# Nuts & Volts

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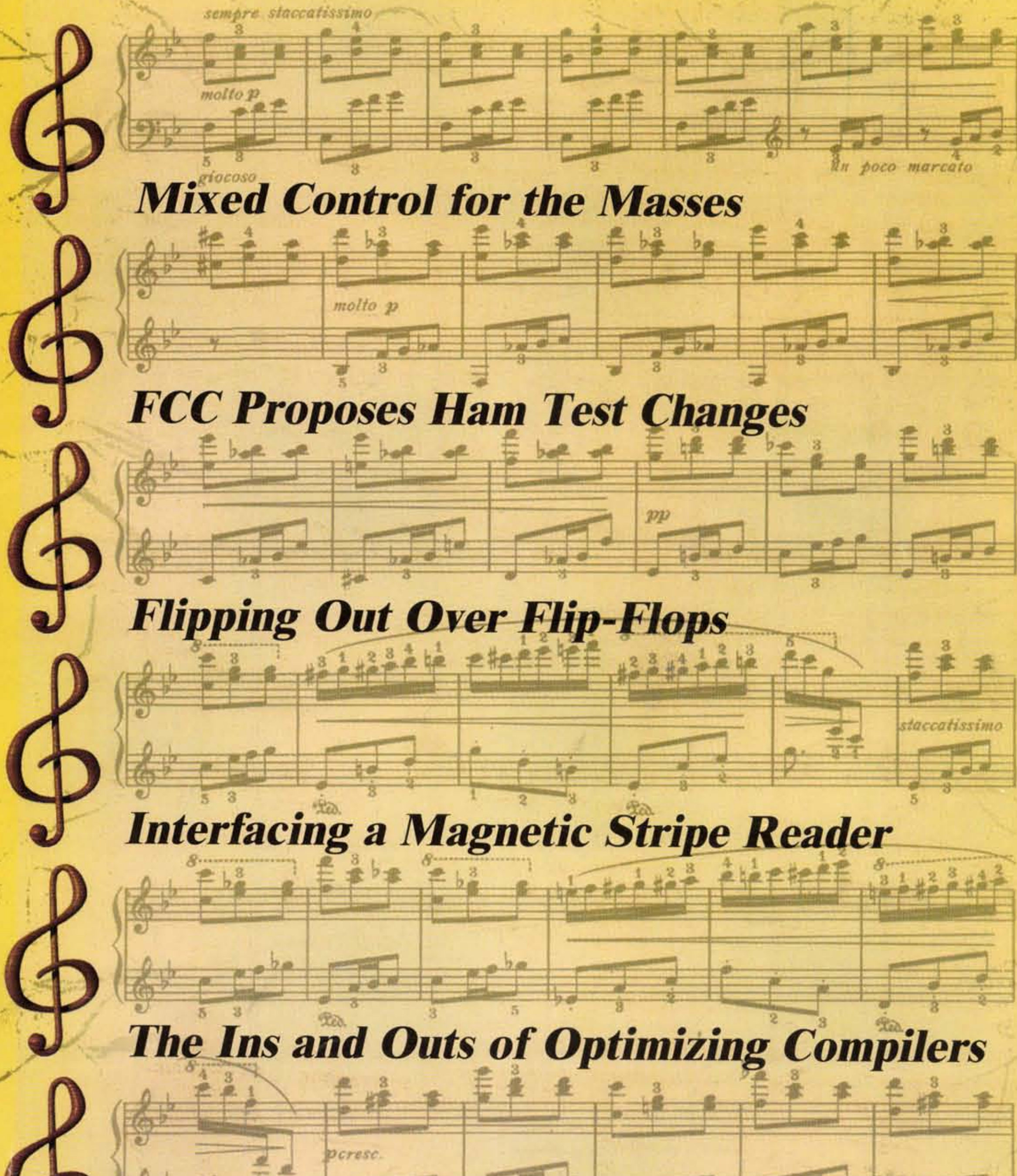
Exploring Electronics And Technology For The Hobbyist And Professional

November 1998 Vol. 19 No. 11




## Mixed Control for the Masses

## FCC Proposes Ham Test Changes

## Flipping Out Over Flip-Flops

## Interfacing a Magnetic Stripe Reader

## The Ins and Outs of Optimizing Compilers

0 74470 89295 3 11>

Write in 133 on Reader Service Card.

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- JTS, Model #C2000-3AF
- 3882 Cyl. 16 Hd. 63 Sec.
- 6-1/8" L x 4.0" W x 5/8" H
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- Mini-Tower, 3 - 5.25" and 4 - 3.5" bays
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- Takes standard mini-tower supply See our #17316 (this ad!)

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- Full-sized tower case, for AT or ATX!
- Comes w/AT-style power supply
- ATX cutouts on rear panel, just change to our #XTC312 ATX power supply!
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- Extra PIO and SIO slots on rear panel!
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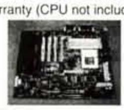

HSC# 80437 **$49.95**

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- "Netpower" logo on front, never used, 90-day warranty

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## PC Power Supplies

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- Install software, inst. included.
- Win 3.x, W95 compatible
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- Factory RMA's from dealers, unused, 90-day warranty
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## 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)
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- Both styles new in box, 90-day warranty

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## Video-hacker Dream!

- Logitech Videoman Video-conference camera & interface
- These units were sold with Hewlett Packard S-700 workstations for videoconference capability
- We do not have technical data, software or manuals
- All we have is cameras with stand, and SCSI-II interface
- The camera is on a weighted stand that extends from 13" tall to over 20" tall, and has a stereo microphone
- Color camera is digital output only (not NTSC) as far as we can tell -- but who knows?
- Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video out (BNC), and the connector for the camera cable.
- Note: HP and Logitech will provide no information on these

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- 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
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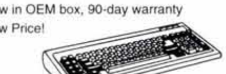

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- Great Software Bundle -- Amazing Value!
- Includes Corel Wordperfect 7, Corel Quattro Pro 7, Paradox 7, Corel Presentations 7, CorelDRAW 6, CorelFLOW 3, Sidekick 95, Netscape Navigator, Dash board 95, 1000 fonts, 10000 clip-art images, more!
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**Write in 139 on Reader Service Card.**

# New Product News

## JIMHANDY™ CW INTERFACE

MFJ's new JimHandy™ CW interface lets you use your two-meter or 440 MHz handheld to practice Morse code on-the-air! You can get your ham buddies together or even your entire club on-the-air.

Everybody can join in, including No Code Techs, Novices, TechPlus and anybody who wants to upgrade. You simply plug the JimHandy into your two-meter or 440 MHz handheld transceiver and plug in a straight key. Your CW is converted into audio tones that are sent to your mic jack and transmitted by your HT for everyone to copy.

The transmit/receive switch automatically keys your push-to-talk on your HT as soon as you start sending CW. It keeps it keyed until you've finished sending. Then it returns your HT to receive so you can copy. An adjustable T/R delay knob lets you send fast or slow CW.

The JimHandy is available for $59.95.

## SIX-METER LOW-ANGLE DX VERTICAL ANTENNA

MFJ's omni-directional low-angle vertical radiator lets you work plenty of DX in all directions even with low power. It's super quiet – no static noise – and it's easy-to-put up. It fits anywhere!

It uses MFJ's exclusive GroundIsolated™ radial system to give you a much cleaner radiation pattern. You'll get more signals at desired low-angle radiation for easy DX. It eliminates common mode current paths and reduces undesirable feedline and supporting structure radiation. It also reduces conducted noise reaching the antenna over the outside of the feedline or the antenna support. MFJ's system ensures that the length of the feedline or support does not change the antenna's resonant frequency or SWR.

MFJ-1756 is quiet. A DC grounded radiator eliminates noise generated by static. It is easily cut for your favorite part of the six-meter band. A rugged adjustable air insulated matching stub lets you obtain a near perfect 1:1 SWR – a non-adjustable standard ground plane is much less than 50 ohms.

MFJ's large diameter radiator gives you wide bandwidth and a heavy duty ceramic insulator gives low RF loss. MFJ-1756 has fiberglass ground isolators, a 55 inch high-strength aluminum radiator and four 60 inch radials. It will mount on any 1 to 1-1/2 inch mast with a single U-bolt (included). Mast is not supplied.

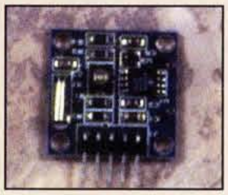
The MFJ-1756 is available for $69.95.

For more information, contact:

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



## CLOCK MODULE



The Pocket Watch B contains a real-time clock, a calendar, and advanced timing features. The clock module keeps track of seconds, minutes, hours, days, months, and years. Adjustments for leap year are automatically performed. It is year 2000-compatible.

This real-time clock communicates via an easy-to-use, asynchronous, one to two wire, serial communications interface. Baud rates of 2.4K 4.8K, and 9.6K are supported with a user-friendly automatic baud detect system.

System timing functions can easily be implemented with any of the four advanced alarm types. There is a standard level alarm, a single shot alarm, and two alarms with variable output pulse duration and repetition rates.

The Pocket Watch B's small size and connection scheme allow the device to be inserted directly into circuit boards for production runs, or into breadboards for easy prototyping. Complete data sheets and application notes are available at www.solutions-cubed.com

The Pocket Watch B comes in a 1"x1" SIP module, and sells for $24.95.

For more information, contact:

**SOLUTIONS CUBED**
**3029 ESPLANADE, STE. #F, DEPT. NV**
**CHICO, CA 95973**
**530-891-8045 FAX: 530-891-1643**
**E-MAIL: lon@solutions-cubed.com**
**URL: www.solutions-cubed.com**

## OSZIFOX HANDHELD STORAGE SCOPE

In a pen-style housing, osziFOX is a handheld multifunctional 20 MHz storage scope that includes a small back-lit LCD readout with a performance that matches some benchtop units.

With sample rates from 50 nS to 1 mS, and auto, manual, or external triggering, AC and DC voltages or even frequencies can be measured easily, and simultaneously displayed on a PC screen.

Weighing only 70g, osziFOX's six-bit resolution is great for taking measurements in audio amplifiers, digital circuits, telephone installations, communications debugging, and test or service departments.

Using the serial cable and Windows software supplied, signals recorded in the internal 128 byte memory can be stored on disk or printed on the PC's standard printer.

OsziFOX is available for $129.00 each.

For more information, contact:

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**1193 MOSELEY RD., DEPT. NV, VICTOR, NY 14564**
**716-425-3753 FAX: 716-425-3835**
**E-MAIL: saelig@aol.com WEB: www.saelig.com**

## DATA INTERFACE ADAPTERS


Use your personal computer to log data from global positioning systems, depth sounders, radar, and other marine navigational devices with these data interface adapters from B&B Electronics.

The plug-in connectors convert NMEA (National Marine Electronics Assn.) standard data signals so they can communicate with any RS-232, RS-422, or RS-485 device such as a personal computer or printer.

Two adapter models are provided to suit either the older NMEA or the latest NMEA specs.

B&B Model 183COR converts the earlier NMEA0183 version 1.x data signal to EIA RS-232, RS-422, or RS-485 signals. Model 183V2C is for NMEA0183 version 2.x, the latest version of the NMEA specification. It converts one data signal in each direction between NMEA0183 and EIA RS-232.

Costs are $99.95 for either of the NMEA converters.

For more information, contact:

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**707 DAYTON RD., DEPT. NV**
**OTTAWA, IL 61350**
**815-433-5100 FAX: 815-434-7094**
**E-MAIL: sales@bb-elec.com**
**WEB: www.bb-elec.com**

## PTZ ROBOTIC CAMERA

ActivMedia's new Pioneer Pan-Tilt-Zoom (PTZ) system integrates a high-speed, wide-range pan-tilt sony camera with Pioneer PSOS software and Saphira software plug-in for intelligent camera control mounted, or easily added to any Pioneer robot.

Pioneer mobile robotic platforms offer sturdy, well-tested, affordable bases for research, prototyping, education, and applications indoors and out.

Teleoperate the camera remotely from a PC or let it roam on its own under Pioneer's Saphira or other software. Monitor images in real-time or process video with framegrabber and video transmitter-receiver pair.

Key features include: fully integrated with PSOS and Saphira software plug-in for easy operation; pre-mounted on any new Pioneer model or easily installed on existing Pioneers; 12x optical zoom for wide range of applications; high-speed auto-focus lens for responsiveness; quick 200-degree pan moves up to 80 degrees per second; plugs into Pioneer RS232C serial port; and NTSC or PAL.

For more information, contact:

**ACTIVMEDIA, INC.**
**182 HANCOCK RD., DEPT. NV**
**PETERBOROUGH, NH 03458**
**603-924-9100 FAX: 603-924-2184**
**1-800-639-9481**
**E-MAIL: jdietsch@activmedia.com**
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***Continued on page 91***

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- Incredible value—Ni-Cd battery and AC charger included in this low price!
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- Equipped with channel-monitoring button and 16 frequencies (set DIP switch to one channel)
- Optional CTCSS (private channel) board for extra privacy (sold separately)

Great for small-business owners to stay in touch with workers or serve customers more efficiently. A full 2W output delivers clear communication over ranges of several miles, depending on location. Advanced phase-locked loop circuitry stabilizes frequency for highly dependable business or recreational use. Plus, they offer 20 times the power of conventional family radios. Where privacy is required, add optional CTCSS boards to two radios and ensure a noise-free, private connection. The rechargeable battery will last eight hours (based on 90% standby time). (*Includes:* antenna, rechargeable Ni-Cd battery, belt clip and AC adapter/wall charger. *Mfr. Warranty:* one-year parts and labor. *Size:* 5.31×2.5×1.25" (HWD). *Weight:* 11.5 oz.)

| | | | |
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| **940-0098** | **Model SPH21DT VHF** | Reg 159.95 | **Sale ea 79.95** |
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| **940-0126** | **CTCSS Plug-In Board** | Reg 42.00 | **Sale ea 34.95** |
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***FCC License Required:*** *You must have a valid FCC Business Radio Service license before you can start enjoying the many benefits these transceivers provide. There is no test, but the FCC does require a nominal fee. Transmitting without a license can result in fines and/or confiscation of equipment.*

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# Contents

## ARTICLES



## COLUMNS



*Gordon West WB6NOA says "Write the FCC with your comments about the proposed rule changes for ham testing today!"*

•

*The comment period closes on December 1st!!*

**Check out Santa's Special on page 96!!**

## DEPARTMENTS



## CLASSIFIED AD INDEX





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.

Nuts & Volts Magazine is published monthly for $19.00 per year by T&L Publications, Inc., 430 Princeland Court, Corona, CA. POSTMASTER: Send address changes to Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719.

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

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

**Subscription Order ONLY Line**
**1-800-783-4624**

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MORSE CODE REQUIREMENTS MAY SOON DROP IN SPEED

# FCC PROPOSES HAM TEST CHANGES

by Gordon West WB6NOA

Amateur radio operators and EVERYONE interested in obtaining an amateur radio license are flooding the Federal Communications Commission (FCC) with comments about proposed rulemaking that could dramatically change ham test requirements. At the same time, amateur radio's largest non-profit steering organization — the American Radio Relay League (ARRL) founded in 1914 — proposes the retaining of the no-code VHF/UHF license, and dropping the Morse Code telegraphy examination in speed for General class from the present 13 wpm down to five wpm. And, until the Morse Code requirements on an international basis ultimately go away, No Code International also recommends dropping the Morse Code test speed for General class down to a simple five wpm exam.

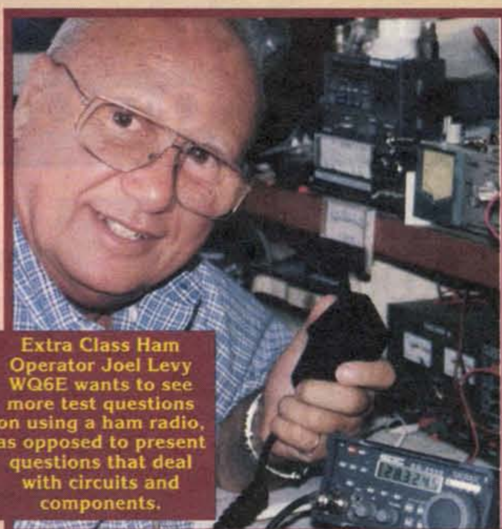
"No Code International would like to see CW testing for all classes of amateur license to a five wpm speed," comments Fred Maia W5YI, Executive Director. "NCI does not at all oppose the USE of Morse Code in the amateur bands by those amateurs who choose to use it in that mode ... we just don't believe that Morse Code is an important enough factor in today's communications world that it should be a licensing criterion at any level beyond the absolute minimum required by international regulations," adds Maia. Ultimately, NCI stands for the complete elimination of Morse testing for all amateur licensing.

## THIS ONE IS FOR REAL

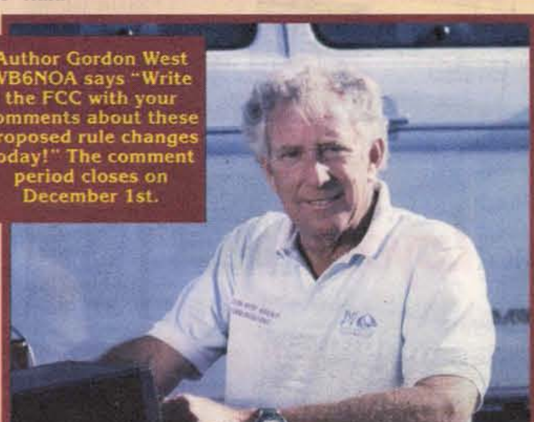
Every couple of years different organizations propose dropping code test speed requirements to the FCC. The ARRL will usually conduct a survey and normally reports back that this is an unpopular idea to change CW test speed requirements, and ultimately the FCC does nothing.

But this one is for real — the FCC has put the amateur radio service within its 1998 biennial Regulatory Review, and has officially released a Notice of Proposed Rulemaking Docket No. 98-143 to streamline the service and eliminate unnecessary and duplicative rules as they might effect ham testing. And this is not just an FCC Notice of Inquiry — this is the real thing — Notice of Proposed Rulemaking where the FCC has put the amateur radio service on "fast track" and could get new rules in place by the first of next year.

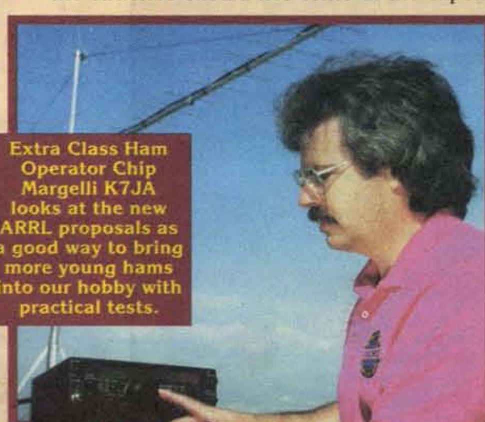
The FCC proposes to modify the amateur radio service rules as follows:



Extra Class Ham Operator Joel Levy WQ6E wants to see more test questions on using a ham radio, as opposed to present questions that deal with circuits and components.



Author Gordon West WB6NOA says "Write the FCC with your comments about these proposed rule changes today!" The comment period closes on December 1st.



Extra Class Ham Operator Chip Margelli K7JA looks at the new ARRL proposals as a good way to bring more young hams into our hobby with practical tests.

1. Reduce the number of license classes from six to four.

2. Provide greater opportunities to volunteer examiners (VEs) to participate in the examination process — in other words, make some changes to code and theory tests.

3. Eliminate Radio Amateur Civil Emergency Service (RACES) licenses because the emergency communications that are routinely transmitted by RACES stations can be transmitted by primary, club, or military recreational stations.

4. Finding out ways for improving the enforcement processes as they relate to amateur radio.

Most hams were surprised that it was the ARRL who came out first with a proposal to drop General class and Extra class code test speeds. Everyone knew that the FCC was soon to come out with some big changes for ham radio, and we all expected that the ARRL would wait until the NPRM was issued before they came up with a counter-proposal. So, approximately 30 days before the FCC NPRM, the ARRL decided on the recommendation of four classes of licenses, and a drop in the General class code speed from the present 13 wpm down to five wpm. They also suggested that the highest license — the amateur Extra — would require a code speed of only 12 wpm.

"Board members at the ARRL emphasized that the objective is to rationalize the amateur license structure without reducing their requirements for any class of license," comments the ARRL in their announcement. "Where reductions in Morse Code requirements are proposed by the League, there would be a corresponding increase in written examination standards." The Board members were adamant that simplifying the structure should not come at the expense of privileges already earned by ham operators.

The ARRL also recommended renaming the classes of amateur radio license to classes A through D. Class D would be the present no-code Technician class license, and Class A would be the Extra class license. The slow-code five wpm General license would be Class C, and the Advanced class license would be Class B.

"We were surprised on how many negative comments we received regarding renaming the amateur licenses as ham Class A through D," comments ARRL President Ron Stafford W6ROD, at the recent ARRL Southwestern Division Convention. At the convention, most hams were quite upbeat with positive comments on the reduction of their General class code speed from 13 wpm down to five wpm which would turn many entry-level hams into worldwide-band ham operators. Amateur operators already holding a five wpm certificate for Novice or Technician-plus would probably just take one or two more written exams to advance up to General class with no other code test required.

## WHAT THE FCC DIDN'T SAY

But most surprising to seasoned ham radio operators was the FCC saying absolutely NOTHING about a specific code speed change for General class or Extra class. Rather, the FCC indicated they will take their incoming comments from hams as a good way to finally announce any code test or written test changes.

And here are some of the points that the FCC raised to solicit comments from hams and non-hams on how the amateur tests would be structured in the future:

**A.** The present six classes of amateur license would be streamlined into four classes. The FCC was rather firm in indicating it will probably phase out the Novice license, as well as the five wpm Technician-plus class, leaving only the entry-level no-code Technician class. The present no-code Technician class is a popular one, and hams can get on the air above 50 MHz by simply completing two written exams. Under the new rules, just one written exam would probably be administered for Technician class.

Worldwide ham activity will increase with the lowering of CW test scores — and small worldwide ham sets can be installed mobile almost anywhere!

To get to the worldwide General class license, all that would be necessary is a code test and one more additional written General class exam. In fact, under the ARRL proposal, the ONLY way a new ham could get on the worldwide bands would be to pass the five wpm, and ALSO pass the General written test. The restricted operation on Novice CW frequencies would go away, and also would the Technician-plus test for maybe coming up on a portion of the 10-meter phone band.

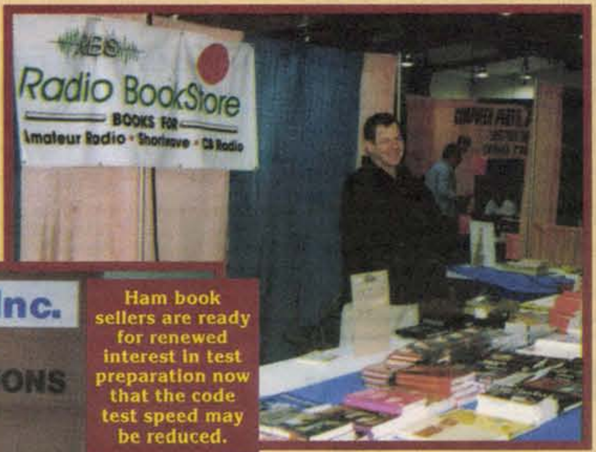
Under the ARRL proposal to the FCC rules, only five wpm and passing one more written test gives you EVERY worldwide General class band. And you won't be restricted just to one or two bands — with five wpm and the General theory test, you can operate on General class segments of EVERY worldwide band, plus unlimited access to all frequencies above 50 MHz.

Now don't panic if you are already a Tech-plus operator or a Novice operator, chances are you won't lose any present privileges. Good news for you — since you already have the five wpm satisfied, just a simple written examination and you could very well be turned into a grandfathered General class operator.

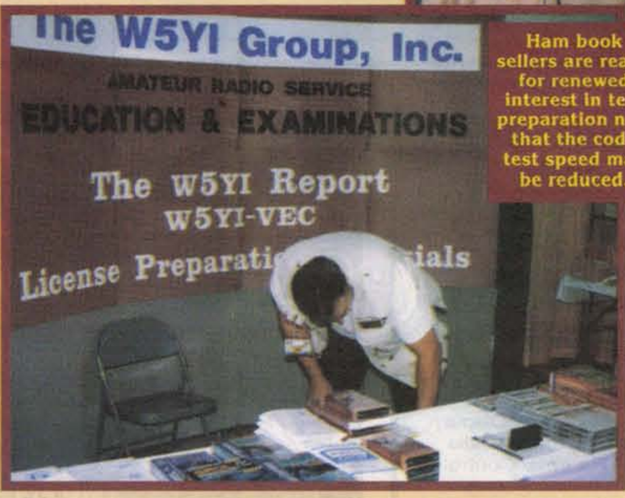
But the FCC does not go as far as the ARRL in saying dump the code speed. "We seek comments on all aspects of the Morse Code standards used in our examinations," writes the FCC in Point #24 of their NPRM. "Do the three levels of five, 13, and 20 wpm remain relevant to today's communications practices? Should we continue to have three different levels, or should these be reduced to one or two — and, if so, what should be the required speed?" asks the FCC. They also indicate they are looking for comments on whether or not they would add elements to the written examination to insure a working knowledge of newer digital technology which, in part, is replacing the Morse Code.

The FCC also asks whether or not the code test of copying one minute out of five perfectly is appropriate. They ask whether or not the volunteer examiners could determine how to test for code speed. They suggest that volunteer examiners accredited by a volunteer examiner coordinator could take a greater role in the examination process, not necessarily restrained by specific FCC rules.

At the recent Southwestern Division ARRL Convention, a 12-year-old Technician-plus ham recounted his story about being tested by a local VEC where he missed passing the General class exam by having a single letter error in one minute of perfect copy. He told me there were several places in his copy where he copied almost perfectly, but it didn't quite add up to the required 64 letters in a row. I am surprised that the volunteer examination team didn't take an overall look at the entire copy, and come up some sort of comprehensive test where this young lad would certainly pass. After all, he knew the content of the code at 13 wpm — he just didn't write it down letter perfect. Give me a break!




Ham book sellers are ready for renewed interest in test preparation now that the code test speed may be reduced.




**B.** GREATER VOLUNTEER EXAMINER OPPORTUNITY. The FCC is suggesting that Advanced class operators be able to administer General class testing. The ARRL also recommends this, so we think that this will probably go through without any negative comments. The FCC and ARRL agree that ham operators who have passed a specific class test should be able to become certified through a participating volunteer exam coordinator and administer the same type of test that they have successfully passed.

But there IS some heated discussion about amateur operators who have been issued code test certificates of completion based on a handicap physician's statement. The discussion is about an alarming rate of handicap statements coming through without the FCC having the time and staff to actually verify the physician's report. Volunteer examiners are concerned that there is no verification of the physician's statement, and they ask how can these operators administer code tests if they aren't able to copy the code themselves? Again, the FCC is asking for public comments.

The scope of the volunteer examiner might also be expanded to allow that examiner to specifically tailor written and five wpm examinations to very young and very old candidates. Presently, the ARRL VEC allows examiners to take age into consideration when conducting code and written tests. Yet, the rules are clear that written questions and the four distractors may not be varied by the examination team. The FCC raises the point on whether or not volunteer examiners may take a more interpretive look on how a candidate is suited for passing or failing the test.

The FCC also suggests that new testing procedures could be implemented — maybe submitting a log book for upgrades to insure they have worked so many contacts before they next go higher up the ham radio upgrade ladder. Or, for new students, maybe home study where a local "elmer" may help sign off certain requirements before the written and code test. The FCC suggests we all take a look at ham testing, and come up with more creative ways to make our ham service more attractive to beginners.

**C.** RACES. In the FCC NPRM, they are suggesting eliminating the specific RACES license. But, if you are a member of RACES, don't hit the panic button — they don't want to eliminate the RACES service, only the formality of having a special license for a RACES station. RACES operation would continue as normal.

**D.** VIOLATION ENFORCEMENT. The FCC is in agreement that prosecution of radio violators is next to minimum on the ham bands. This is because all of the FCC efforts are more directed to safety of life violations — such as catching the bad guys jamming aeronautical frequency 121.5, or coming up on a local paramedic channel and asking for 10 grams of cocaine to be delivered to a specific address. They are also busy tracking down police radio jammers, as well as the idiot using a marine VHF on Coast Guard Channel 16 and repeatedly calling "Mayday, Mayday, Mayday. I have run out of beer."

This means that CB radio and ham radio, including most routine land-mobile radio systems, go unmonitored. When they do get proof of a rule violator, they generally don't have the resources to start any enforcement action. The FCC asks what might be done to get them out of the loop, and to have enough evidence that might go directly into the court system. All you attorneys, here is your time to help reshape ham radio enforcement. The FCC is asking how this might be done.

**F.** WRITTEN TESTS. The FCC asks hams to take a more active part in redesigning the written examination. Should we come up with more questions on digital techniques, replacing the high-speed code requirements with more written digital questions? And how should these questions be administered — fill-in-the-bank, multiple-choice, or essay? The FCC wants as much input from hams as possible.

**G.** The FCC will also dispose of other smaller petitions that have been hanging around their office for years. Maybe they'll find mine where I suggest lifting the old ham radio rule that says a marine single-sideband radio shall not be used as a ham radio. The new technology of marine SSB equipment makes marine sideband radios perfect for both purposes without any necessary modification that could injure their operation on distress frequencies. One radio for two purposes makes good sense to me!

## CONCLUSION

"Here at the FCC, we propose (1) to phase out the Novice class operator license and Techplus operator license; (2) to authorize Advanced class operators to prepare and administer General class operator license exams; and (3) to sunset RACES station licenses by not issuing any license renewals.

We invite comments of the amateur community with respect to improving our enforcement processes as they relate to amateur radio. We also invite comments regarding the specific telegraphy speed requirements for the various license classes, and comments on ways to streamline and improve the operator written examinations," comments the FCC.

