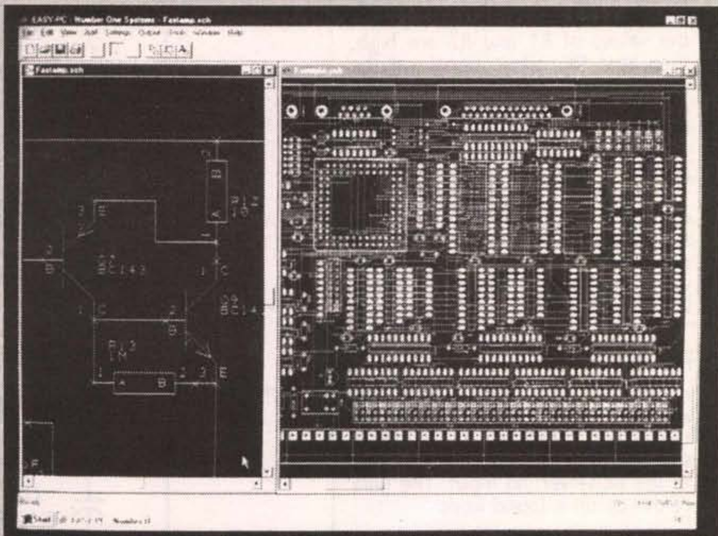


Figure 4.

Printed Circuit Board Software



For a number of years, I've used Easy-PC to layout printed circuit boards. It griped me a little that it was a DOS-based program in a Windows-95 era. Indeed, I even had difficulty running Easy-PC on one of my Windows 3.1 machines because it operated in the lower 640K of RAM, and I had other things running there, too. As a result, I needed a separate systems configuration file to run Easy-PC and my antenna modeling software.

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**. 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 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**

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.

Community College Instructors

I would like to hear from community college and four-year BSET program instructors in electronics technology programs. I am interested in finding out how well your programs are faring, how they are changing, and what the future looks like for the programs in this electronics age. Contact me at the postal and/or E-Mail addresses listed.

Connections ...

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at CARRJJ@AOL.COM.

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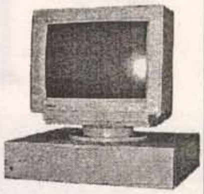

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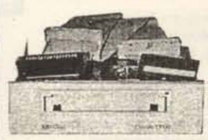

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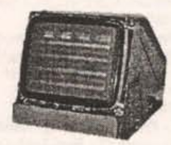

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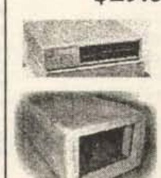

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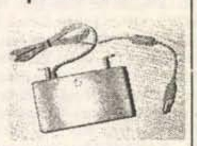
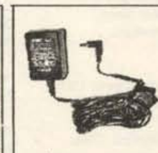


Apple PowerBook Duo P/S



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Events CALENDAR

JUNE 1998

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Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

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Events Calendar
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Corona, CA 91719
Phone 909-371-8497
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E-mail events@nutsvolts.com

JUNE 5-6-7

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

TX - ARLINGTON - West Gulf Division Convention. Tom Gentry 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 Hamfestival. Hudson-ville 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: w4cq@qsl.net Web: http://members.aol.com/wn4bbj/w4cq

TN - NASHVILLE - ARC Hamfest. TN State Fair-grounds. 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 Fair-grounds. 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 Fair-grounds. 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 WA7TSP, 509-663-1081. E-Mail: g.c.johnson@mail.sprint.com

JUNE 7

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: r.borriello@snet.net

IL - PRINCETON - Starved Rock RC Hamfest. Debbie Burton N9DRU, 815-795-2201. E-Mail: dbkatz@mtco.com Web: http://www.prairienet.org/srrc/

IN - WABASH - County ARC Hamfest. 4-H Fairgrounds, State Rd. 13N. Don Spangler W9HNO, 219-563-8487. Web: http://www.netusal.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 Blasdell KB4EFP, 703-369-2877

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

JUNE 12-13

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

JUNE 12-13-14-15

NY - ELLENVILLE - Chaverim 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.ve3whs@sympatico.ca Web: http://www.kwarc.org/fleamarket

ID - RATHDRUM - Hamfest. Lions Club, Hwy 53. Jim Monroe 208-667-4915. E-Mail: jmonroe@dmi.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 Fair-grounds. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NY - CORTLAND - Skyline ARC Hamfest. Andrew Slaugh KB2LUV, 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 Fair-grounds. Georgia Mountain Productions 706-838-4827

FL - TAMPA - Computer Show. FL State Fair-grounds. 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 Pavillion. 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

Events CALENDAR

KY - ERLANGER - Ham-O-Rama '98. Lions Park. 8am-3pm. Robert Blocher N8JMV, 513-797-7252 eves. E-Mail: krood@tso.cin.ix.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 Computer 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
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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@WORLD NET.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 Alternbernd KA1MQX, 617-253-3776. http://web.mit.edu/wlmx/www/swapfest.html
MD - FREDERICK - ARC Hamfest. Eric Gammeter N8AAY, 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 Fair-grounds. 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. Monagahan Fire Hall, 245 W. Siddonsburg Rd. Michael Kalbaugh N3HLK, 717-232-6087. fabinfo@fabral.com n3njb@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 Snydal 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 http://www.tfs.net/~caltman/phdara/phdara.htm
NC - SALISBURY - NC Alligator Group Hamfest. Civic Center. 8am-1pm. Walter Bastow N4KVF, 704-279-3391. E-Mail: alligatorl@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 Kerouac K9NR, 815-939-7548. E-Mail: K9nr@juno.com Web: http://www.geocities.com/CapeCanaveral/Hangar/5711/
MA - SWANSEA - Computer Show. Venus DeMilo. Northern Computer 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: scarcnj@qsl.net Web: http://www.qsl.net/scarcnj/
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-A-Rama & Computer Show. Wood Co. Fairgrounds. 8am-1pm. 419-354-1811. E-Mail: sjhudson@wcnet.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@pgh.net Web: http://nharc.pgh.pa.us

JULY 17-18-19

MT - EAST GLACIER - MT State Convention. Gerry Leach VE6BVZ, 403-285-5547. E-Mail:

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 Fair-grounds, 8am-3pm. Clark Beckman N8PZD, 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. Waubonsee Community College. James Von Olnhausen 630-897-3042. E-Mail: n9uzc@amsat.org

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

MA - WORCESTER - Computer Show. Worcester Centrum Centre. 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 K0ZH, 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/~n2mdq

OH - VAN WERT - Hamfest. County Fairgrounds, US 127 S. Louie Thomas WD8LLO, 419-238-2812. E-Mail: barnesrl@bright.net Web: http://www.bright.net/~barnesrl/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: n11pn@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 ARS Hamfest. Dana Laurie WA8M, 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: n1lpn@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 - TIMONIUM - 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 KB8KPJ, 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. 904-268-2302. Web: http://www.pobox.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. Ruritan Fairgrounds. Tom Martin KF4TNX, 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 KI0FE, 319-393-4224. E-Mail: ki0fe@usa.net

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

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

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 Allbright 619-278-4284

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 - CHANUTE - Chanute Area ARC Hamfest. Charlie Ward WD0AKU, 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

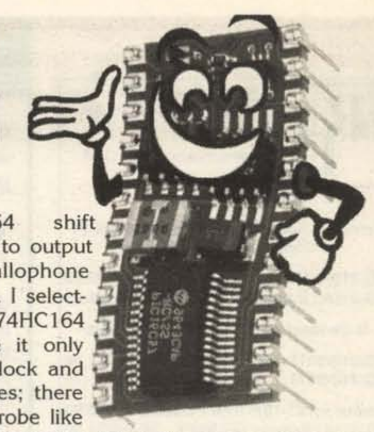
AUGUST 16

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.

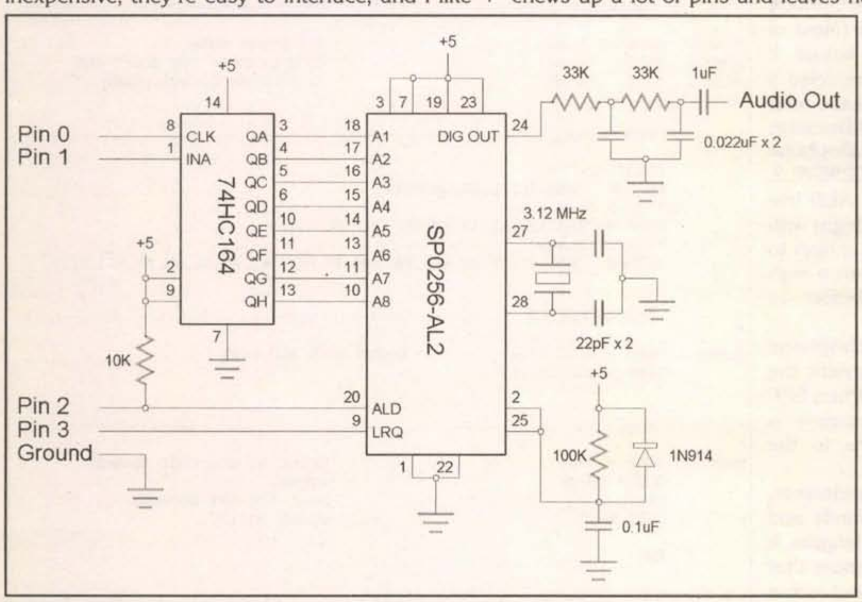
Making The Connection

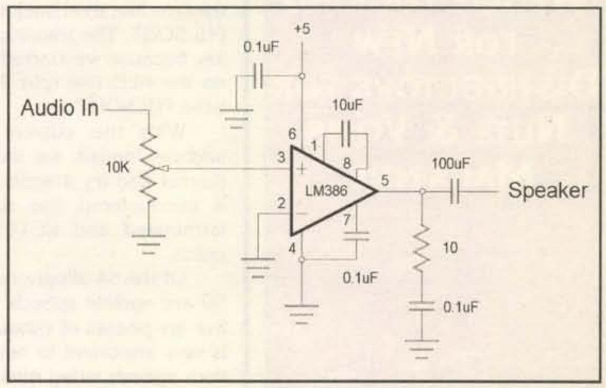
To make a straightforward connection to the SP0256-AL2, we need eight lines: six for the allophone address, and one each for ALD and LRQ. You could, of course, connect direct, but this chews up a lot of pins and leaves nothing left if you're using a BS1. I cut the pin count down to four by using a 74HC164 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





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).

```
' 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
```