**REQUIREMENTS FOR AMATEUR LICENSES UNDER THE ARRL PROPOSAL**

| License Class | Written Exam | Morse Exam | Level of Difficulty |
|---|---|---|---|
| Class **D** | Operational and technical questions relevant to VHF/UHF | None | Same as present Technician |
| Upgrade from **D** to **C** | Operational and technical questions relevant to HF | 5 words per minute | Same as upgrading from present Tech Plus to General |
| Upgrade from **C** to **B** | Similar to present Element 4A (Advanced) | 12 words per minute | Same as upgrading to present Advanced, plus Morse exam |
| Upgrade from **B** to **A** | More advanced technical questions | None | Same as upgrading from Advanced to Extra |

## HERE'S HOW TO COMMENT

First, the date is right around the corner where your comments might go in the trash bin. Get your comments to the FCC BEFORE December of this year. Just days away.

The easiest way to file comments is through the FCC's electronic filing system (EFS). Comments filed through the EFS can be sent as an electronic file via the Internet to http://www.fcc.gov/e-file/ecfs.html. Only one copy of an electronic submission must be filed. You may also submit an electronic comment by Internet E-Mail. To get filing instructions for E-Mail comments, commentors should send an E-Mail to ecfs@fcc.gov and include the following words in the body of the message ... "Get form — your E-Mail address."

You can also file by paper, submitting one original and six copies of your comments. File to FCC, Commission Secretary Magalie Salas, FCC Building, 1919 "M" Street, N.W., Room 222, Washington, DC 20554.

You can also choose to file on diskette. Diskettes should be submitted to N.J. DePont, Public Safety & Private Wireless Division, Wireless Telecommunications Bureau, Room 8332, 2025 "M" Street, N.W., Washington, DC 20554. Word Perfect 5.1 for Windows or compatible software, please.

You should also send your comments to the ARRL They will ultimately see them, and may offer a reply to your comments. But if you work closely with the ARRL now, you can help strengthen your agreement on what each of you will ultimately say. You can file your thoughts with www.arrl.org.

You can also look at the NRPM on the ARRL web page at http://www.arrl.org. You can also download it from the FCC at www.fcc.gov and follow the instructions to receive WT Docket 98-143.

Whether you are a ham radio operator or not, WRITE THE FCC WITH YOUR COMMENTS! Get your thoughts down on paper or on computer, and get them into the FCC today.

I will look forward to reading your comments soon. **NV**

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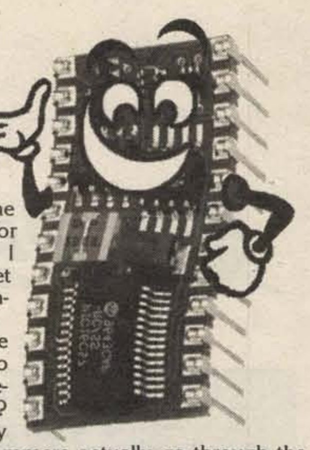
# STAMP APPLICATIONS

by Jon Williams



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

### Timing Is Everything

*One of the regular pokes taken at the Stamp is its lack of interrupts. A fair complaint perhaps, but not all micros have them and quite a few products are built with micros that don't. With a little bit of programming discipline – and a helpful second Stamp – we can write code that emulates a software interrupt.*

I recently converted a PIC-based (16F84) project to the BS2. The trickiest part of the conversion was the way I monitored the four sensor (switch) inputs. In the PIC, I have a software interrupt that causes the inputs to be scanned several times per second. With no interrupts in the BS2, I had to use a different method.

It's simple, but not necessarily easy. The main code loop has to be fine-tuned so that no matter what path it takes, its execution time is always the same. Geez, how do we do that? The truth is that the process can be very tricky, especially with complex code (so we'll keep our demo simple). I believe the easiest way to write such a program is by creating a state machine. PBASIC makes this very easy with the BRANCH command.

Let's say we want to monitor a couple of inputs and, if each is active beyond some threshold, we take an action. This doesn't sound like a big request, does it? So how would you pull it off? The way that I chose to do it was by monitoring the inputs at a regular interval. If the input is active, a counter is incremented; otherwise, it's cleared. If the counter exceeds a given threshold, then some action is taken. The upside of this technique is that the inputs are debounced by the process.

Listing 1 is a very simple demo using a Stamp II and the Parallax BASIC Stamp Activity Board (BSAC). Two switches (on pins 8 and 9) are monitored. If either of the inputs is held long enough, a corresponding LED is lit (in addition to the input LED). If both are lit at once, they are flashed.

Take a look at the code. What you should notice is that the subroutine **ChkSw** is always run through each execution of the loop. By trimming the loop timing so that it's constant, we're able to write our processing code based on predictable behavior. In this case, each run through the loop is about 100 milliseconds. So, to alarm on a two-second input, the input would have to be active for 20 iterations through the loop (20 * 100 ms = 2 seconds).

You might be wondering why I chose to use a loop in ChkSw with only two inputs. The reason is that it makes the code very easy to expand, even if it does make it a little tricky to time. There are a couple of PAUSE commands inserted in this code to make the timing as even as possible, regardless of the state of the inputs.

Another thing that I did was use a nibble-sized variable for the alarm state. This technique will give you the ability to have differing alarm levels. As an example, a BS2-based product I developed (and upon which this demo is based) has a secondary threshold for each channel. By monitoring the alarm state for each channel, I was able to set the alarm threshold accordingly.

Okay, the code works, so how do we fine-tune the timing? Some assembly language programmers actually go through the arduous process of counting machine cycles. Thankfully, we don't have to do that. What we're going to do is use a spare pin on our project to talk to another Stamp. The second Stamp will measure our code and display the timing on a Scott Edwards serial LCD.

Listing 2 is a program that performs the measurement. The code measures a high pulse on pin 15. Since the resolution of PULSIN is two microseconds, dividing by 500 gives us milliseconds – a timing unit that's a little easier to deal with. Keep in mind that this program is designed to measure short evens. Due to the constraints of PULSIN, the maximum duration that can be measured is 131 milliseconds.

Once you've connected the timing Stamp to your project, you'll need to isolate the section under test. With the section isolated, place the line HIGH x at the beginning of the section and LOW x at the end of the section (x is the pin number). So long as the fragment is within the limits of PULSIN, the time will be displayed on the LCD.

In the demo, ChkSw takes about nine milliseconds to run. I added a couple of pads (PAUSE statements) to keep things as even as possible, regardless of the inputs. With that done, each state routine is checked and padded so that they're equal. With the state processes equal, the last thing to do is pad the main loop to achieve

**Listing 1**

```
' Listing 1
' Nuts & Volts: Stamp Applications, November 1998

' -----[ Title ]-----------------------------------------------------
'
' File...... STATE.BS2
' Purpose... State machine framework
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' WWW....... http://members.aol.com/jonwms
' Started... 03 OCT 98
' Updated... 04 OCT 98

' -----[ Program Description ]---------------------------------------
'
' This program demonstrates the general operation of a state machine. Its
' purpose is to monitor and debounce several inputs with near real-time
' precision (emulating a software interrupt-based process).
'
' Run the program on a Parallax BSAC

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

' -----[ I/O Definitions ]-------------------------------------------
'
SW0_    VAR     In8             ' switch inputs
SW1_    VAR     In9
LED0_   VAR     Out10           ' LED outputs
LED1_   VAR     Out11

' -----[ Constants ]-------------------------------------------------
'
On      CON     0               ' active low output
Off     CON     1

' -----[ Variables ]-------------------------------------------------
'
state   VAR     Byte
tics    VAR     Byte(2)
alarm   VAR     Byte(2)
swMax   VAR     Byte(2)
x       VAR     Byte
test    VAR     Byte

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

' -----[ Initialization ]--------------------------------------------
'
Init:   DirC = %1100
        state = 0

        LED0_ = Off                     ' start with LEDs off
        LED1_ = Off

        tics(0) = 0                     ' clear the input counters
        tics(1) = 0

        alarm(0) = Off                  ' alarms clear
        alarm(1) = Off

        swMax(0) = 20                   ' alarm on 20 "tics" (2 sec)
        swMax(1) = 50                   ' alarm on 50 "tics" (5 sec)

' -----[ Main Code ]-------------------------------------------------
'
Main:   ' HIGH 0                ' start of timing pulse
        GOSUB ChkSw                     ' check the inputs

        ' process the current state
        BRANCH state,[Proc0,Proc1,Proc2]
        GOTO Main
```

```
Proc0:  LED0_ = alarm(0)           ' update the LEDs
        LED1_ = alarm(1)
        PAUSE 50                   ' pad to simulate other code
        GOTO NxtSt

Proc1:  test = alarm(0) + alarm(1)
        IF test > 0 THEN P1x             ' if both on, flash
          LED0_ = Off
          LED1_ = Off
P1x:    PAUSE 50
        GOTO NxtSt

Proc2:  ' do something else
        PAUSE 51
        GOTO NxtSt

NxtSt:  PAUSE 38                   ' main loop timing trim
        state = (state + 1) // 3 ' update the state

        ' LOW 0                          ' end of timing pulse

        GOTO Main

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

ChkSw:  ' check the state of the input switches
        FOR x = 0 TO 1                   ' loop through inputs
          BRANCH x,[CS0,CS1]
CS0:      IF Sw0_ = OFF THEN SwNo
            GOTO SwYes
CS1:      IF Sw1_ = OFF THEN SwNo
            GOTO SwYes
SwYes:    PAUSE 1                        ' timing trim
          tics(x) = tics(x)+1            ' update input counter
          IF tics(x) < swMax(x) THEN SwNext
            alarm(x) = On                ' set alarm for input
            tics(x) = 0                  ' start new counter
            GOTO SwNext
SwNo:     PAUSE 2                        ' timing trim
          alarm(x) = Off                 ' clear the alarm bit
          tics(x) = 0                    ' reset the input counter
SwNext: NEXT
        RETURN
```

the desired loop timing (100 ms).

How long will trimming a program take? Obviously, that depends on the complexity of the program. And sometimes the process will seem like voodoo. I've found it helpful to make a copy of the program to extract code fragments for test. This prevents me from wrecking an otherwise working program.

Just remember that the purpose of this design style is to emulate a timed software interrupt process. If you need to deal with spurious events, stretch the input(s) with a one-shot (a 555 will do) so that you can see the event when you run your pseudo-interrupt process.

## Serial Follow-Up

Every time I work on a project that involves the Stamp communicating with a PC, I'm reminded of Roger Arrick's (of Arrick Robotics) E-Mail tag line: *It's harder than it looks.* No kidding. I've done two Stamp designs recently that get set-up data from the PC. I thought I'd share what I've been through — perhaps I'll save you a bit of frustration in your projects.

I'm using Visual Basic to develop the PC side of my projects. One of the points that I want to reiterate is to use text mode (versus binary mode) with the MSComm control. Why? It's just plain easy. You take your data and convert it to a string (with Chr$(x)) to send it. On receipt, you get a string back that can be parsed and converted with Asc(x). Simple, right? You bet. I'm sure there's somebody that will disagree with me, but I've found the binary mode a nightmare and just plain choose not to use it.

Recently, I had a short conversation about the merits of text versus binary with Jan Axelson. She expressed some concern that some bytes might not convert properly (since VB stores strings with Unicode). We independently ran experiments and concluded that this was not the case.

Just to be safe, you should run your own test, especially if you run a version of Windows that is not a western language (i.e., Japanese or Chinese).

On my end, I created a simple application that sent the value of a spin control to the Stamp. The Stamp program simply waited for the byte and sent it back. A quick check on the transmitted versus received bytes was enough to convince me that text mode would work with my projects.

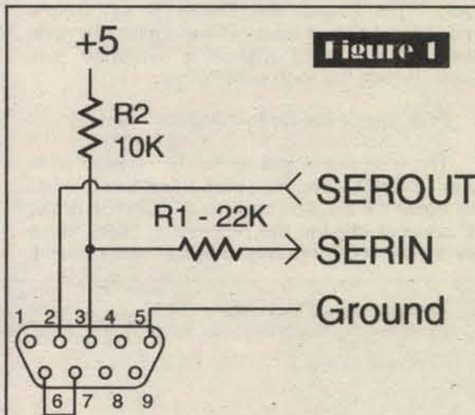
One of my designs uses the BS2 programming port as the serial connection. I feel a bit like a dope for only recently noticing that the Stamp was echoing anything sent to it. The echo is caused by the hardware design of the serial connection. Take a look at the BS2 schematic in the Stamp manual. Notice the resistor connected between the transmit and receive lines? That's the culprit. It's not a problem though, especially since VB includes some nice string functions.

For example, you want to send a two-byte command to the Stamp and expect a response that is eight bytes long. What you'll want to do is wait for 10 characters to show up and strip the first two (the echoed transmission) with the Mid$() function. The resultant string can be parsed to extract the Stamp's data.

One of the nice aspects of the BS2 SEROUT function is the optional pacing parameter. Unfortunately, VB doesn't have such a facility. There will be times when you'll want to insert a delay between the characters sent to the Stamp. I borrowed some code from Jan's book, *Serial Port Complete*, to perform a delay. Delays are particularly important when the Stamp needs to do some sort of processing between PC transmissions. Just keep in mind that you might need to adjust your SERIN timeout value if the PC has a delay on its end.

Enough chitchat, let's look at a program (Listing 3). I developed this project — EEMover — as a test-bed for uploading and downloading

**Figure 1**



parameters from the Stamp. It also gave me a chance to work with polling versus interrupt reception in VB (we talked about that in the StampNet 1 project).

Let's look at the Stamp side first. Set-up parameters are stored in the first 64 bytes of the Stamp's EEPROM (note that for this demo program the data is completely arbitrary). After this data block is a three-byte revision code that will not be overwritten. Its purpose is to identify the code and features of the attached controller.

The first thing the program does is check to see if the PC is connected. This is accomplished by looking at the state of the receive line. Take a look at Figure 1. As you've seen in many Stamp projects, R1 limits the current into the Stamp from the RS-232 connection. The purpose of R2 is to pull the line high (1) when nothing is connected. As soon as you connect a PC, this line will go low (0). In my production project, I look to see if a PC is connected and jump the code that allows set-up parameters to be changed. Even if you don't need to detect a PC, it's good practice to tie the input line to Vcc or ground. This will prevent noise from causing a false start bit on a floating input and corrupting your serial input.

Back to the demo. Once we see the PC, we wait on a start byte ($FF) and a command. It's a good idea to use the timeout parameter so that your program doesn't hang up if something goes wrong. In this case, we simply loop back to the beginning and look for the PC again. After the start byte and command arrive, the command is converted to a cleaner format with LOOKDOWN, and the program BRANCHes to the code that's appropriate for the command received.

The first possible command is the general query. This causes the Stamp to return the embedded revision code. Once again, the code takes advantage of PBASIC's symbolic constants. Notice the loop control line:

```
FOR addr = RevCode TO (RevCode + 2)
```

The loop reads and sends the revision code bytes to the PC. The nice part about this is that I can move the revision code to any portion of the EE and not change the processing code. Since this is my last opportunity to preach (more later), I encourage you to write programs that are easy to read and maintain. Enough said.

Processing the upload command is identical; it just sends more information to the PC.

The trickiest part of the program is downloading new parameters. Once the download command is received, we wait for 64 bytes to be sent from the PC. In order to keep things synchronized and in order, the PC actually sends a start byte (for framing), and the address and data to be written to the address. After reception, the Stamp writes the data to EE, reads it back, then sends the address and data back to the PC for confirmation. By reading back the just-written data, we're able to detect transmission and EE errors. As we'll see in just a minute, the PC will only tolerate a few errors before giving up.

Okay, let's look at the PC code for downloading (Listing 4). Here's a basic description before we get to the specifics: After sending the download command, the code will loop through 64 iterations. If there is no data

## SOURCES

For more information on the BASIC Stamp, contact:

**Parallax, Inc.**
3805 Atherton Road, #102
Rocklin, CA 95765
phone **(916) 624-8333**
**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**

**Jan Axelson**
**Lakeview Research**
2209 Winnebago St.
Madison, WI 53704
Phone: **(608) 241-5824**
Fax: **(608) 241-5848**
**jan@lvr.com**

**Jon Williams**
3718 Valley View Lane #3040
Irving, TX 75062
**(903) 509-1691**
**jonwms@aol.com**
**http://members.aol.com/jonwms**
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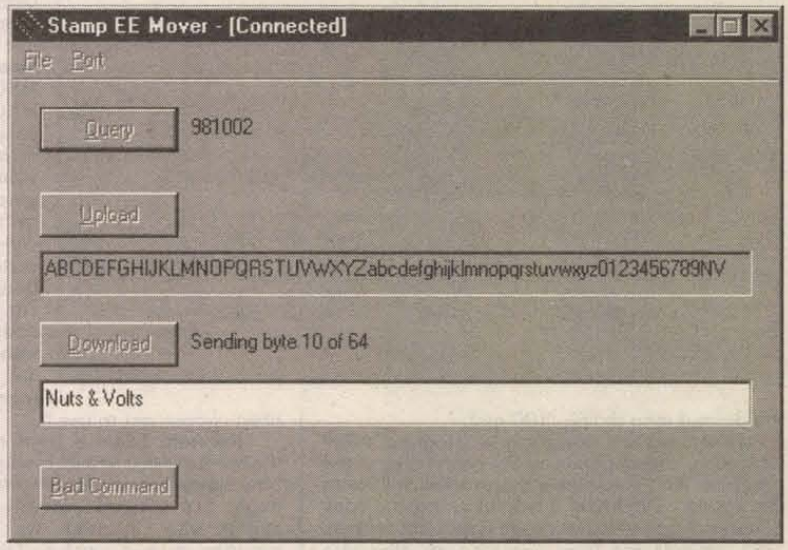


```
' Listing 2
' Nuts & Volts: Stamp Applications, November 1998

' -----[ Title ]-----------------------------------------------------------
- `
'
' Program... SPDTEST.BS2
' Purpose... Speed monitor for code sections
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' WWW....... http://members.aol.com/jonwms
' Started... 23 SEP 1998
' Updated... 23 SEP 1998


' -----[ Program Description ]---------------------------------------------
'
' This program is designed to test code fragments for execution speed. The
' speed is measured in milliseconds in order to allow PAUSE commands into
' the code for speed tuning.
'
' The program monitors a high-going pulse on Pin 15 and displays the
' result (in milliseconds) on a SEETRON LCD. To use, connect a spare pin
' on your project to pin 15. At the beginning of your test section, inser
' HIGH x (where x is your output pin). At the end of the section place
' LOW x to stop the timing.


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


' -----[ I/O Definitions ]-------------------------------------------------
'
LCDpin  CON     0                       ' SEETRON LCD serial line
PInput  CON     15                      ' PULSIN pin


' -----[ Constants ]-------------------------------------------------------
'
N2400   CON     $418D                   ' 2400b baud, inverted
Inst    CON     254                     ' backpack LCD instruction byte
ClrLCD  CON     1                       ' clear the LCD
CrsrHm  CON     2                       ' move to line 1, col 1


' -----[ Variables ]-------------------------------------------------------
'
pTime   VAR     Word                    ' pulse width (2 us units)
msTm1   VAR     Word                    ' ms - whole portion
msTm2   VAR     Word                    ' ms - fractional portion


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


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

Init:   PAUSE 1000                      ' let LCD intialize

        SEROUT LCDpin,N2400,[Inst,ClrLCD,"Ready..."]
        PAUSE 200


' -----[ Main ]------------------------------------------------------------

Main:   PULSIN PInput, 1, pTime
        msTm1 = pTime / 500
        msTm2 = pTime / 5 // 100
        SEROUT LCDpin,N2400,[Inst,CrsrHm,DEC msTm1,".",DEC2 msTm2," ms
"]
        GOTO Main


' -----[ Subroutines ]-----------------------------------------------------
```

for the loop iteration, a zero is downloaded. After sending the start, address and data byte, the PC waits for the address and data to come back. If the address and data do not come back correctly, another attempt is made. If five attempts are made to the same address and the data still comes back bad, the process is aborted. Whew! There's a lot going on.

The first thing we do is prevent a premature program shutdown so that the Stamp's EE doesn't get trashed and cause problems. This is done by disabling the buttons and menus and setting a flag called "downloading." This flag is checked in the QueryUnload event in case the operator clicks the form's close [x] button.

With the process safe from user-interruption, the command is sent and the program waits for 200 milliseconds for the Stamp to get ready. This is a case where the Stamp SERIN timeout for the downloaded data needs to be longer than 200 milliseconds.

```
' Listing 3
' Nuts & Volts: Stamp Applications, November 1998

' -----[ Title ]-------------------------------------------------------
-
'
' File...... EEMOVER.BS2
' Purpose... Stamp to PC Communications Experiments
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 30 SEP 98
' Updated...  2 OCT 98

' -----[ Program Description ]-----------------------------------------
-
'
' This program awaits a PC command and processes it accordingly: send the
' revision code, upload the EE-stored parameters or allow the download of
' a new (64 byte) parameters block.
'
' For convenience, this project was built on a Parallax BSAC. A SEETRON
' 4x40 LCD module was used in debugging.

' -----[ Revision History ]--------------------------------------------
-
'
'  2 OCT 98 : Finally figured it all out and everything works!

' -----[ I/O Definitions ]---------------------------------------------
-
'
TXpin   CON     0                       ' serial output to PC
RXpin   CON     1                       ' serial input from PC
LCDpin  CON     15                      ' debugging pin (SEETRON LCD)
PGMpin  CON     16                      ' uses BS2 programming port

PCcon   VAR     In1                     ' pc connected?
LEDrx   VAR     Out8                    ' receive LED
LEDtx   VAR     Out9                    ' transmit LED

' -----[ Constants ]---------------------------------------------------
-
'
N9600   CON     84                      ' non inverted (through driver)
T9600   CON     $4054                   ' inverted (direct)

Off     CON     1                       ' active low
On      CON     0

Yes     CON     0
No      CON     1

Start   CON     $FF                     ' start byte
CmdQr   CON     $A7                     ' query - return date code
CmdUp   CON     $A0                     ' upload ee
CmdDn   CON     $A1                     ' download new ee

' -----[ Variables ]---------------------------------------------------
-
'
cmd     VAR     Byte                    ' command byte
addr    VAR     Byte
dByte   VAR     Byte
tries   VAR     Byte

' -----[ EEPROM Data ]-------------------------------------------------
-
'
Setup1  DATA    "ABCDEFGHIJKLMNOPQRSTUVWXYZ"
Setup2  DATA    "abcdefghijklmnopqrstuvwxyz"
Setup3  DATA    "0123456789"
Setup4  DATA    "NV"

RevCode DATA    98,10,02        ' embedded revision code

' -----[ Initialization ]----------------------------------------------
-
'
Init:   DirA = %0001
        DirC = %0011

' -----[ Main Code ]---------------------------------------------------
-
'
Main:   LEDtx = Off                             ' clear the TX/RX LEDs
        LEDrx = Off

        ' look for PC
        IF PCcon = Yes THEN M1                  ' look for low on input line
          SEROUT LCDpin,T9600,[12,"PC is not connected"]
          PAUSE 250
        GOTO Main

M1:     SEROUT LCDpin,T9600,[12,"Connected. Waiting..."]
        SERIN  RXpin,T9600,5000,Main,[WAIT (Start), cmd]

        LEDrx = On                              ' show transmission received
        PAUSE 50
        LEDrx = Off

        LOOKDOWN cmd,[CmdQr,CmdUp,CmdDn],cmd     ' decode command byte
        BRANCH cmd,[CQry,CUpLd,CDnLd]            ' branch to processing
        GOTO CBad

CQry:   SEROUT LCDpin,T9600,[12, "Query "]
        GOSUB RCode
        PAUSE 1000
        GOTO Main

CUpld:  SEROUT LCDpin,T9600,[12, "Upload"]
        GOSUB UpLoad
        PAUSE 1000
        GOTO Main

CDnld:  SEROUT LCDpin,T9600,[12, "Download"]
        GOSUB DnLoad
        PAUSE 1000
        GOTO Main

CBad:   SEROUT LCDpin,T9600,[12, "Invalid Command"]
        PAUSE 1000
        GOTO Main

' -----[ Subroutines ]-------------------------------------------------
-
'
RCode:  ' send revision code to PC
        LEDtx = On
        FOR addr = RevCode TO (RevCode + 2)
          READ addr, dByte
          SEROUT TXpin,T9600,[dByte]
        NEXT
        LEDtx = Off
        RETURN

UpLoad: LEDtx = On
        FOR addr = 0 TO 63
          READ addr, dByte
          SEROUT TXpin,T9600,[dByte]
        NEXT
        LEDtx = Off
        RETURN

DnLoad: ' download new set-up data
        LEDrx = On
        SERIN  RXpin,T9600,2000,DLx,[WAIT (Start),addr,dByte]
        LEDrx = Off

        ' show the transmission
        SEROUT LCDpin,T9600,[1,"Writing... ", DEC2 addr, "->",DEC3 dByte]
        SEROUT LCDpin,T9600,[" (",dByte, ")  "]

        ' copy to ee
        WRITE addr,dByte                        ' write to ee
        READ addr,dByte                                 ' read it back

        ' return address and data
        LEDtx = On
        SEROUT TXpin,T9600,[addr,dByte]
        LEDtx = Off

        IF addr < 63 THEN DnLoad        ' do 64 bytes
DLx:    RETURN
```

```
' Listing 4
' Nuts & Volts: Stamp Applications, November 1998

Private Sub cmdDnload_Click()
 Dim addr As Byte
 Dim tries As Byte
 Dim temp As String
 Dim x As Byte
 Dim response

 Call EnableButtons(False)
 mnuFile.Enabled = False
 mnuPort.Enabled = False
 Screen.MousePointer = vbHourglass
 downloading = True

 ' send download command
 Call SendHeader(CmdDn)
 Call Delay(200)

 ' download the ee data
 addr = 1
 Do
  lblByteCount.Caption = "Sending byte" & Str(addr) & " of 64"
  tries = 0
  Do
   ' get a byte
   temp = Mid$(txtDnload.Text, addr, 1)
   ' if empty, program the location with 0
   If (temp = "") Then temp = Chr$(0)
   ' build the buffer (adjusted address + byte)
   txBuf = Chr$(addr - 1) & temp
   ' send Start byte and buffer
   MSComm1.Output = Chr$(Start) & txBuf

   ' wait for two-byte response
   Do
    DoEvents
    x = MSComm1.InBufferCount
   Loop Until (x = 2)
   rxBuf = MSComm1.Input

   ' increment tries counter
   tries = tries + 1
  Loop Until (tries = 5) Or (rxBuf = txBuf)

  ' exit if bad chip
  If (tries = 5) And (rxBuf <> txBuf) Then
   response = MsgBox("Error: Cell " & Str(addr), vbOKOnly)
   addr = 65
  End If

  addr = addr + 1
  Call Delay(150)
 Loop While (addr <= 64)

 lblByteCount.Caption = ""
 Call EnableButtons(True)
 mnuFile.Enabled = True
 mnuPort.Enabled = True
 Screen.MousePointer = vbDefault
 downloading = False
End Sub
```

A Do-Loop construct is used for the overall download structure. The control variable addr is initialized to 1 before starting the loop and checked for exceeding 64. This structure makes it easy to break out of the Do-Loop by setting the control value to greater than 64.

The first part of the loop core gets a piece of data to send. In this case, we're grabbing a character from a text input field. If you are dealing with non-string data, remember to convert the byte to a string with the Chr$() function. In this program, a null string (the input is less than 64 characters) is converted to 0. I used this because some of the elements in my Stamp production are zero-terminated strings. With the character in hand, the start byte, and address and data are sent. As I stated earlier, I decided to send the start byte through each iteration to keep everything in sync.

After the transmission, we wait for two bytes to come back from the Stamp. Notice the use of the DoEvents function in the reception loop. This is really important, especially if something goes wrong on the Stamp end. DoEvents allows Windows to do other things while processing the loop.

The received input is checked against the data sent. If it's the same, we move on to the next address. If it's not, we'll try the same address again. If the same address fails five times, the loop is terminated and the user is notified.

It all looks pretty easy now that it works, but it was a bear in the process. Good luck with your PC/Stamp projects. They really are a lot of fun when everything is working right.

## Farewell, Friends

As those of you that monitor the Stamp list know, this article will be my final *regular* Stamp Applications column for *Nuts & Volts*. I stress "regular" because I am not walking away from Stamping and I really do enjoy writing about my projects. It's just that time is scarce for me right now. With a full-time engineering job and a budding career as an actor (and all the craziness that goes along with that ...), I honestly don't have the time to write a full column each month. I will submit articles as time permits — including the conclusion of StampNet. I promise.

I really do want to thank Larry Lemieux and his staff at *Nuts & Volts* for allowing me to write the column this past year and for giving me complete freedom to write about what I chose. Of course, I have to thank my buddy Scott Edwards for trusting me with his creation, for his support, his encouragement, and for his friendship. And I certainly couldn't have done what I've done without the support of Ken Gracey and the good folks at Parallax. Thank you, Parallax, for everything.

Finally, I must thank my dearest friend, Kim Jaech. Who's Kim? Kim is the miracle worker that translates my techno-gibberish into intelligible English. And all along you folks thought I was a pretty good writer, didn't you? Well, not without Kim. Everything that I've ever had published has passed through her capable hands and so long as I have my way, everything I ever write in the future will too. Thanks, Kim. I love you.

For those of you in the Metroplex, perhaps I'll see you at a DPRG meeting or at Tanner's on one of my Saturday afternoon parts runs. For those that I've met via E-Mail, snail mail, or the telephone, thanks for your kind words and valuable suggestions for the column. I sincerely appreciate your comments and your input. May God bless each of you always.

Happy Stamping. I'll see you in the movies! **NV**

# reader FeedBack

Dear Nuts & Volts:

I enjoyed the reference article by Gordon West (Apr. '98, "Copper Foil Grounding for RF.")

As an avid boater and an old-time electroniker, I am usually well read on RF things written for boaters. I have never seen copper foil grounding mentioned in the sailing literature that I have read. Perhaps I have missed it, but if such an article has never been printed, I am certain it would be well received by sailors.