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 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.

```
' 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         (note leading underscore)
SYMBOL  AR      = $3B   ' alARm
SYMBOL  YR      = $3C   ' cleaR
SYMBOL  GG2     = $3D   ' Guest
SYMBOL  EL      = $3E   ' saddLE
SYMBOL  BB2     = $3F   ' Business

' 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 probably 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-oriented 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**

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.

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
info@seetron.com

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Orders: **800-276-2206**
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HP 5316A 100 MHz/100 nS Universal Counter, HPIB $600.00
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HP 5334A 100 MHz Universal Counter, HPIB $850.00
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Univ.Counter; OCXO, DVM, 1.3 GHz C-ch., rear in
HP 5334B-010,060 100 MHz $1,000.00
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SECURITY ELECTRONICS SYSTEMS AND CIRCUITS – Part 5

by Ray Marston

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

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 sensitive' 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.

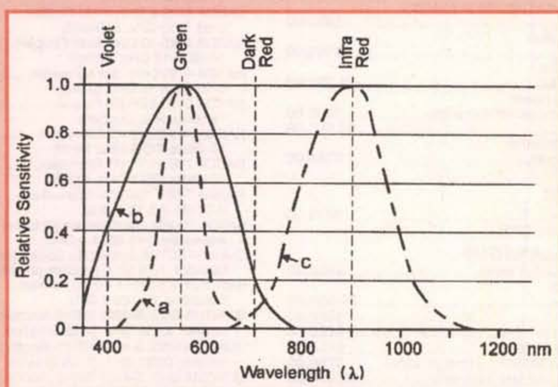


Figure 1. Typical spectral response curves of (a) the human eye and (b) general-purpose, and (c) IR photodiodes/transistors.

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 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,

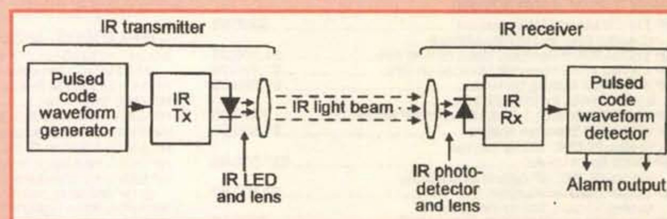


Figure 2. Simple IR direct light-beam alarm system.

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

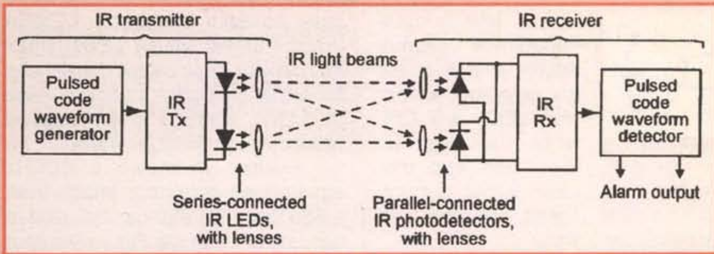


Figure 3. IR dual light-beam alarm system.

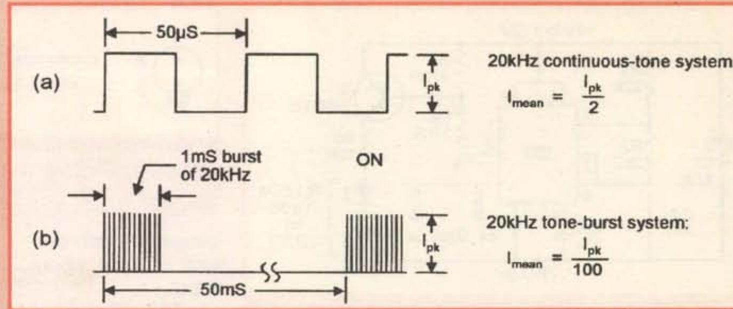


Figure 4. Alternative types of IR light-beam pulse-code waveforms, with typical parameter values.

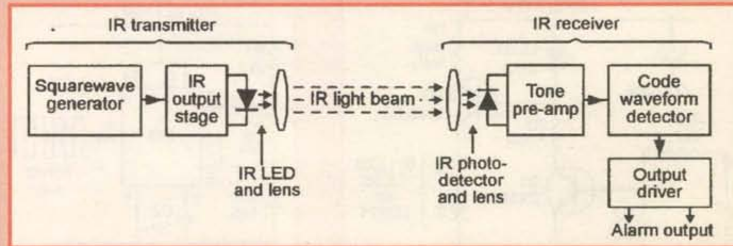


Figure 5. Block diagram of a continuous-tone IR light-beam intruder alarm/detector system.

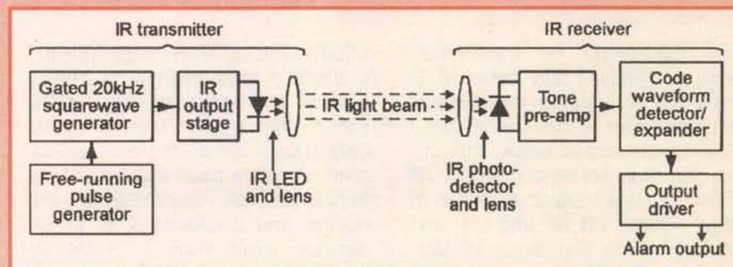


Figure 6. Block diagram of a tone-burst IR light-beam intruder alarm/detector system.

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.

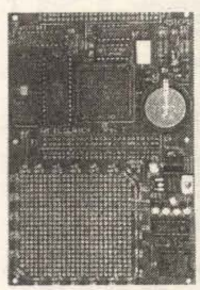
The continuous-tone system (*Figure 5*) is very simple, with the transmitter comprising nothing more than a squarewave generator driving an IR output stage, and the receiver comprising a matching tone pre-amplifier and code waveform detector, followed by an output driver stage that can activate a device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



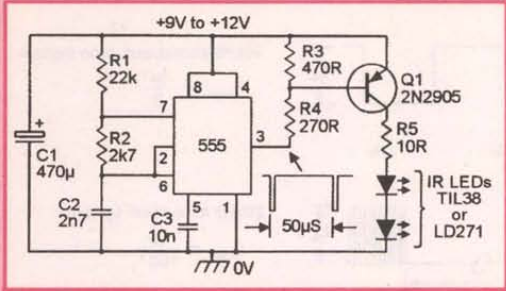


Figure 7. Simple continuous-tone IR light-beam transmitter.

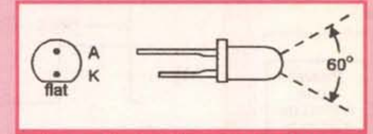


Figure 8. Outline and connections used by the LD271 and TIL38 IR LEDs.

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 consumes 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 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 5k0 (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 200mA.

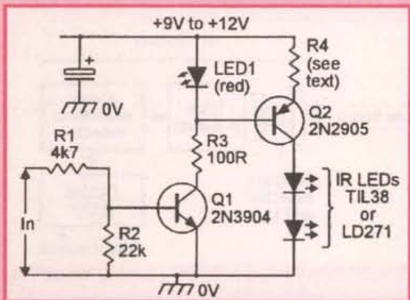


Figure 9. 'Universal' IR transmitter output stage.

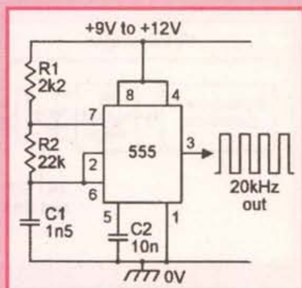


Figure 10. 20KHz squarewave 'tone' generator.

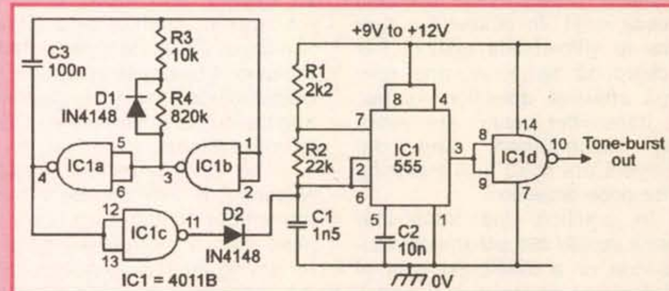


Figure 11. Tone-burst (1mS burst of 20KHz at 50mS intervals) waveform generator.

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 (IC1c), 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 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 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)*.

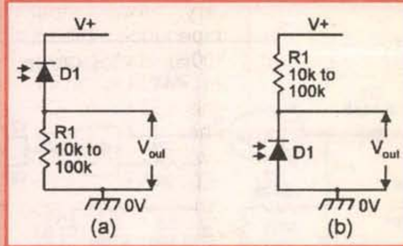


Figure 12. Alternative ways of using a photodiode as a light-to-voltage converter.

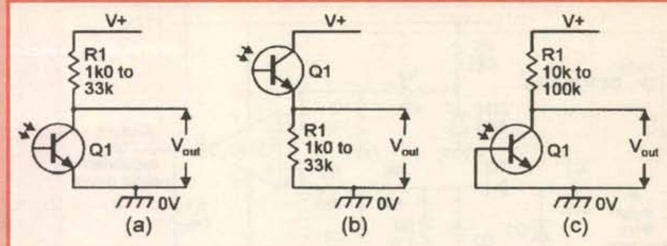


Figure 13. (a) and (b); alternative phototransistor configurations. (c); a three-lead phototransistor use as a photodiode.

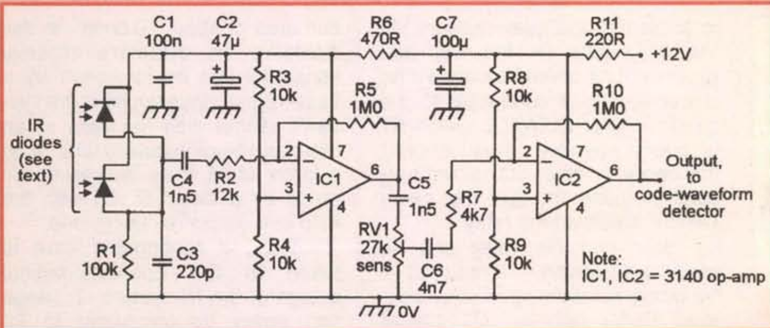


Figure 14. IR receiver pre-amplifier circuit.

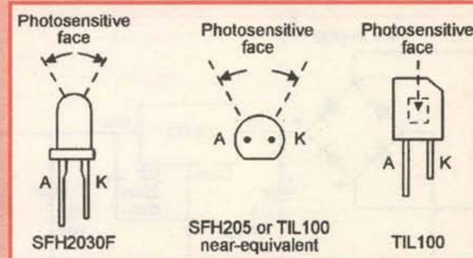


Figure 15. Case outline and IR-sensitive face positions of three popular types of IR photodiode.

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 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 overall circuit action is such that the op-amp output is high (near the positive supply rail voltage) when a 20KHz tone input signal is present, and is low (at near-zero volts) when a tone input signal is absent. If the input signal is derived from a tone-burst system, 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

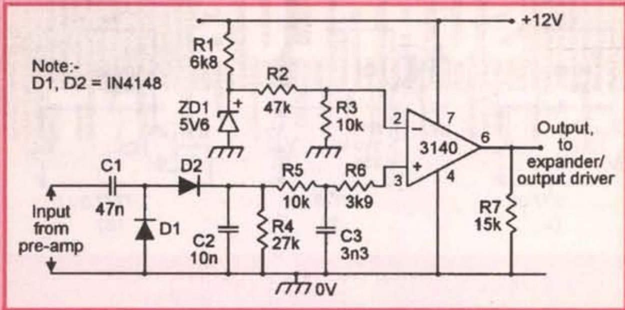


Figure 16. Code-waveform detector circuit.

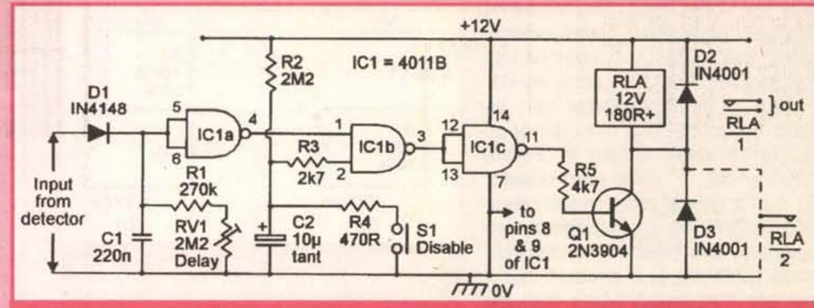


Figure 17. Expander/output driver circuit.

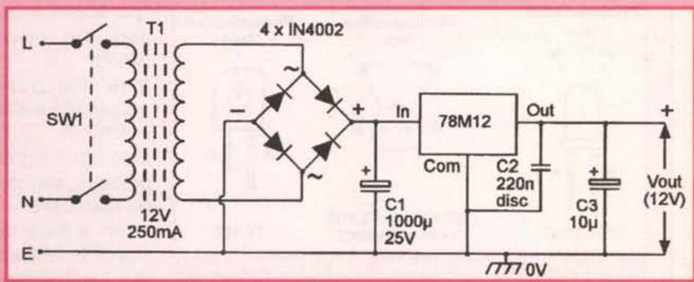


Figure 18. Line-powered regulated 12V, 250mA supply.

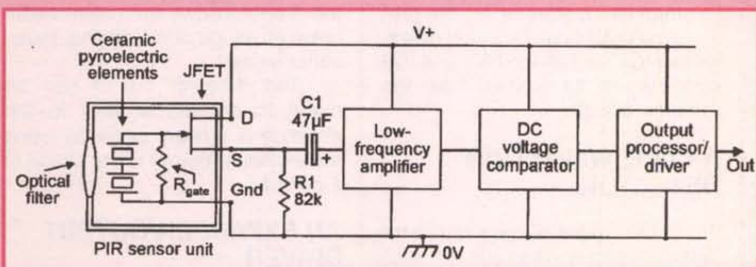


Figure 19. Basic PIR detector usage circuit.

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 collection area of about 19.6mm^2; 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^2 focusing lens, or by a factor of 36 (thus increasing the range by a factor of six) with the help of a 30mm^2 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 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.

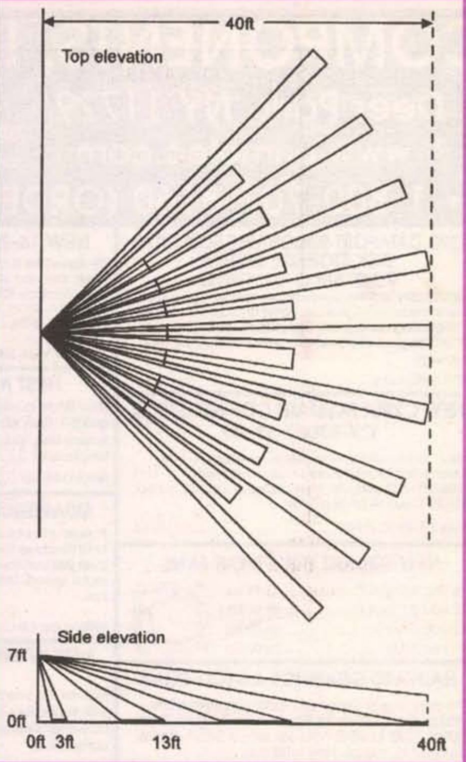


Figure 20. Typical PIR sensing pattern of a commercial 'intrusion detector' unit designed for normal domestic-type applications.

In practice, pyroelectric IR detectors of the simple type just described have — because of the small size (usually about $20mm^2$) 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 $2000mm^2$) 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, 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 interchangable) 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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All parts, all socket pulls (must be Cleaned & Erased). *Note: Speed selection available at additional charge and all parts subject to availability.

EPROMS

2708	$0.75	27C256	$1.35
2516	$0.65	27512	$1.75
2716	$0.65	27C512	$1.95
2732	$0.65	27C010	$2.25
2764	$0.65	27C100	$2.25
27C64	$0.65	27C1001	$2.25
27128	$0.65	27C1024	$2.25
27128A	$0.65	27C020	$2.95
27256	$1.25		

All DRAMS are clean socket pulls and have full leads.

4164-15	$0.18 Ea.	41256-15	$1.00 Ea.
4164-12	$0.25 Ea.	41256-12	$1.25 Ea.
		41256-10	$1.35 Ea.

NEW ALPS 2.88 MEG 3.5" FLOPPY DISK DRIVE FOR 755 SERIES THINKPAD LAPTOP

New 2.88 Meg 3.5" floppy disk drive mfr. by Alps for IBM Thinkpads 755 Series computers. This drive replaces the 1.44 Meg drive by transferring it into the original mounting bracket (5 min.) and it will be auto-detected when the computer is started. Supports 720K/1.44Meg/2.88Meg standards.

TP755/2.88 (IBM P/N 1619718) .... $49.95 Ea.

NEW HAYES ACCURA 28.8 INTERNAL FAX/MODEM

28.8 Hayes Accura internal plug-n-play fax/modem. Card comes with Quarterdeck InternetSuite 2 and Webtalk. Requires 16 bit ISA slot. Windows 95 Plug-n-Play compatible. Five year manufacturer's warranty. Accura 28.8 Fax Modem .... $49.95 Ea.

NEW INTEL A80487SX PGA MATH CO-PROCESSOR

New retail box Intel math co-processor comes complete with user guide, utility and diagnostic software. Great price and easy installation on upgradable systems. (Chip package 169 pin PGA.)

A80487SX .... $24.95 Ea.

NEC 6X CD-ROM DRIVE FOR VERSA 2400 SERIES

New fast 6X CD-ROM add-on or upgrade for NEC Versa 2400 laptop computer. Slides easily into VersaBay 2400 slot. One year manufacturer's limited warranty.

OP-260-65001 (Versa CD 6X Drive) .... $69.95 Ea.

NEW MATROX MILLENNIUM PCI VIDEO CARD

Matrox's award-winning MGA 64-bit graphics processor with 2Meg of WRAM memory and PCI design. The MGA Millennium delivers superior 2D acceleration for high-end applications, CAD, etc. Board is upgradeable to 8Meg. Complete with manual and drivers. OEM packaging for Digital Equipments PC systems and compatibles.

MGA-MIL/2 .... $54.95 Ea.

USED MICROSOFT PS/2 MOUSE (New Style Contoured Type)

Used Microsoft PS/2 mouse, from older upgraded computer systems. All test with 30-day warranty.

Used MS PS/2 Mouse .... $6.95 Ea.

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Input: 117 Vac 50/60 Hz. Outputs Available.

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9Vdc 300Ma	$2.50 Ea.
9Vdc 450Ma	$3.50 Ea.
9Vac 500Ma	$2.95 Ea.
9.5Vac 750Ma	$3.50 Ea.
12Vdc 100Ma	$1.25 Ea.
12Vdc 200Ma	$1.50 Ea.
12Vdc 500Ma	$2.95 Ea.
12Vdc 600Ma	$3.95 Ea.
12Vdc 800Ma	$6.95 Ea.
12Vac 830Ma	$4.95 Ea.
14Vdc 700Ma	$5.95 Ea.
16Vdc 1.2Amp	$6.95 Ea.

Quantity Pricing Available

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NEW NISCAN/GS PLUS OCR/ 256 GRAY SCALE SCANNER

Brand New True 256 Gray Scale Hand Scanner.
Resolution: 25-400 DPI.
Scan Width: 4.2 In. Scan Length: 11 In.
Interface: 16 Bit high speed (ISA) card, 64K SRAM.
System Requirements: 286/386/486 PC Compatible (16MHz).
Available 16-Bit Interface slot,
Windows 3.1, 4 Meg RAM,
10 Meg of Available HD space (Min.),
Mouse or Other pointing device.
........Software Included: Picture Publisher LE 3.1, (Imaging Software), Perceive Personal 2.1, (OCR Software)

Niscan/GS Plus .... $29.95 Ea.

NEW TANDY SUPER VGA 1 MEG DRAM (16-Bit ISA Bus Type)

This board is your basic super VGA video board with 1 meg of DRAM type memory. (ISA BUS TYPE.) Core Logic Chip: WD90C31-ZS-00-02. Resolution/Color: 640x480/256C, 800x600/256C, 1024x768/256C, 1024x1024/16C. Note: Software drivers included with board. Windows 3.1, VESA, Autocad, etc.

Tandy SVGA 25-4055 .... $12.95 Ea.

NEW 300W BABY SWITCHING POWER SUPPLY UL & CSA RATED 110-220VAC

Input voltage: 110-220VAC 50Hz/60Hz UL & CSA. Output voltage: +12VDC @ 12 amp/-12VDC @ 0.5 amp; +5VDC @ 30 amp/-5VDC @ 0.5 amp.

Model # Hipro HP-300PPFS .... $39.95 Ea.

CRC DATAPORT REMOVABLE SCSI HARD DISK STORAGE SYSTEM 5-1/2" BAY (3-1/2" DRIVE)

High quality SCSI hard drive removable storage system. Unit is made with aluminum frame and drive carrier with ball-bearing cooling fan. Compatible with SCSI-1 and SCSI-2 (50-pin IDE) power and drive activity LEDs, with two keys.

SCSI Dataport V .... $34.95 Ea.

NEW CYRIX FASMATH COPROCESSOR CX-83D87-33-GP

New Cyrix FasMath coprocessors for 80386DX16-33 systems. This FPU unit is used in place of Intel's 80387DX16-33 part. Originally priced at $100.00, a steal $10.95. Case: 68 pin grid array.

Cyrix CX-83D87-33-GP .... $10.95 Ea.

NEW SQUARE EQUIPMENT FANS

115 Vac 3.1" or 4.7"	$7.95 Ea.
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HARVARD GRAPHICS 4.0 (CD-ROM)

The easy way to create professional presentations. Designed exclusively for Windows 95. Pentium 75 or better. 13MB to 44MB hard disk space, SVGA display, Windows 95, mouse. New retail box

Harvard Graphics 4.0 (CD-ROM) .... $24.95 Ea.

512K PCMCIA SRAM CARD

New 512K PCMCIA SRAM card made by Fujitsu. Will work in most laptop, PDA, or handheld computers with PCMCIA socket and socket management software. HP100/200, OmniGo, Zaurus, Etc. Requires one lithium coin battery (BR2325/CR2325).Note: Battery not included.

Fujitsu (512K SRAM PCMCIA) .... $24.95 Ea.

NEW 28.8/V.34 PCMCIA MODEM/FAX MADE SIMPLE TECHNOLOGY

New 28.8/V.34 PCMCIA modem/FAX, cellular ready (MNP10-EC & TX-CEL Protocol) with Flash upgradeability to 33.6. Windows 95 Plug n' Play, Hot swap capabilities. Bitware Fax software included.
Note: Separate purchase of connecting cable from Simple Technology needed for cellular operation.
28.8 Communicator (Simple Tech.) .... $49.95 Ea.

USED PULLED WORKING ASSORTED HARD DRIVES

Pulled from working equipment, tested and guaranteed for 30 days. IDE and SCSI, from 40 Megs to 500 Megs. Call for availability,model numbers, and current pricing.

NEW TEAC 1.2 MEG 5-1/4" FLOPPY DRIVE

5-1/4" Half Height Teac. Model #FD-55GFR. Tan face plate only.

1.2M TEAC FD-55GRF .... $14.95 Ea.

INTEL PCMCIA 10/100 ETHERNET ADAPTERS

These 16-bit PCMCIA ethernet adapters are tested demo units in excellent condition. Limited quantity available. Consists of card, cable, driver disk (WIN95 Plug & Play). Note: Sorry, manual not supplied.

PRO/100 PCMCIA .... $49.95 Ea.

NEW 16-BIT 256K ISA VGA CARDS

Designed for the PC-XT/PC-AT & compatibles, this is a basic low cost VGA video card. 256K DRAM with chips & technology 82C451. Full backward compatibility with EGA, CGA, MDA, and Hercules modes. Card type: ISA 16-bit.

Model # VGA 300 (VGA Card) .... $9.95 Ea.

FIRST AID 95 BY CYBERMEDIA

New retain boxed CD-ROM version for Windows 95 and 3.1. Fixes Windows problems automatically. System Req. IBM Compatible 386 or higher PC with Windows 95, 3.1, 3.11 / 4MEG RAM / 7MEG HD Space.

FirstAID 95 Ver. 2.0 .... $9.95 Ea.

QUARTERDECK WINprobe4 (3.5" Disk)

Powerful troubleshooting software tool for Windows and Windows 95 operating systems. Program can run over 200 individual tests to keep your system running at full speed. 1MB free HD space required. New retail box.

WINprobe 4.0 (3.5" Disk) .... $9.95 Ea.

NEW INTERNAL IMES 6X IDE CD-ROM DRIVE

New 6X IDE interface, Caddyless design. Drive comes with instructions sheet, IDE cable, and driver disk for DOS and Windows. Unit is Windows95 Plug & Play compatible.

IMES 6X CD-ROM Drive .... $49.95 Ea.

NEW MICRONICS PENTIUM HX CHIPSET MOTHERBOARD

New Micronics Model D5CUB Pentium AT style motherboard. This motherboard comes with built-in I/O support for 4) IDE devices, 2 com ports, floppy controller, and printer port. The motherboard is built around the Intel HX Chipset and can support MMX and NON-MMX Pentium CPUs and Cyrix 6X68 CPUs 100MHz through 200MHz, 256K cache, 4) 72-pin SIMM sockets.

Micronics D5CUB .... $74.95 Ea.

NEW 1.44 MEG 3.5" FLOPPY DRIVE WITH BEIGE FACE PLATE

Floppy 1.44/Gray .... $19.95 Ea.

NEW INTEL PENTIUM 60/66 CPU HEATSINK 12VDC FAN COMBO

New Pentium 60/66 heatsink 12VDC fan combo for cooling the older, hotter, CPUs. Low profile type with seven inch wires. Can be used on other CPUs if you have the physical space..

Pentium 60/66 CPU Cooler .... $4.95 Ea.

NEW TEAC COMBO 700 TAPE BACKUP AND FLOPPY DRIVE 1.44 3.5"

The Teac combo is a 3.5" floppy drive and QIC tape backup unit built into 5.25" half height frame. Great for systems with limited drive bays. Tape backup unit utilizes the PC's existing floppy controller. Capacity: 680MB compressed/340MB uncompressed. Tape Format: QIC-3010-MC. Data Trans. Rate: 0.5 & 1Mbps. Tape Media: 3M MC3000XL (400 ft.). Software Incl.: Arcada Backup for Windows 95, Windows 3.1 & DOS (1.44 Meg floppy). (Note: Back-up tape or cables not included with drive.)

FF-3101/700 Combo .... $69.99 Ea.

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EZ-EP DEVICE PROGRAMMER - $169.95

Check Web!! -- *www.m2l.com*

Fast - Programs 27C010 in 23 seconds

Portable - Connects to PC Parallel Port

Versatile - Programs 2716-080 plus EE and flash (28, 29) to 32 pins

Inexpensive - Best for less than $200

- Correct implementation of manufacturer specified algorithms for fast, reliable programming.
- Easy to use menu based software has binary editor, read, verify, copy, etc. Free updates via bbs or web.
- Full over current detection on all device power supplies protects against bad chips and reverse insertion.
- Broad support for additional devices using adapters listed below.

Available Adapters	
EP-PIC(16C5x,61,62x,71,84)	$49.95
EP-PIC64 (16C62-5,72-4)	$39.95
EP-PIC12 (12C50x)	$39.95
EP-PIC17 (17C4x)	$49.95
EP-51 (8751,C51)	$39.95
EP-11E (68HC11 E/A)	$59.95
EP-11D (68HC711D3)	$39.95
EP-16 (16bit EPROMS)	$49.95
EP-Z8 (Z86E02,3,4,6,7,8)	$39.95
EP-SEE2 (93x,24x,25x,85x)	$39.95
EP-750 (87C750,1,2)	$59.95
EP-PEEL (ICT22v10,18v8)	$59.95
EP-1051 (89C1051,2051)	$39.95
EP-PLCC (PLCC EPROMs)	$49.95
EP-SOIC (SOIC EPROMs)	$49.95
EP-TSOP (TSOP EPROMs)	$59.95

Many Other Adapters Available

M²L Electronics
310/837-7818
Fax/BBS: 310/841-6050
3526 Jasmine #4;
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CA orders please add 8.25% sales tax.
http:/www.m2l.com

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WEIGHT 290 LB -
ORIGINAL COST $ 5400.00
OUR PRICE JUST $995.00

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Amplified computer speakers
•3" magnetically shielded speakers for monitor,drive and disc protection •bass boost •single sided speaker control •3.5mm stereo plug connection •power output: 1.35 watts RMS/ Ch., 5.4 W total p.p. •Freq. response 80 - 16000Hz •Built in power booster •Led Indicator •compatible with pc soundcards, CD-Rom players PC & MAC computers. BRAND NEW
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MULTIMEDIA MICROPHONE
Omnidirectional microphone is ideal for voice and sound input into your computer multimedia applications. 6 ft. cord with 1/8" stereo jack. Include stand with tape back for mounting, or mic can be attached to lapel.
BRIGAR SALE PRICE ... $1.50

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Computer Grade Capacitor
10,000 uf - 40 VDC
Size: 3-1/2" x 2" dia.
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BANNER MINI-BEAM #SM312FPHMHS
Self contained DC-operated Visible-red fiber optic sensor. Compact, modulated sensor for 10-30 vdc operation. Useable in opposed and diffused fiber optic modes Fiber optic sensing is often the answer when there are space or environmental limitations.

- supply voltage: 10 - 30 vdc
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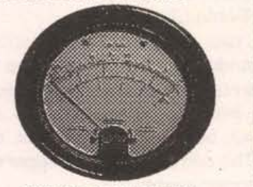
- Protection: false pulse,polarity reversal, overload & short circuit.
- response time: 1 Millisecond
- Red Led indicator for alignment
- SENSING RANGE: 0.5" TO 10'

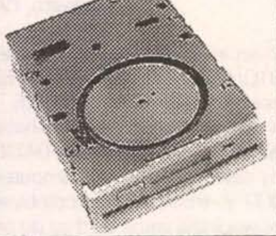
schematics and instructions included.
PRICE $59.95

MULTIMETER
MFG: PHASTRON
Analog meter movement 50 Micro Amp D.C. full scale. Large 4.5"diam - 3.5" viewing area. Zero adjustment knob. White face. Scales: In Green, Black, and Blue letters. Three AC & three DC Volt Scales. 0 - 2.5,5 and 10. One resistance scale from 0 to infinity. Includes mounting hardware.
BRAND NEW - FACTORY BOXED.
REDUCED PRICE $4.95



ANALOG PANEL METER
PART # 40-013857

3.5" 1.44MB FLOPPY DRIVE
NEWTRONICS CO. # D359T5
5 VDC - WHITE FACE PLATE FOR USE WITH IBM & IBM Compatible computers. HIGH Density. ***BRAND NEW ... $19.95***



POWER PRODUCTS # HE381
Linear power supply module.
Size: 2-1/4"w x 4-3/4"L x 1-1/2"D
Input: 115vac 50/60hz 271 ma.
Output: 5vdc 5000ma.
Price... $24.95 ea.

JOHNSON #27120
6-12VDC Toy/Hobby Motor
Miniature - Reversible Dc motor. 6vdc @ 6000 RPM
12 Vdc @ 12,000 RPM
Size: 1-1/4"L x 1"W x 13/16"
Shaft: 3/4"L x 1/16"Dia.
Price ...... 60¢ ea.
10 For $4.00

Pheonix contact # CM62-PS-120AC/24
Linear Regulated compact POWER SUPPLY
INPUT: 120VAC
OUTPUT: 24VDC 1AMP
fuse & overload protected.
UL & CSA APPROVED.
SLIDE MOUNTABLE.
Unit includes heat sink
SIZE: 3"W X 5-1/2"H X 2-1/2"D NEW FACTORY BOXED. MANUALS INCLUDED.
LIST PRICE .. $259.95
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2 x 16 SMART LCD DISPLAY *GOLDSTAR*
MODEL #LC16208 •Character: 16 •Line: 2 •Power requirement: 5vdc @ 3mA •Window size: 5/8" x 2-1/2"L - 2 goldstar drivers: #GM9120 - Display comes mounted on a 3-3/4" x 4-1/4" circuit board with 16 mini push button switches and 3 rectangular LED'S. (Comes complete with schematics , 68hc11 program and initialization steps)
SALE $12.95