I used to work on an underwater missle that had a wooden nose cone. Yes, it was made of spruce plywood, and it had a one foot wide copper foil strip that ran from its tip down to a wide contact that connected to the aluminum body of the rocket.

The explanation was that it carried static charges away from the metal nose tip fitting. This puzzled me as I never thought that static charges had much difficulty going wherever they pleased, and that a simple piece of wire would have done the job. As usual, I find that there is always more to learn.

**Jess Talley**
**via Internet**

Dear Nuts & Volts:

In the Sept. '98 issue, Mr. H. Halney requests actual examples of Y2K problems. He seems to have overlooked an actual problem included in his letter.

He states "some clock chips only tell you what the year is modulo 4, that is, will February have 28 days or 29?"

Those chips are an actual Y2K problem. They will tell you that the last year of the 20th Century is a Leap Year, which it is not! The next Leap Year is 2004.

**Emil Rossdeutscher**
**New York, NY**

Dear Nuts & Volts:

In your Sept. '98 issue, pages 25 and 26, in answer to #89814 about charging a 72-volt battery system, Fernando Garcia said, "I don't think you would die from a 72-volt shock."

Although 72 volts is less dangerous than higher voltages, I have read documented reports of people being killed by 40 volts, and I have received a good jolt myself from 24 volts by getting across it with wet fingers.

As a result, I would consider any electrical circuit with 24 or more volts between any conductor and ground — or between any two conductors — to be potentially dangerous.

Personal contact with such energized conductors must always be prevented. I even encountered a high power audio amplifier (200W into 8 ohms) with a warning on the rear panel stating that the voltage at the speaker terminals (40V @ 5A when going full blast) is "hazardous to human life."

**Michael Kiley**
**Crestwood, IL**

Dear TJ Byers:

The answer to the well-depth question (Aug. '98 Q & A) may provide a workable solution, but a pressure transducer would be a better choice. Mount the sensor near the pump and use its output to drive a meter or an LED bar graph as a depth indicator. You could use the voltage or current output from the sensor with a set of comparators to trigger events when the water goes down to limits that you preset. The pressure under about 35 feet of water is +1 atmosphere, so a 0-1 atmosphere absolute pressure gauge that can work submerged in water would nicely meet the needs of "Stano." Getting the transducer down the well pipe might take a bit of doing, but a piece of PVC pipe (larger inside diameter than the outside diameter of the water pipe) sawed in half lengthwise and clamped together around the water line would easily slide down to the pump. Using the pipe as a guide would also keep the sensor out of the muck at the bottom of the well.

**Jon Titus**
***Test & Measurement World Magazine***
**Newton, MA**

*Response:*

*This approach will work, but at a higher price. The problem isn't the cost of the pressure sensor, which you can buy from **Omega Engineering (1-800-826-6342**; http://www.omega.com) and **EG&G IC Sensors (1-800-767-1888**; http://www.egginc.com/bin/webmate/egg/page/egg/index) for about $15.00, but the additional support electronics. These are piezoresistive pressure sensors, suitable for PC board mounting, that come in a TO-5 package. They are available in full-scale ranges from 5.0 to 100 PSI (pounds per square inch). All models are operated from a constant-current excitation supply of 1.5 mA. The problem is the low voltage output from the sensor, which is a mere 5.5 mV per PSI for Omega's PX71-030AV sensor needed for a 35-foot well, as shown in the chart below.*

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| *0 to 15 PSI* | *9.5 mV per PSI* | *PX71-015AV* | *PX72-015AV* |
| *0 to 30 PSI* | *5.5 mV per PSI* | *PX71-030AV* | *PX72-030AV* |
| *0 to 60 PSI* | *3.0 mV per PSI* | *PX71-060AV* | *PX72-060AV* |
| *0 to 100 PSI* | *2.0 mV per PSI* | *PX71-100AV* | *PX72-100AV* |

*Subtracting for the earth's 14.7 PSI barometric pressure, this translates into about 2.3 mV per foot -- or just 82 mV from full to empty. Given the harsh electrical environment at the well site, a signal this weak has to be amplified and filtered before it can be processed. The total cost is going to be more than the $10.00 thermistor version. But as you point out, it's a reliable depth gauge that'll survive the ravages of time.*

***TJ Byers***
***Q & A Editor***

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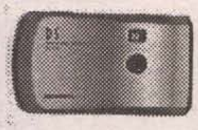

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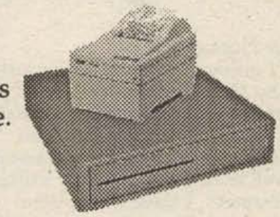

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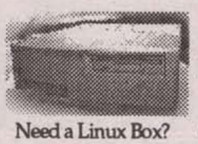

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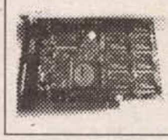

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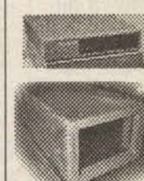

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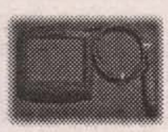

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*by Gerald Roylance*

# Interfacing a Magnetic Stripe Reader

## Magnetic Stripes

Cards with magnetic stripes on the back are everywhere. Credit cards, ATM cards, student ID cards, and even driver's licenses have them. If you go to a trade show, they will give you an ID with a magnetic stripe. Even my grocery card has a magnetic stripe. You cannot get away from this technology.

You can read a card's magnetic stripe by wiring a magnetic stripe reader (MSR) to your computer's parallel port and running a simple program. Figure 1 shows my reader with the LPT port adapter – the only additional requirement is a five-volt supply to power the reader.

My interest in magnetic stripes was peaked by some recent events. During my last trip to the DMV, the clerk typed in all the info on my driver's license instead of swiping the card or just entering my license number – and he made mistakes! Then I was at a tradeshow where the organizers made a tidy profit renting MSR readers and printers to the exhibitors. I've also been curious about the information on the card – if you haven't noticed, many store credit card transactions now print your name on receipt. Does the store get that information from the card or from the credit card company's computer?

All this came to a head when I picked up a magnetic stripe reader for a few dollars at a local surplus store. A little poking around and a search of "magstripe" on the Web turned up a lot of information.

Some of the information in this article comes from http://vvv.com/~tommy/files/magcard1.txt and http://www.ee.washington.edu/eeca/text/cardreader.txt. If you want to try reading a card with iron fillings and cellophane tape, look at http://b63334.student.cwru.edu/projects/card/card.htm.

*Figure 1*

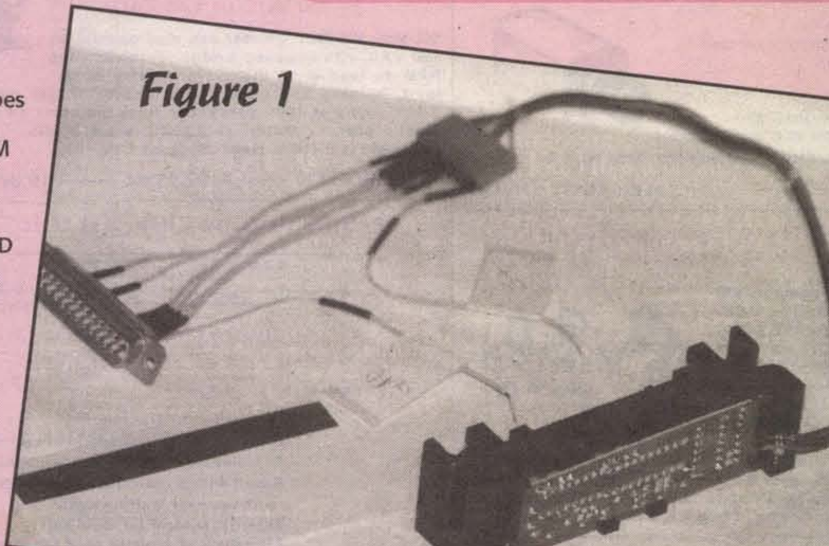
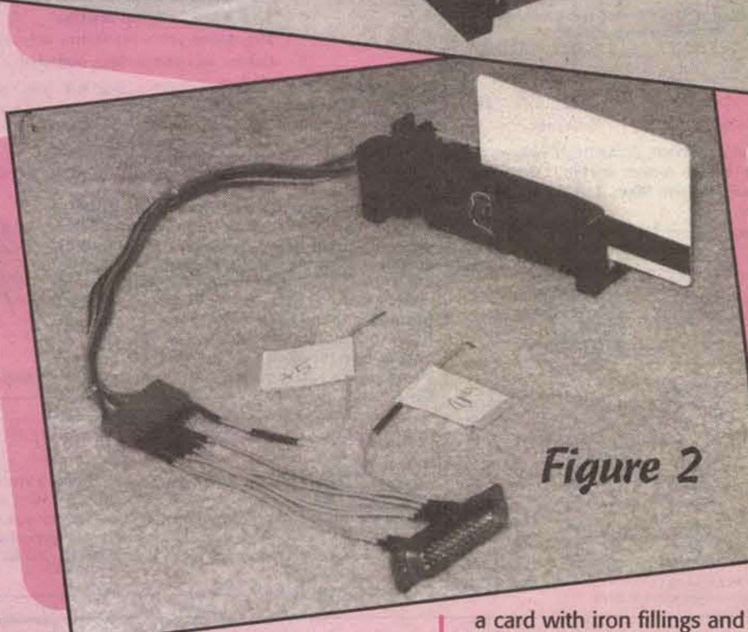


*Figure 2*



## What's on the Back of the Card

The card geometry is 3.375 inches by 2.118 inches. The magnetic stripe on the back may have up to three tracks (ISO 3554), appropriately called Track 1, Track 2, and Track 3. Each track is 0.110 inches wide, and all data is recorded serially. The tracks are recorded at different densities and have different formats.

- Track 1 is recorded at 210 bits per inch (BPI). The track contains information in seven-bit characters, and each character has six information bits plus one parity bit. Each track can hold 79 alphanumeric characters.
- Track 2 is recorded at 75 BPI and five bits per character. Each character has four information bits and one parity bit. The track holds 40 digits.
- Track 3 is recorded at 210 BPI and five bits per character. The track holds 107 digits.

Some cards have additional tracks, and some cards use different formats. The California driver's license, for example, records Track 1 at six bits per character (no parity) to squeeze more data on the track.

The magnetic card specifications are also covered in ANSI Standard X4.16 from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018. Other relevant standards are ISO 7810-1985, ISO 7811-2, and ISO 7811-6.

## The Plan

Reading the magnetic stripe involves several tasks.

| Signal | MSR pin | Color | LPT DB25 pin | Port Bit Position | Description |
|---|---|---|---|---|---|
| +5 Volts | 10 | Red | NC | NA | Power |
| RCP2_L | 6 | Blue | 13 | 0x10 | Track 2 Clock |
| RDP2_L | 5 | Green | 15 | 0x08 | Track 2 Data |
| RCP1_L | 4 | Yellow | 10 | 0x40 | Track 1 Clock |
| RDP1_L | 3 | Orange | 12 | 0x20 | Track 1 Data |
| CLS_L | 2 | Brown | 11 | 0x80 | Card Present |
| GND | 1 | Black | 18, 19, 20, 21, 22, 23, 24, 25 | NA | Power and Signal Ground |

**Table 1. Magnetic Stripe Interface**

| | |
|---|---|
| Start sentinel | 1 character |
| Format code = 'B' | 1 character |
| Primary account number | Up to 19 characters following ANSI X4.13 |
| Separator '^' | 1 character |
| Last Name/First Initial | e.g., "Public/John Q" |
| Separator '^' | 1 character |
| Expiration date or separator | 4 (YYMM) or 1 characters |
| Other data | Variable |
| End sentinel | 1 character |
| LRC | 1 character |

**Table 2: Track 1 Format Code B**

1. Connecting the MSR to the computer.
2. Capturing the MSR bit stream into the computer.
3. Extracting the track characters from the bit stream.
4. Testing the track for errors and possibly correcting them.
5. Interpreting the information on the track.

The first task physically connects the reader to the computer, and the other tasks are performed in software by the C program MAGCARD listed here in the article.

## Connecting the MSR to the Computer

My magnetic stripe reader is a Neuron Corp, Model MCR-133-2R-2020, Serial 2110249. Its interface signals and pinouts are given in Table 1. All signals are active low. Other MSRs will have similar signals, but their pinouts will vary.

I picked up my reader at a surplus store, and you might do the same. If not, Digi-Key (http://www.digikey.com) sells some Panasonic magnetic card readers. A reader that only reads Track 2 (ISO2) sells for $30.00, and one that reads both Track 1 and Track 2 (ISO1/ISO2) sells for $70.00. I haven't tried them, but they should be similar.

Wiring the MSR to the parallel port is easy because there are

```
/* -*- Mode: C -*- */

// Read a Credit Card Magnetic Stripe

// Copyright Gerald Roylance 1998.  All rights reserved.

#include <stdlib.h>
#include <stdio.h>
#include <assert.h>
#include <ctype.h>
#include <conio.h>                    // for inp() and kbhit()

#define LPTOUT 0x378
// port+0 (bidirectional data)
// port+1 (pins are input only)
//   pin 15 = 0x08    !RDP2
//   pin 13 = 0x10    !RCP2
//   pin 12 = 0x20    !RDP1
//   pin 10 = 0x40    !RCP1
//   pin 11 = !0x80   !CLS
#define Active(b) ((b)&0x80)

// Define the bit test masks for a track
struct MTrack
{
  unsigned char bClock;
  unsigned char bData;
};
struct MTrack mtTrack1 = {0x40, 0x20};
struct MTrack mtTrack2 = {0x10, 0x08};

// Define the codes used on each track
struct MCode
{
  unsigned int  cBits;
  unsigned int  fParity;
  unsigned char bSentinel;
  unsigned char bTerminal;
};
struct MCode mc7Bit = {7, 1, 0x45, 0x1F};      // Industry Standard
Track 1
struct MCode mc6Bit = {6, 0, 0x05, 0x1F};      // California Drivers
License
struct MCode mc5Bit = {5, 1, 0x0B, 0x1F};      // Industry Standard
Track 2

// Capture raw signal data at the LPT input port

// returns
//   < 0 if there is a problem capturing the data
//     0 if user types a key
//     # of bytes of data
int CaptureRaw(int cbRaw, unsigned char *abRaw)
{
  // I/O Port values
  int portOut = LPTOUT;
  int portIn  = portOut+1;
  int portInt = portOut+2;
  unsigned char b;                // current I/O byte
  unsigned char bLast;            // last I/O byte
  int cb = 0;                     // number of output bytes
  // timeout counter ... don't hang the machine forever
  long dwDelay      = 0;
  long dwDelayLimit = 10000000L;

  // make sure the arguments are reasonable
  assert(cbRaw > 256 && abRaw != NULL);

  // Initialize the LPT port
  // put the open collector drivers on I/O port in a reasonable state
  //   we don't need to do this ...
  outp(portInt, 0x00);
  // no interrupts
  outp(portInt, 0x00);

  // -CLS should be high
  assert(!Active(inp(portIn)));

  // wait for -CLS to go active
  while (1)
    {
      // read the port
      b = inp(portIn);
      // test if active
      if (Active(b))
        break;

      // if the user types a character, give up
      if (kbhit())
        {
          (void)getchar();
          return 0;
        }
    }

  // remember this byte
  bLast = b;
  // record the first active data byte
  abRaw[cb++] = b;

  // capture data while -CLS is active
  while (1)
    {
      b = inp(portIn);
      // record if I/O data byte changed
      if (b != bLast)
        {
          // remember b for next data change
          bLast = b;

          // record the new data
          abRaw[cb++] = b;

          // bail out if we run out of buffer
          if (cb >= cbRaw)
            {
              // Raw buffer full!
              return -1;
            }

          // reset the failsafe counter
          dwDelay = 0;
        }

      // quit when the select line goes inactive
      if (!Active(b))
        break;

      // failsafe counter ...
      if (dwDelay++ > dwDelayLimit)
        {
          // *** Failsafe counter expired!
          return -2;
        }
    }

  return cb;
}

// Turn array of port raw data values into a track byte string

// returns # of bytes in Track > 2 if successful
int ExtractTrack(struct MTrack *pmtTrack, struct MCode *pmcCode,
                 int cbRaw,   unsigned char *abRaw,
         int cbTrack, unsigned char *abTrack)
{
  // the number of bits in a character
  unsigned int  cBits      = pmcCode->cBits;
  unsigned char bWeight    = (1 << (cBits-1));
  unsigned char bSentinel = pmcCode->bSentinel;
  unsigned char bTerminal = pmcCode->bTerminal;
  // specify the Clock and Data bits of the interface byte
  unsigned char bClock = pmtTrack->bClock;
  unsigned char bData  = pmtTrack->bData;
  // initialize the state machine
  unsigned char bLast  = abRaw[0];
  unsigned char bShift = 0;
  int iStripe = -1;                  // iStripe = -1 -> search for sentinel
  int iBit    = 0;                   // which bit we are working on
  int iRaw;

  // data is LSB first
  for (iRaw = 0; iRaw < cbRaw; iRaw++)
    {
      unsigned char b  = abRaw[iRaw];

      // Look for Falling Clock Edge
      if (((bLast&bClock)!=0) && ((b&bClock)==0))
        {
          // there is a clock edge.
          // Determine the bit (reader signal is active low)
          unsigned char bit = ((b&bData)?0:bWeight);

          // shift the register and or in the new bit
          bShift = ( (bShift>>1) | bit);
          iBit++;

          // process the new bit
          if (iStripe < 0)
            {
              // iByte < 0 means we have not seen a start sentinel yet.
              // Check if this bit now reveals the sentinel.
              if (bShift == bSentinel)
                {
                  // fprintf(stderr, "Start Sentinel found\n");
                  // start recording characters ...
                  iStripe = 0;
                  abTrack[iStripe++] = bShift;
                  iBit  = 0;
                }
            }
          else
            {
              // we've seen a start sentinel, so mark off each cBits into a
byte
              if (iBit == cBits)
                {
                  // we've picked up a new byte
                  abTrack[iStripe++] = bShift;
                  iBit = 0;

                  // if the byte before this one was the end sentinel,
                  // then this byte is the LCC and we are done with the string
                  if (iStripe >= 2 && abTrack[iStripe-2] == bTerminal)
                    {
                      // fprintf(stderr, "End Sentinel found\n");
                      return iStripe;
                    }
                  // will we run out of room?
                  if (iStripe >= cbTrack)
                    {
                      break;
                    }
                }
            }
        }        // end of look for falling edge

      // remember this byte for the next iteration
      bLast=b;
    }          // end of for loop

  // we did not find an end sentinel or ran out of room
  return -1;
}

// Convert the Stripe Bytes to a character string

void DumpRaw(int cb, unsigned char *abRaw)
{
  FILE *file = fopen("magcard.txt", "wt");

  if (file == NULL)
    {
      perror("DumpRaw");
    }
  else
    {
      int i;

      for (i = 0; i < cb; i++)
```

only a few wires. The essential task is making an adapter cable from the MSR's connector to the LPT port connector. Each pin on the MSR is wired to a male DB25 connector that plugs into the LPT port. The pins are called out in Table 1. Connect all the LPT ground leads together, and make some provision for powering the MSR.

If your reader doesn't have Track 1 or Track 2, then you can leave its clock and data pins open. You must supply a connection for CLS_L for the software to recognize a card.

When a card is swiped, CLS_L goes low (becomes active) and then the clock lines continue to toggle at a reasonably constant rate. Initially both data lines are held high (logic zero), but after a short time, they start changing back and forth. The data should be clocked on the high to low transition of its clock line – the software given handles that.

## Getting the Data into the Computer

The connection to the LPT port allows the computer to sample the instantaneous signal values from the MSR. For the connection to be useful, the computer must sample the port often enough to notice all the clock changes before a data line changes. The procedure CaptureRaw reads the port data and records every change. The port data only needs to be saved when the CLS line is active (i.e., when a card is being swiped), so the routine waits for CLS_L to go active, and then records all the data until CLS_L becomes inactive.

To get an idea of how often we must look at the port, an MSR can read cards that are swiped at 4 to 60 inches per second. For Track 1, that implies bit rates of 840 to 12,600 bits per second. In order to catch all the clock changes, it should sample at least four times the data rate – about 50,000 samples per second or every 20 microseconds for a fast swipe.

| | |
|---|---|
| Start Sentinel | 1 character |
| Format code = 'D' | 1 character |
| Name | 58 characters |
| Address | 29 characters |
| City | 13 characters |
| End sentinel | 1 character |
| LRC | 1 character |

**Table 3: Track 1 for California Driver's License**

```
    {
      unsigned char b = abRaw[i];

      fprintf(file, "%02x %d%d%d%d%d%d%d%d\n",
              b,
              (b>>7)&1, (b>>6)&1, (b>>5)&1, (b>>4)&1,
              (b>>3)&1, (b>>2)&1, (b>>1)&1, (b   )&1);
    }
    fclose(file);
  }
}

int fOddParity(unsigned char bByte)
{
  register unsigned char b = bByte;

  b ^= (b>>4);
  b ^= (b>>2);
  b ^= (b>>1);

  return (b&0x01);
}

char cYYY(unsigned int cBits, unsigned int cx)
{
  if (cBits == 4 || cBits == 5)
    {
    return '0' + (cx&0x0F);
    }
  else if (cBits == 6 || cBits == 7)
    {
    // characters are six bit + parity ...
    return ' ' + (cx&0x3F);
    }
  else
    {
    // *** unknown code!
    assert(0);
    return '*';
    }
}

void PrintTrack(struct MCode *pmcCode, int cbLength, unsigned char
*abTrack)
{
  int i;
  int cBits = pmcCode->cBits;

  for (i = 0; i < cbLength; i++)
    {
    fprintf(stderr, "%c", cYYY(cBits, abTrack[i]));
    }
  fprintf(stderr, "\n");
}

void PrintTrackParity(int cbLength, unsigned char *abTrack)
{
  int i;

  for (i = 0; i < cbLength; i++)
    {
    fprintf(stderr, "%c", (fOddParity(abTrack[i]))? ' ' : 'X');
    }
  fprintf(stderr, "\n");
}

char *szStripeToChar(int cbTrack, unsigned char *abTrack, char
*acStripe)
{
  int i;

  for (i = 0; i < cbTrack; i++)
    {
    acStripe[i] = cYYY(7, abTrack[i]);
    }
  // *** should guarantee from for the null byte ...
  acStripe[cbTrack] = '\0';

  return acStripe;
}

// Process one Track

// return length of track
int ProcessTrack(struct MTrack *pmtTrack, struct MCode *pmcCode,
                 int cb,      unsigned char *abRaw,
                 int cbTrack, unsigned char *abTrack)
{
  int iReturn = -1;

  // we got stuff ...
  int cbLength = ExtractTrack(pmtTrack, pmcCode, cb, abRaw, cbTrack,
abTrack);

  assert(cYYY(7, 0x45) == '%');
  assert(cYYY(7, 0x3E) == '^');
  assert(cYYY(7, 0x5F) == '?');

  // if cbLength <= 2, then we did not find the sentinels!
  if (cbLength <= 2)
    {
    fprintf(stderr, ".. no sentinels found\n");
    }
  else
    {
    // Print the raw data
    fprintf(stderr, "Track Raw length %d bytes\n", cbLength);
    PrintTrack(pmcCode, cbLength, abTrack);

    // Do error detection
      {
      unsigned char bLCC = 0;
      int cBits    = pmcCode->cBits;
      int fParity  = pmcCode->fParity;
      unsigned char bMaskP = (0xFFU >> (8-cBits));
      unsigned char bMaskD = (fParity)? (bMaskP>>1) : bMaskP;
      int cErrors = 0;
      int iError  = 0;
      int i;

      // calculate # of parity errors and LCC
      for (i = 0; i < cbLength; i++)
        {
        bLCC ^= abTrack[i];
        if (!fOddParity(abTrack[i]))
          {
          cErrors++;
          iError = i;
          }
        }

      // do we have a parity error
      if (fParity && cErrors != 0)
        {
        PrintTrackParity(cbLength, abTrack);
        fprintf(stderr, "Parity Errors: cErrors = %d, LCC = %02x\n",
cErrors, bLCC);
        if (cErrors == 1)
          {
          fprintf(stderr, "Correcting single error:\n");
          abTrack[iError] ^= bLCC;
          PrintTrack(pmcCode, cbLength, abTrack);
          // but say we failed anyway
          iReturn = -1;
          }
        }
      else if ((bMaskD & bLCC) != 0)
        {
        fprintf(stderr, "LCC Error: LCC = %02x\n", bLCC);
        }
      else
        {
        // no errors found!
        iReturn = cbLength;
        }
      }
    }
  return iReturn;
}

// Read and Print a Card

unsigned char abRaw[16384];
int           cbRaw = sizeof(abRaw);

int MagReadAndPrint(void)
{
  int iReturn = 1;

  fprintf(stderr, "Swipe Card — or press a key to quit\n");
  {
    // capture the data and the number of samples
    int cb = CaptureRaw(cbRaw, abRaw);

    fprintf(stderr, "Capture data return %d bytes\n", cb);

    assert(cb <= cbRaw);
    if (cb < 0)
      {
      fprintf(stderr, "— Problem capturing the data:  error = %d\n", cb);
      }
    else if (cb == 0)
      {
      // user quit
      iReturn = 0;
      }
    else
      {
      unsigned char abTrack[256];
      int           cbTrack = sizeof(abTrack);

      // dump port data to a file
      // DumpRaw(cb, abRaw);

      fprintf(stderr, "TRACK1 — 7bit\n");
      if (ProcessTrack(&mtTrack1, &mc7Bit, cb, abRaw, cbTrack,
abTrack) < 3)
        {
        int cbDriver;

        // if 7 bit failed, try 6 bit ...
        fprintf(stderr, "TRACK1 — 6bit\n");
        cbDriver = ProcessTrack(&mtTrack1, &mc6Bit, cb, abRaw,
cbTrack, abTrack);
        if (cbDriver > 2 && cYYY(6, abTrack[1] == 'D'))
          {
          int i;
          int cName    = 58;
          int cAddress = 29;
          int cCity    = 13;
          int iName    = 2;
          int iAddress = iName    + cName;
          int iCity    = iAddress + cAddress;
          int iEnd     = iCity    + cCity;

          fprintf(stderr, "California Driver's License\n");
          for (i=iName;    i < min(cbDriver, iAddress); i++)
            fprintf(stderr, "%c", cYYY(6, abTrack[i]));
          fprintf(stderr, "\n");
          for (i=iAddress; i < min(cbDriver, iCity   ); i++)
            fprintf(stderr, "%c", cYYY(6, abTrack[i]));
          fprintf(stderr, "\n");
          for (i=iCity;    i < min(cbDriver, iEnd    ); i++)
            fprintf(stderr, "%c", cYYY(6, abTrack[i]));
          fprintf(stderr, "\n");
          }
        }
      fprintf(stderr, "TRACK2 — 5bit\n");
      ProcessTrack(&mtTrack2, &mc5Bit, cb, abRaw, cbTrack, abTrack);
      }
  }

  return iReturn;
}

// Main

int main(void)
{
  assert(fOddParity(1) && !fOddParity(0x71));

  // read and print card until the user hits a character ...
  while (MagReadAndPrint())
    {
    }

  return 0;
}
```

| | |
|---|---|
| Start Sentinel | 1 character |
| Primary account number | Up to 19 characters |
| Separator | 1 character |
| Country code (3 characters) | Only if primary account number starts with 59 ... USA is 840 |
| Expiration Date or separator | 4 characters YYMM or 1 character |
| Other data ... | |
| End Sentinel | 1 character |
| LRC | 1 character |

**Table 4: Track 2 Format**

| | |
|---|---|
| A | Issuer is BCD unless |
| 0 | Government, issuer is BCDE |
| 1 | UATP |
| 2 | Airlines |
| 3 | Travel and Entertainment |
| 4 | Bank, issuer is BCDEF |
| 5 | Bank<br>if B is 1, 2, or 3, then issuer is 1, 2, or 3 digits<br>if B is 0, 4, 5, 6, 7, 8, then issuer is BCDEF |
| 6 | Retail (Restricted), issuer is BCDE |
| 7 | Petroleum |
| 8 | <future> |
| 9 | National Card |

Unfortunately, Windows cannot perform such high sample rates, so the program must run in MS/DOS mode. Windows runs in protected mode and installs a virtual device driver (VxD) for the LPT I/O ports. That VxD traps all I/O instructions to the LPT port and then emulates the I/O. Instead of one simple I/O instruction, the computer will execute hundreds of instructions and perform some task switches. Furthermore, Windows may switch to another application and cause large gaps in the sampling.

Instead of fighting Windows or building more exotic hardware, we can run the code in real mode under MS/DOS. The real-time clock will still interrupt the sampling routine, but its effect is minor. To run the program, put Windows into MS/DOS mode by executing Start | Shut Down, and then select "Restart the computer in MS/DOS Mode." Then run MAGCARD.EXE from the MS/DOS command line.

## Grouping the Bits into Characters

The procedure CaptureRaw saves the instantaneous values at the data port. The procedure ExtractTrack examines the raw port data for clock transitions, determines the bit value, and assembles the bits into characters. To get the information from two tracks, we call ExtractTrack twice – once for each track.

The basic format of each track is a preamble, a start sentinel character, an arbitrary number of data characters, the end sentinel character, and a longitudinal check character (LCC). The data come from the card in bit serial fashion with the LSB first. A special bit pattern – called the start sentinel – marks the end of the preamble and the start of the data. Succeeding bits are grouped into appropriately-sized characters for the track. Another special character – the end sentinel – marks the end of the data and tells us the next character is the LCC.

## Testing for Errors

If ExtractTrack finds the sentinels, then the track data will be stored in the array abTrack. Now we need to test that information for errors. In the standard formats, each character has a parity bit, so each character is tested for proper (odd) parity. Any bad parity indicates the track was misread.

All track formats have a longitudinal check character (LCC). When the track was recorded, the LCC was chosen so that a bitwise XOR of all the characters in the track will produce zero. After reading a track, if XORing all of the characters does not produce zero, then there was a read error. The LCC is an even parity check bit across all the track characters. If either the parity test or the LCC test fails, then there is a problem with the data. We must either reread the track or correct the data.

The parity and LCC checks are redundant: either test will detect a single bit that went bad. We don't need both tests to detect a single bit error – one test would be enough. With the two tests, we can actually correct a single bit error. We may not want to do this because it lowers our reliability (we may mistakenly "correct" a detected error to the wrong value), but it will improve our ability to read some cards.

If only one character has bad parity, then we can reconstruct the character using the LCC. The bad parity tells us which character has the error, and the LCC tells us which data bits in that character are bad.

For example, assume bit 3 of the 10th character should be a zero, but is misread as a one. The 10th character (as read) now has an extra one bit, so the 10th character's parity is even. That tells us there is a problem with character 10. When we bitwise XOR all the characters in the track, we don't get zero.

The erroneous bit 3 of the 10th character causes bit 3 of the XOR to be nonzero. Putting the two pieces of information together, we know that bit 3 of character 10 is wrong; complementing that bit should fix the data.

Well, maybe not. Although the parity and LCC scheme can fix single bit errors, multiple errors may confuse it. If there were two errors in one character, then the LCC comes out wrong but all the parity calculations are right. We know there's an error, but we don't know which character. Even worse, there may be two errors in one character and one error in a second character.

The parity calculation indicts only the second character, and the correction algorithm mistakenly believes fixing only the second character will fix the track.

Consequently, it may be better not to correct errors and instead to ask the operator to swipe the card again or key the information in by hand. In technical terms, the Hamming distance of the parity and LCC code is 4. That means we can detect all single, double, and triple bit errors, but will miss some four bit errors.

If we use correction, then we can correct all single bit errors and detect double bit errors – but we will turn some triple bit errors into four bit errors. If we don't correct, then we are much more certain that the data we do read is correct.

## Interpreting the Data

After the track has been read without errors (or corrected), then we can decode the information in the track. There are several conventions for encoding the data in a track. Track 1 is a high-density track with up to 79 alphanumeric characters. The first character of the track tells us how to decode the remaining data. Track 2 is a low-density track with more rigid encoding.

### Track 1 Format

Track 1 encodes alphanumeric information. The first character following the start sentinel describes the remainder of the track. Usually the first character will be an 'A' (signifying that the following format depends on the card issuer) or a 'B' (signifying a standard layout for the initial data fields).

Of course, seeing format code 'A' doesn't help you unless you know what the card is. Seeing format code 'B' means you can figure out some things about the card.

In the next sections, we cover the character code used by Track 1 and format code 'B.'

### Track 1 Character Code

The code is six bits (64 possible characters). The code can be converted to ASCII by adding 0x20 (a space) to the six-bit code, but many of the possible characters are reserved or prohibited. Space, 'A'-'Z', '0'-'9', '#', '$', '(', ')', '-', '.', and '/' are legitimate characters. The start sentinel is 0x45 ('%'), the end sentinel is 0x1F ('?'), and the separator is 0x3E ('^') and have special purposes.

### Track 1 Format Code B

If the character following the start sentinel is a 'B,' then the remainder of the track has an account number, name, and expiration date. The 'B' format code is used by most credit and ATM cards, and is show in Table 2.

The data following the account number is sometimes dependent upon the account number. If the account number starts with "59," then a country code follows the account number separator. More information can be found in ANSI X4.16.

### Track 1 for the California Driver's License

The California driver's license has an unusual format (Table 3). In order to pack more data into the track, they forgo parity and record the data at six bits per character. The format code is a 'D' instead of a 'B.'

### Track 2 Format

Track 2 is the low-density, numbers-only track that can hold up to 40 characters. The track usually contains an account number, an expiration date, and some additional information.

### Track 2 Character Code

The Track 2 character code is four bits plus parity, so the track can hold only hexadecimal digits. The hex digits can be converted to ASCII by adding the code for '0.'

The characters 0-9 are used for data, and three characters are designated the start sentinel (B or ';'), the end sentinel (F or '?'), and the separator character (D or '='). The remaining three characters are for hardware control (A or ':' and E or '>') or are reserved (C or '<').

### Track 2 Format

Table 4 describes the Track 2 format. The data following the expiration date is determined by the card issuer.

```
// Credit Card Checksum Algorithm
// ANSI X4.13-1983
#include <assert.h>
#include <string.h>
#include <ctype.h>

#define digit_weight(x) (assert(isdigit(x)),
(x - '0'))

// Calculate the value of the check digit ...
int iCCCheckCalc(char *szAcct, int n)
{
 int s = 0;
 int i;

 assert(n > 0);

 for (i = n-2; i >= 0; i--)
  {
   // weights alternate 1,2,1,2,... and
// the check digit (i==n-1) has weight 1
   int a = ((n-1-i)&0x1) ? 2 : 1;
   int x = a * digit_weight(szAcct[i]);

   s = s + (x%10) + (x/10);
  }

 // calculate the additive inverse modulo
10
 return (10 - (s%10)) % 10;
}

// Return nonzero if checksum is OK
int fCCChecksum(char *szAcct)
{
 int n = strlen(szAcct);
 int c = digit_weight(szAcct[n-1]);
 int s = iCCCheckCalc(szAcct, n);

 return c == s;
}
```

### California Drivers License Track 2

Although Track 1 of the California driver's license uses the unusual six-bit character format, Track 2 is conventional. Driver's licenses have expiration dates just like credit cards, so Track 2 dutifully records that information.

The driver's license number is encoded as an account number. Amusingly, the state of California is apparently a retail establishment because its account number string starts with a 6 (see the section on account numbers below). The encoding appears to be

6 + 006460 + <class> + <driver's license number> + <check digit>

where a class C license is coded as 3. The variable information following the expiration date is the driver's birth date encoded as YYMMDD.

### Account Numbers

ANSI X4.13-1983 describes the format of account numbers.

#### Account Number Format

The table below tells how to decode an account number. If the digits of the account number are ABCDEFGH ..., then use the first digit (A) to decode the remaining digits.

#### Credit Card Checksum

Account numbers also have a checksum algorithm. Retailers and banks want to make sure they got the account number correct, so they include a check digit.

Not only does the checksum algorithm detect a bad digit, but it also detects the common error of swapping two neighboring digits (i.e., turning "37" into "73"). The routine fCCChecksum will test the checksum. **NV**


*HO! HO! HO!*
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# News Bytes

## 1999 Trinity College Fire-Fighting Home Robot Contest

### over $4,000.00 in prizes

The Trinity College Fire-Fighting Home Robot Contest will be held on the Trinity College campus in Hartford, CT on Sunday, April 18, 1999.

This is the largest, public, true Robotics competition held in the US that is open to entrants of any age, ability, or experience from anywhere in the world.

Last April, we had a great contest. People came from all over the US, Canada, and Europe to compete, participate, watch, learn, and enjoy. This April, the contest will be even better.

The goal of the 1999 contest is the same – to build a Robot that can find and extinguish a fire in a house. The challenge is to build a computerized (not radio-controlled) Robotic device that can move through a model of a single floor of a house, detect fire (a lit candle), and then extinguish it. Robots that accomplish this task in the shortest time win.

Other events scheduled on the contest weekend include Robotics seminars and exposition.

This weekend-long international event will culminate months of work and effort by Robotists of all ages. Last year's contest drew interest from people in all 50 states and 14 countries. Participants ranged from college professors and engineers to elementary school students and they came from as far as Switzerland and Argentina.

The 1999 rules are very much like last year's rules, but some slight changes have been made to make the contest more realistic, more fun, and more like the real world. There will be two divisions again this year. A Junior division for those in High School and younger and a Senior division for everyone else. There will be a cash prize of $1,000.00 awarded to the top winner in each division with additional prizes to other winners in those divisions.

Trinity College is also helping to set up regional contests around North America. Check the Home Page to see if there is a site near you.

Video tapes of the 1998 contest are available for $25.00 each (includes shipping). Copies of the updated 1999 rules are available for $3.00. Send cash, check, or money order payable to: **Trinity College, Jake Mendelssohn, 190 Mohegan Dr., West Hartford, CT 06117.** E-Mail: JMENDEL141@AOL.COM. Or download the information from the contest Home Page at http://www.trincoll.edu/~robot.

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HP 8903B-001,013,051 Audio Analyzer, ... $2,500.00
20 Hz-100 kHz; C-message, CCITT
TEK DA4084 Programmable Distortion Analyzer ... $1,000.00

### RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, ... $450.00
180 uV-700 V, 10 Hz-20 MHz
FLUKE 8922A True RMS Voltmeter, ... $450.00
180 uV-700 V, 2 Hz-11 MHz
HP 209A Sine/Square Wave Generator, ... $225.00
4 Hz-2 MHz, 5 VRMS max.

### OSCILLATORS

HP 3336C Synthesizer/ Level ... $1,400.00
Generator, 10 Hz-21 MHz
TEK SG5010 Programmable ... $2,750.00
Oscillator, 10 Hz-163.8 kHz
TEK SG502 Sine/Square Osc., ... $200.00
5 Hz-500 kHz, 70 dB step atten.,TM500

### MISCELLANEOUS

HP 3575A-003 Phase-Gain Meter, ... $850.00
1 Hz-13 MHz, dual display option
HP 4437A Step Attenuator, 0-119.9 dB, ... $175.00
DC-1 MHz, 600 ohms unbal.
HP 461A Amplifier, 20/40 dB, ... $125.00
1 kHz-150 MHz, 0.5 V/50 Ohms
KROHN-HITE 3103 High/Low Pass Filter, ... $400.00
10 Hz-3 MHz, 24 dB/octave
KROHN-HITE 3342R Dual HP/LP Filter, ... $1,100.00
0.001 Hz-99.9 kHz, 48 dB/octave
KROHN-HITE 3750 LP/HP/BP/BR Filter, ... $700.00
0.02 Hz-20 kHz, 6/12/18/24 dB/oct.
KROHN-HITE DCA-10R 10 Watt Amplifier, ... $450.00
20 dB gain, DC-1 MHz, 600-1000 Ohms
ROCKLAND 852 Dual Highpass/Lowpass ... $1,000.00
Filter, 0.1 Hz-111 kHz
TEK AF501 Tunable Bandpass Filter / ... $300.00
Amplifier, 3 Hz-35 kHz
TEK AM502 Differential Amplifier, ... $475.00
0.1 Hz-1 MHz, TM500 series

## RF & MICROWAVE

### SPECTRUM ANALYZERS

HP 11517A/19A/20A Mixer Set, ... $600.00
18.0-40.0 GHz, for HP 8555A/8569A
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz ... $1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz ... $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz ... $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz ... $1,400.00
HP 8444A-059 Tracking Generator, ... $1,250.00
0.5-1500 MHz, for 8554,8568,etc.
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A ... $650.00
HP 8565A-100 Spectrum Analyzer, ... $4,500.00
10 MHz-22 GHz, 100 Hz min. res.
HP 8566B Spectrum An., 100 Hz-22 GHz, ... $37,500.00
HP calibration certificate
HP 8569B Spectrum Analyzer, ... $7,500.00
10 MHz-22 GHz, 100 Hz min.res.bw.
TEK 7L14-039/7603 Spectrum Analyzer, ... $2,500.00
1 kHz-2.5 GHz, 30 Hz min. res. bw.
TEK TR503 Tracking Generator, ... $850.00
0.1-1800 MHz, for 492/4/5/6
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz ... $1,500.00

### NETWORK ANALYZERS

HP 85021C Directional Bridge, ... $1,000.00
0.01-18 GHz, 33 dB dir,for 8755/6/7
HP 8756A Scalar Network Analyzer ... $2,500.00

### SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., ... $2,750.00
0.1-1050 MHz, 10 Hz res., GPIB
FLUKE 6060A/AN Synthesized Signal ... $1,750.00
Gen.,10 kHz-520 MHz, 10 Hz res.,GPIB
FLUKE 6062A Synthesized Signal Gen., ... $5,000.00
0.1-2100 MHz, 10 Hz res., GPIB
GIGATRONICS 600/10-18 Synthesized ... $3,000.00
Source, 10-18 GHz, 1 kHz res., GPIB
GIGATRONICS 875/50 Levelled Multiplier, ... $2,500.00
x4, 50.0-75.0 GHz output, -3 dBm
GIGATRONICS 875/86 Levelled Multiplier, ... $3,750.00
26.5-40.0 & 50.0-75.0 GHz outputs
GIGATRONICS 900/2-8 Synthesized ... $3,000.00
Signal/Sweep Gen., 2-8 GHz, 1 kHz res.,GPIB
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio ... $750.00
HP 85100V Frequency Mult., ... $3,750.00
10-15 GHz in / 50-75 GHz out >0 dBm
HP 8640B-001,002 Signal Gen., ... $1,750.00
0.5-1024 MHz, AM, FM, var. audio osc.
HP 8656A Synthesized Signal Gen., ... $2,500.00
0.1-990 MHz, 100 Hz res., HPIB
HP 8657A-002 Signal Generator, ... $3,250.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8660C/86602B-002 Synth. Sig. Gen., ... $3,250.00
1-1300 MHz, FM / Phase mod. w/86635A
HP 8660C/86603A-002 Synthesizer, ... $4,500.00
1-2600 MHz, FM / Phase Mod., w/86635A
HP 8683B Signal Generator, ... $3,500.00
2.3-6.5 GHz, AM, WBFM, Pulse
HP 8684B Signal Generator, ... $3,500.00
5.4-12.5 GHz, AM, WBFM, Pulse

### SWEEP GENERATORS

HP 8350A/83545A-002 Sweep ... $4,000.00
Oscillator, 5.9-12.4 GHz, 70 dB step attenuator
HP 8350B/83592B-002 Sweep ... $14,500.00
Generator, 10 MHz-20 GHz, 70 dB step attenuator
HP 83545A RF Plug-in, ... $1,750.00
5.9-12.4 GHz, +17 dBm levelled
HP 8601A Generator/Sweeper, ... $400.00
0.1-110 MHz, +20 dBm levelled
HP 8620C Sweep Oscillator Frame ... $550.00
HP 86222B-002 RF Plug-in, ... $1,500.00
10-2400 MHz, +13 dBm levelled, 70 dB atten.
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled ... $500.00
HP 86235A-001,002 RF Plug-in, ... $600.00
1.7-4.3 GHz, +14 dBm levelled, 70 dB atten.
HP 86240C RF Plug-in, ... $700.00
3.6-8.6 GHz, +16 dBm levelled
HP 86241A-001 RF Plug-in, ... $300.00
3.2-6.5 GHz, +8 dBm levelled
HP 86242D-004,008 RF Plug-In, ... $300.00
5.9-9.0 GHz, +10 dBm levelled
HP 86250D RF Plug-in, ... $500.00
8.0-12.4 GHz, +10 dBm levelled
HP 86260A RF Plug-in, 12.0-18.0 GHz, ... $500.00
+10 dBm unlevelled
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, ... $500.00
+10 dBm unlevelled
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled ... $1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled ... $2,000.00
WAVETEK 962 Sweep Generator, ... $1,500.00
1.0-4.0 GHz, markers, +12 dBm unlvld.
WILTRON 6619A Sweep Generator, ... $1,500.00
2-8 GHz, +10 dBm levelled

### POWER METERS

ANRITSU MA72B Power Sensor, ... $300.00
-20 to +20 dBm, 0.01-18 GHz
ANRITSU MP-81B/ML-83A Power ... $2,500.00
Meter, 75-110 GHz (WR10), -20 to +20 dBm
BIRD 4410A/4410-1 Wattmeter, ... $350.00
with 200-535 kHz 10 W-10 kW element
BOONTON 4200-01A,03/&-4A x2 ... $1,500.00
Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors
BOONTON 42B/41-4B Analog Power ... $375.00
Meter, with 1 MHz-12 GHz sensor
BOONTON 42B/41-4E Analog Power ... $500.00
Meter, with 1 MHz-18 GHz sensor
GENERAL MICROWAVE 476/4240A ... $300.00
Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm
HP 435A/8481A Power Meter, ... $900.00
10 MHz-18 GHz, -30 to +20 dBm
HP 435A/8482H Power Meter, ... $950.00
0.1-4200 MHz, -10 to +34 dBm
HP 435B/8482B Power Meter, ... $1,800.00
0 to +43 dBm, 100 kHz-4.2 GHz
HP 8477A Power Meter Calibrator, for HP 432 series ... $500.00
HP K486A WR42 Thermistor Mount, ... $350.00
18.0-26.5 GHz, for 432 series
HP Q8486A Power Sensor, ... $1,500.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R486A WR28 Thermistor ... $350.00
Mount, 26.5-40 GHz, for 432 series

### RF MILLIVOLTMETERS

BOONTON 92B-opt.05 RF Millivoltmeter, ... $500.00
10 kHz-1.2 GHz, 75 Ohms scale
RACAL 9303 TRMS Level Meter, ... $875.00
10 kHz-2 GHz, -77 to +23 dBm, GPIB

### AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 1W1000 ... $650.00
Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output
BOONTON 82AD-opt.01A Modulation ... $900.00
Meter, AM, FM, 10-1200 MHz, GPIB
HP 11715A AM/FM Test Source ... $1,600.00
HP 415E SWR Meter ... $300.00
HP 465A Amplifier, 20/40 dB, ... $125.00
5 Hz-1 MHz, 1/2 Watt/50 Ohms
HP 8447A Amplifier, 20 dB, ... $375.00
0.1-400 MHz, 5 dB NF, +6 dBm output
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, ... $750.00
+13 dBm output
HP 8447F Preamplifier / Power Amplifier, 0.1-1300 MHz ... $1,200.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz ... $3,000.00
HP 8901B-1,2,3 Modulation An., ... $4,000.00
0.15-1300 MHz, rear input, OCXO, ext.LO
HP 8970A Noise Figure Meter ... $5,000.00
HUGHES 1177H02F000 TWT Amplifier, ... $1,500.00
4.0-8.0 GHz, 10 Watts output
MICROWAVE SEMI.CORP. MC5112 Noise Source, ... $275.00
25.5 dB ENR, 1-12.4 GHz, N(m), +28 VDC
ROHDE & SCHWARTZ ESH2 Test ... $5,000.00
Receiver, 9 kHz-30 MHz

## COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 ... $95.00
Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
FXR/MICROLAB S3-02N Triple ... $125.00
Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance ... $400.00
Trombone Line, 0-44 cm, DC-2 GHz
GR 900-Q GR900 14mm Interseries Adapters ... $125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... $450.00
HP 11612A Bias Network, 45 MHz-26.5 GHz, APC3.5 ... $550.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz ... $450.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz ... $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz ... $275.00
HP 778D-011 Dual Dir. Coupler, ... $450.00
20 dB, 100-2000 MHz, APC7 test port
HP 8470B Crystal Detector, ... $250.00
10 MHz-18 GHz, neg. pol., APC7
HP 8472A Crystal Detector, ... $150.00
10 MHz-18 GHz, neg. pol., SMA
HP 8494G-002 Programmable Step ... $350.00
Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8495G-002 Programmable Step ... $300.00
Attenuator, 0-70 dB, DC-4 GHz, SMA
HP 8495H-002 Programmable Step ... $400.00
Attenuator, 0-70 dB, DC-18 GHz, SMA
HP 8497K-004 Programmable Step ... $750.00
Attenuator, 0-90 dB, DC-26.5 GHz
HP K422A WR42 Flat ... $350.00
Broadband Detector, 18.0-26.5 GHz
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz ... $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $350.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
HP R375A WR28 Variable Attenuator, ... $375.00
0-20 dB, 26.5-40 GHz
HP R532A WR28 Frequency Meter, 26.5-40 GHz ... $500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz ... $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz ... $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz ... $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz ... $650.00
HP X870A WR90 Slide Screw Tuner ... $150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz ... $450.00
HUGHES 45712H-1000 WR22 ... $900.00
Frequency Meter, 33-50 GHz
HUGHES 45732H-1200 WR22 Level Set ... $250.00
Attenuator, 0-25 dB, 33-50 GHz
HUGHES 45772H-1100 WR22 Thermistor ... $400.00
Mount, -20 to +10 dBm, 33-50 GHz
HUGHES 45775H-1100 WR12 Thermistor ... $800.00
Mount, -20 to +10 dBm, 60-90 GHz
HUGHES 47316H-1111 WR10 Tuneable ... $600.00
Detector, 75-110 GHz, positive polarity
HUGHES 47323H-1211 WR19 Flat ... $650.00
Broadband Detector, negative, 40-60 GHz
HUGHES 47974H-1000 WR15 SPST ... $375.00
PIN Switch, 250 MHz speed, 60-62 GHz response
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC ... $100.00
KRYTAR 1818 Directional Coupler, ... $200.00
16 dB, 2-18 GHz, SMA(f)
M/A-COM 3-19-300/10 WR19 ... $450.00
Directional Coupler, 10 dB, 40-60 GHz
MIDWEST MICROWAVE 3537 DC ... $40.00
Block, 0.1-12.4 GHz, SMA(m/f) *NEW*
MINI-CIRCUITS ZFDC-20-4 Directional ... $25.00
Coupler, 19.5 dB, 1-1000 MHz, SMA(f)
MINI-CIRCUITS ZHL-42 Amplifier, 30 dB gain, ... $400.00
0.7-4.2 GHz, +28 dBm, 15V, SMA
NARDA 25171 Level Set Attenuator, ... $100.00
0-17 dB, 2-8 GHz, SMA(f)
NARDA 26298 20 dB Attenuator, ... $200.00
150 Watts, DC-1 GHz, N(f/f)
NARDA 3000-SERIES Directional Couplers ... $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz ... $300.00
NARDA 3090-SERIES Precision High Directivity Couplers ... $225.00
NARDA 368NM Coaxial High Power Load, ... $400.00
500 Watts, 2.0-12.4 GHz, N(m)
NARDA 369BNF High Power Termination, ... $325.00
175 Watts, 0.7-18 GHz, N(f)
NARDA 3753B Coaxial Phase Shifter, ... $1,250.00
0-55 deg./GHz, 3.5-12.4 GHz
NARDA 4000-SERIES SMA Miniature ... $75.00
Directional Couplers
NARDA 4245-10 Directional Coupler, ... $100.00
10 dB, 4-12 GHz, SMA(f)
NARDA 4799 Level Set Attenuator, ... $135.00
0-15 dB, 4-18 GHz, SMA(f)
NARDA 5070-SERIES Precision ... $300.00
Reflectometer Couplers
NARDA 765-10 10 dB Attenuator, ... $135.00
50 Watts, DC-5 GHz, N(m/f)
NARDA 766-10 10 dB Attenuator, ... $100.00
20 Watts, DC-4 GHz, N(m/f)
NARDA 792FF Variable Attenuator, ... $375.00
0-20 dB, 2.0-12.4 GHz
NARDA 794FM Direct Reading ... $375.00
Variable Attenuator, 0-40 dB, 4-8 GHz
OMNI-SPECTRA 2085-6010-00 ... $50.00
Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)
PAMTECH KYG1014 WR42 Junction ... $250.00
Circulator, 18.0-26.5 GHz
SONOMA ENG. S-4901 WR15 ... $125.00
Junction Isolator, 57-59 GHz, 30 dB isolation
SONOMA ENG. S-4906 WR15 ... $125.00
Junction Isolator, 60-62 GHz, 30 dB isolation
SONOMA ENG. S-4907 WR15 Junction Isolator, ... $125.00
62-64 GHz, 30 dB isolation
SONOMA SCIENTIFIC 21A3 WR42 ... $75.00
Circulator, 20 dB, 20.6-24.8 GHz
SPACEK LABS DQ-1 WR22 Flat ... $400.00
Broadband Detector, 33-50 GHz
SPACEK LABS K-2X Frequency Doubler, ... $350.00
9.0-13.25 GHz in/ 18.0-26.5 GHz out
SPACEK LABS KA-3X Frequency Tripler, ... $350.00
8.83-13.33 GHz in/ 26.5-40.0 GHz out
TRG B528 WR22 Direct Reading ... $1,250.00
Phase Shifter, 0-360 deg.,33-50 GHz
TRG V551 WR15 Frequency Meter, 50-75 GHz ... $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz ... $750.00
WAVELINE 100080 WR28 ... $200.00
Terminated Crossguide Coupler, 30 dB
WEINSCHEL 1515 Power Divider, ... $125.00
2-Way, DC-18 GHz, SMA(m/f/f)
WEINSCHEL DS109 Double Stub ... $150.00
Tuner, 1-13 GHz, N(m/f)
WEINSCHEL DS109LL Double Stub ... $150.00
Tuner, 0.2-2.0 GHz, N(m/f)

## COMMUNICATIONS

HP 59401A HPIB Bus Analyzer ... $700.00
TEK 1410R NTSC Gen., w/SPG2 ... $800.00
sync. generator, TSG7 color bars
TEK 1411R PAL Gen.,w/SPG12 sync; ... $750.00
TSG11 color bars;TSG13 linearity
TEK 1411R PAL Test Gen., ... $1,000.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., w/
SPG12,TSG11,TSG12,TSG13,TSG15,TSG16 ... $1,100.00
TEK 1411R-opt.04 PAL Test Gen.,w/
SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ... $1,400.00
TEK 1420 NTSC Vectorscope ... $600.00
TEK 147A NTSC Test Signal ... $800.00
Generator, with noise test signal
TEK 148 PAL Insertion Test Signal Generator ... $700.00
TEK 520A NTSC Vectorscope ... $750.00
TEK 521A PAL Vectorscope ... $750.00
P.A.R. 5206-95,98 Two-Phase ... $1,500.00
Lock-in Amp., 2 Hz-100 kHz, GPIB
P.A.R. 5209 Lock-in Amp., ... $2,500.00
0.5 Hz-120 kHz, 130 dB dynamic reserve
TEK TM5006 5000-series 6-slot ... $600.00
Programmable Power Module
TEK TM504 500-series 4-slot Power Module ... $175.00
TEK TM506 500-series 6-slot Power Module ... $250.00
TEK TM515 500-series 5-slot Traveller Power Module ... $275.00

Write in 135 on Reader Service Card.

# ELECTRONICS Q & A

With TJ Byers

*In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can 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:

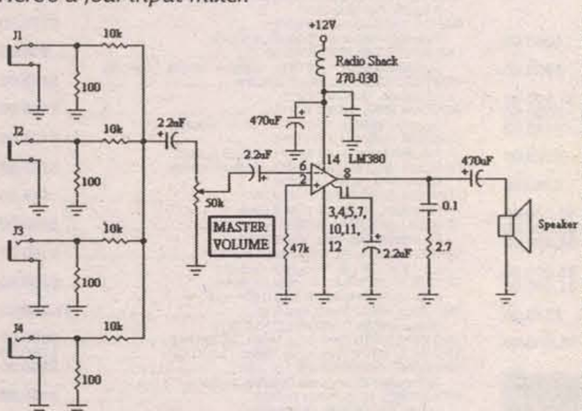
One man's trash is another man's treasure: two types of metal detectors. Transistor basics for want-to-be engineers. Maxim's new family of tunable low-pass filters and an audio mixer. Two Q & A answer updates (space-age stepper motor controller and well-depth gauge), and hard disk hardware fixes.

### Mix And Match Audio

**Q.** I have a simple problem for which I hope you can give me a simple solution. Between scanners, ham radios, and broadcast band, I have more than a couple receivers in my truck. Is there a simple circuit that would combine the audio outputs together via the external speaker (earphone) jack on each rig and run them through one quality speaker? I don't want the output of one rig to feed back into another and cause damage.

**John Chaput**
**via Internet**

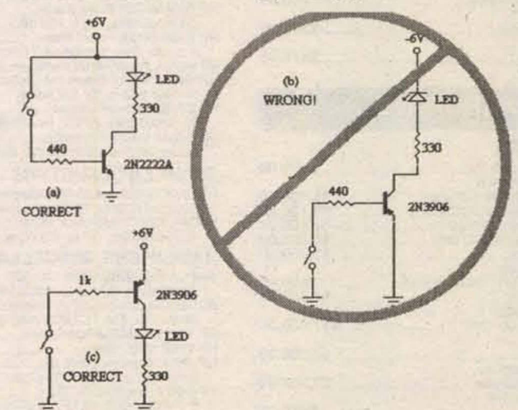
**A.** *Yes, there's a simple solution called an audio mixer. This circuit is used extensively in the recording industry to combine different sound sources – basically, the way the two channels of a stereo recording are created by combining sounds from 16 or more separate sources. Here's a four-input mixer.*




*The outputs of your receivers plug into jacks J1 through J4 – the order isn't important, and you don't have to fill all four (two or three work the same). The 100-ohm resistor simulates the load of an earphone, and the 10K resistor prevents the output from feeding back into the other inputs (receivers). The combined inputs now go to an LM380 power amplifier, which gives you enough sound to be heard over the noise of your truck. Make sure to use the Radio Shack hash filter shown, otherwise you'll get more engine noise than you will radio. To use the mixer, turn the Master Volume up full, plug the receiver into the desired jack, and adjust its volume control for the desired loudness. Turn off that receiver and proceed to the next, then the next, etc. After that, use the Master Volume to adjust the sound level. While only four inputs are shown, you can add as many as you wish – well, up to a point. After about a dozen, you may want to consider an intermediate amplifier (an op amp between the 10K resistors and Master Volume control) to make up for the losses. If you want to have some fun, turn on two receivers at the same time and use their respective volume controls to fade from one source to the other, just like the sound engineers do.*

### Transistor Basics

**Q.** I know this may be very basic for most of your readers, but I'm trying to do some simple tests with transistors before assembling a more complex design and I cannot get the PNP transistors (2N3906) to work. Here are the two test circuits – (a) and (b).




Closing the switch in circuit (a) turns on the LED; when I do the same in circuit (b) it doesn't work. What am I doing wrong?