DISPLAYS COMES COMPLETE WITH 3.5" DISKETTE. FILES CONTAIN 68HC11 PROGRAM, LIST OF COMMANDS schmatics & Initialization steps.

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compact 30mm x 30 mm (Approx 1"sq.)
High performance & picture quality of a full featured camera on a compact board.
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Card requires a 16 bit expansion slot. Captures Video in .avi format at various frame rates & size. Frame graber saves pictures in the following format (.jpg) (.bmp) High Q card will work with both NTSC & PAL Video devices. High Q card will handle up to two Video input devices & audio input devices. Comes complete with software.
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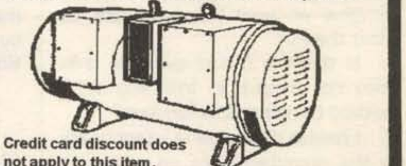

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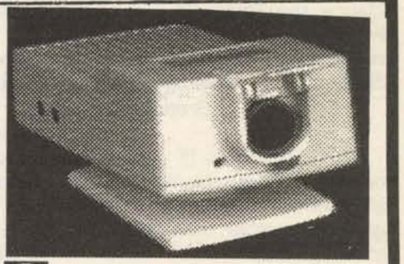

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TELECAMERA #HA4700 COLOR CCD CAMERA with built in Microphone
CAMERA COMES COMPLETE WITH POWER ADAPTOR - VIDEO CABLE - SWIVAL BASE
Camera uses a 1/3" CCD advanced imager, automatic gain control, electronic auto iris, fixed focus glass lens, and attractive enclosure - designed for videoconferencing. Real time capability. composite signal output for standard interface to : TV monitors,VCRs,use with video networks,frame grabber compatibility etc ....
•**Scanning system**: ntsc (525 vert lines 300 fps)
•**sync system**: internal sync only
•**Resolution**: Horizontal TV lines 330
•**Max Illumination**: 10 lux •**NTSC Compatable**
•**Focal distance**: 600mm fixed
•**Video S/N Ratio**: 46dB
•**IRIS System**: Electronic auto iris
•**CCD imaging**: 532h x 500v 270k pixels
•**Video output**: composite video
•**Rear connections**: Audio & video RCA jack, AC adaptor jack
•**Size**: 68.5mm(w) x 43mm(H) x 122mm(D)
BRAND NEW FACTORY BOXED...... *$189.95*

SEALED BALL BEARING
MFG: FAFNIR PART # 203 VV
■BORE: .668" ■Dia. 1.575" O.D.
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$1.50 **WHY PAY MORE?**

1 MEG 30 PIN SIMM MEMORY MODULE
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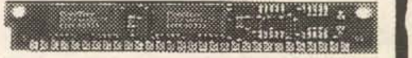

Write in 191 on Reader Service Card.

Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 91719, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

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 Therimin. 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 ± DC supply and drive a toroidal transformer with power 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 + -3 dB) amplifier with a gain of +20 dB.

The input impedance is 10 megohms and the output impedance is 50 ohms.

I've tried several J-FET and Comlinear 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

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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-

ANSWER TO #5989 - MAY 1998

The following is a generic listing of printer cable and plug pinouts.

A DB-25 (male pins) plug attaches to the PC printer port and, in this example, a 36-pin Centronics plug attaches to the printer.

Parallel Printer Signal Pinout

Printer Centronics Jack Pin	Signal	Printer	Port	PC LPT1 DB-25 Jack Pin	Function
1	Strobe	Input	Output	1	Enables data 1-8
2	Data 1	Input	Output	2	PTR data
3	Data 2	Input	Output	3	PTR data
4	Data 3	Input	Output	4	PTR data
5	Data 4	Input	Output	5	PTR data
6	Data 5	Input	Output	6	PTR data
7	Data 6	Input	Output	7	PTR data
8	Data 7	Input	Output	8	PTR data
9	Data 8	Input	Output	9	PTR data
10	Acknowledge	Output	Input	10	PTR received data
11	Busy	Output	Input	11	PTR busy
12	Paper Out	Output	Input	12	PTR out of paper
13	Select	Output	input	13	PTR on/off line
14	Autofeed XT	Input	Output	14	Add LF to each CR
15	Error	Output	Input	15	PTR fault/off line
16	Signal ground				
17	Chassis ground				
18	+5VDC/NA	Output			
19	Strobe return				
20	Data 1 return				
21	Data 2 return				
22	Data 3 return				
23	Data 4 return				
24	Data 5 return				
25	Data 6 return				
26	Data 7 return				
27	Data 8 return				
28	+5 VDC/NA	Output	Input		
29	Busy Return				
30	INIT return	Input	Output		
31	INIT	Input	Output	16	Reset PTR
32	Error	Output	Input		
33	Signal ground				
34					
35	+5VDC/NA				
36	Select In	Input	Output	17	Notify PTR
				18-25	Grounds

Stanley Link
San Diego, CA

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 sits.

There are also a number of E-Mail mailing lists available on the Internet.

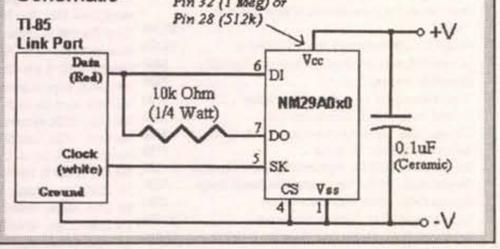
As far as adding more memory to your TI-85, a modification has been done that increases the amount of RAM to either 512K or 1024K. The device is known as "The Expander SF" and connects to the 2.5 mm female stereo "link connector" on the bottom of the TI-85.

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

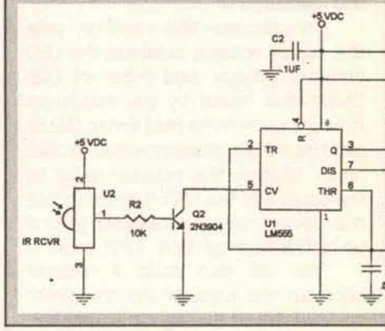


ANSWERS TO #49814 - APR. 1998

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's-cope or frequency counter on pin 3 of U1, adjust R10 for 40 KHz. See the schematic for construction details.



Kevin Goodwin
Oceanside, CA

... 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 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
Fenelton, 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-

TECH FORUM

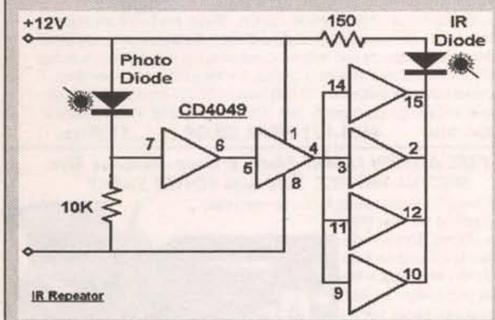
ANSWERS TO #49814 - APR. 1998

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 comon 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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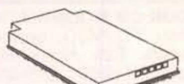

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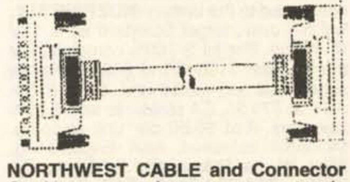

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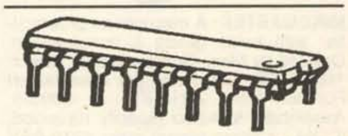

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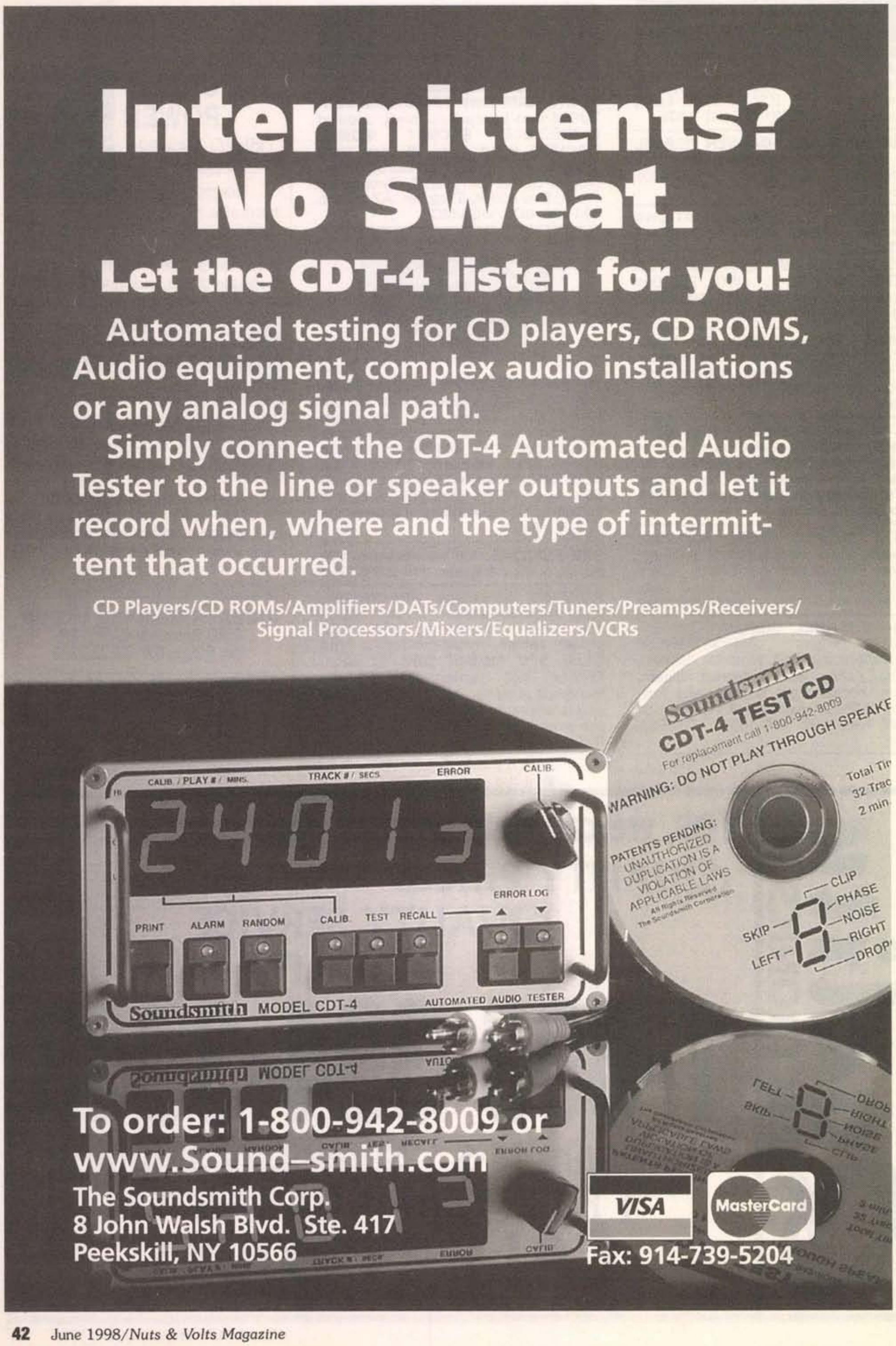

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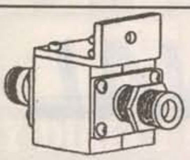

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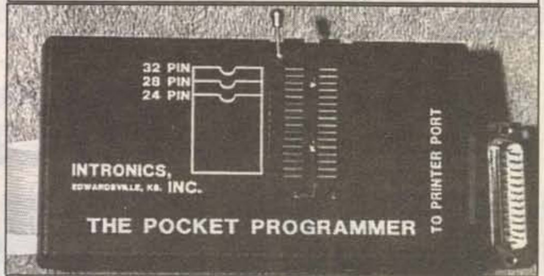

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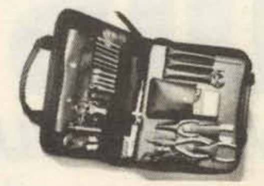

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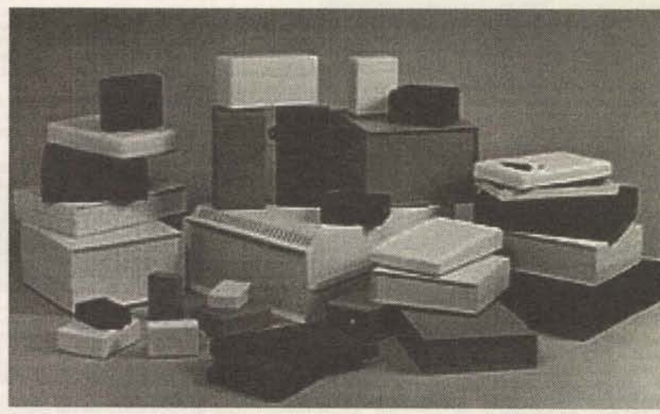

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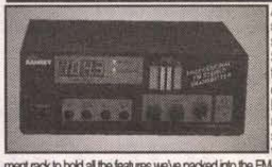
Super Pro FM Stereo Radio Transmitter



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

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

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

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 setable 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 wire 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

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

TG-1, Tone Grabber Kit.......$99.95
CTG, Matching Case Set for TG-1 Kit.......$14.95
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Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture! Transmits color or B&W up to 150' to any TV tuned to cable channel 59 with a solid 20 mW of power. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Deluxe model includes sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Our cameras shown below have been tested to mate perfectly with The Cube and work great. Fully assembled.

C-2000 Video Transmitter Cube.......$89.95
C-3000 Video and Audio Transmitter Cube.......$149.95

CCD Camera Interface Board

Here's a nifty little kit that eases hook-up of your CCD camera module to any video monitor, VCR or video input TV set. The board provides a voltage regulated and filtered source to power the camera (CCD Cameras require a stable source of power for best operation), sensitive electret condenser mike for great sound pick-up and RCA Phono jacks for both audio and video outputs. Runs on 11 - 20 VDC

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

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If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. These cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, these are super IR (Infra-Red) sensitive! Available with Wide-angle (80°) or super slim Pin-hole style lens. Both run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our Interface board (below) for Audio sound pick-up and direct wire connection to any Video monitor or TV video/audio input jacks. Fully assembled.

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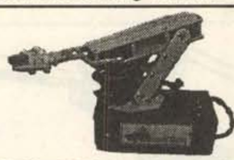

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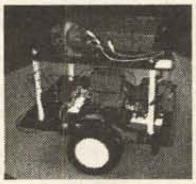

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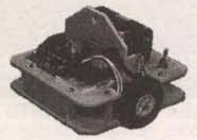

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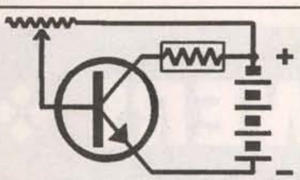

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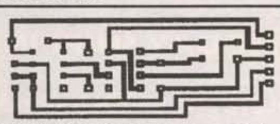

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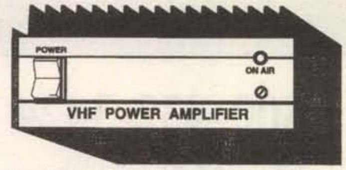

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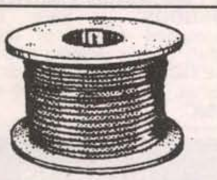

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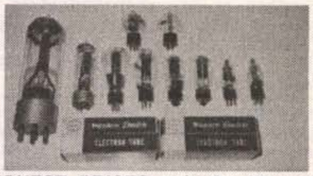

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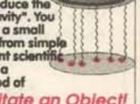

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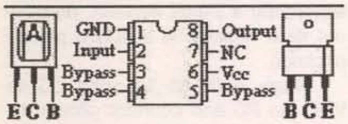

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Continued from page 39

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

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 program 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 different 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 program 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 contains 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 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 feature.