**Gregory M. Kiyoi**
**via Internet**

**A.** *Well you've done a lot of things right. For example, you reversed both the LED diode and the polarity of the power supply. That's smart. Your mistake is that you don't have a current path through the base of the transistor. Basically, a transistor is two back-to-back diodes with the base as common. For a transistor to work, you need to have current flowing from the base to the emitter. This current causes current to flow from the collector to the emitter; the amount of current flow is determined by the gain (hfe) of the transistor. If the transistor has an hfe of 100, 1 mA through the base-emitter will produce a flow of 100 mA through the collector-emitter. In circuit (b), there is no current path through the base-emitter. Since you're mixing NPN and PNP transistors in a more complex circuit, the correct way to handle the situation* *is to invert the 2N3906 transistor (c) so that you can run off a single-polarity power source. In this configuration, current will flow from the emitter (+6V) through the base via the 1K resistor when the switch is closed. This causes the LED to glow. Good luck with your project!*

### Hard Disk Fixes

**Q.** My 2GB (nearly full) hard disk went from being fully operational to being "not detected" by the computer's BIOS. A spare hard disk works just fine in the computer. Because the BIOS doesn't recognize the drive, I'm thinking that the failure is with the drive's electronics and not a mechanical crash. Some questions: Is my assumption likely to be correct? Are there any fuses on a typical drive? Can the drive be repaired or the data retrieved? If so, can you provide a repair/restoration vendor's contact or name two?

**Derek Neely**
**via Internet**

***A.*** *Been there many times, most recently a couple of weeks ago. Yes, you have a hard disk problem. There are many reasons why a hard disk fails. Let me list them in the order of failure rate.*

***1)*** *The disk gets "stickism" where the bearing freezes or the read/write head "glues" itself to the platter, preventing the disk from rotating. If you don't hear the drive rev up when power is applied, it may be stuck. To fix it, hold the drive horizontally in your hand and give it a quick twist. This often frees the stick and gets the disk up and running, but not for long. Remove the data immediately. Some data may be lost, but probably nothing important.*

***2)*** *Heat and vibration inside the PC cabinet has caused the solder joints on the controller board, mounted directly under the drive itself, to loosen and lose electrical contact. This most frequently happens with the milk-white power connector. VERY carefully apply soldering iron heat to these four pads on the controller board. Also push down – don't remove – any socketed ICs on the controller board to reseat them.*

***3)*** *The controller board has died. Unfortunately, there are no fuses to replace. However, this problem is fixable if you can find a used drive of the same make, model, and relatively-close serial number. Simply remove the board from the used drive and drop it into your drive. The controller board is coupled to the drive via a couple of flexible printed circuit cables. These are fragile, as are the connectors that attaches them, so be careful. I've repaired several drives this way.*

***4)*** *The drive is dead and you've exhausted all the hardware options. If the drive contains valuable data it's probably worth having a professional retrieve them for you. Expect to pay about $500.00. You'll find a list of data recovery services at http://www.btinternet.com/~gfd/links.htm. Although I've never used a data recovery service, the following two companies sound like they know what they're doing: ECO Data Recovery (**1-800-339-3412**; http://www.eco-datarecov.com/index.html) and Data Recovery Labs (**416-510-6990**; http://www.datarec.com/index5.html).*

### Well-Depth Gauge Revisited

**Q.** In a previous column (Aug. '98), you published a schematic of a well-depth alarm using thermistors. I thought of using this circuit for a cistern, but how would you get the thermistors down the well and be watertight too? Phone wire?

**Stephanie Drake**
**via Internet**

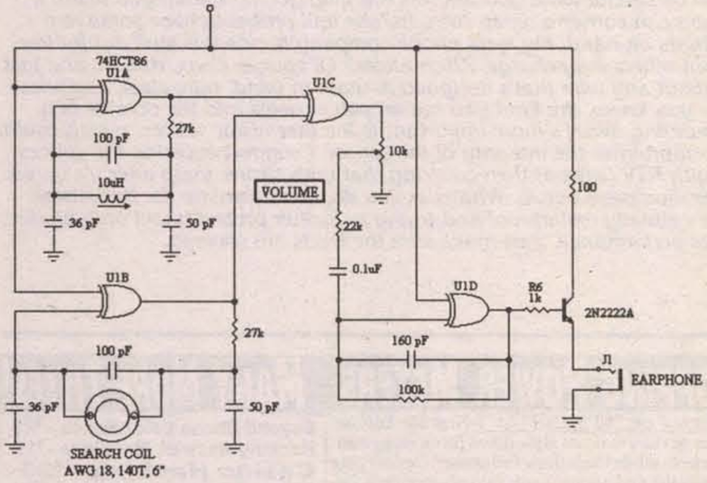
***A.*** *Yes, I'd use phone wire – but not the kind you buy from Radio Shack. Instead, contact your local phone company and ask for a hank of direct burial cable. It has about six twisted pairs and is encased in silicon-filled rubber. However, the last time I asked for a "slice" of this cable (I needed about 36 feet) they gave me a full spool, so be careful what you ask for. You may get more than you want! If you can corner a repair tech, he/she will probably have some remnants on hand. My local phone company hands this stuff out for free, but others may charge. Alternatives? Of course. Coax, ribbon, and just about any wire that's designed to work in wind, rain, sleet, and snow – you know, the kind you see on power poles and the outside of a building. What's more important is the thermistor splices, which could compromise the integrity of the sensor. I suggest covering the splices with RTV (silicon) then covering that with shrink warp after it's cured, as illustrated below. Whatever you do, don't insulate the thermistor. It's already waterproof and trying to further protect it will only hinder its performance. Just make sure the leads are covered.*

## Let The Treasure Hunt Begin

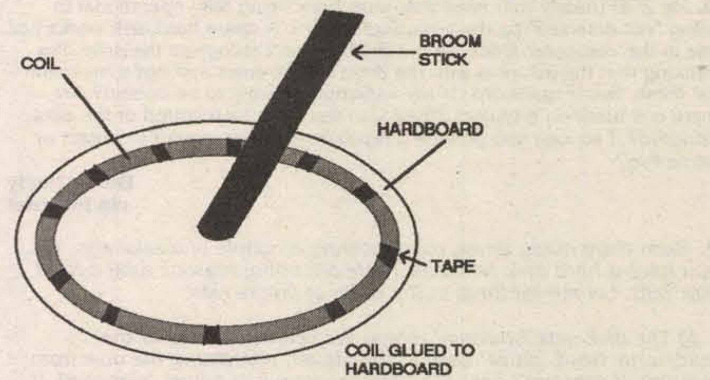
**Q.** I'm trying to find plans for a transmit/receive type metal locator. I understand the concept and the principles of the system, but that's a long way from actually building one. I was referred to a book by Charles Rakes on building metal locators but haven't been to find it.

**Karl Klein**
**via Internet**

***A.*** *Like all technologies, today's metal detector doesn't look anything like the ones Mr. Rakes describes in his 1986 book (which is long out of print). Back in those days, the BFO (beat frequency oscillator) detector was all the rage. Today, it's pulse induction and VLF (very low frequency), with magnetometers playing a small part. Here's how they compare. Pulse induction is the least sensitive and the least expensive. It can't discriminate between gold or tin – but it's great at finding beer cans and watches. Magnetometers, often called flux gates or gradiometers, are mainly sensitive to iron objects. The unique thing about VLF metal detectors is that they can tell the difference between a gold coin and a bottle cap – well, most of the time. Unfortunately, it's not an easy trick because it requires a microprocessor. Radio Shack sells an entry-level VLF metal detector (63-3005) for just $49.99, but the serious units run about $400.00. While I don't have the space to show you how to build a VLF metal detector, you can have fun with this medium low-frequency BFO metal detector.*




*This metal detector uses four exclusive-OR gates, two of which (U1A and U1B) are wired as twin oscillators. The search coil is the inductance element of one oscillator (U1B). One oscillator is tuned to 161 KHz and the other is tuned to 160 KHz. U1C serves as a mixer, which outputs difference and sum frequencies of 1 KHz and 321 KHz, the latter of which is filtered out by the 10 kHz filter at U1D. When the loop coil is brought near metal, the metal changes the inductance of the inductor which changes the oscillator's frequency and the pitch of the audio. While not as sensitive as a VLF, the sensitivity is enough to detect a coin buried under a foot of sand. The coil is 140 turns of scramble-wound 18-gauge enamelled wire on a six-inch, round form that you make by pounding eight 6-penny nails into a board (a kitchen pot works, too). The coil is then taped and glued to a piece of hardboard or plywood. An old broom stick serves as a handle.*




*To use the detector, tune the variable inductor until you hear a tone in the headphones – then have fun!*

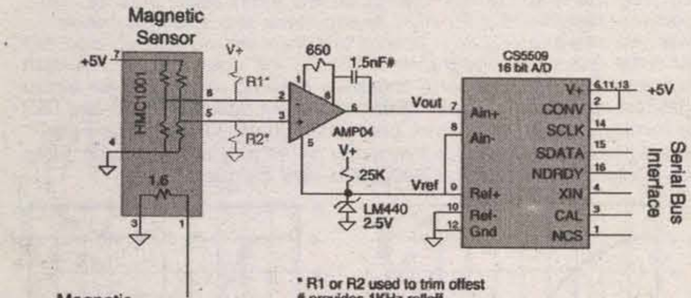
## Gradiometer Sees Through Rock

**Q.** As a treasure hunter for many years, I've used a wide variety of metal detectors, including a long boom proton differential magnetometer, dual-loop deep range metal detectors by White, and the more common coin detectors by Fisher and others. Now that I'm fully retired, I need to hold down the cost of owning such gadgetry, plus I'd enjoy building or modifying my own. The objects I search for are made of old iron, weighing between 20 and 200 pounds, and are buried at depths ranging between 5 to 20 feet in mud or rock-filled pits. Given these parameters, relatively minor anomalies in the earth's magnetic field is probably the only way to find them. Do you know anything about the sensitivity of the FGM-3 flux gate sensors or have any other circuit recommendations for sensitive differential detectors that balance out the earth's field?

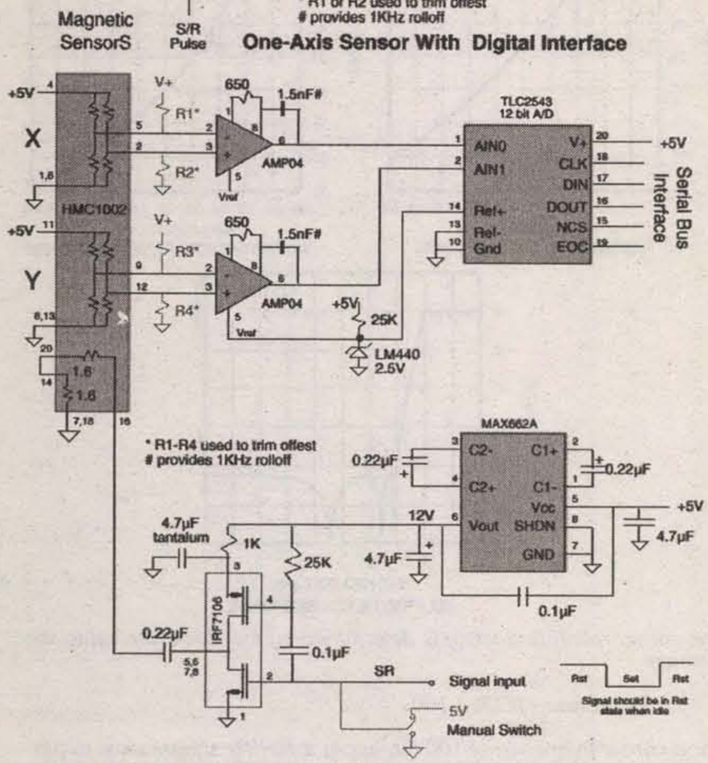
**WO Enderle W7IZR**
**via Internet**

***A.*** *Honeywell (**612-954-2093**; http://www.ssec.honeywell.com/products/magsensor_index.html#a) claims to have the most sensitive magnetic field detectors for low-cost commercial applications, and are well-suited for your need. Honeywell's magnetic sensing elements are Anisotropic magnetoresistors (AMR) made of nickel-ferrite (NiFe) thin films deposited on silicon to form a balanced Wheatstone bridge, where the resistance of the four resistors is the same. This material has the unique property of changing resistance when a magnetic field is applied perpendicular to the current flow in the AMR material. In the Wheatstone configuration, the magnetic field causes one pair of resistors to decrease in value and the opposing pair to increase in resistance. The result is a differential output voltage with a sensitivity of just 27 microgauss (uG). The output is linear over a range of -2G to +2G. (By comparison, the earth's magnetic field is 300 milligauss (mG)). Because of the fine resolution and wide range, these sensors are used in compasses, traffic detection, navigation systems – and gradiometers. Here are two simple designs using the HMC1001 one-*

*axis detector and HMC1002 two-axis detector.*




**One-Axis Sensor With Digital Interface**



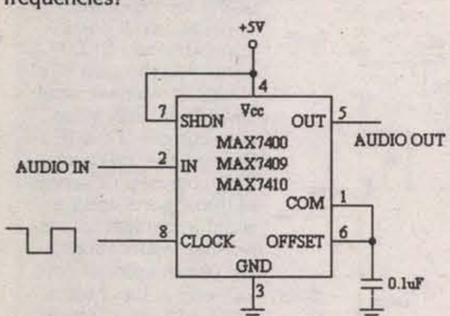

**Two-Axis Sensor With Set/Reset Circuit and Digital Interface**

*You can buy the HMC1001 and HMC1002 from Newark Electronics (1-800-639-2759; http://www.newark.com) for $18.00 and $31.00, respectively. For a complete schematic of a gradiometer, download document AN204 from the Honeywell Web site.*

## Tunable Low-Pass Filters

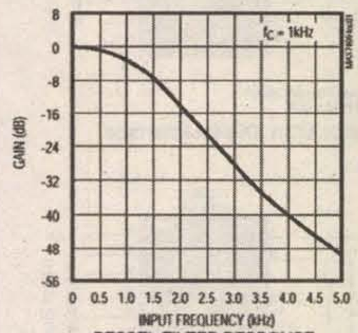
**Q.** I've made a home-grown infrared gas analyzer using two DACs (digital-to-analog converter) on an instrumentation card. The DAC signals are carried through a 20-foot cable with other signals and DC power to a terminal strip for connection. What I need is a filter to smooth out the stairsteps of the outputs. The required response is DC to 10 Hz, and the sampling rate is 50 Hz. Currently, I'm using a simple two-pole Sallen-Key Bessel filter with unity gain — and less than stunning performance. Would you suggest cascading two of these filters and if so how should I distribute the cut-off frequencies?

**Steve Roberts**
**via Internet**

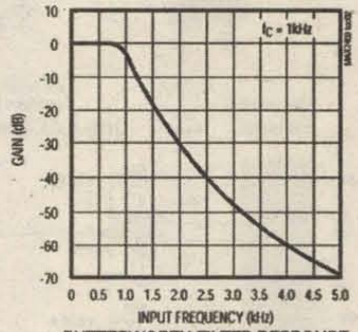



***A.*** *This is a very timely question because Maxim Integrated Products (**408-737-7600**; http://www.maxim-ic.com) just announced a family of switched-capacitor filter ICs specifically designed for ADC anti-aliasing and DAC postfiltering. The MAX7409 is a fifth-order, low-pass, Bessel, switched-capacitor filter; the MAX7410 is a fifth-order, low-pass, Butterworth, switched-capacitor filter; and the MAX7400 is an eighth-order, low-pass, Elliptic, switched-capacitor filter.*

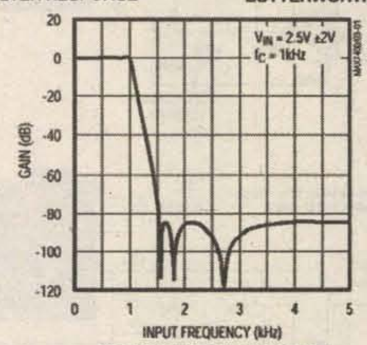
*Low-pass Bessel filters delay all frequency components equally, preserving the shape of step inputs. Bessel filters settle quickly — an important characteristic for ADC applications that use multiplexed inputs. An anti-aliasing filter placed between the multiplexer and ADC must settle quickly as the inputs are switched. Low-pass Butterworth filters provide a flat passband response, making them ideal for instrumentation applications that require minimum deviation from the DC gain throughout the passband. Low-pass Elliptic filters provide the steepest possible rolloff with frequency of the four most popular filter types (Bessel, Butterworth, Chebyshev, and Elliptic).*




BESSEL FILTER RESPONSE




BUTTERWORTH FILTER RESPONSE




ELLIPTIC FILTER RESPONSE

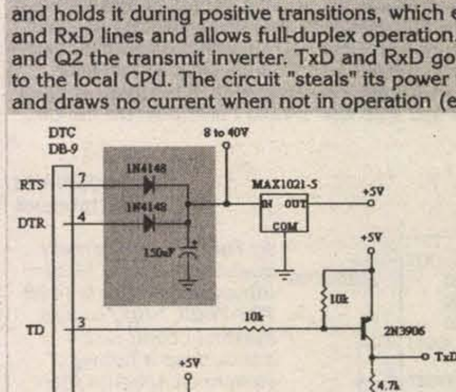
*The corner rolloff frequency is determined by the clock rate using the formula*

*clock rate = fCLK / 100*

*For a corner frequency of 100 Hz, apply a 10-KHz squarewave to pin 8. When using the filter for anti-aliasing or DAC postfiltering, you have to synchronize the DAC and filter clocks. If the clocks aren't synchro-*

### Reader's Tip

Several simple RS-232 interfaces built around bipolar transistors have appeared in N&V articles, but most have shortcomings. The following circuit is small, simple, inexpensive, compatible with the RS-232 standard, and works in full-duplex operation, something most simplified interfaces can't do. The circuit is based on the one used for the BASIC Stamp II microprocessor. The modification is the addition of diode D1 and capacitor C1 to the Parallax circuit. When RxD is active, C1 charges to -12 volts and holds it during positive transitions, which effectively isolates the TxD and RxD lines and allows full-duplex operation. Q1 is the receive inverter, and Q2 the transmit inverter. TxD and RxD go to the host TD and RD go to the local CPU. The circuit "steals" its power from the host serial port, and draws no current when not in operation (except for transistor leakage currents), making it useful for low-power applications. It costs approximately $1.00, about 1/3 the cost of a MAX232 interface, and saves the 5 mA quiescent current of the IC. Further, the TxD and RxD channels of several of these ports can be wired in parallel for networking applications. We use this circuit consistently at baud rates up to 115,200 through 12-foot cables.




**Dan Michaels**
**Oricom Technologies**
**oricom@sni.net**

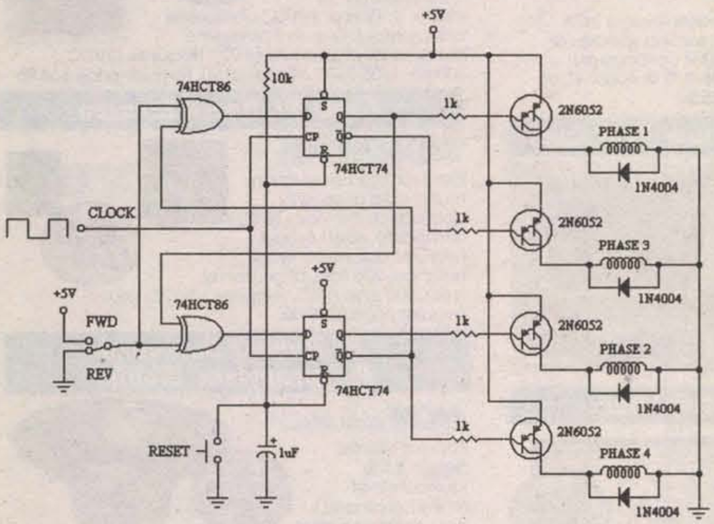
*nized, beat frequencies will alias into the passband. I can't find the ICs at any of the local watering holes yet, but you can order the part directly from Maxim at 408-737-7600, extension 3468. However, I'm sure their regular distributors, like Digi-Key (**1-800-344-4539**; http://www.digikey.com), will have them in stock anytime soon. They cost about $3.00.*

### Space-age Stepper Motor Controller Update

**Q.** In the Feb. '98 issue, you published a schematic of a "Space-Age Stepper Motor Controller." In a later issue, you published a correction reversing the TIP120 transistors. I have tried this circuit and cannot get it to work. Can you explain the logic for this circuit? I'm having trouble understanding how bipolar current flow can be achieved with fewer than eight transistors.

**J. D. Mather**
**Johnson City, TN**

***A.*** *Actually, there were two mistakes in that schematic, which I copied from a supposed "NASA" source in my sleep and didn't check for errors. Here's the same circuit from EDN's "Ideas For Design" submitted by a JPL engineer that I know works – I tried it!*




*How does it work? Sit tight and buckle up because this will be fast. Different magnetic polarity sequences are needed to drive a stepper motor. For forward motion, Phase 1 leads Phase 2 by 90 degrees; for reverse motion, Phase 2 leads Phase 1 by 90 degrees – just the opposite. Using XOR gates and flip-flops, it's easy enough to make this happen because flipping the switch flips the phase shift from lead to lag – just what's needed. As always, the speed of the motor is proportional to the clock pulse; the higher the clock speed, the faster the motor spins.*

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# The Ins and Outs of Optimizing Compilers

by Jeff Stefan

## *Want to write better code? Consider understanding compiler optimizations.*

If you're not writing computer programs in hand-coded assembly, chances are you're using a compiler. If you're using a compiler, chances are the compiler is performing optimizations on your code, possibly unbeknownst to you. Compilers are where text touches silicon; your abstract source code becomes a concrete program that runs on an actual machine. Being aware of compiler optimization techniques can save you a measured amount of frustration, especially when debugging your code.

### Fundamental Compiler Technology

Compilers are usually broken up into two parts: a front end and back end. The front end takes care of scanning and parsing the source code, and the back end takes care of generating and optimizing code. Figure 1 illustrates the basic components of a compiler.

As the source code enters the compiler, the front end reads the characters in the input stream and separates them into tokens, as shown in Figure 2. This is the part of the compilation process that's called lexical analysis. Tokens are symbols that cannot be reduced any further. Tokens are not restricted to single characters. For example, if you have a variable named MyVar in your source program, MyVar cannot be reduced any further, therefore, MyVar is a token. In some compiler literature, tokens are occasionally called atoms.

As the tokens are scanned, their type is determined and the token and its type are placed in a data construct called a symbol table. The symbol table is a convenient storage device that allows other components to access expressions, variables, and types. Symbol tables are usually implemented as linked lists.

The next component in the compiler's front end is the parser. The parser does essentially two things. First, it determines whether the input represents a legal construct of the language. Second, it puts the input expression into an intermediate form that makes it easier for the code generator to process. The parser tries to mach the sequence of tokens to a set of rules called productions. The set of productions that make up the rules for a language is called a grammar.

If you look in Appendix A, Section A13 of Kerninghan and Richie's book *The C Programming Language*, the grammar for C is listed. Productions or grammar rules are usually expressed in Backus-Normal Form, or BNF. BNF was invented and used to express the grammar for the first implementation of FORTRAN. BNF is an adaptation of the way linguists express natural language. John Backus is credited for creating FORTRAN and for first developing BNF, so BNF is named after him. BNF is a convenient way to express a programming language's grammar and has stood the test of time. An example of a grammar for simple arithmetic expressions is shown in Figure 3.

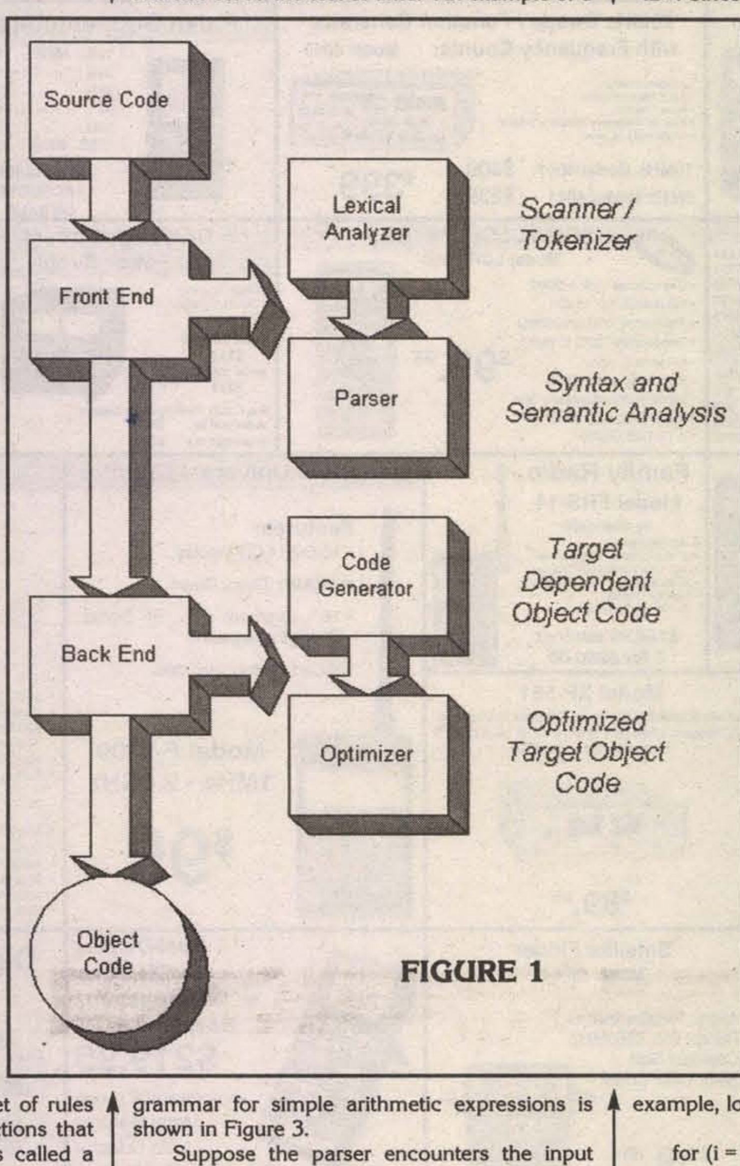



FIGURE 1

Suppose the parser encounters the input expression i = j + k * z. In order to determine if this is indeed a legal expression, the parser needs to match it to the grammar rules given in Figure 3. Is i = j + k * z a legal expression? First, the parser must determine whether j + k * z can be derived from the grammar rules. If it can, then code can be generated for this expression, and the resulting computation can be stored in the variable i.

Here's the derivation:

First, we can consider j + k * z to be an expression <Expr>. From the grammar rules, <Expr> can be rewritten as <Expr> ::= <Expr> * <ID>. Since <ID> can be rewritten as a letter or a digit, this derivation resolves to <Expr> * z. Next we need to figureure j + k into the derivation. We do this by rewriting <Expr>* z with <Expr> + <ID> * z. We can substitute the token k for <ID>, resulting in <Expr> + k * z. Lastly, we can rewrite <Expr> as <ID>, yielding <ID> + k * z. We can substitute the token j for <ID> , resulting in j + k * z. Since we were able to match the expression to the grammar rules, the input expression is indeed legal and can be correctly compiled. Figure 4 shows the complete derivation sequence.

### Code Generation

After parsing is complete, the grammar rules are matched, and the symbol tables filled, code generation can begin. Code generation may take the form of assembly language, or the compiler may skip assembly code generation and directly produce code for the target machine. This is called native code generation. Most C compilers for embedded systems produce assembly code, which is then optimized before any object code is produced.

### Low-Tech Optimization

There's a lot you can do before your source code is ever compiled. Careful programming can make the compiler's job easier. By using a few hand-optimization techniques, your code will run tighter and faster when it's compiled. Hand optimization is a low-tech approach, but it pays off. For example, look at the following C code fragment:

```
for (i = 0; i < 10; i++)
{
  x = 10;
  y = i + x;
}
```

Simply removing the assignment x = 10 radically increases the efficiency of this code fragment. This type of source level optimization is fairly obvious, and even beginning programmers recognize this. More subtle methods include using pointers instead of using array indices as the following example illustrates:

```
/*
* Non-pointer method of access buffer elements
using an index variable
*/
 printf("\nBuffer access using index variable\n");
for(I = 0; i < 10; i++)
 printf("%c",Buffer[i]);
```

Performance of this code is increased by using a pointer:

```
/*
* Set pointer to start of Buffer and print values
*/
printf("\nBuffer access using pointer\n");
ptr = Buffer;
while(*ptr)
 printf("%c",*ptr++);
printf("\n");
```

These are simple optimizations that a careful programmer can accomplish on his or her own.

## Profiling

Another useful procedure is to profile a program without any compiler optimizations turned on. Profilers are important, but sometimes little used tools. Profilers — or performance analyzers — find run-time bottlenecks in your program while it executes. You compile and link your program, then execute it under the profiler's control. When the program terminates, the profiler generates program performance statistics.

You can discover where your program spends most of its time, how many times certain routines were called, how much CPU time was consumed, and how many interrupts occurred, among other things. Profilers are extremely powerful tools that are sometimes bundled for free with some compilers.

## Common Optimization Techniques

A compiler doesn't necessarily produce object code or an executable program exactly the way your program intended it to. All a compiler is expected to do is to reproduce the way the program was intended to behave.

From a compiler's perspective, as long as the program produced works the same way as your program text intended, what happens algorithmically within the program doesn't matter. This is surprising, but true. Knowing that the optimized program a compiler produces may not be exactly what you programmed is a good thing to bear in mind when you're debugging your code.

Some of the compiler optimization methods have strange sounding names that, on the surface, don't seem to make a lot of sense, such as loop induction, peephole optimization, or constant folding. It's worth the time to understand optimization terminology so you can make informed decisions about what optimizations to allow when compiling your code.