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 populer 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 synchronously 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 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 nominally 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

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.

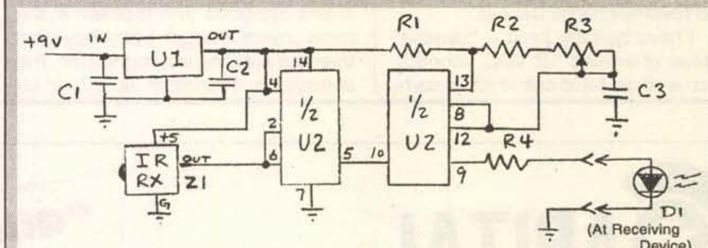
The schematic shows how I have incorporated that detector into a repeater. The detector gates a 40-KHz oscillator, made from half of a 556 timer. (The other half works as a logic inverter.) The oscillator drives an infrared LED which can be at the end of a cable that goes to the device to be remote-controlled. 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 squarewave frequency to 40 KHz, using a fequency 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

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 adding 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 go down 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

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, 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.

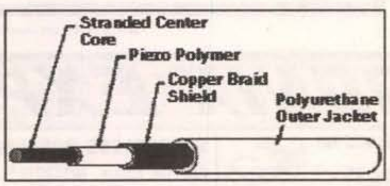
Steve Craddock
via Internet

A. *Boy, has the mention of this product raised a lot of response. First, the contacts.*

AMP Sensors Americas
Glen MacGibbon
P.O. Box 799
Valley Forge, PA 19482
Tel: **610 650-1500**
FAX: 610 650-1509
E-Mail: **sensors@amp.com**

Pete Smith
172 Big Valley Road
Folsom, CA 95630
Tel: **916 983-8644**
FAX: 916 983-0479
E-Mail: **prsmith@amp.com**

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.



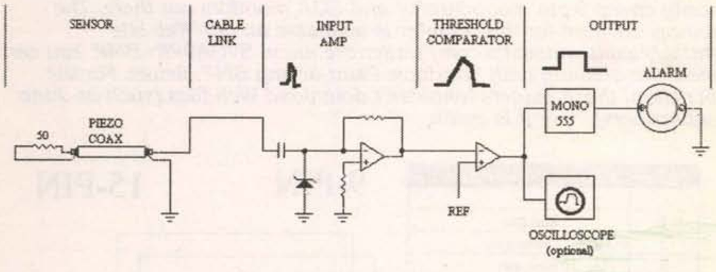
The cable can be buried for perimeter fence security, traffic sensors with vehicle classification, and other safety and security applications. Other applications include sensors for floor mats, touch pads, and door edges. The piezo cables feature the same piezoelectric properties that are characteristic 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^3	1890
Acoustic Impedance	MRayl	4.0
Relative Permittivity	@1kHz	9
tan δ_e	@1kHz	0.017
Hydrostatic Piezo Coefficient	pC/N	15
Longitudinal Piezo Coefficient	Vm/N	250 x 10^{-3}
Hydrostatic Piezo Coefficient	Vm/N	150 x 10^{-3}
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-

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.



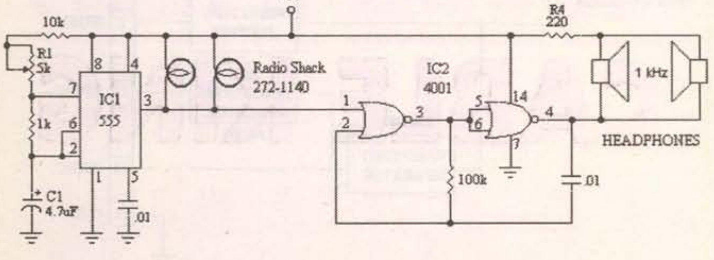
The first stage is the piezo coax cable itself. While the cable can pass a signal (such as an audio message between a gate speaker and your home), it's most likely you'll want to use it just to alert the passage of an object, like a car, across your parameter. If you don't have a signal source, a termination 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 *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.*

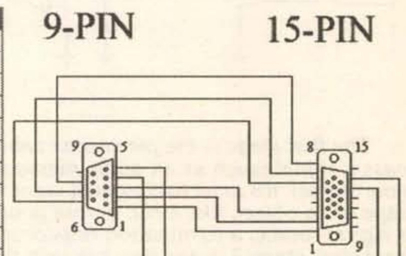
Old Monitors Still Live!

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

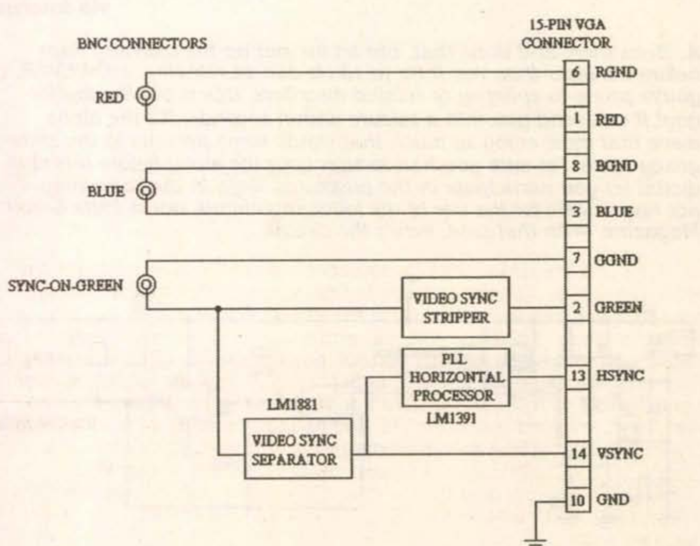


RGB to SVGA Converter

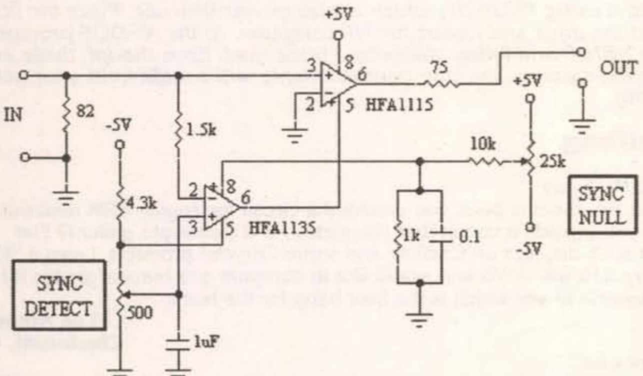
Q. I have an old Hewlett-Packard UNIX computer with three BNC video outputs (RGB) that I wish to use with my SVGA monitor. Is there an interface available or a circuit that I can build to accomplish this?

Chuck Karbginsky
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 *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.*



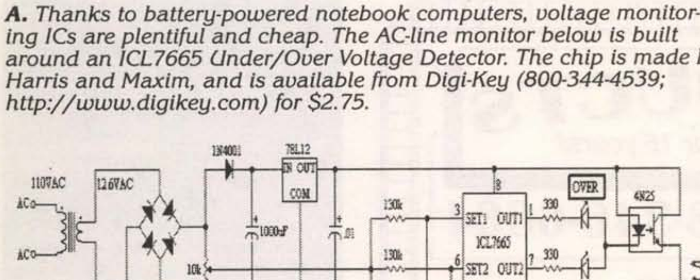
BTW, the LM1881 chip is an industry staple that's cloned by several vendors, including Elantec and Philips. Now let's hope your SVGA monitor has the right capture range to support the HP's scan rates. Can you buy a commercial unit that converts RGB video to VGA video? Not that I can find. Virtually all 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.

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!

Just send or E-Mail your questions to the Tech Forum or Q & A column.

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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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, 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 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 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 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 length of a four AA-cell battery holder, the kind where all four batteries lay flat in a row.

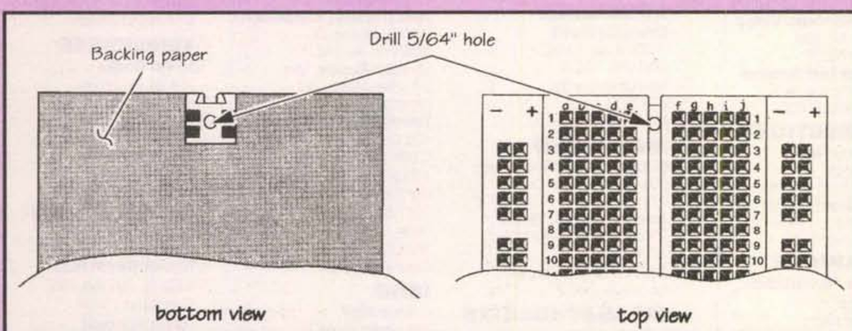

Figure 1. Breadboard modifications.

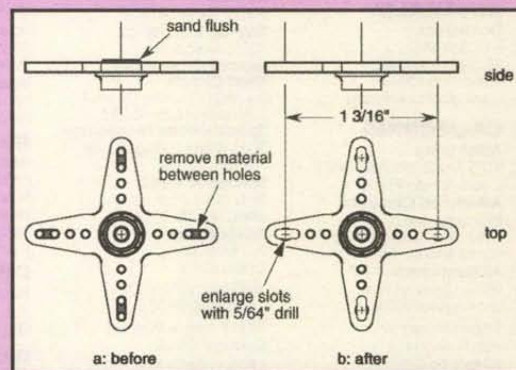

Figure 2. Servo control horn modifications.

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).

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 are ideal for this), then mark and drill a hole to match the one in the breadboard. This square of plastic will serve to insulate the contacts from the metal shaft collar of the caster assembly.

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 servos, I urge you to take a look at the SRS webpage before proceeding: http://www.seattlerobotics.org/guide/.

Peel away the portions of the backing paper you cut in the previous step to expose the sticky foam, the sections between the 0.5" and 2.125", and the 3.0" and 5.5" marker lines. Leave in place the strips of backing paper in between (on the ends and in the middle). These covered sections of sticky foam will be used for attaching sensors and whatnot in the future.

Mount your modified servos in the orientation shown in Photo 3. Take care that the mounting tabs of the servos line up with the edge of the breadboard (see Photo 7). With the measurements given, the shafts of both servos will be about 1.75" from the front end of the breadboard. To make the servos more secure, place a strip of cellophane tape across them.

Mount the battery holder with its power leads facing what will be the left side of the robot. Now is a good time to neaten up the servo cables and power leads with a few nylon cable ties; leave about 2.5" free on the ends of the cables so you can route them up around to the component side. The female servo connectors each mate with three-pin strip-line headers plugged into the breadboard; for the time being, the tinned wire ends of the power leads plug directly into the left-side distribution busses, so to remove power from the board you pull the power lead out.

Mounting the wheels

I used the four-arm, 1-1/2" control horns that come with S148 servos to mount the wheels. Both the Futaba control horns and the 2-1/4" Stream Line wheels must be modified to fit each other.

First, the control horns: sand off the ribbed hub ring that protrudes above the top side of the control horn (the side with the numbers on it). This hub ring only sticks up about 1/64", but since it's a larger diameter than the hub hole in the wheel, it must be removed so the control horn will lie flush with the wheel disk (Figure 2a).

With a hobby knife and a needle file, remove the plastic between the two outermost holes on each control arm (Figure 2b). The idea is to make slots to match up with the four screw holes of the wheel disks. At first, make the slots slightly narrower than the 2-56 screws (you will enlarge them in a later step).

Now for the wheels: The Stream Line wheel consists of two snap-together, injection-molded plastic wheel disks that sandwich a rubber O-ring tire. The inboard disk has four hollow pins that mate with corresponding holes on the outboard disk (I use the terms "inboard" and "outboard" meaning facing either toward or away from the robot,

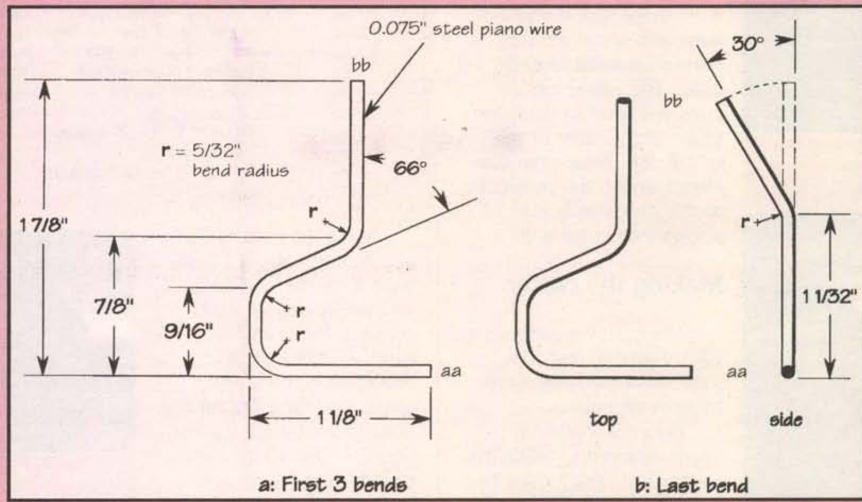

Figure 3. Making the caster strut.

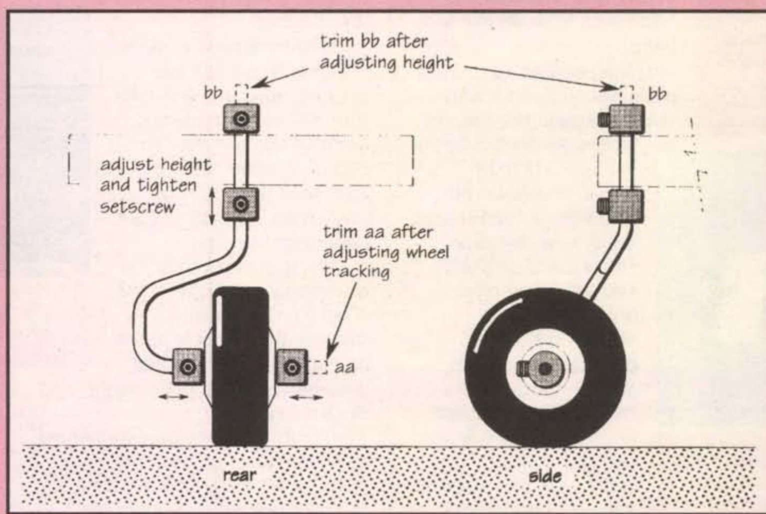

Figure 4. Adjusting caster tracking and height.

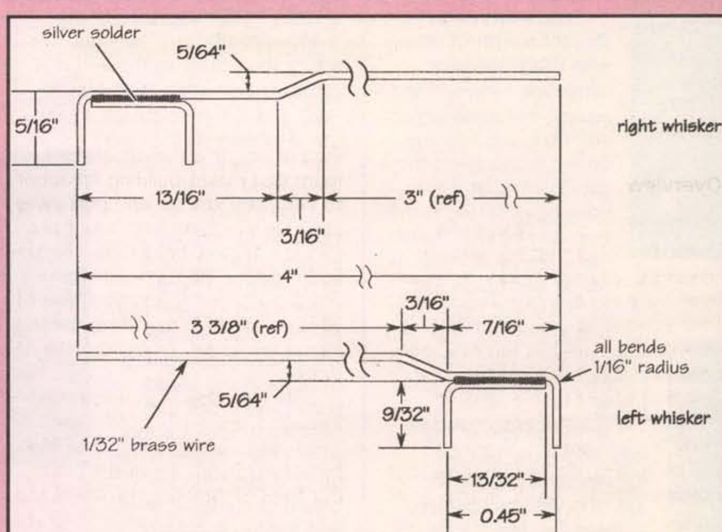

Figure 5. Fabricating the whiskers.

respectively). Snap the wheel disks together without their tires, and mark both halves of each with "L" and "R," respectively. With a 5/64" bit, ream out the four screw holes in each wheel disk (this operation is best done with a drill press, but you can use a hand drill if you are careful). Insert 2-56x1/2" flathead machine screws through the holes to check the fit. You may need to countersink the holes in the outboard disks so the screw heads lie flush. Remove the screws, and set aside.

Do a jig

The final step is to mate the wheels to the control horns. You will need to ream the slots you made earlier with a 5/64" drill bit so the screws will go through the slots (Figure 2b), but getting the slots aligned with the holes in the wheel disks can be a bit tricky.

You can eyeball it, but I found a better way is to use a quarter-inch 4-40 threaded spacer as a temporary jig to hold everything in alignment while you drill the slots out. The hub of the wheel disk is just the right size to fit a 1/4" round aluminum spacer, and a 4-40 machine screw fits the screw hole in the control horn hub. Place the inboard disk on a flat surface, hollow pins up, and press the spacer into the wheel hub. The fit will be very snug, and if you have any trouble, try chamfering the rim of the hub with a hobby knife to remove any plastic flash. Push the spacer in until it is even with the outer surface of the disk. If it protrudes beyond the outer surface, press it back flush.

Now place the control horn with its sanded side against the outer surface of the wheel disk, center the hubs, and secure the control horn to the spacer with a round head 4-40 screw. If the head of the screw is too large to fit in the splined hub of the control horn, use a washer larger than the hub to keep the screwhead on top of the hub. Don't force the screwhead to fit in the hole, or you risk stripping the splines and rendering the control horn unable to mate with the servo shaft. Finger-tighten the screw, then turn the control horn until its four slots align with the four holes in the wheel disk.