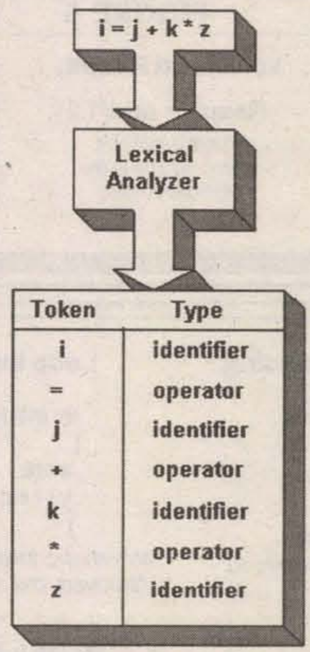



FIGURE 2

```
<Expr>  ::=  <ID>  |
             <Expr>  +  <ID>  |
             <Expr>  *  <ID>
<ID>    ::=  <letter>  |  <ID> <letter>  |
             <ID> <digit>
<letter> ::=  A|B|C|...|a|b|c|...z
<digit>  ::=  0|1|...9
```

FIGURE 3

FIGURE 4

```
Rule Matching for  j + k * z
<Expr> ::= <Expr> * <ID>
<Expr> ::= <Expr> * z
<Expr> ::= <Expr> + <ID> * z
<Expr> ::= <Expr> + k * z
<Expr> ::= <ID> + k * z
<Expr> ::= <ID> + k * z
<Expr> ::= j + k * z
```

## Register Allocation

Register allocation is probably the simplest and most ubiquitous of all optimizations. When a variable is accessed, the compiler first looks if it can use a CPU register to store the variable instead of storing it in external memory. This is a speed-oriented optimization, since no memory address bus cycles are used. Register allocation must be done in the back end of the compiler during code generation, since the front end of the compiler does not know how many registers the target machine contains.

## Dead Code Elimination

If a value is computed but never used, it's dead code. An optimizing compiler will recognize this and eliminate it in the code generation phase. This can be distracting if code stubs are placed in a program to be filled in later. For example, if you have the following lines in your program:

```
int Result;
Result = add(1,2);
```

and your program never used the variable Result again, the code may be completely optimized out of your program. If this was a program stub that you were going to build upon later, you'd be in trouble. A way to place stubs into the code without having them optimized out and without turning off compiler optimizations is to add the following assignment immediately after the call to add(1,2):

```
Result = Result;
```

This uses the variable Result without really doing anything. This simple trick costs nothing and allows the stub to avoid the optimizer's axe. You could also declare Result as volatile. Declaring a variable as volatile forces the compiler to use the variable under all circumstances, since the keyword volatile suppresses any compiler optimizations. Be careful using the keyword volatile, since all of the variables of this type will never be optimized. See Figure 5 for a simple side-by-side comparison of this code.

## Loops

Loops are obvious candidates for optimization. Most programs spend most of their CPU cycles within loops. Here are some common loop optimizations.

## Loop Unwinding

Loop unwinding is a classic example of the code-size, code-speed tradeoff. When loop unwinding occurs, the loop is decomposed into linear code. The linear code is copied the number of times the code iterates. This produces more code, but it runs faster. An example of loop unwinding is shown in Figure 6.

## Loop-Invariant Code

If code exists in a loop that doesn't change, then there is no reason for the code to be executed over and over again within the loop. It wastes CPU and bus cycles, which wastes time. Optimizing compilers that are sensitive to loop-invariance recognize this type of code and extract it from the loop. The loop-invariant code is placed above the loop, yielding more efficient code. We saw this example before, in the Low-

Tech Optimization section. An example of loop-invariant code elimination is show in Figure 6.

**FIGURE 5**

| int Result; | volatile int Result; | int Result; |
|---|---|---|
| Result = add(1,2); | Result = add(1,2); | Result = add(1,2); |
| | | Result = Result; |
| *This code is optimized out by the compiler* | *Result is NEVER optimized due to the keyword volatile* | *This code is not optimized out due to the simple benign assignment Result = Result;* |

### Loop induction

Pointers are more efficient than indexes, and addition is more efficient than multiplication. With loop induction optimization, the compiler attempts to replace array index multiplications with pointer additions, again yielding more efficient code. We saw a simple form of this in the Low-Tech Optimization section where we substituted pointers for array indexes in the for loop code example.

**Loop Unwinding**

```
for (i=0;i<3;i++)
{
  x = x+i;
}
```

*When this code unwinds, it resolves to:*

```
x = x+0;
x = x + 1;
x = x + 2;
```

**Loop Invariant Code**

```
for (i=0; i< 10; i++)
{
  x =10;
  y = i + x;
}
```

*When the invariant code is removed, the code resolves to:*

```
x = 10;
for (i=0; i< 10; i++)
{
  y = i + x;
}
```

**FIGURE 6**

### Constant Folding

This is a somewhat strange name for performing calculations at compile-time instead of run-time. When a compiler encounters expressions that can be evaluated at compile time, the compiler does the actual calculation and then stores the result. For example, a code fragment such as:

```
#define MAX_TEMPERATURE 100
y = 25;
x + y + 2 * MAX_TEMPERATURE;
```

is optimized to x + 225 by the compiler by utilizing constant folding.

### Peephole Optimization

The last technique we'll examine is peephole optimization. This is also sometimes called linear optimization. Peephole optimization is common throughout almost all compilers, since it is one of the easier techniques to implement. A peephole optimizer scans through the code examining only a small fragment at a time, like it's examining the code through a little peephole (hence the name).

The peephole optimizer then tries to improve the current fragment, possibly reducing redundant instructions or placing memory references into registers. After it's done optimizing a segment, the peephole optimizer examines another segment of code and continues optimizing.

### Burned by the Optimizer

Optimizing compilers can sometimes cause confusion and cost time, which translates directly to money. Here's a personal experience I had with an optimizing compiler for a 32 bit processor that was used in an embedded system. We compiled and loaded a small test program that was supplied with the operating system code.

Since this was our first experience with this particular processor and operating system, we figured it was a good place to start. The program ran correctly on the target system, so we decided to add a new function. We declared a simple integer function that added two numbers together:

```
int add( int x, int y);
```

The actual call to the function in the body of the code was:

```
Result = add(1,2);
```

It was hard to think of a simpler function to start experimenting with. We compiled, linked, downloaded, and ran the code through the debugger on the target system. The debugger stepped right over the function call as if it didn't exist in the code! We checked the code, recompiled, downloaded, and ran again with the same result.

Everything appeared to be completely legal. We tried it on a PC with another compiler, and the line containing the function call was executed. We returned to the target environment, recompiled, and ran again. The debugger still stubbornly refused to execute the function call.

To add to our confusion, we could set a breakpoint within the function body, but could not set a breakpoint at the function invocation. Meanwhile, several hours had elapsed.

We decided to call the development environment vendor, thinking that we had encountered a bug in the compiler or debugger. After talking to a couple of support engineers, we finally happened upon one who had previously encountered a similar problem. His response was "Welcome to the world of optimizing compilers!" It turned out that our result value was never used in the program, so via dead code elimination, the compiler decided to optimize out the code.

The moral of this story is, however valuable compiler optimizations may be, TURN THEM OFF when you are initially developing code for a new system using new tools. Incrementally turn on optimizations as your code development progresses. If you don't, you may get burned when you're debugging. **NV**

# 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**

How can I interface and set the switches of a HP PaintJet printer to work with a IBM-compatible PC? I do not have a manual. The printer appears to be a RS232 serial port. The printer does a self-test okay. There are two DIP switches to be set.

**11981** **Cliff**
**Canyonville, OR**

I recently bought a used computer.

The sound does not work and before it boots up, it gives me the following message: "!!Warning!! The Primary Wave Device does not appear at I/O address 534. The sound card will not be fully functional without this device. Check the hardware settings, and then check the hardware configuration panel associated with this program. The "Waveport" parameter must match port address selected by the hardware jumpers. Press any button to continue."

After this, my Windows95 runs just fine although with no sound

**11982** **John Rehm**
**via Internet**

How do underground wire locators work? Do you have a simple circuit for building such a device?

**11983** **Richard Haendel**
**via Internet**

I have prepared a cassette tape for teaching purposes. Is there any way to prevent the duplication of this tape by others?

I need an electronic piece to go with the tape to prevent direct and easy duplication.

**11984** **via Internet**

I have several new surplus 3UP1 CRTs that have been in my junk box for over 20 years. I cannot bring myself to toss them out, especially since I just completed a homebrew spectrum analyzer and one of them would be a great fit for it. They are a natural to dress up any new PIC project, too!

My difficulty is not the 2 KV of HV required for the anode or focus electrodes since the new laser kit power supplies will adapt neatly there. I need help on part selection/design for the deflection circuits. I want to be able to drive the CRT with a 0 to 5V output from a DAC.

The only specs for the 3UP1 show that I will need about -300 to +300V drive into a 20 pF load. By driving it with DAC output from a PIC, I could even generate simple text if it had about 3 MHz of bandwidth. For the spectrum analyzer, I only need 50 KHz or so, of bandwidth.

Is there a simple way to create a deflection circuit for this project (perhaps with an op-amp and MOSFET)?

**11985** **Ron L. Sparks**
**Katy, TX**

I have a RadioShack multimeter, a Micronta 22-168, which includes the capacity to communicate via the serial port. It works fine with the supplied software, but I have been unable to access it with the suggested (GW Basic) basic code. Here's the QB version of the code to read the data in the multimeter once:

```
OPEN "COM1:
1200,N,7,2,RS,CS,DS,CD" FOR RANDOM AS #2
  A$ = "D"
  PRINT #2, A$
  IN$ = INPUT$(14, #2)
  PRINT IN$
  CLOSE #2
```

The program does not get past the IN$ line. IN$ is always empty if I print it from outside the program. Does anyone have Quick Basic code which will access this meter?

**11986** **Grant Fair**
**Ontario, Canada**

I am able to buy a surplus generator that puts out 400 Hz. Can you help me with a way to convert it to 60 Hz? Articles or projects?

**11987** **Gary Stiffler**
**via Internet**

I have a Tystar VGA monitor I am running on my older 486 PC. When I run America Online, It tells me I don't have 256 colors selected as AOL requires to run properly. I tried to change the VGA drivers in Windows Setup, but all it did was cause the monitor to be completely out of sync. I have two questions:

**1.** How does one know how many colors a given monitor will support, assuming you have no documentation?

**2.** Which VGA driver should I use for this application?

**11988** **Lonnie W. Sutton**
**Dugway, UT**

I tried to modify the SA8500-321, cut a jumper W310, and install a .01 uF disk cap, and the resistor connect to pin 21 in IC305.

The problem is, it only works for a short time and turns the screen black. If the channel is changed, it will work again, but for a short time. Maybe I am doing something wrong.

**11989** **Alfredo Gonzalez**
**Presidio, TX**

I replaced a HP C1599A SCSI DAT tape drive after it failed. But after checking out the failed drive, all the motors run and the tape tries to stat against the VCR type heads. The tape lowers itself twice then the yellow LED comes on blinking silently and failing. Can someone point me to a repair path?

**119810** **George Clute**
**Mercer Island, WA**

I'm looking for a simple circuit to detect randomly inverting video. Ideally, the circuit would light an LED when this happens.

**119811** **Anonymous**

## ANSWERS

**ANSWER TO #89810 - AUG. 1998**

Make sure you are disabling the touchpad in the laptop's BIOS, not just removing it from Windows. Also, your touchpad probably uses DOS drivers, because you are using Win 3.1. Make sure any mousy looking lines in AUTOEXEC.BAT and CONFIG.SYS are "rem"ed out (type REM in front of the offending line, (i.e., REM C:\DOS\TOUCHPAD.COM) instead of C:\DOS\TOUCHPAD.COM). This temporarily disables the drivers.

You will then have to add lines pertaining to your mouse drivers (MOUSE.COM) if the automatic setup doesn't do it (i.e., add C:\MOUSE\MOUSE.COM, if you copied your drivers to C:\MOUSE\).

Then reboot and see if your mouse works. If it doesn't, poke around for any other touchpad drivers. Also, try running your mouse as COM2.

To do this, you will have to add a command line switch to the MOUSE.COM line in AUTOEXEC.BAT. At the DOS prompt, switch to the directory containing your new mouse drivers and type MOUSE /? [ENTER].

This will tell you about the options available. One last thing to try is to disable all power saving related to the serial ports. You will have to do that through your laptop's BIOS, too.

**Evan Weaver**
**Hockessin, DE**

### ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

### QUESTION INFO

**TO BE CONSIDERED FOR PUBLICATION**

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

**INFORMATION/RESTRICTIONS**

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

**HELPFUL HINTS**

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

**ANSWER TO #109811 - OCT. 1998**

The LM3914, LM3915, and LM3916 are designed to do just that. They require a minimum of parts to operate and most come with diagrams on how to hook them up as either a VU meter or a power meter.

Two or more of these units can be cascaded together to drive 20 or more LEDs, LCDs, or vacuum fluorescent displays. A single pin changes the mode of operation from a "moving dot" to the "bar graph" mode.

The LM3914 senses an analog voltage and divides into 10 segments which drive 10 separate outputs. These outputs are regulated and fully programmable which means that you can program it for low-power usage, as well as high-power amps.

The LM3915 is a logarithmic version of the LM3914 with a 3 dB interval between segments.

The LM3916 has all of the same features as the LM3914 and LM3915, but is designed specifically for use as a "VU" meter.

Several cross reference numbers are:

National Semiconductor part # LM3914
ECG part #1508
NTE part #1508

National Semiconductor part # LM3915
ECG part #1509
NTE part #1509

National Semiconductor part # LM3916
NTE part #1549

**Chris**
**Bieber, CA**

**ANSWER TO #7984 - JULY 1998**

A "Roger Beep" or End of Transmission (EOT) beep circuit is fairly easy and inexpensive to build as the schematic diagram shows.

The circuit can be assembled on a small section of perfboard using point-to-point wiring and installed inside most any transceiver.

The circuit is designed around an LM1458 dual op-amp IC, but any similar IC such as the LM358, etc., will also work. The circuit operates as follows:

When push button switch S2 (microphone PTT switch) is pressed, the relay coil is energized which causes the transceiver to transmit. When the microphone PTT button is released, the transceiver remains in transmit for approximately .27 seconds during which time, the beep tone is transmitted.

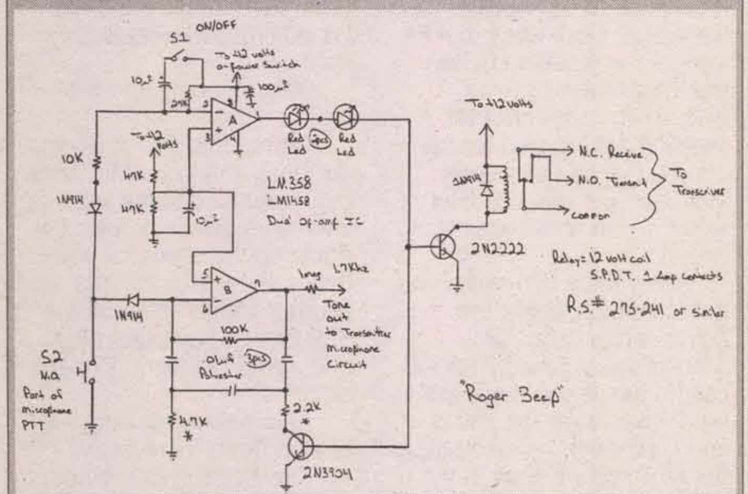
After the .27 second delay time has passed, the relay coil is de-energized which places the transceiver back into receive.

When switch S1 (normally a mini toggle, etc.) is open, the EOT beep tone is not transmitted. The frequency of the beep tone (currently 1700 Hz) can be changed somewhat by altering the component values of either one or both of the resistors marked with "*".

Increasing their values will lower the frequency while decreasing their values will raise the frequency.

A different value resistor may need to be substituted in place of the one megohm output resistor at pin 7 of the IC in order to avoid over-modulating the transmitter. Increasing the resistance value will lower the modulation level.

**Brian Pliler**
**Baxter Springs, KS**




**ANSWER TO #109815 - OCT. 1998**

Do not use port I/O to control your soundcard — use the waveIn driver.

Windows puts a lot of overhead on I/O port instructions, and soundcards require double-buffered DMA transfers and other sophisticated device programming methods. Application software should talk to the hardware through the system device drivers.

There are many benefits. Not only do you avoid fiddling with low-level programming, but your program will also work with soundcards that are not SoundBlaster compatible.

The proper driver is the waveIn multimedia device. I know how to access it in C, but not VB. You should be able to find the details about PCMWAVEFORMAT and the equivalents of waveInOpen, waveInPrepareHeader, MM_WIM_DATA, and friends.

There are also calls to control the mixer settings, but I recommend working on the decoding algorithm before tackling the soundcard and mixer programming.

The quick fix is to use the Sound Recorder (Start | Accessories | Multimedia Sound Recorder) to record a .WAV file with your weather satellite image, and writing a VB program to process the .WAV file.

Using the soundcard directly implies processing the image on the fly, and it may take a while before your program can do it on the fly. Using a .WAV file will give you consistent data and let you focus on the algorithms without worrying about processing speed.

Record the image in mono at 8 KHz with 8 or 16 bit samples. The .WAV file has some header information and then the data. The eight-bit samples are offset 128 numbers and the 16-bit samples are two's complement.

Several people have used soundcards to process weather satellite information. The August '97 QST has an article about a freeware satellite decoder, but I don't know if it does

*Continued on page 74*

# Resistance is Futile!

***by E. Z. Camp***

Looking for a new career? I've got a great one, if you don't mind when or IF you eat or sleep! The money's good, you get to travel, and you meet lots of interesting people. In your spare time, you're parked in front of a computer screen, when you're not on the phone doing your investigations.

Me, I'm a technical writer. Free-lance to be specific. Yep, it's a 24/7 work week, but I love it! You wouldn't believe the things I've seen and places I've visited, not to mention getting paid for my efforts. I've met extremely intelligent people, beautiful women, and some real nut cases!

Every once in a while, you get to verbally abuse the Editor, when "editorial license" is stretched. This job can be fun, if you don't get fired! Like I said, the pay is good, although never on time, but that's how it goes in the publishing business.

Fringe benefits? You bet! Some of the technical stuff you pick up is like money in the bank. The sharp tech writer can develop some ideas legally from this material, and really cash in.

You've got to be super careful here, as you don't want to get black-listed for piracy. Your job could disappear overnight!

This job can get dull and boring, but within a couple of days you're on something new – just like the weather, it's always changing. Sometimes, it even gets risky, or should I say, downright dangerous? Take for instance, the Metalloid Affair ...

The phone was buzzing at me again, damn! Getting really tough to concentrate on editing.

"Hello?"

"Skip? It's Fred. You busy?"

"Always, Fred! What's up with you?"

"I'm working on a new project farmed out to me from DIGI-LOG and I ran out of acrylic spray – got any?"

"Yeah, I think I've got about half a can left. DIGI-LOG, huh? That's the outfit I'm editing data sheets for right now."

"Oh, anything interesting?"

"Sure looks like it! Seems our dead-and-gone Ms. Anna Log developed some very interesting linear circuits. I'm doing up the specs for what they call the 741 op-amp, and another gadget they call the 555 timer. They expect big sales! And I think they might be right."

"You've been getting a lot of work from them lately."

"No kidding! Ever since that article I did for them before they pulled out of digital manufacturing and changed their name. How'd you hook up with them?"

"They saw a letter I sent into a hobbyist electronic magazine a while back. I was looking for information on temperature coefficients of certain metal and non-metal alloys."

"I guess they saw something they liked?"

"Sure did. They contacted me as soon as the mag hit the newsstands! Wanted some independent research conducted on attempting to come up with a zero-tempco metal alloy. They offered me a juicy contract, and I took it!"

"Good for you! Well, I'm

ready for a little break. How about if I bring you over the acrylic spray and we rap for a bit?"

"Great! Bring those specs you're working on – I want to see them."

"Right! See you in 15!"

Fred's a scrawny little guy with those rough, good looks that women can't seem to resist. He's got himself a centerfold wife, and both of them have those upper-stratosphere type IQs. His 'workshop' is something to behold, money being no object.

"Hi, Fred! Where's the wife?"

"Out nailing down another software contract. I'm free for the afternoon. How's yours?"

"Great! She's really getting heavy into this anti-fraud stuff now that New Jersey has the highest auto insurance rates on the planet. There seems to be an abundance of "dirty" doctors and patients in the area."

"Tell me about it! Hand me that acrylic spray, huh?"

He began to gingerly spray a coat of the crystal clear plastic onto a beautifully labeled aluminum panel. "Has she had any luck yet nailing any dirty lawyers?"

Walking over to open a window for ventilation, I replied, "No luck yet. They're pretty well protected. Looks like lots of cash changing hands up top. Boy, that spray stinks!"

"Yeah, but not as bad as those lawyers!"

"Agreed, but not all of them are dirty. We still need them, like it or not. What's that panel for?"

"Oh, I had a little accident with the chart recorder DIGI-LOG loaned me for this job. I kind of destroyed their front panel, so I made a new one," offered Fred.

Fred is always having 'little accidents.' For such a sharp guy, it always amazes me how he does it! "How many coats are you putting on there? I'm getting a buzz!"

Fred grumbled, "Relax Skip, I'm done. Want to see the test rig?"

"Sure, is this it?" I replied, pointing to his bench.

On the bench was a neatly made fixture holding a shiny, metallic rod about the size of a lead pencil. Several sets of wires led off to the chart recorder.

A pair of triple-ought cables almost a 1/2" in diameter were connected to the jig and hung off the bench. These went down to the floor and tied in to three series-connected graphite rods about the size of flashlights. The cables disappeared through a wall grommet.

Fred saw my puzzled look, "Those are my homemade variable resistors – see the sliders on the rods? I needed some kind of current limiting on this set-up. I'm using my door stop for the power supply."

Said 'door stop' is a huge, 75-pound transformer rated at five volts at 1 KVA. That's a 200-amp supply, folks! I asked sarcastically, "Think you've got enough current, Fred?"

A straight-faced Fred: "Just about enough, maybe! I've been running conductivity tests on different alloys supplied to my specs from another outfit. Their standard sample size is 1/4" by 5", so I needed something hefty to get a measurement."

I asked, "So you said DIGI-LOG wants you to investigate alloys for zero-tempco; what's the point?"

Fred laughed. "The zero-tempco they're interested in is not dimensionally related, but electrically related. They apparently have a use for conductors that exhibit no conductivity change over wide temperature variations. This was not my original intent, but if they wanted to pay me, why not bag two birds with one stone?"

"So what are you looking for?"

Fred explained, "My original theory was that it should be possible to form an alloy from two or more metals or non-metals that would have very high and constant conductivity at any temperature. By combining a metal, whose conductivity decreases as temperature increases, I hoped to get something that worked."

"Bloody hell, you say! Did you do it?"

He looked upset. "Yeah, I fulfilled their contract. Would you believe I found two workable alloys?"

I was intrigued to say the least, "How'd you do it?"

Fred pondered. "Did you know that aluminum is NOT a metal? Not many people do. It's a metalloid; its conductivity varies directly with temperature, as opposed to real metals. This was the key to my experiments, as aluminum already has a high conductivity, like gold and silver and copper. The trick was to alloy one or more real metals with aluminum in the right proportions. Two of the dozen alloys I dreamed up show the zero-tempco effect, and I've still got three more to test."

"So, why the long face?"

"I'm still not seeing what I expected to see!"

"Let's see how your rig works, okay Fred?"

He brightened up. "Sure! This thing's really pretty simple, just set up for high power. I apply power to the sample rod from the door stop through the variable resistors using those monster cables, starting out at about 10 amps and ending up at 50-100 amps. At those currents, the sample 'self-heats' which saves me using a separate heater."

"And you print out the run on the chart recorder."

"Right! The three upper recorder pens trace out the sample temperature, current through the sample, and the voltage drop across it. The fourth pen gives the calculated resistance of the sample. What you want to see is a flat line on that trace."

I was impressed. "Nice chart recorder they loaned you."

"Yeah, I was lucky I was able to fix it! Want to watch a

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run or two or three?" He was already in the middle of sample #10's first run.

I checked my watch, "Can't, gotta get on home and toss a couple of Cornish hens in the oven before the wife gets home."

"Come to think of it, I'm getting hungry myself. Well, I've got time for another run – I'll let you know how it goes."

"Okay, take it easy. I'll give you a call tomorrow." I beat a hasty retreat out to my car.

And then, all of a sudden WHAM!!!

I woke up with my face flat on his concrete sidewalk, with people milling all around me, and a meat wagon up on the curb! Lying next to me was the plastic spray can lid.

Said I, "What the hell?" and finally managed to sit up.

"Are you okay?" asked the ambulance driver.

"I think I'm in one piece, but my ears are ringing."

Right then Fred came staggering out what used to be his front door, one arm dangling uselessly, obviously broken. In his other, he was clutching a piece of chart recorder paper and waving it at me with a big grin! "I did it!"

"You certainly did," I said, looking at his demolished house front, "but what the heck did you do?"

"Look at all of these flat lines!" he said, pushing the recorder paper in my face, "Notice anything unusual? I pushed the current from 10 amps to 200 amps: ambient temperature, flat line! Zero voltage drop, flat line! Zero resistance, flat line! What's that tell you?"

I was starting to hurt. "You blew up your house, and your Old Lady's gonna be a little miffed?"

Fred was unperturbed, "I'll buy her a few more! Come on, read the chart, will you?"

I finally got it: "A room temperature superconductor! You're now fabulously wealthy – so THAT was your original theory! What about DIGI-LOG? Don't they own it?

Now Fred was miffed! "Don't you remember, I already fulfilled their contract! They're getting two working alloys. This one's all mine. Although, they'll probably charge me for a new chart recorder; theirs didn't survive the blast."

"And I'm going to write your story up for a mere 10 times my usual fee! What caused the explosion anyway, Fred?"

"Oh, I had a little accident – dropped the acrylic spray can right on the resistor assembly. Which promptly vaporized when a slider shorted and put full current right through that big steel bench – shrapnel was flying all over the place. Pretty much missed everything except my wing."

Well, they loaded us into the meat-wagon, assuring us that our injuries weren't anything life-threatening. I finally had a chance to reflect, "You know, Fred, I never did like those ceramic superconductors."