Sighting through the hollow pins from the wheel disk side will help you get the alignment perfect; when everything is aligned, tighten the screw. Drill the first slot out with the 5/64" bit and place one of the 2-56 screws through the newly enlarged slot to ensure everything stays aligned while you drill out the next three. Repeat for the second wheel and control horn. It's a good idea to use a permanent marker to designate which control horn goes with which wheel; also mark the first hole you drill on both pieces so you can later re-assemble them in the same orientation.

When you're done, you can unscrew everything, and pull out the aluminum spacer. Congratulations: you've just converted ordinary control horns into precision wheel mounts.

Now, put the wheels together

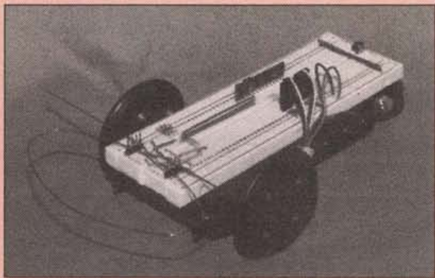

Photo 1. Breadbot with "bow tie" front bumper and side whiskers.

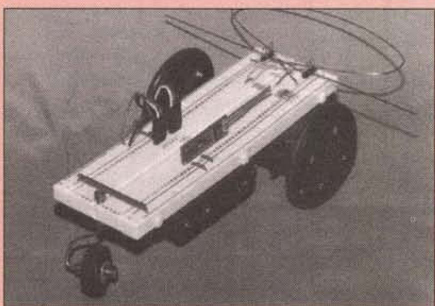

Photo 2. Reverse angle shot. Notice the jumper wires tying together the left and right power and ground distribution busses; both jumpers must be far enough forward that the setscrew in the top shaft collar can clear the jumpers when the caster turns.

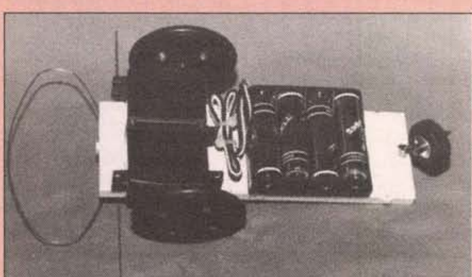

Photo 3. Breadbot's underside. I used nylon cable ties to hold the servo cables neatly in place between the battery holder and the servos.

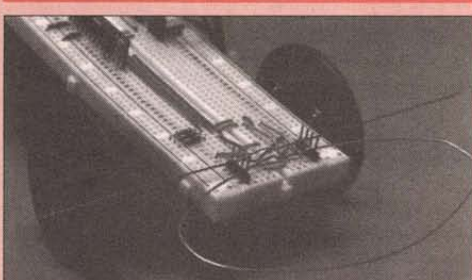

Photo 4. Close-up of Breadbot's whiskers and "bow tie" bumper.

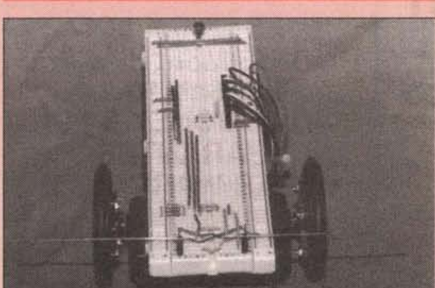

Photo 5. View of Breadbot with "bow tie" bumper removed.

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.	NWM100BLACK
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.

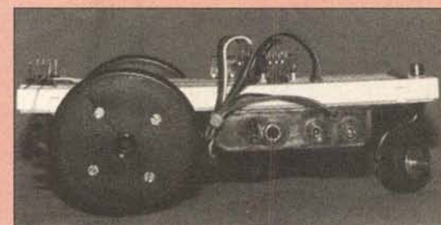

Photo 6. Side view showing the battery holder. Another cable tie secures the battery holder wires to the servo cables.

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.

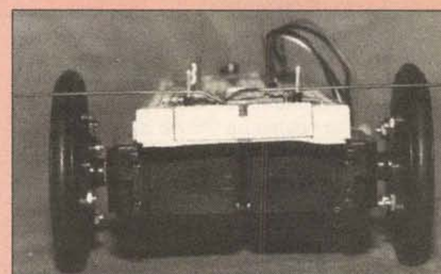

Photo 7. Head-on close-up of servos and whiskers ("bow tie" bumper removed for clarity).

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.

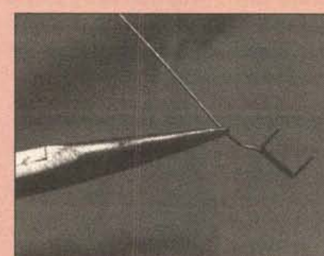

Photo 8. Close-up of the left whisker.

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 battery holder when batteries are in place.

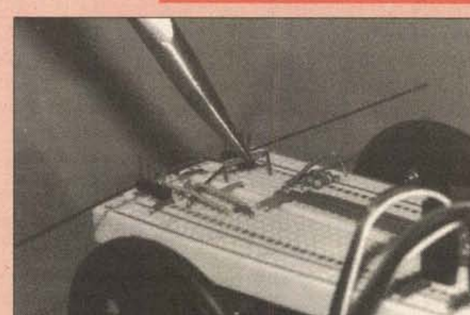

Photo 9. Installing the left whisker. The jumper wire visible to the right of the whisker is shown unconnected; in its final position, it lays over the left whisker lead to connect to the strip-line header for the right whisker.

Suppliers Mentioned:

Digi-Key Corp.
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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 rearmost 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 caster 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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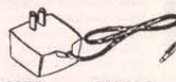

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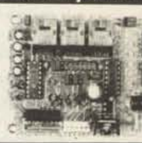

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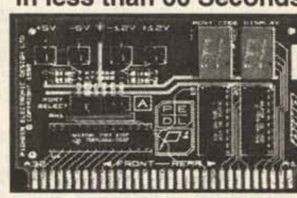

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Don Lancaster's

RESOURCE BIN

number seventy seven

A look at accessing offshore electronics.

Our usual reminder here that the *Resource Bin* is a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja questing*, personal publishing, money machine, or computer topic by calling me at **(520) 428-4073** weekdays 8-5 Mountain Standard Time.

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-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.

NEXT MONTH: Don shows us some star-tup secrets for your own web site.

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 Phillipine-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 to dominate the results. The closer you come to their mainstream topics, the better this service becomes.

They do give you a monthly CD-ROM that started off kinda empty, but is certainly becoming more and more useful. These are usually included with each issue of your subscription. Speaking of which, this magazine is not cheap. Prices start at $80.00 per year for ordinary mail delivery, and range up to $165.00 for premium air service.

Scoring free copies is tricky. If

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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.*

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.*

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 *Elecktor 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 & Electronik (Germany)
E.E. Times Taiwan (Taiwan)
Electronic Engineering (England)
Electronic Times (England)
Electronik 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
EPIT Electrosource

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.* 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.* 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.*

Some Additional Web Sites

A nice collection of international web sites hosted by *Arizona Central* appears at *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.ttauk.com.* This one is a fee-based service.

Yet another useful resource is at *www.asia-inc.com.* Their site includes Far East business news, along with a searchable database 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.*

The content at *www.chinabig.com* is a comprehensive online Yellow Pages and bilingual resource.

Finally, look into *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.* 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 difficult to cheaply pick up a few parts. But new sources such as *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* link from *Southwest Auction Weekly* and others on *www.tinaja.com/beewb01.html* for the latest auction info. Or the great *Bentley's Auctions* link you'll find on *www.tinaja.com/dntkwb01.html*. These fine people at Bentley can be your ultimate source for quality electronic test gear. Offered by the semi load.

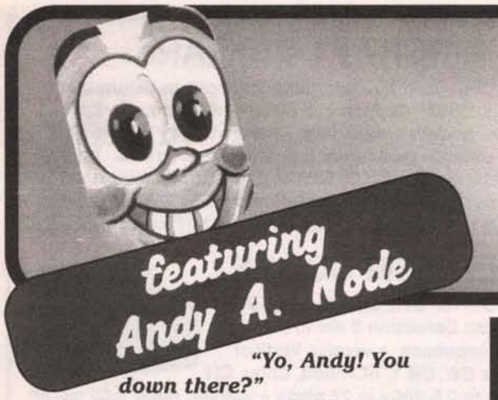
Or check out RESBN73.PDF and my *Resource Bin* reprints for the insider electronic auction secrets. Or do visit *www.barg01.html* for all of the goodies themselves.

Custom assistance in pinning down any electronic component or service is found at *www.tinaja.com/info01.html*.

Let's hear from you. There's some exciting new opportunities here. **NV**

Microcomputer 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.coml/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****.*



THE WEEKEND WORKBENCH

Andy Builds An IR Switch
Don't clap — zap that light on/off with your VCR remote

"Yo, Andy! You down there?"

"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, 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.

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!!

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

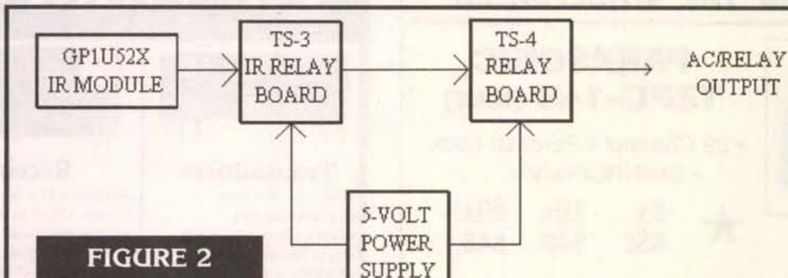
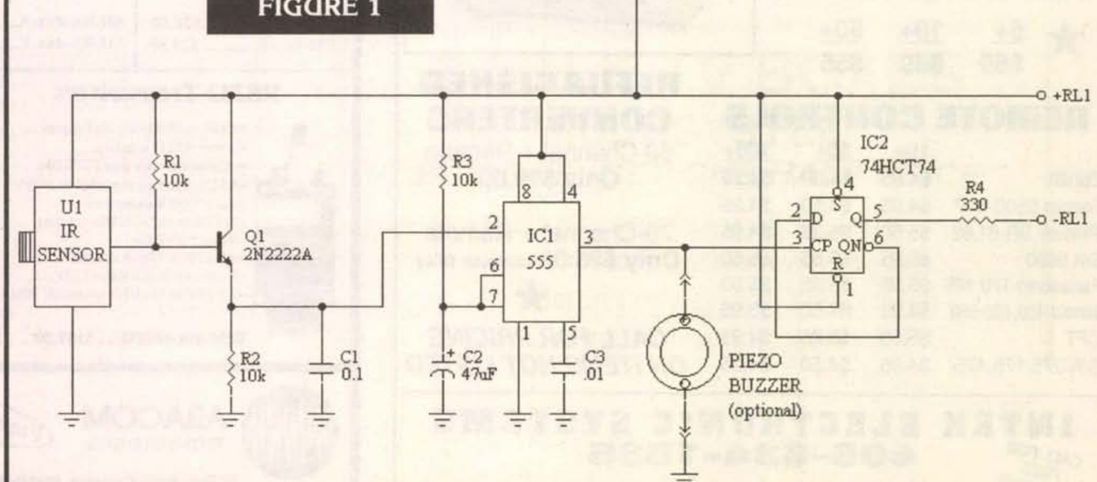


FIGURE 2

FIGURE 1



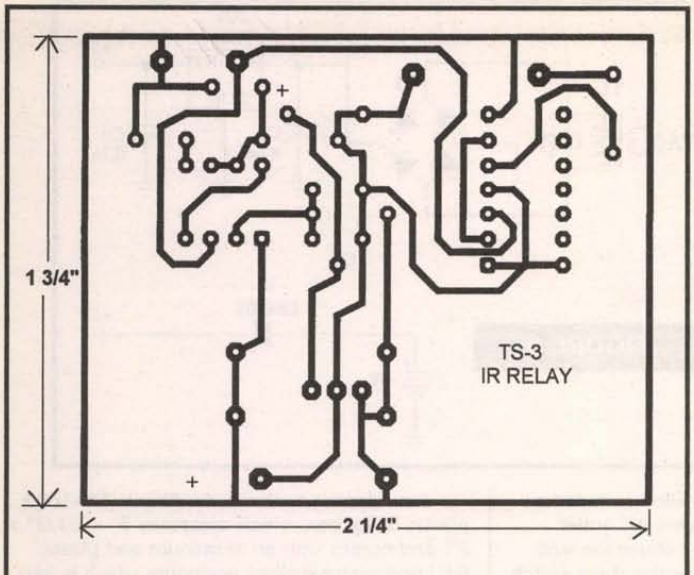


FIGURE 3

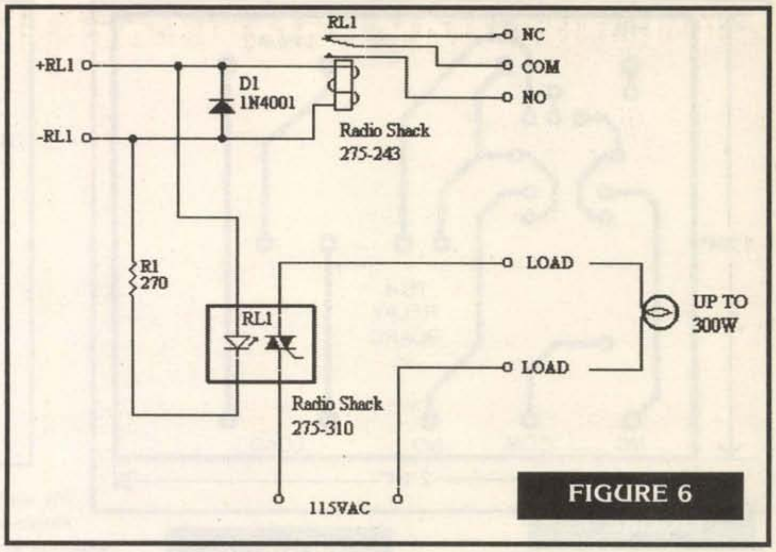
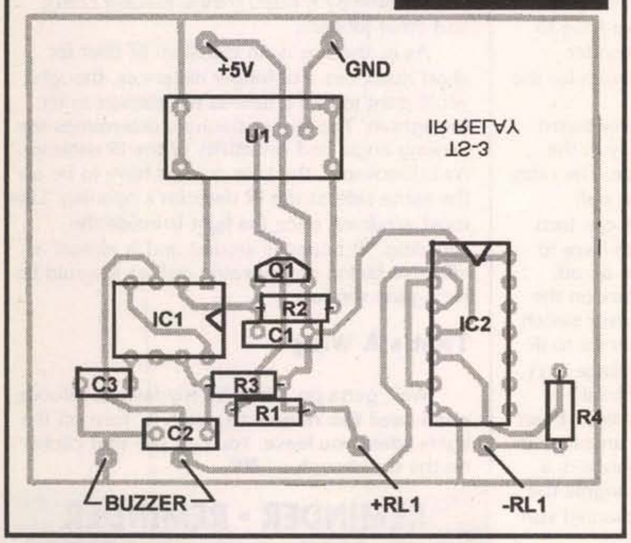


FIGURE 6

FIGURE 4



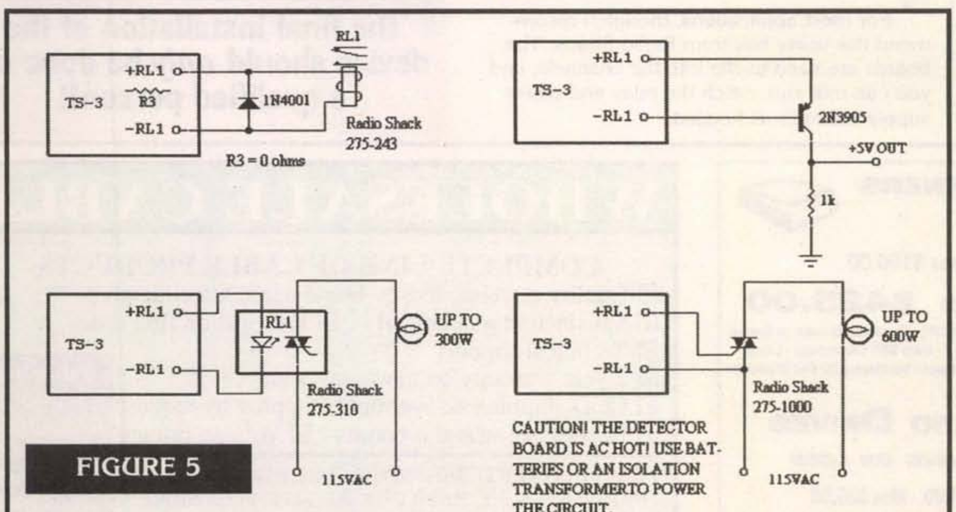


FIGURE 5

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 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 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.

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"

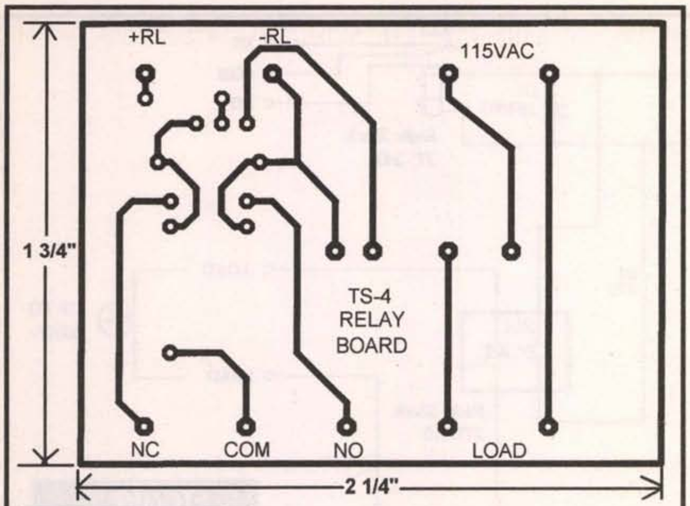
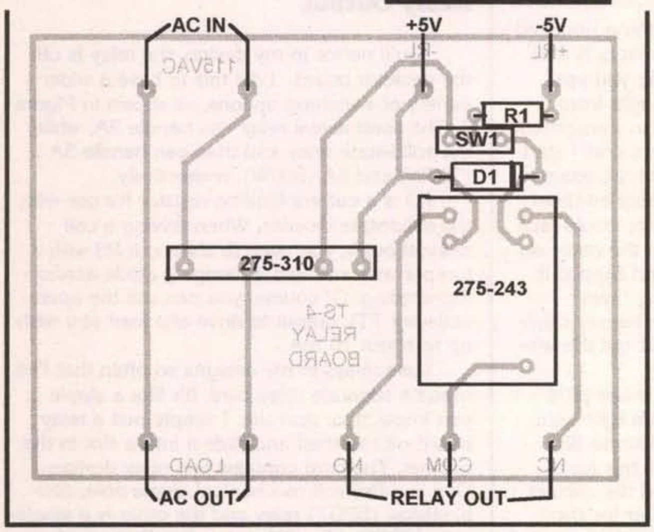


FIGURE 7

FIGURE 8



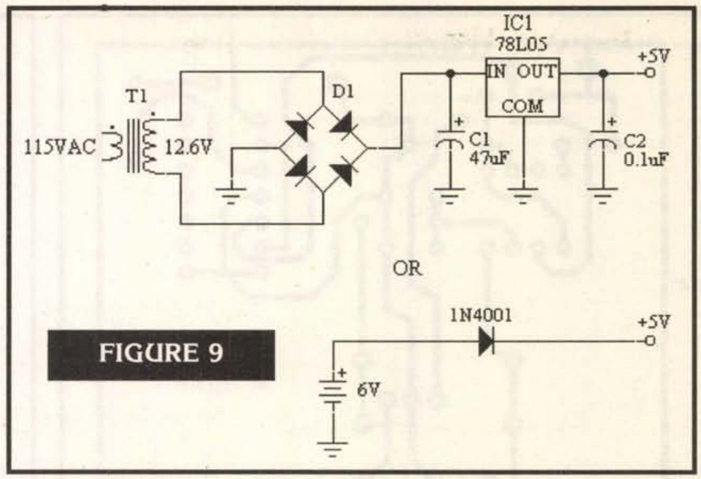


FIGURE 9

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 Vcc 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.

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 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.

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**

REMINDER • REMINDER

The final installation of the device should *only* be done by a qualified person!!

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 bandpass 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 U1 turns on and Q1 turns off, which causes C1 to discharge through R2. When the voltage reaches 1/3 Vcc, 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.

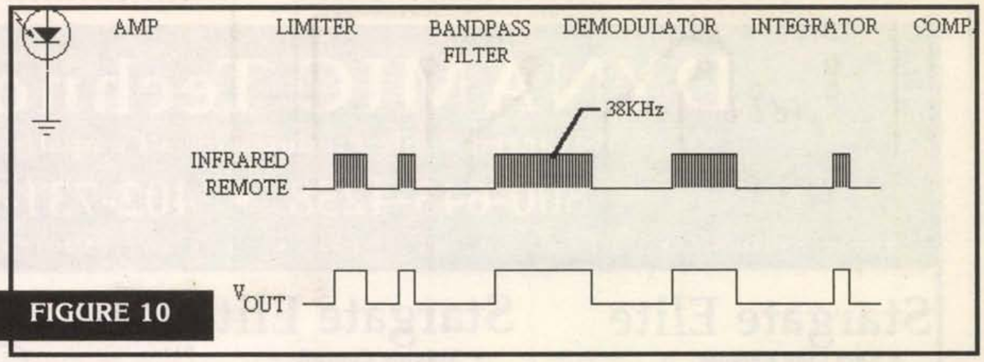


FIGURE 10

Parts List: IR Detector

Reference	Description	Digi-Key	Radio Shack
Semiconductors			
IC1	LM555	LM555CN-ND	276-1723
IC2	74HCT74	MM74HCT74N-ND	276-2816
Q1	2N2222A	2N4401-ND	276-2058
Resistors			
R1,R2,R3	10K	10KQBK-ND	271-1335
R4	330	330QBK-ND	271-1315
Capacitors			
C1	0.1uF	EF1104-ND	272-1069
C2	47uF	P5230-ND	272-1027
C3	0.01uF	EF1103-ND	272-1065
Misc.			
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
Semiconductors			
D1	1N4001	1N4001GICT-ND	276-1101
Resistors			
R1	270 ohms	270QBK-ND	271-1314
Misc.			
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
Semiconductors			
D1	FW rectifer	DF01M-ND	276-1161
IC1	78L05	NLM78L05FA-ND	276-1770
Capacitors			
C1	47uF	P5230-ND	272-1027
C2	0.1uF	EF1104-ND	272-1069
Misc.			
T1	12V, 300 mA	T309-ND (see text)	273-1385B

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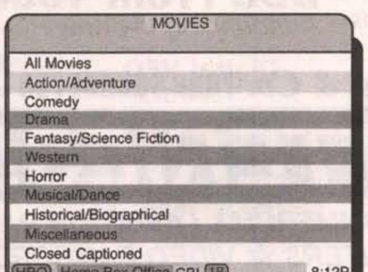

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C Pointers and Linked Lists

This article helps you understand pointers and provides linked list code that you can use in your own applications.

by Jeff Stefan

Pointers, 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.

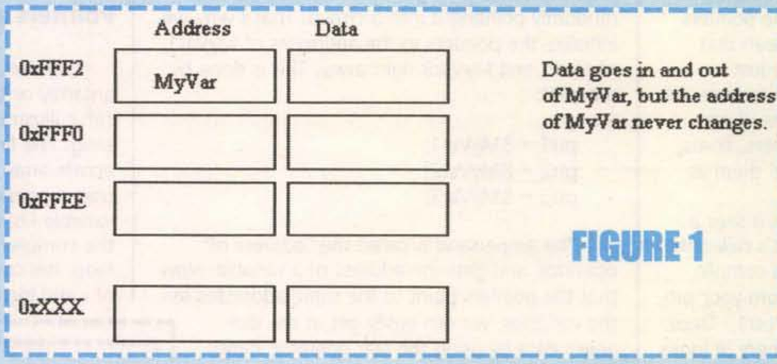


FIGURE 1

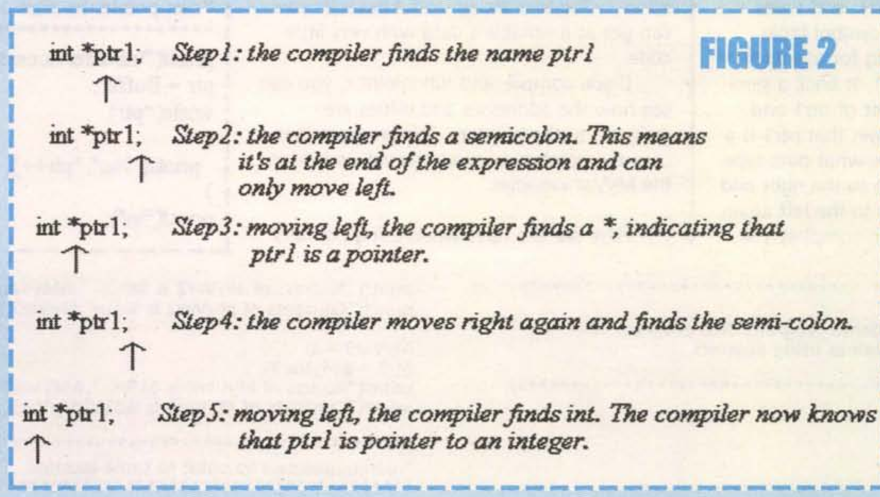


FIGURE 2

In our example, address 0xFFF2 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.

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

```
/*****************************************************
 * 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("Addrss 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.

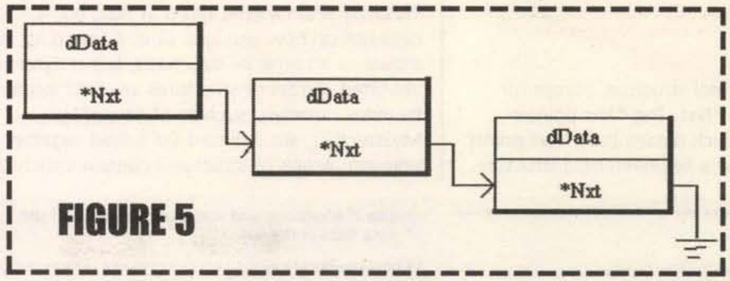
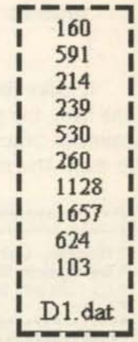


FIGURE 5



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 shoving 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 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;
```

```
/*****************************************************************
* 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
 ***************************/
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");
}
```

```
    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,*SrchPtr;
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:     %4.3lf\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 SrchData)
{
 /*********************************
 * point to first element of list
 *********************************/
 SrchPtr = First;
 while(SrchPtr)
 {
  if(SrchPtr->dData == SrchData)
  {
   printf("Data found\n");
   break;
  }
  SrchPtr=SrchPtr->Nxt;
 }
 if(SrchPtr == 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+=1;
  }
  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 lst
 *******************************/
 TmpSum=0;
 while(Node->Nxt)
 {
  TmpSum = TmpSum + Node->dData;
  Node=Node->Nxt;
 }

 /*****************
 * calcuate 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 *SrchPtr. 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 *SrchPtr.

The next thing to do is to create the list. The function CreateLst( ) 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 lst 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 lst 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 SrchList( ) 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 SrchList( ) 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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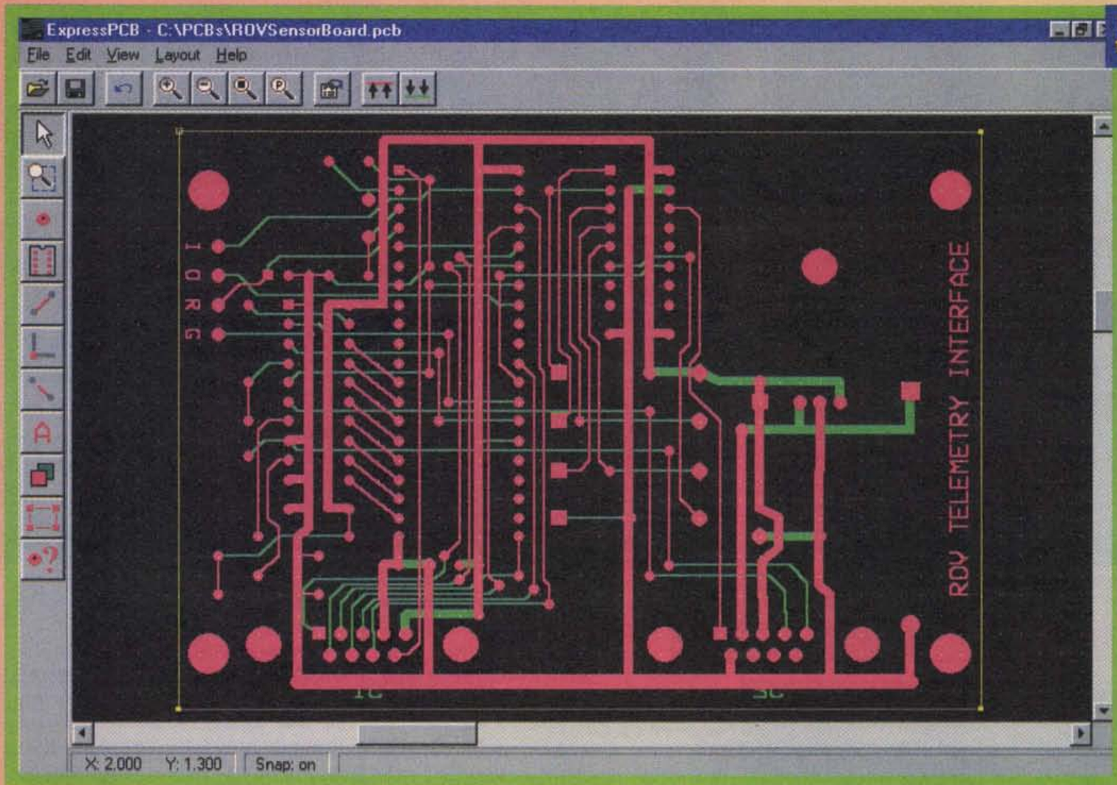


Figure 1. Graphical user interface for ExpressPCB's layout program.

Printed Circuit Boards for Everyone

by David Schneider and Stanley Reifel

Most 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 combination 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 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 generated 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 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 the corner of the default rectangle displayed in the main window. That act automatically establishes two grids of fiducial points.

Contrary to popular belief, prototyping with printed circuit boards can be inexpensive and hassle-free.

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 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.

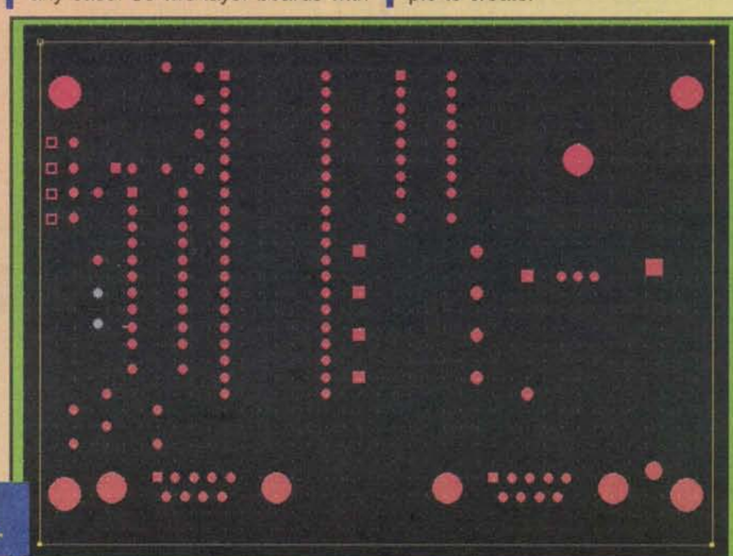


Figure 2a. Layout for telemetry controller board with components placed.

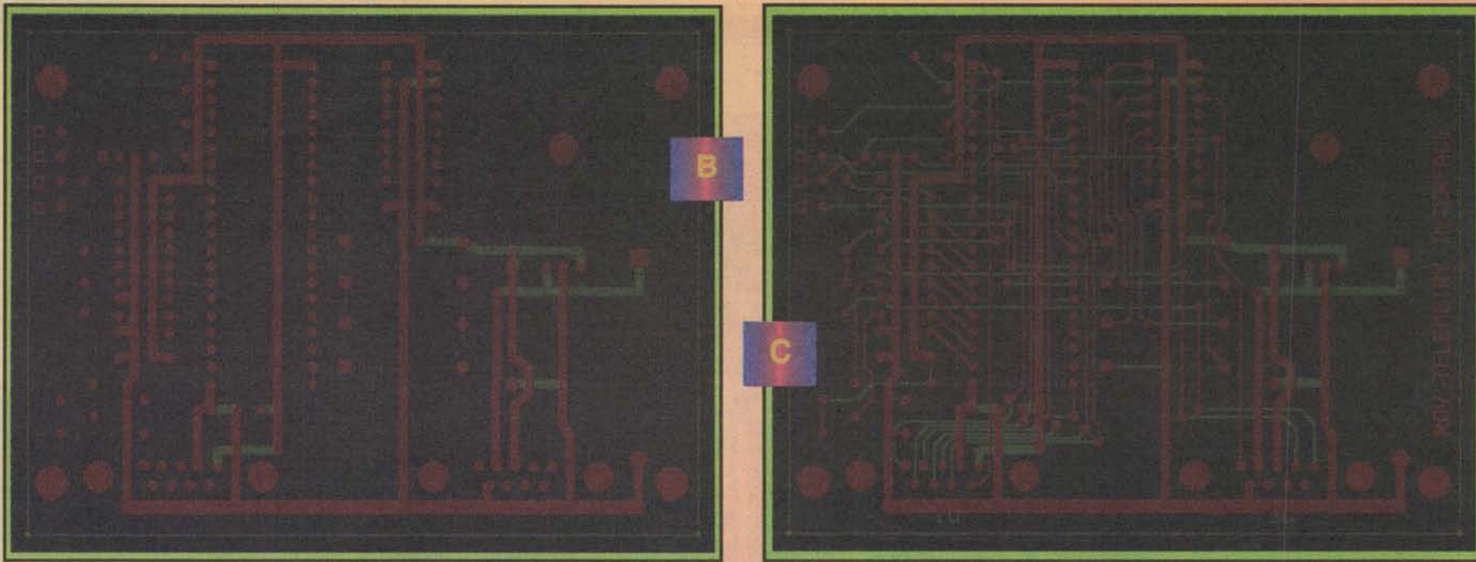


Figure 2b and 2c. Layout for telemetry controller board with components placed with power and ground traces added (b), and complete with signal traces (c).

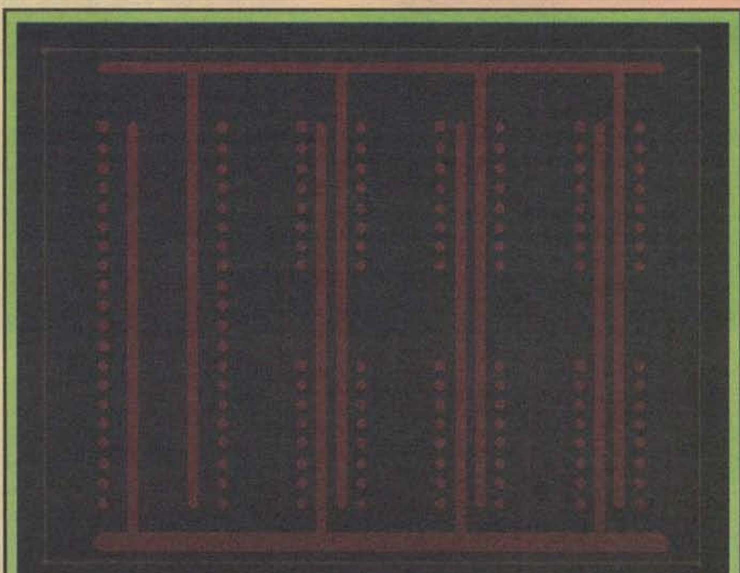


Figure 3. Suggested interfingering pattern for power and ground traces.

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 copper 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).