"Me neither, Skip. They don't bend." Go Figure!!! NV

# Events CALENDAR

## NOVEMBER 1998

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

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

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
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**Events Calendar**
430 Princeland Court
Corona, CA 91719
**Phone** 909-371-8497
**Fax** 909-371-3052
**E-mail** events@nutsvolts.com

### NOVEMBER 1

**CA - LIVERMORE** - Hamfest. Livermore ARK, Cliff Kibbe KF6EII, 209-835-6715. E-Mail: larkswap@hotmail.com

**IA - DES MOINES** - Hamfest. Tikva Tracers ARC, Randall Lees N0LMS, 515-279-4241. E-Mail: rclees@raccoon.com

**IL - MACOMB** - Hamfest. National Guard Armory. 8am-1pm. VE Exams. Talk-in: 147.060/147.660, 444.300/449.300. Lamoine Emergency ARC, Don Johnson KA9SQB, 309-833-4626. E-Mail: Don Johnson@ccmail.wiu.edu

**NY - FARMINGVILLE** - Hamfest. Radio Central ARC, JoAnn Colletti N2IME, 516-399-1877. E-Mail: w02n@li.net

**OH - MASSILLON** - Hamfest. Stark County Fairgrounds, 305 Wertz Ave. N.W. Talk-in: 147.18+ repeater. MARC, Don Wade W8DEA, 330-497-7232; Terry Russ, 330-837-3091 before 10pm. E-Mail: MARC.HAMCLUB@JUNO.COM

### NOVEMBER 7

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

**FL - MIAMI** - Hamfest. Flamingo Net/University of Miami ARC, Walt Dixon W4DWN, 305-895-0398

**FL - SORRENTO** - Hamfest. Lake ARA, Chuck Crittendon KA4EXM, 352-669-2075

**KY - HAZARD** - Swapfest. Hazard High School, south end of Rt. 15, Hazard Bypass. 8am-2pm. VEC Exams. Talk-in: 146.07/.67. KY Mountains ARC, John Farler K4AVX, 606-436-5354. E-Mail: jfarler@mis.net Web: http://www.geocities.com/SiliconValley/2564/hf.html

**NH - LONDONDERRY** - Ham Radio Flea Market. Lions Club, Mammoth Rd. (Rt. 128). 8am-1pm. The Interstate Repeater Society ARC, Paul Gifford, 603-432-1538. E-Mail: k1llx@juno.com

**NM - SOCORRO** - Hamfest. SARA, TARA, & City of Socorro, Al Braun AC5BX, 505-835-3456 days or 505-835-1061 eves. E-Mail: AC5BX@juno.com Web: http://www.ees.nmt.edu/sara/

**OK - ENID** - Hamfest. Garfield County Fairgrounds, Hoover Bldg., Oxford & 4th Sts. 8am-5pm. VE Exams. Talk-in: 147.15+ 444.400+. Tom Worth N5LWT, 580-233-8473, E-Mail: N5LWT@HOTMAIL.COM. Fred Selfridge N5QJX, 580-242-3551, E-Mail: FREDNNEL@IONET.NET

**SC - MYRTLE BEACH** - Beachfest '98. Myrtle Beach High School, 38th Ave. N. VE Exams. Talk-in: 147.12. GSARC, Jim Wood KF4CJE, 843-238-0800. E-Mail: kf4cje@juno.com Web: www.w4gs.org, http://www.qsl.net/kf4hav/hamfest.htm

**TX - AZLE** - Hamfest. Tri-County ARC, David Johnson KB5YLG, 817-922-1081 days, 817-444-2369 eves. E-Mail: kb5ylg@gte.net Web: http://www.qsl.net/tcarc-ntxl

**WI - WAUKESHA** - Hamfest. Milwaukee Repeater Club, Mike KB9PHA, 414-258-4435. Web: http://execpc.com/~mrc/friendlyfest.htm

### NOVEMBER 7-8

**GA - LAWRENCEVILLE** - Hamfest. Gwinnett County Fairgrounds. Sat: 9am-5pm, Sun: 9am-3pm. VE Exams. Talk-in: 145.45, PL 107.2 if necessary. Alford Memorial RC, Randy Bassett KR4NQ, 770-410-3989. E-Mail: Hamfest@totr.radio.org

**TX - ODESSA** - Hamfest. Ector County Coliseum, Exhibit Bldg. D., 42nd & Andrews Hwy. Sat: 8am-5pm, Sun: 9am-1pm. VE Exams. Talk-in: 145.470. West TX ARC, Robert Jordan N5RKN, 915-335-7980. E-Mail: n5rkn@apex2000.net Web: http://www.apex2000.net/personal/wd5cwj/main2.htm

### NOVEMBER 8

**WI - KAUKAUNA** - Hamfest. Starlite Club, Corners of Hwy. 55 & CR JJ. VE Exams. Talk-in: 146.52 simplex. Fox Cities ARC, Chad Pennings N9PRC, 920-993-0485. Web: http://www.w9zl.ampr.org

### NOVEMBER 14

**AL - MONTGOMERY** - Hamfest & Computer Show. Garrett Coliseum, S. AL State Fairgrounds. 9am-3pm. Phil 334-272-7980 after 5pm CST. E-Mail: wb4ozn@worldnet.att.net E-Mail: kf4ilp.arthur@worldnet.att.net Web: http://jschool.troyst.edu/~w4ap/

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

**FL - PORT ST. LUCIE** - Hamfest. St. Andrew Luthern Church, 295 N. Prima Vista Blvd. 8am-2pm. Talk-in: 146.955. Port St. Lucie ARA, Roy J. Cox KT4PA, 561-340-4319. Paul Harrison KI4MG, 561-878-2475. E-Mail: julian@ecqual.net Web: www.geocities.com/CapeCanaveral/Hangar/4533

**FL - TITUSVILLE** - Hamfest. Titusville ARC, Bud Hughes K4CWB, 407-267-3450. E-Mail: bud@expedient.com

**LA - WEST MONROE** - Hamfest. Twin City Ham Club, Mark Ketchell N5MYH, 318-323-6621. E-Mail: TCHC@iAmerica.net E-Mail: n5myh@iamerica.net Web: http://cust.iamerica.net/TCHC

### NOVEMBER 14-15

**IN - FT. WAYNE** - Hamfest & Computer Expo. Allen County War Memorial Coliseum-Expo Center. Sat: 9am-4pm, Sun: 9am-3pm. VE Exams. Talk-in: 146.88(-). Doug Jones N9NNT, 219-484-3317. E-Mail: djones2233@aol.com Web: http://www.pipeline.com/~dagagnon/

### NOVEMBER 15

**MA - PLYMOUTH** - Hamfest. Mayflower ARC, Jack Kenealy K1BFJ, 508-830-3452. http://members.aol.com/wa1vkd/flyer.htm

**NC - BENSON** - Jarsfest. American Legion Complex, Hwy. 301, N. 8am-4pm. Talk-in: 147.270 + 600. VE Exams. Johnston ARS, Paul Dunn KD4BJD, 919-894-3100 Web: http://www.jars.net

### NOVEMBER 18

**FL - ST. PETERSBURG** - Hamfest. Pelican Chapter #128 QCWA, Jay Strom K9BSL, 813-822-9107

### NOVEMBER 20-21

**MS - OCEAN SPRINGS** - Hamfest/Swapfest. Latimer Community Center, N. of I-10, Exit 50. Fri: 5-9pm, Sat: 8am-2pm. Talk-in: 145.110 N5OS (-600). West Jackson County ARC, Phil Hunsberger W9NZ, 228-872-1499; Harry McLemore KD4AK, 228-872-0732

### NOVEMBER 21

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

**IL - LITCHFIELD** - Hamfest. Central IL/St. Louis Area ATV Club, Scott Millick K9SM, 217-532-3837

### NOVEMBER 21-22

**FL - TAMPA** - Suncoast Amateur Radio & Computer Convention. State Fairgrounds, Expo Hall. Ed Pellenz N4HRN, 813-685-7115 or 813-272-7021 xt. 3320. E-Mail: epellenz@cftnet.com Web: http://www.fgcarc.org

### NOVEMBER 22

**IL - WHEATON** - Radio Fest, Electronics Flea Market. DuPage County Fairgrounds, Manchester Rd. GMRS of Illinois, Inc., 815-756-3933 or 630-393-3937

**NY - POUGHKEEPSIE** - Hamfest. Mt. Beacon ARC, Ken Akasofu KL7JCQ, 914-485-9617

### NOVEMBER 28

**IN - EVANSVILLE** - Winter Hamfest. Vanderburgh County Fairgrounds, Exposition Center. 8am-2pm. 145.150- Evansville, 146.925- & 443.925+ Vincennes. EARS, Neil WB9VPG 812-479-5741.

*Continued on page 72*

### COMPUTER SHOWS

**AGI Shows**, 317-299-8827. E-Mail: info@agishows.com http://www.agishows.com

**Blue Star Productions** 612-788-1901 http://www.supercomputersale.com

**Computers And You**, 734-283-1754. www.a1-supercomputersales.com

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**Georgia Mountain Productions** 706-838-4827. E-Mail: gamtnpro@blrg.tds.net georgiamountain.com

**Gibraltar Trade Center, Inc.** 734-287-2000. Taylor, MI.
**Gibraltar Trade Center, Inc.** 810-465-6440. Mt. Clemens, MI.

**MarketPro, Inc.**, 201-825-2229 http://www.marketpro.com

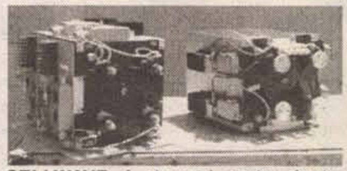
**MarketPro, Inc.**, 301-984-0880. E-Mail: md@marketpro.com http://marketpro.com

**Northern Computer Shows** 978-744-8440 E-Mail: inquiries@ncshows.com Web: ncshows.com

**Peter Trapp Computer Shows**, 603-272-5008. Web: www.petertrapp.com

## HAM GEAR FOR SALE

**WANTED: ROCKWELL**-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smartlink.net



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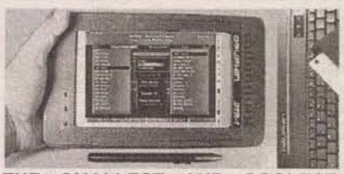

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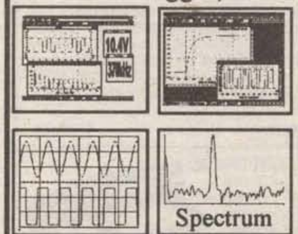


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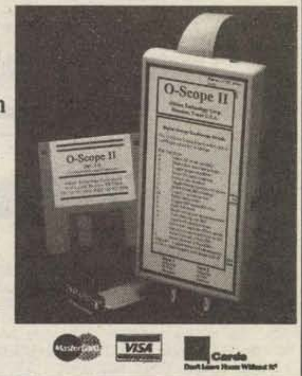


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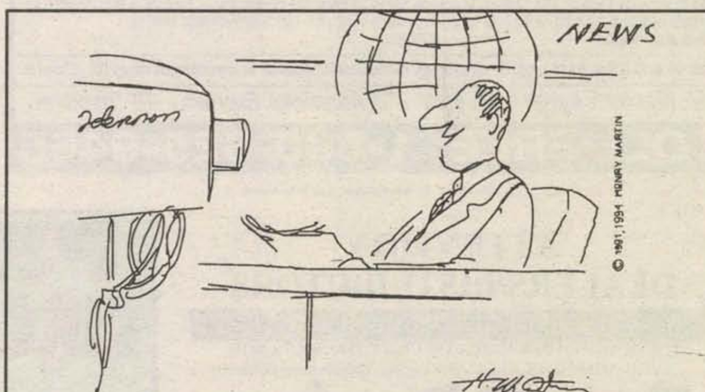


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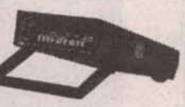

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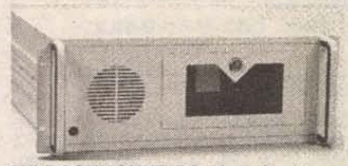

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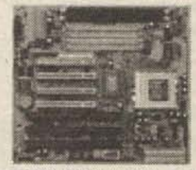

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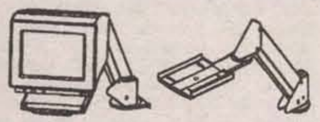

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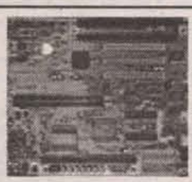

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| **Network Concentrators (Hubs)** | |
| Asante 5 Port FriendlyHub | $39 |
| Bay Netgear 8 Port/16 Port Hub | $79/$119 |
| SMC EtherEZ Hub 8 Port Desktop/16 Port Rackmount | $139/$379 |
| 3Com OfficeConnect 8 Port Hub | $ 149 |
| 3Com Superstack 12 Port Rackmountable Hub | $ 329 |
| Call about Network Equipment Not Listed! | |

## SVGA Monitors

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| Iiyama Visionmaster 350 - 15" 0.28 Dot Pitch, Digital, 1280 x 1024 | $239 |
| Iiyama Visionmaster 8617E 0.26 Dot, 1600 x 1280,Digital | $429 |
| **Iiyama Visionmaster 9017E, 0.25 AG - PC Editor's Choice 9/97** | **$489** |
| Iiyama Visionmaster 450 - 19" Monitor - 0.26 Pitch - PC World Best Buy | $649 |
| Iiyama Visionmaster 8721, 21" Monitor, 1800 x 1440 Resolution | $999 |
| Iiyama Visionmaster 9221E, 21" Diamondtron, 1800 x 1440 Resolution | $999 |
| Iiyama Visionmaster Prolite 36 CM LCD Monitor- Incredible Screen | $999 |
| Megaplus 14" Non-Interlaced 0.28 Dot Pitch | $119 |
| Megaplus 15" Non-Interlaced 0.28 Dot Pitch | $149 |
| Sony Multiscan 15sf Trinitron, Digital | $289 |
| KDS VS-7 17" Non-linterlaced 0.28 Dot Pitch, 1280 x 1024 | $239 |
| Megaplus 17" Non-Interlaced, 0.28 Dot Pitch, 1280 x 1024 | $279 |
| **Goldstar 17" Non-Interlaced, 0.26 Dot Pitch, 1600 x 1280** | **$329** |
| **KDS VS-9 17" Non-Interlaced 0.26 Dot Pitch, 1600 x 1280** | **$329** |
| Panasonic S70, 0.27 Pitch, 3 Year warranty-1Year onsite! | $399 |
| NEC Multisync XV17 + 0.25 Dot Pitch, CromaClear, Digital | $499 |
| **KDS 20" SVGA (18.8" Viewable) 0.28 Dot Pitch, Excellent** | **$499** |
| NEC Multisync P1150, 0.28 Dot Pitch | $1499 |
| Sony SPD300 SFT, 0.25 AG, Trinitron Tube | $1699 |
| Viewsonic 21-810 | $999 |

## Memory/Microprocessors

| 30 Pin SIMM Modules | |
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| **4M x 9 SIMM** | **$19** |
| **72 Pin SIMM Modules** | |
| **4M NonParity/EDO/Parity** | **$12/$12/$25** |
| **8M NonParity/EDO/Parity** | **$14/$13/$24** |
| **16M NonParity/EDO/Parity** | **$29/$23/$39** |
| **32M NonParity/EDO/Parity** | **$49/$39/$59** |
| **64M EDO/Parity** | **$99/$149** |
| **168 Pin DIMM Modules** | |
| **16M SDRAM 10 ns** | **$25** |
| **32M SDRAM 10 ns/PC100** | **$39 / $59** |
| **64M SDRAM 10 ns/PC100** | **$79 / $129** |
| **128M SDRAM 10 ns/PC100** | **$159 / $219** |
| **Microprocessor Chips** | |
| **Pentium ® II- 450/400 Mhz** | **$599/$429** |
| **Pentium ® II- 350/333 Mhz** | **$329/$279** |
| **Pentium ® II- 300/266 Mhz** | **$239/$199** |
| **Celeron ® 333/300A -128K Cache** | **$199/$159** |
| **Celeron ® 300/266 - 0K Cache** | **$99/$89** |
| **Pentium ® 233 MMX/200 MMX** | **$139/$119** |
| **Pentium ® 200 Mhz/166 MMX** | **$139/$99** |
| **Pentium ® 166 Mhz/133Mhz** | **$85/$75** |
| **AMD K6 - 300/266 MMX** | **$99/$89** |
| **Pentium®II /Pro/Pentium®Fans** | **$12/$15/$8** |

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| Enhanced IDE and Ultra DMA Drives | |
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| 2.14 Gig Seagate, 12 ms access | $119.99 |
| 2.14 Gig Western Digital,10 ms access | $119.99 |
| 2.14 Gig Quantum Fireball Ultra DMA, 9 ms | $129.99 |
| 2.55 Gig Maxtor Diamondmax, 9 ms access | $139.99 |
| 3.2 Gig Western Digital, 11 ms access | $129.99 |
| 3.2 Gig Seagate Medalist Ultra DMA, 10 ms | $129.99 |
| 4.3 Gig Western Digital, 10 ms access | $139.99 |
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| 6.4 Gig Seagate Medalist,Ultra DMA, 11 ms | $179.99 |
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| 8.4 Gig Quantum Fireball, Ultra DMA, 9 ms | $219.99 |
| 8.6 Gig Seagate Medalist, Ultra DMA, 9 ms | $199.99 |
| 9.1 Gig Seagate Medalist Pro 7200 RPM | $269.99 |
| 11.5 Gig Maxtor Diamondmax, 9 ms | $289.99 |
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| 2.1 GB Quantum Atlas Ultra Wide, 9 ms | $ 199.99 |
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| 4.5 GB Seagate Barracuda Ultra/Ultra Wide, 7.9 ms | $469/$479 |
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| **9.1 GB Micropolis Tomahawk UW SCSI2** | **$439.99** |
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| 9.1 Gig IBM Deskstar Ultra Wide 7 ms | $ 599.99 |
| 9.1 Gig Quantum Atlas Ultra Wide, 9 ms | $ 599.99 |
| 9.1 Gig Seagate Cheetah Ultra/Ultra Wide | $949/$999 |
| 18.2 Gig Seagate Cheetah Ultra/Ultra Wide | $1899.99 |

## Motherboards for Pentium®Processors

| | |
|---|---|
| **BCM 575 AT/550 ATX-430TX,P75-233PCI w/512K,DIMM** | **$79** |
| Tyan Tomcat , Single/Dual CPU, w/8 SIMMs,512K | $99/$119 |
| Tyan Turbo-2 AT/ATX, Intel 430TX w/6 SIMM/2 DIMM 512K | $79 |
| SuperMicro P55MMS98-Intel 430TX, 512K | $79 |
| ASUS TX97/TX97E, AT-430TX,P75-233 PCI w/512K | $99 |
| **Motherboards for the Pentium®Pro Processor** | |
| **BCM 600 - 150-200 MHz, Intel 440FX Chipset, PCI/ISA** | **$179** |
| Supermicro ,AT or ATX 150-200, Intel 440FX, PCI/ISA | $149 |
| Tyan Titan Pro - Single/Dual processor PCI/ISA, AT or ATX | $129/$249 |
| Intel PR440FX - Dual Pro, UW SCSI,10/100 LAN, Audio, ATX | $429 |
| **Motherboards for the Pentium®II Processor** | |
| **BCM 632 - Intel 440LX Chipset, PCI/ISA/AGP/DIMMs, ATX** | **$109** |
| **BCM QS440BX - Intel 440BX Chipset, PCI/ISA/AGP/DIMMs, ATX** | **$129** |
| Intel AL440LX - Intel 440LX, PCI/ISA/AGP/DIMMs,Audio,ATX | $ 129 |
| Intel SE440BX - Intel 440BX, PCI/ISA/AGP/DIMMs, Audio, ATX | $ 159 |
| Intel N440BX - Intel Server Board, PCI/SCSI/LAN/DIMMs/Dual | $ 529 |
| Abit BH-6 - Intel 440BX, PCI/ISA/AGP/DIMMs, ATX | $ 129 |
| Abit LX-6 - Intel 440LX, PCI/ISA/AGP/DIMMs, ATX | $ 129 |
| Asus P2L97/P2L97S - Intel 440LX, PCI/ISA/AGP, ATX, SCSI | $129/$199 |
| Supermicro P6SLS/DLS-440LX,Single/Dual P2,2940UW SCSI | $219/$299 |
| Supermicro P6SBS/DBS-440BX,Single/Dual P2,3940UW SCSI | $229/$349 |
| Soltek SL61B-440LX, PCI/AGP/ISA-AT FORM, SIMM/DIMM!! | $ 109 |
| Soltek SL67AC / SL67A - 440BX - With/Without SCSI2 | $229/ $129 |
| **Tyan 1830 - 440BX, 4 ISA/4 PCI/ 1 AGP, AT Form Factor** | **$159** |
| Tyan Tiger Dual - 440LX, Dual Processor, 3 Year Warranty | $ 169 |

## CD-ROM/Modems/Sound

| CD ROM Drives | |
|---|---|
| Mitsumi EIDE 4X, 145 ms | $34.99 |
| Toshiba EIDE 32X, 85 ms | $69.99 |
| Toshiba 32X SCSI2, 80 ms | $99.99 |
| Plextor 32X SCSI2, 80 ms | $179.99 |
| Mitsumi 2X/8X CD-Writer | $249.99 |
| HP CD-ReWriter EIDE/Ext Parallel | $399/$489 |
| Teac 4X/12X CD-Writer SCSI2 | $389.99 |
| Plextor 4X/12X CD-Writer SCSI2 | $429.99 |
| **Creative Labs DVD2 Encore Kit** | **$199.99** |
| **(Plus $30 Rebate 'til 12/98!!!)** | **$169.99** |
| **Modems** | |
| **56K X2 Compatible with Voice** | **$69** |
| USR Sportster 56K Int/Ext | $89/$129 |
| **Diamond Supra 56K V.90 Int/Ext** | **$79 / $109** |
| **Sound Cards** | |
| Ensoniq PCI 3D Sound Card | $49.99 |
| Diamond Monster Sound MX80 | $89.99 |
| Creative Sound Blaster 16 PNP | $39.99 |
| Creative Sound Blaster 64 Value | $49.99 |
| Creative Sound Blaster 128 PCI | $59.99 |
| Creative Sound Blaster Live! | $169.99 |

## SVGA Cards and Accelerators

| | |
|---|---|
| Trident PCI with 2M DRAM / AGP with 4M | $29 /$49 |
| Diamond Stealth 3D, 2M/4M DRAM PCI | $39/$59 |
| ATI Video Xpression 2M PCI | $49 |
| Diamond Monster 3D II-8M/12M 3DFX VooDoo2 Chipset | $179/$229 |
| Matrox Mystique 220 PCI with 4M RAM | $89 |
| **Matrox Millenium II PCI 4M/8M WRAM** | **$129/$179** |
| Matrox Millenium II Rainbow Runner/TV Tuner | $169/$89 |
| **ATI Xpert @ Work/Xpert @ Play AGP 4M (8M +$50)** | **$79/$99** |
| **Diamond Viper 330 Pro AGP with 4M RAM** | **$89** |
| **ATI All in Wonder Pro PCI/AGP 4M/8M** | **$179/$249** |

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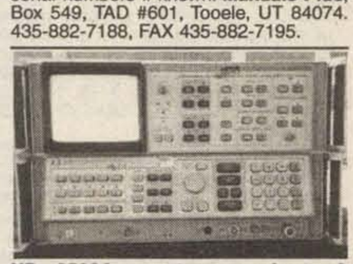

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| HP 5328A, Counter, 100MHz w/DVM/Opt. 021 | $250 |
| HP 5328A, Counter, 500MHz | $350 |
| HP 5334A, Counter, 100MHz, Opt. 010 Oven | $600 |
| HP 5340A, Counter, 18GHz (nixie) | $700 |
| HP 5345, Counter, 500MHz | $450 |
| HP 5345A, Counter, 500MHz, HP-IB | $650 |
| HP 59307A, VHF Switch | $125 |
| HP 6104A, Precision Power Supply, 20V @ 3A, 20-40V @ 1A (metered) | $175 |
| HP 6112A, Power Supply, 40V @ .5A (metered) | $175 |
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| HP 6202B, Power Supply, 40V @ .75A (metered) | $175 |
| HP 6203B, Power Supply, 7.5V @ 3A (metered) | $175 |
| HP 6205B, Power Supply (dual), 0-40V @ .3A, 0-20V @ 8A (metered) | $225 |
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| HP 6260B, Power Supply, 10V @ 100A (metered) | $400 |
| HP 6265B, Power Supply, 40V @ 3A (metered) | $250 |
| HP 6266A, Power Supply, 40V @ 6A (metered) | $250 |
| HP 6289A, Power Supply, 0-40V @ 1.5A (metered) | $225 |
| HP 6294A, Power Supply, 0-60V @ 1A (metered) | $275 |
| HP 8011A, Pulse Generator, .1Hz-20MHz | $175 |
| HP 8013B, Pulse Generator, 1Hz-50MHz | $275 |
| HP 8015A, Pulse Generator, .1Hz-50MHz 30V | $425 |
| HP 8091A, Rate Generator (1GHz) w/8092A Delay Generator (1GHz) w/8093A Output Amp w/15401A & 15400A | $2,000 |
| HP 8165A, Programmable Sig Source, 1milliHz-50MHz | $950 |
| HP 8180A, Data Generator | $425 |
| HP 8410B, Network Analyzer Mainframe | $275 |
| HP 8414A, Polar Display | $225 |
| HP 8443A, Tracking Generator, 1KHz-110MHz | $325 |
| HP 8444A, Tracking Generator for 141T System, .5-1300MHz | $750 |
| HP 8445B, Auto Preselector, 1.8-18GHz | $550 |
| HP 8553B, RF Plug-in (for 140 Series Mainframes), 1KHz-110MHz | $425 |
| HP 8553L, RF Plug-in (for 140 Mainframes), use with 8552A, 1KHz-110MHz | $125 |
| HP 8601A, Sweeper Generator, .1-110MHz | $425 |
| HP 8614A, Signal Generator, 800-2400MHz, AM/FM Leveled | $475 |
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| HP 86242D, RF Plug-in, 5.9-9.0GHz | $350 |
| HP 8640B, Signal Generator, .5-1050MHz, Opt. 002/001 or 003 | $1,800 |
| HP 8640B, Signal Generator, .5-512MHz, Opt 001 or 003 | $950 |
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| HP 8901A, Modulation Analyzer | $1,000 |
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| Huntron Tracker 2000, w/410 Switcher (nice) | $1,000 |
| Kepco ATE15-50M, Power Supply, 0-15V @ 50A (metered) | $650 |
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| Tek PS501-1, Plug-in Power Supply | $150 |
| Tek PS503A, Plug-in Power Supply Triple | $175 |
| Tek OIG-502, Plug-in Optical Impulse Generator (unused) | $950 |
| Tek T922, Scope (15MHz), Dual Trace, nice | $175 |
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| Tek TM504, Power Module, 4 Slot | $150 |
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| Wavetek 145, Pulse/Function Generator, .0001-20MHz | $350 |
| Wavetek 185, Lin Log Sweep Generator, .0001Hz-5MHz | $425 |
| Wavetek 288, Synthesized Function Generator, 20Hz-20MHz (unused) | $950 |
| Wavetek 3000, Signal Generator, 1-520MHz | $525 |
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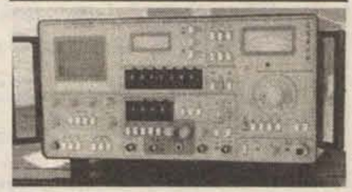

**CT SYSTEM, Inc. service monitor:** model 3000B, $800, good working condition. Frequency range 400KHz to 1GHz, RF output 0.03UV to 316MV, receive sensitivity 2UV, RF sweep generator, tone generator/decoder, FM marker at 600Hz and 5KHz, internal wattmeter, internal distortion analyzer, oscilloscope. Tel: 714-778-5151 Fax: 714-778-0312.

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**HP 8620C** sweep oscillator opt 011 with 862 42A RF plug-in $500; **HP** 8444A tracking generator $350; **Tek** 7912 AD programmable digitizer $400; **Tek** 7CT1N curve tracer $250; **Tek** SC 502 15MHz scope $250. Each with manual and 10 day right of return. **WALL SURPLUS,** phone/fax 732-681-2032 anytime.

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**SOLDER EXTRACTORS:** Pace MBT200 solder/desolder, $350; Pace SX25 with rotary vein pump bases rebuilt, $175; Weller DS100 mint, $250; Weller DS1000 digital readout, $350. Soldering stations: Weller EC2000 digital readout, $100, WTCP with Weller Ungar pencil new, $50. Ultrasonic cleaner, $75, Mesei **hot tweezers**, $50. 310-515-2058.

**TEST EQUIP.** Gen-Rad noise generators 1381, $350; 1382, $350; 1383, $650. All three, $1,000. 978-251-3855.

**HP PLOTTERS,** 7475A six pen HPIB, $250; 7470A, 2 pen HPIB, $200; 7475A, RS232, $150; 7550A, $400. A-COMM ELECTRONICS 303-341-2283.

**POWER METERS,** HP 432A, 8478A, $450; Wavetek 1034A, 1MHz-20GHz, -50/+10 dBm, AC or bat operation, $450; Boonton 42B, 10MHz-18GHz, $350; Boonton 42BD, digital 200KHz-12.4GHz, $450; Bird 43, $150. A-Comm Electronics 303-341-2283.

## SECURITY

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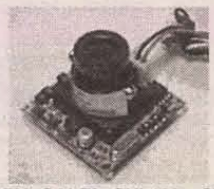

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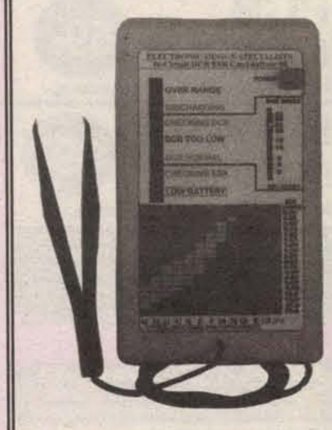

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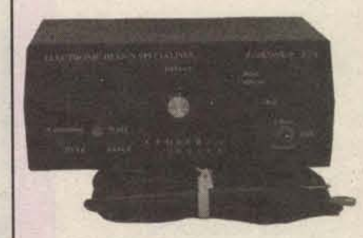

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**EIP 545A**
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Signal Generator, 1 to 2800 MHz, -137 to +10 dBm, frequency resolution is 100 Hz to 1040 MHz and 200 Hz to 2800 MHz, GPIB , 32 front panel stored settings.

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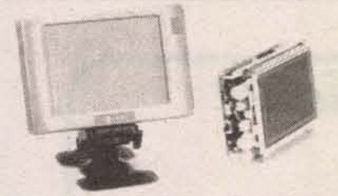

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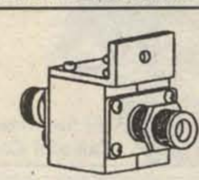

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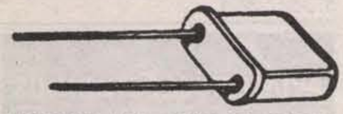

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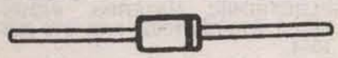

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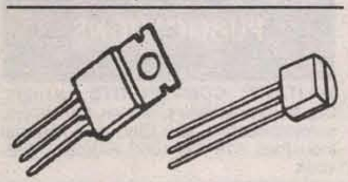

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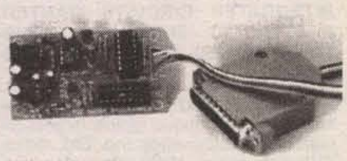

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**HOBBY CATALOG**: Broadcasting and microbroadcasting transmitters, amplifiers, antennas. **Start your own radio station books.** Audio, TV, ham, CB, surveillance, science projects, and more. **PAN-COM** International, Box 130-V, Paradise, CA 95967. **www.panaxis.com**

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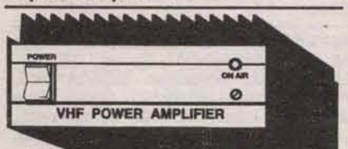
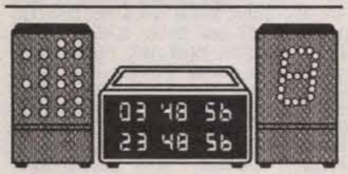
**ELECTRONIC KITS,** projects and supplies for prototyping, designing or hobby. Call 1-888-GO-4-KITS for catalogs or send $3 to Quality Kits, 49 McMichael St., Kingston, ON., K7M 1M8. **http://www.qkits.com**




**BROADCAST FARTHER!** 75-110MHz amplifier connects to stereo transmitters. Produces 2-15 watts. Requires 50-150mW drive. Complete plans with part source and antenna information only $14 + $2 S&H. **Progressive Concepts,** PO Box 586, Streamwood, IL 60107. 630-736-9822.

**SURVEILLANCE TRANSMITTER SCHEMATICS!** FM band- 2 telephone and 3 room transmitters constructed using Radio Shack parts with their numbers given. One telephone and two room transmitters are tunable from 65 to 305MHz, and constructed with listed supply house parts. PC board patterns presented. **PRICE**: $25 + S&H $2. For immediate shipment, pay with money order. **SHEFFIELD ELECTRONICS CO.**, PO Box 377940-E, Chicago, IL 60637-7940. Tel: 773-324-2196. http://www.adnetmk.com/sheffield




**TERRIFIC TIMEPIECES!** LED binary clock. LED digital clocks, other kits! Free catalog! WPC, 805-339-0702. www.west.net/~wpc

**MOD CHIPS for Sony PlayStation.** Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

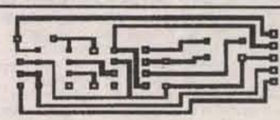
**TEST EQUIPMENT** kits. If you liked Heathkit, you will love Technology Systems, 4 Prospect Pl., Torrington, CT 06790.