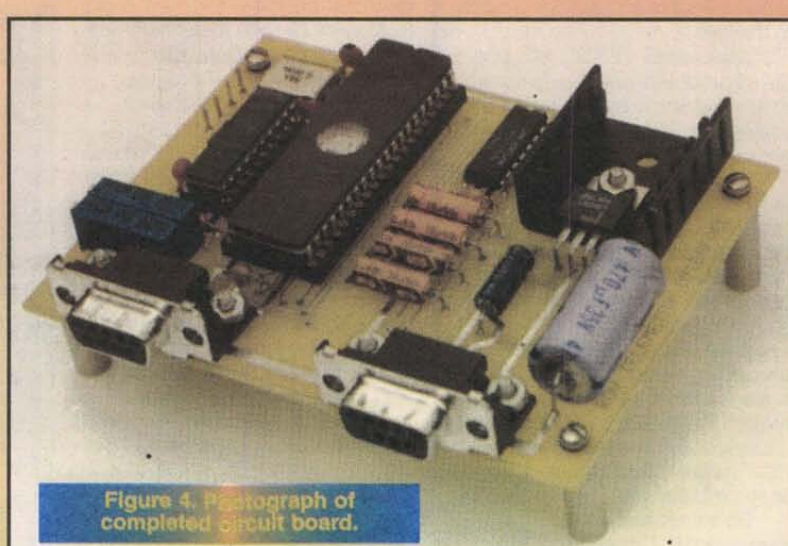


Figure 4. Photograph of completed circuit board.

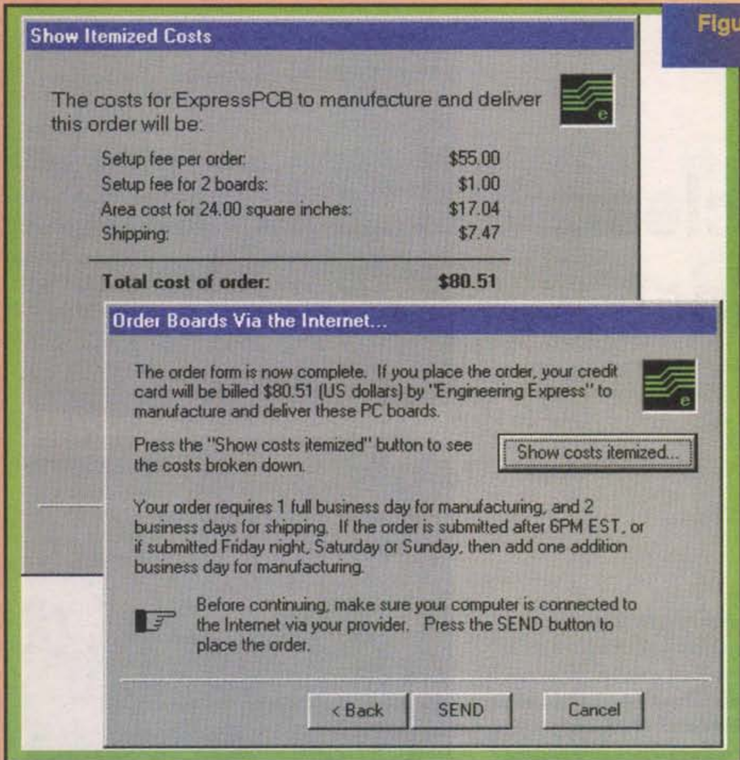


Figure 5. Dialog box showing cost of finished PC board.

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 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, where you'll find an overview of the service and instructions to download the software. NV

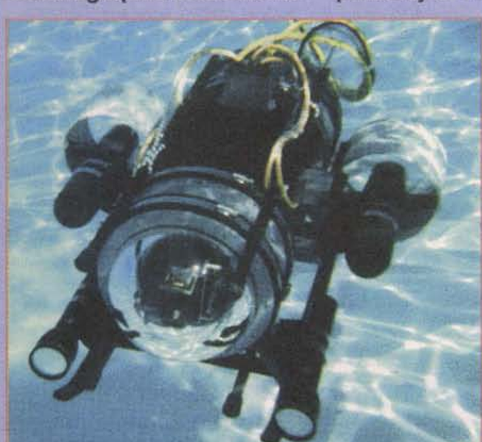
Diving without a Mask, Fins, or Snorkel

Having 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.

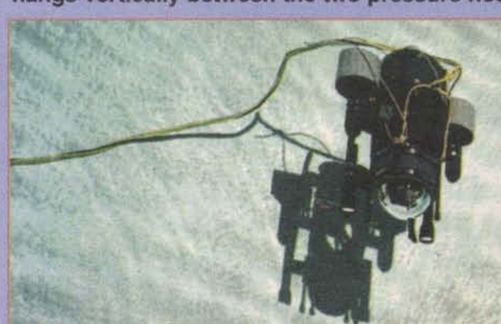
Such ROVs can probe underwater sites that are too deep (or too dangerous) to explore in person. The fact that one of us had some experience with mobile robots and the other had worked with oceanographic gear also encouraged the undertaking.

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.

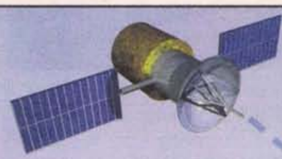


Two underwater "thrusters" (modified trolling motors) are bolted outboard; a third hangs vertically between the two pressure housings. Skids, an acrylic dome, and a couple of pounds of lead ballast complete the basic vessel.



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.

Your neighbors won't know it's there unless you tell them.

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 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.

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.

Get the picture...risk-free. Call now to order the small antennas that get big reception. They both come with a 90-day manufacturer's limited warranty and Comtrad's exclusive risk-free home trial. Try them, and if you're not completely satisfied, return them within 90 days for a full "No Questions Asked" refund.

Indoor/Outdoor Antenna . . . . . .$69.95 $8 S&H

Dishmate™ UHF/VHF Antenna . . $69.95 $8 S&H

The Dishmate™ Antenna will work with 18" dishes from RCA, Toshiba, ProScan, GE, Eurosat, Uniden, Sony and Hughes DSS™ Satellite systems. Please specify when ordering.

Please mention promotional code **3691-13325.**

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To order by mail, send check or money order for the total amount including S&H. To charge it to your credit card, enclose your account number and expiration date.

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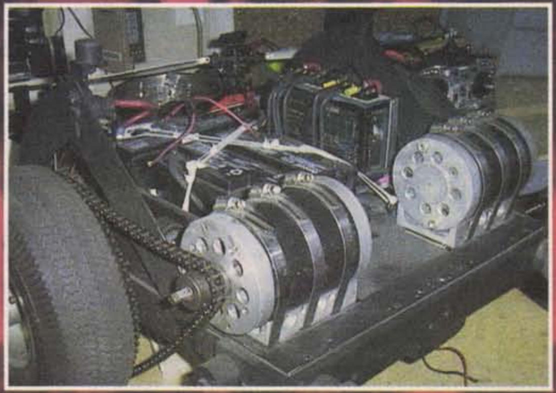
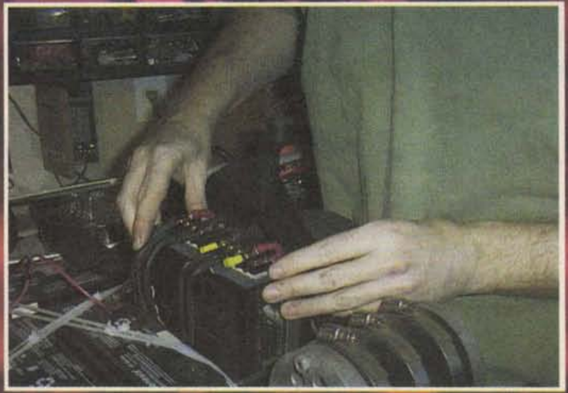
Robot Wars 1997: La Machine

by Dan Danknick

"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 (literally), 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 rewound 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-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 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-owners 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 investigated what broke." Their motto: test everything.

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**

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

Software Wizardry

Getting Animated With Your Graphics

By Harry L. Helms

Plain 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 sequences of .GIF (graphics interchange format) images. .GIF is the Web standard for line art (.JPEG is the standard for photographic images).

Figure 1

This is frame 1.

This is frame 2.

This is frame 3.

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.

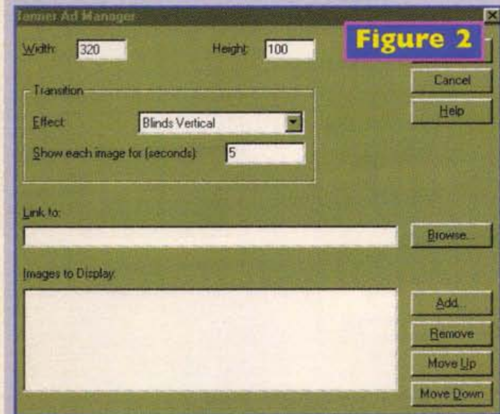
The individual .GIFs in your animation can be created with any program that supports the .GIF format, such as Image Composer, PhotoShop, FreeHand, etc.

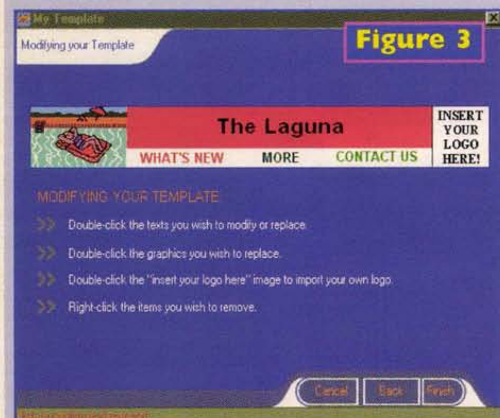
If you've done much Web surfing at all, you know how slowly some .GIF images download and display in your browser. This points to perhaps the biggest concern of using animated .GIFs on your web site: an animation with several "bulky" frames will take a long time to download and "play." If it takes too 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





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.

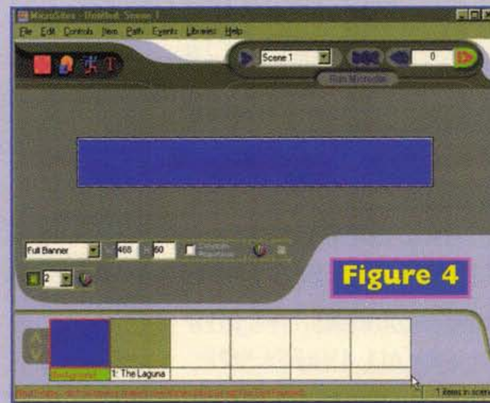
Since it is a true programming language, Perl lets you do some very interesting stuff with animated graphics. For example, you can alter the time sequence with which the individual frames are displayed. You can have the images displayed in a random sequence. And you can have the animation displayed in 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) and Matt's Script Archive (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 creation 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

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 graphic.

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 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 carried 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

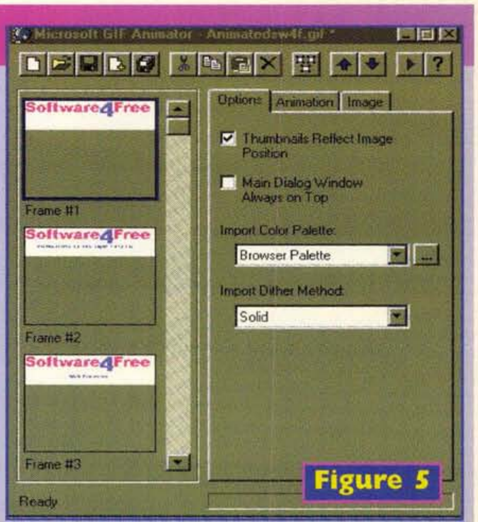


Figure 5

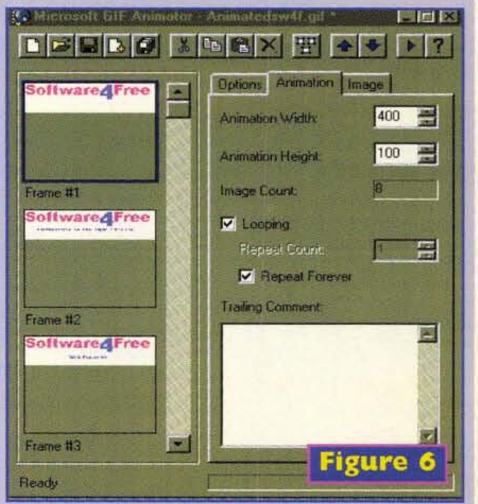


Figure 6

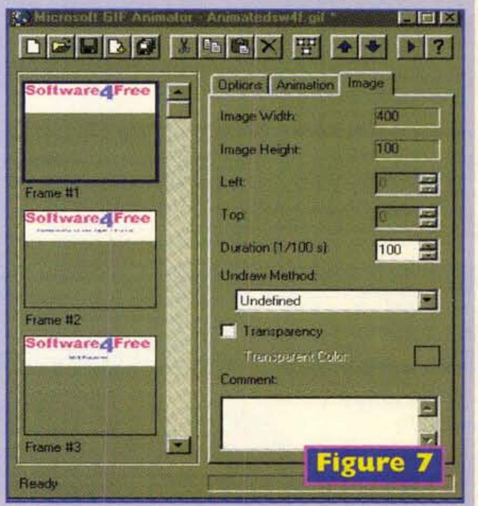
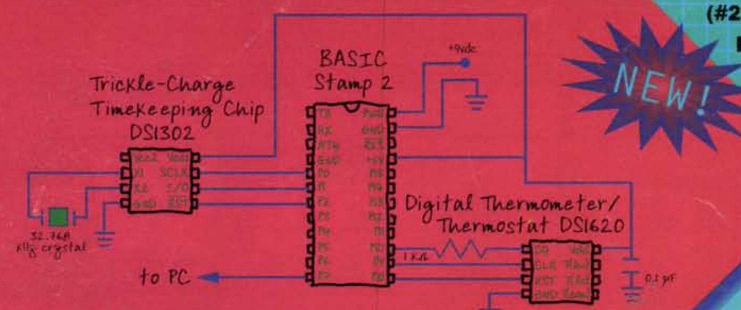


Figure 7

http://www.parallaxinc.com

PARALLAX INC

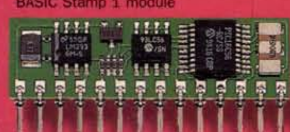


DS1302 Real Time Clock AppKit (#27921 - $26)

DS1620 Digital Thermometer / Thermostat (#27917 - $26)

AppKits include the semiconductor device, source code, technical explanation, and the passive components necessary to interface to the BASIC Stamp I or II. The DS1302 provides an easy solution to add a real-time trickle charge clock to the BASIC Stamp, while the DS1620 measures temperatures between -67° F to +257° F. Use the two AppKits together as shown in the above schematic to collect time-stamped temperature data with your BS2-IC.

BASIC Stamp 1 module



BASIC Stamp 2 module

Green LEDs (#21-0009 - $0.75 ea)

Celebrate summer with green LEDs. Use the Stamp's HIGH command and a 470 k Ohm resistor to electrify.

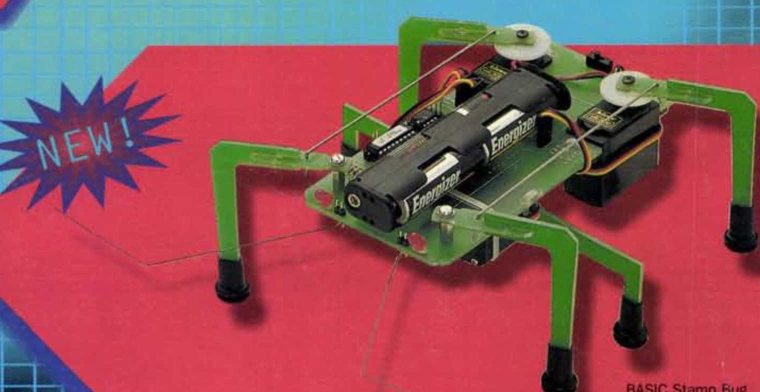
BASIC Stamp 1 module (#BS1-IC - $34)
BS1-IC Starter Kit (#27205 - $99)

BASIC Stamp 2 module (#BS2-IC - $49)
BS2-IC Starter Kit (#27203 - $149)

BASIC Stamp Rev.D module (not shown #27100 - $34)
BASIC Stamp Rev.D Starter Kit (#27202 - $79)

BASIC Stamp Bug (#27922 - $139)

The new BASIC Stamp Bug is an improvement over his genetically unstable predecessor. The new BASIC Stamp Bug uses the PULSOUT command, HI and LOW to control the servos and LEDs. Requires approximately 1 hour to build. Hardware and source code included (4 AA nicad batteries not included).



BASIC Stamp Bug

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