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

**BUILD THE MENDOCINO MOTOR.** This fascinating device is a solar powered, magnetically levitated motor. It will delight and amaze you and your friends. The 27 page plans book includes a list of parts suppliers. The motor uses readily available parts. Plans are $15 plus $2.50 S&H. Write to: St. Elmo's Fire, PO Box 141, Stow, MA 01775. E-Mail: tcv@genrad.com

**200+ ELECTRONICS** PROJECTS. Build for pleasure or make 100% (or more) profits reselling printed plans. $1 (refundable) for catalog & dealer info. MATCO-A5, PO Box 509, ROSEVILLE, MI 48066-0509.

**AWESOME KITS:** voice changers, levitators, lasers, gas sensors, and more! Catalog $1. **LNS Technologies,** PO Box 67243, Scotts Valley, CA 95067. www.ccnet.com/~lnstech



**CIRCUIT BOARDS**. Single sided. No minimum. No set-up fees. No hidden costs. No per hole charge, up to 1,000 holes per panel. Complete price list available. Circuit Design, PO Box 5415, Central Point, OR 97502, 541-664-7904. Phone or Fax. The Worldwide Circuit Design Network, http://www.circuitdesign.net

***PCB Milling***

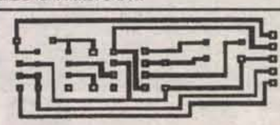
**CIRCUIT BOARDS.** Totally new! Low cost, precision-made PC boards from your Gerber/NC Drill files. Single and double sided. Full details at http://www.pcbmilling.com E-Mail: feedback@pcbmilling.com FAX: 703-818-0071.

**HEATHKIT COMPANY** is selling photocopies of most Heathkit manuals. Only authorized source for copyright manuals. Phone: 616-925-5899, 8-4 ET.

**MATCH BOOK sized FM wireless mic kit,** surface mount, color enclosure included. Details: www.Nmart.com or send $9.50 check/M/O plus $0.50 S&H to Anders Corp., 104 Gray St., Paterson, NJ 07501. Satisfaction guaranteed.

**18" COLOR LCD monitor kit.** Our exciting kit comes complete with an 18" DSTN LCD panel, an enclosure, all the cables, and instructions on how to assemble. Comparable to other monitors priced well over $2,000. Available in black or beige. Kit only $995. Digitron, 150K Mason Cir., Concord, CA 94520. 1-888-676-9971 x264.

**FORTY YEARS** in electronics and fourteen as reverse engineers, has produced 3,000+ schematic diagrams herded into 21 catalogs for sale to technicians trying to earn extra yenom repairing weird tronics, or those just curious how things work. Send **4 stamps** for list of catalogs and hurl inducing propaganda. **Bomarc Services,** Box 1113, Casper, WY 82602. ROLLO@TRIB.COM



**ENGINEERS-ELECTRONIC designers world wide advertising free!** On the world wide circuit design network. Go to **http://www.circuitdesign.net** for details.

## MANUALS – SCHEMATICS WANTED

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

**CASH FOR** your test equipment manuals in good condition for most Tektronix, HP, Fluke, and other test equipment. E-Mail your list and best price to: **manuals@lonemtn.com**

**NEED SERVICE** manual for Masco Sound Systems mod. # MA25 amplifier. Art Heyman, 15275 Desert Star Rd., Apple Valley, CA 92307, 760-240-0152.

**WANTED SERVICE** manual or copy for Radio Shack DUOFONE 16. 518-664-7215.

## MISCELLANEOUS ELECTRONICS FOR SALE

**FREE FLYER** on cable TV, phones, credit cards info, schematics, project boards, other misc. items. Bill 1-800-879-9657.

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

**HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE. European and American screwdrivers, nutdrivers, pliers, hex- keys, balldrivers, and more! Wiha, Bondhus, and Knipex. Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 732-758-8388. E-Mail: w2tv@csi.com**



**ELECTRONICS PARTS: BELOW WHOLESALE PRICES!** Phone, fax, E-Mail for free flyer. Hoffman Industries, 853 Dundee Ave., Elgin, IL 60120. Ph: 847-622-8201, Fax: 847-622-8202, toll free: 1-888-311-4248, E-Mail: hoffind@aol.com Web site & on-line catalog: http://hoffind.com

**ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE** since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors cut & strip to siec. If interested, please call **1-800-626-7540**, FAX: 714-771-5043. Visa/MC/Amex. SEE US ON THE INTERNET: http://www.anaheimwire.com OR E-Mail: info@anaheimwire.com

CAMAC), PMTs, optics, high vacuum, and high voltage components and equipment. Guaranteed quality at reasonable cost. OE Technologies, Box 703, La Madera, NM 87539. Ph: 505-583-2482, Fax: 505-583-9190, E-Mail: oetech@newmexico.com http://www.oetech.com

**CALL FOR** a **free electronics catalog** or visit our web site at **www.bgmicro.com/ B.G. Micro,** PO Box 280298, Dallas, TX 75228. Order line **1-800-276-2206**.

**INVENTORY LIQUIDATION:** DEC, Modicon, Siemens-TI, Sixnet, GE, AB, Delta TAU, Sorensen DC60A P/S, Huntron (circuit analyzer), Arium (logic analyzer), misc: ($1 a lb) components, connector, pins, ICs, indicator lamps, pots, relay, switches, LEDs, caps, transistors, fans, blowers, power supplies, 19 in. VGA monitors. Call Chip at IAS 410-584-7800 Fax: 410-584-7805.

**NEW WEB** SITE WWW.Psitech-Plus.com Purchase and sell test measurement equipment.

**2 NEW** Energizer "N" batteries, surplus catalog. Send $1, EDS, PO Box 502, Columbus, NE 68601.

**HIGHEND SURPLUS** 203-744-4101. OK INDUSTRIES DEMO BLOWOUT. If it is not listed just give us a call, chances are we have it! **SOLDER STATIONS**: total rework, forced convection, hot air. MTR5000 (retail $4,595) sell $2,350; MTR4000 (retail $3,995) sell $1,750; MTR3000 (retail $2,495) sell $1,250; BTR2000 (retail $1,595) sell $775; FCR2000 (retail $1,850) sell $950; BTR1000 (retail $825) sell $400; SMT1160 (retail $1,000) sell $450; SA2000 (retail $395) sell $185; SA1000 (retail $295) sell $150; SA500 (retail $225) sell $75. **PUR-AIR:** Fume exactors. EP101 (retail $1,695) sell $475; EP051 (retail $595) sell $225. **JEM:** Batch ovens JEM310 (retail $7,995) sell $3,600; JEM210 (retail $4,995) sell $2,200. **PICK & PLACE:** Chip placers, vacuum pencils, fluid dispensers. SMT8001 (retail $4,000) sell $1,750; SMT880 (retail $2,200) sell $950; FD1000 (retail $395) sell $175; VP100 (retail $395) sell $175. **BOARD ETCHER:** SSP-75A (retail $995) sell $400. **ALWAYS BUYING: VIDEO, RADIO, PHONE SYSTEMS, COMPUTERS, STEREO, AND BROADCAST EQUIPMENT.**

**SMT MANUFACTURING** equipment. components, digital, analog, & RF test equipment. 26 KVA generator. Closing R&D/manufacturing company. Must sell lots of equipment. Call 1-800-869-7827 or visit www.starcom.com for list.



Write In 54 on Reader Service Card.

**$$ATTENTION$$** Modem coupling transformer for sale mfg. Midcom: P/N 671-8000. 15k in stock for immediate shipping. Limited offer, call 732-294-1944 ask for Alex @ Global. Data sheet available.

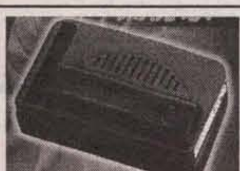
**SOLAR-POWERED FAN HAT**. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

**http://www.pccables.com PC** CABLES and PARTS. 100s of hard-to-find new cables and parts, Free technical information, low prices, fast online ordering & browsing.

**L BAND** quadrifilar T/R antenna, 55 dB LNA, 20 watt HPA, works great for remote GPS. Info at afstar.com.

**FOR SALE:** (E)EPROM, PIC, 874x, 8751, PAL, GAL, PLD, DC motor, stepper, LCD and many other new and used electronics components. Call 425-489-9042, E-Mail: **esreng@jps.net**

**ALPINE XL-15 electronic air cleaners** (four to sell) the best air cleaner in its class. Ozonator/RF ionizer combination **closeout sale** $325 each, 650-842-3268.



**Z64 GAME** recorder: self-contain computer with 32meg RAM, ZIP. Plug into N64 station. Unlimited game storage, saving $375. N64 is a Nintendo trademark. 1-800-266-5706 PCT. Website: mobil-e-tech.com

## MISCELLANEOUS ELECTRONICS WANTED

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

**TESTERS WANTED:** Immediate offers made for Ultrasonic, Magnetic Particle, Eddy Current, X-Ray and Borescopes, 24hrs. Leave detailed message with make/model. 1-800-530-3371.

**WANTED: ELECTRON** tubes, ICs, semiconductors. Summit, PO Box 1850, Linden, NJ 07036. Call 1-800-526-4052.

**WE BUY** your electronic excess inventories. ICs, caps, transistors, LED, connectors, PCBs, computers and related products. Call Tom Freeman 714-558-8813, fax 714-558-1603.

**WANTED: TUBE** HiFi/commercial amps, preamps, corner/horn speakers. Altec, Marantz, McIntosh, Western Electric, etc. 405-737-3312 fax 405-737-3355.

**ELECTRON TUBES,** transistors-RF aircraft radar & comm. Sold or bought. ARS Electronics, 7110 De Celis Pl., Van Nuys, CA 91406. 1-800-422-4250, fax 818-997-6158.

**WESTERN ELECTRIC** audio equipment wanted. 1927-1960's. Amplifiers, "preamps," speakers, transformers, tubes, etc. 1-800-251-5454.







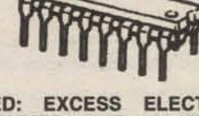
**WANT USED** or surplus DC motor controls or adjustable frequency AC drives, 1/2 HP and up. DC motors fractional to 3 HP. C. Woodruff, 5507 55th Ave. S., Seattle, WA 98118. Voice/Fax 206-723-8487.

**WANTED: TUBES,** radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Cranbury, NJ 08512-4212. Phone: 609-395-1116, FAX 609-395-1117.

**WESTERN ELECTRIC** audio equipment wanted. 1926-1960s amplifiers, speakers, pre-amps, tube, transformers, etc. 1-800-old-mics 1-800-653-6427 Great Wireless Museum.

**DEC EQUIPMENT WANTED!!!** We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

**OLD ICs & TRANSISTORS WANTED: HIGHEST PRICES PAID** please FAX your list with part number, quantity & condition of any semiconductors to Rick @ ESI, 5363 Broadway Ave., Cleveland, OH 44127. 216-441-8500 FAX 216-441-8503. Since 1946! www.electronicsurplus.com



**WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 562-494-4851 OR FAX 562-494-4913.**

**WESTERN ELECTRIC WANTED:** 1920's-1960's. Amplifiers, mixers, preamps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

# HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting hand-written copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

**NUTS & VOLTS MAGAZINE**, 430 Princeland Ct., Corona, CA 91719.

## RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

## WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

## PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **$5.00** to enlarge, reduce, or duplicate line art, or **$8.00** for halftone of photographs. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos.

## FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the **5th**) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

## DEADLINE

Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 5th. Cancellations and changes must be submitted in writing.

## IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

*Choose a category for your ad from the classifications listed below.*

- 10. Ham Gear For Sale
- 20. Ham Gear Wanted
- 30. CB/Scanners
- 40. Music & Accessories
- 50. Computer Hardware
- 60. Computer Software
- 70. Computer Equipment Wanted
- 80. Test Equipment
- 85. Security
- 90. Satellite Equipment
- 95. Military Surplus Electronics
- 100. Audio/Video/Lasers
- 110. Cable TV
- 115. Telephone/Fax
- 120. Components
- 125. Microcontrollers
- 130. Antique Electronics
- 135. Aviation Electronics
- 140. Publications
- 145. Robotics
- 150. Plans/Kits/Schematics
- 155. Manuals/Schematics Wanted
- 160. Misc. Electronics For Sale
- 170. Misc. Electronics Wanted
- 175. BBS & Online Services
- 180. Education
- 190. Business Opportunities
- 200. Repairs/Service

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**GET THE BEST PRICES AND SERVICE**

ALL UNITS ARE IN STOCK FOR IMMEDIATE SHIPMENT

# CABLE CONVERTERS AND ACCESSORIES

## CALL FOR PRICING ON ITEMS NOT LISTED

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| **NEW CONVERTERS** | | | | | |
| CENTURY CT-3000 | $64 | $60 | $55 | $50 | CALL |
| COMMERICIAL-11 | $75 | $70 | $65 | $62 | CALL |
| VIEWSTAR-550 MHZ | $50 | $45 | $42 | $38 | CALL |
| DIGITECH-550 MHZ | $55 | $49 | $48 | $46 | CALL |
| **EXPLORER CONVERTERS** | | | | | |
| EXP-6600 | $250 | $225 | $200 | $175 | CALL |
| **PANASONIC CONVERTERS** | | | | | |
| PAN-175/VOL | $165 | $155 | $145 | $135 | CALL |

WE WILL MEET OR BEAT ANY ADVERTISED PRICE

**1-800-800-0766**

**KIMTRONIX**

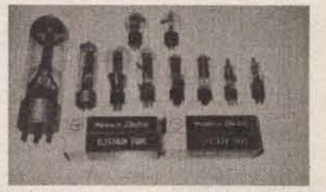
30 day money back guarantee. All shipping and handling at customers expense. Anyone implying theft of cable service will be denied sale. NO FLORIDA SALES.

WE WILL MEET OR BEAT ALL COMPETITOR'S PRICES IN THIS MAGAZINE

KIM-12

Write In 57 on Reader Service Card.

**WANTED: ELECTRONIC estates.** Ham, broadcasting, military, test, public address, tubes, transformers, telex equipment. The bigger the pile, the more worthwhile. We fly anywhere. Sumner McDanel 1-800-251-5454.



**HIGHEST PRICES paid for Western Electric tubes, new and used. Call Don Singerhouse/Singerhouse Sound. Toll free 1-888-715-tube.**

**WANTED: AVIONICS** test equipment, IFR, 600A, 401L, others, Collins, King, Sperry, North Atlantic, Litton INUs LTN series, rate and tilt tables, air data test sets, 941-625-3222 P, 941-625-0494 F, E-Mail: avionics@afcon.net

**WANTED: BALANCING** machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

**RADAR/MICROWAVE** equip: Aviation, marine, fire control. Like TPS 21, APS 10, 42 APG 30. Parts, TM's, etc. Radar, Box 10215, Pittsburgh, PA 15232.

**NERDY PROFESSOR** seeks equipment for restoration/display. Will pay fair price and shipping. Please E-Mail kovacs@cis.stanford.edu or fax 650-424-8931 if you have for sale: HP 9100A or B, 9810A, 9815A, 9820A, 9830A, HP 55, 65 or 67 or other early HP calculators, HP 01 calculator watch, HP quartz thermometer probes, HP 200A audio oscillator (tilt-to-open lid), HP 521 frequency counter, HP 970A handheld multimeter, Tek 511 oscilloscope.

## BBS & ONLINE SERVICES

**VISIT DON** Lancaster's **GURU'S LAIR** website at **http://www.tinaja.com** PICs, pseudoscience, PostScript, patents, Tinaja quests, flutterwumpers, book-on-demand, magic sinewaves, money machines, Navicubes, tramways, wavelets, and Webmastering. Online reprints, consultants net, forums, annotated hot links, surplus bargains, great heaping bunches more.

**MOD CHIPS for Sony PlayStation.** Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

## EDUCATION

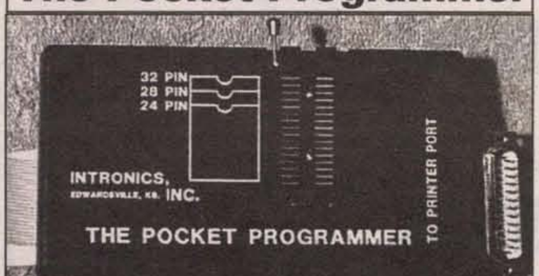
**START YOUR OWN TECHNICAL VENTURE!** Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

**DON LANCASTER'S ACTIVE FILTER COOKBOOK** is back in print. Autographed copies of the seventeenth(!) classic printing $28.50. **SYNERGETICS PRESS**, Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

**GRAND UNIFIED THEORY MADE EASY.** 110 page book explains a new theory linking gravity, electronics & magnetism. Explores universe mysteries, goes beyond relativity & quantum theory. **$9.95.** To order: send check or M/O to American Science Innovations, PO Box 155, Clarington, OH 43915.

**WANTED: SOMEONE** to teach me PIC and/or single board computers. I have some knowledge, but need more! I have a project that needs stepper motor controls, among other things. Would like to find someone in the central NJ area if possible. E-MAIL: GARYBAL@AOL.COM

## The Pocket Programmer




The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs E(E)prom, Flash & Dallas Ram. 27(C)/28(C)/28F/ 29F/29CXXXX & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, MCU's 874X, 875X, 40-Pin X 16 & Serial Eprom's, PLCC, 5-Gang, 82/74 ·Prom's and Eprom Emulator to 32K X 8.

Only $129.95

**Same Name, Address & Phone Number for 16 Years.... Now isn't that Amazing ?**

**Intronics, Inc.**
**Box 13723 / 612 Newton St.**
**Edwardsville, KS 66113** — **Add $5.00 COD**
**Tel. (913) 422-2094** — **Add $4.00 Shipping**
**Fax (913) 441-1623 Visa / Master Charge / Amex**

# ACP's 88th GIANT COMPUTER SWAP★MEET


**All Day Sunday 8am-2pm**

**Nov 29th**

**FREE** Admission & Parking
Shop 100's of Sellers

***in ACP's Giant Parking Lot !!!***

**Advanced Computer Products, Inc.**

**ACP SUPER★STORE**

*Since 1976*

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

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**MILLIONS $$$** in "scrap gold" from old computers and electronics junk. Message: 603-645-4776 or www.tiac.net/users/quiksand/goldtek.htm

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

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*Try a classified ad in Nuts & Volts. Details on page 68.*





Write In 58 on Reader Service Card.

 Continued from page 47

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Web: http://members.aol.com/earsam/

**NOVEMBER 29**

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

**NY - PATCHOGUE** - Hamfest. Mid Island ARC; Mike Grant N2OX, 516-736-9126. E-Mail: globalcm@erols.com Web: http://members.aol.com/midisarc/98fest.html

## DECEMBER 1998

**DECEMBER 5**

**AL - DOTHAN** - Hamfest. Wiregrass ARC, Cheryl Tucker KD4BWE, 334-677-7485

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

**GA - CLAXTON** - Hamfest. Veterans Community Center, Hwy. 280 W. VE Exams. Talk-in: 147.075+. Claxton AR Emergency Service, Mr. Ellie Waters WB4CJB, 912-653-4939. E-Mail: ellie@premierweb.net. Wes Kennedy KU4SR, 912-739-2047, E-Mail: ku4sr@mci2000.com

**LA - MINDEN** - Christmas Hamfest. Civic Center, 520 Broadway. 8:30am-3pm. VEC Exams. MARA repeater 147.300+. MARA, Inc., Dusty Collins KB5WFE, 318-371-0636.
E-Mail: dustyc@prysm.net
Web: http://www.norwesla.com/mara.htm

**MN - GOLDEN VALLEY** - Hamfest. Courage Handi-Ham System, Nancy Meydell, 612-520-0512

**NC - GREENSBORO** - Hamfest. Coliseum Special Events Center. 9am-3pm. 76 Group, 336-851-1676. http://www.sabwc.com/gsohamfest

**DECEMBER 6**

**CA - LIVERMORE** - Hamfest. Livermore ARK, Cliff Kibbe KF6EII, 209-835-6715.
E-Mail: larkswap@hotmail.com

**DECEMBER 12**

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

**FL - LAKE CITY** - Hamfest & Computer Show. Columbia County Fairgrounds, SR 247, Gateway to FL #4. Columbia ARS, Joe Aymond WD4EOJ, 904-935-2405 6-10pm, E-Mail: wd4eoj@isgroup.net or Colin Boutwell WA5RKR, 904-755-7960, E-Mail: wa5rkr@isgroup.net

**SC - UNION** - Hamfest. Union County ARC, Roger Gregory KI4RG, 864-427-1462.
E-Mail: rgregory@carol.net

**DECEMBER 19**

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

## JANUARY 1999

**JANUARY 2**

**TN - MORRISTOWN** - Hamfest & Computer Show. Talley Ward Recreation Bldg. Talk-in: 147.303+ & 53.030-. Lakeway ARC, Perry Hensley N4PH, 423-828-4848 E-Mail: n4ph@juno.com. Kemp Lawson KF4AGB, 423-587-3320. E-Mail: kemplawson@aol.com.
Web: www.usit.net/mfawbush/larc.html

**JANUARY 9**

**SC - GREENWOOD** - Hamfest & Computer Show. Greenwood Civic Center, 1610 Hwy. 72 E. 9am-5pm. FCC exams. Talk-in: 147.165+ (open) alternate: 146.52 simplex. Greenwood ARS, Frank Kolar WA9FWO, 864-229-5639.
Web: http://www.w4gwd.org

**WI - WAUKESHA** - Hamfest. Waukesha County Expo Center Forum. 8am-2pm. West Allis RAC, Phil Gural W9NAW, 414-425-3649

**JANUARY 9-10**

**FL - FT. MYERS** - Hamfest. Sat: 9am-3pm, Sun: 9am-2pm. Talk-in: 146.880. Ft. Meyers ARC, Colleen Sammons KQ4TR, 941-936-1431.
E-Mail: csammons@juno.com

**JANUARY 10**

**IN - SOUTH BEND** - Hamfest. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, 219-291-0252

**JANUARY 16**

**FL - LANTANA** - Flea Market. Next to Pizza Hut, 6170 S. Congress Ave. 7am-12pm. Talk-in: 146.67. The Major Armstrong FM Assn., Jeff Beals WA4AW, 561-586-5120. Al West W4SDC, 561-641-8244

**LA - HAMMOND** - Hamfest. Southeast Louisiana ARC, Jack Stang N5XVJ, 504-542-7605.
E-Mail: jstang@i-55.com

**MI - FLINT** - Hamfest. AR & Youth, Clay KF8UI, 810-233-7889. E-Mail: clay@iavbbs.com

**MO - ST. JOSEPH** - Hamfest. Ramada Inn, I-29 @ Frederick Ave. 8am-3pm. Talk-in: 146.85 and 444.925. Missouri Valley ARC & Ray Clay ARC, John Winkler WB0VRA, 816-424-6484. Gaylen Pearson, E-Mail: WB0W@IBM.Net

**JANUARY 17**

**MI - HAZEL PARK** - Hamfest. Hazel Park High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64 (-). Hazel Park ARC, Tom Austin N8TMQ, Tom Krausnick WC9F. HPARC, POB 368, Hazel Park, MI 48030.

**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053

**JANUARY 23**

**NC - WINSTON-SALEM** - FirstFest. Dixie Classic Fairgrounds, Home & Garden Bldg. Forsyth ARC, Inc., 336-723-7388. E-Mail: n4loz@ibm.net
Web: http://www.rbdc.com/~kq4lo/farc.htm
Web: http://members.xoom.com/w4nc/

**JANUARY 24**

**OH - DOVER** - Hamfest. Tusco ARC, Howard Blind KD8KF, 330-364-5258

**JANUARY 29-30**

**MS - JACKSON** - Hamfest. Jackson ARC, Ron Brown AB5WF, 601-956-1448 or 601-982-0101.
E-Mail: ab5wf@juno.com
Web: http://www.jxnarc.org

**JANUARY 30**

**AL - GREENVILLE** - Hamfest. Butler & Pike County RACES, Jerry McCullough KE4ERO, 334-382-7644. E-Mail: w4mpq@alaweb.com

**JANUARY 31**

**MD - ODENTON** - Hamfest. Maryland Mobileers ARC, Bill Ziegler KA6TYY, 410-987-2384.
E-Mail: ka6tyy@juno.com

## FEBRUARY 1999

# Events CALENDAR

**FEBRUARY 6**

**SC - NORTH CHARLESTON** - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: BRYCEMYERS@AOL.COM

**FEBRUARY 6-7**

**FL - MIAMI** - Tropical Hamboree. Fair Expo Center, S.W. 112th Ave. & Coral Way. VE Exams. Talk-in: 146.925, 146.76, 444.525. Dade Radio Club of Miami, Evelyn Gauzens. 305-642-4139, E-Mail: edg@elink.net. 305-226-5346, E-Mail: wd4sfg@bellsouth.net. Web: www.hamboree.org

**FEBRUARY 7**

**OH - LORAIN** - Hamfest. Northern Ohio ARS, Mike Willemin W8EU, 440-324-4574

**FEBRUARY 12-13-14**

**FL - ORLANDO** - Hamfest. Northern FL Section Conv., Tim Starr AE4NJ, 407-850-9258. E-Mail: AE4NJ@aol.com
Web: http://www.oarc.org/hamcat.html

**FEBRUARY 13**

**NY - WESTFIELD** - Hamfest. Westfield Exempt Volunteer Fireman's Assn., 75 Bourne St. 8am-3pm. Talk-in: 145.350 (-). Chautauqua County RAs, Eric Kroon N2PCQ, 716-595-3220. E-Mail: ekroon@netsync.net

**FEBRUARY 20**

**FL - BROOKSVILLE** - Hamfest. Spring Hill VFW Post 10209, Spring Hill Dr. between US 41 & Mariner Blvd. Talk-in: 146.715. Hernando County ARA, Ralph Wilson AF4FC, 352-754-9653. Jim Angello KE4SZP, 352-688-5214.
E-Mail: iangello@fiber-net.com
Web: www.fiber-net.com/pub/hcara/index.htm
**MN - BLAINE** - Hamfest. Robbinsdale ARC, Jerry Dorf N0FWG, 612-537-1722.
E-Mail: jerryd@skypoint.com

**FEBRUARY 21**

**NC - ELKIN** - Hamfest. Briarpatch & Foothills ARCs, Jimmy Holbrook KB4GKI, 336-957-3820. E-Mail: kb4gki@aol.com Web: http://members.aol.com/kb4ghi/kb4gki.html

**FEBRUARY 27**

**KY - CAVE CITY** - Hamfest. Mammoth Cave ARC, 502-651-2363. E-Mail: lbrumett@glasgow-ky.com Web: http://www.scrtc.blue.net/mcarc

**FEBRUARY 27-28**

**OH - CINCINNATI** - Convention. Great Lakes Div. Conv., William Tittle KA8LAY, 513-661-1861. E-Mail: gldivconvention@juno.com

**FEBRUARY 28**

**NY - MELVILLE** - Hamfest. Radio Central ARC, JoAnn Colletti N2IME, 516-399-1877. E-Mail: wo2n@li.net
**OH - CIRCLEVILLE** - Hamfest. Teays ARC, Roy Ulko KG8EK, 740-477-8310. E-Mail: royulk@scioto.net
**OH - CUYAHOGA FALLS** - Hamfest. Cuyahoga Falls ARC, Carl Hervol N8JLQ, 330-497-7047. E-Mail: carlh@pop.raex.com

## MARCH 1999

**MARCH 5-6-7**

**NE - NORFOLK** - State Convention. Fred Wiebelhaus N0VLX, 402-379-1929.
E-Mail: dfwiebel@sufia.net Web: http://members.aol.com/davidn0xbn/evarc.html

**MARCH 6-7**

**FL - NEW PORT RICHEY** - Hamfest. Gulf Coast ARC, Rick Brown KF4GXS, 813-842-2127. E-Mail: richar@gte.net

**MARCH 7**

**NY - LINDENHURST** - Hamfest. Great South Bay ARC & Suffolk County RC, 516-422-9594. E-Mail: ka2d@li.net Web: http://www.gsbarc.org
**WI - WAUKESHA** - Swapfest. Waukesha County Expo Center. 8am-2pm. VE Exams. Talk-in: 146.82 PL 127.3. SEWFARS, John Breecher N9NWN, 414-835-7035

**MARCH 13**

**MO - KANSAS CITY** - Hamfest. Ararat AR Shrine Club, Steve Dowdy WJ0I, 816-941-3392. E-Mail: sdowdy@qni.com
**WA - PUYALLUP** - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 253-631-3756 or 425-867-4797. E-Mail: mwdink@eskimo.com

**MARCH 13-14**

**NC - CHARLOTTE** - Hamfest & Computerfair. Charlotte Merchandise Mart, 2500 E. Independence Blvd. Mecklenburg ARS, Tim Slay WO4G, 704-382-3234 (W) or 704-948-6283 (H).
E-Mail: wo4g@w4bfb.org
Web: http://www.w4bfb.org/hamfest.html

**MARCH 14**

**OH - CONNEAUT** - Hamfest. Conneaut ARC, Jack Marttila KA8TUU, 440-593-3353

**MARCH 20**

**FL - STUART** - Hamfest. Martin County ARA, David Millard KE4AMW, 561-288-7100

**MARCH 20-21**

**TX - MIDLAND** - Hamfest. Midland ARC, Beverly Harwood KC5BNT, 915-686-1841.
E-Mail: shamrock@apex2000.net
Web: http://www.lxnet/edge/midswap.htm

**MARCH 21**

**NC - KINSTON** - Down East Hamfest. Lenoir County Fairgrounds, Hwy. 11 S. 8am-3pm. Doug Burt W4OFO, 252-524-5724
**OH - MAUMEE** - Hamfest. Toledo Mobile Radio Assn., Brenda Krukowski KB8IUP, 419-243-3836. Web: http://www.tmrahamradio.org

**MARCH 27-28**

**MD - TIMONIUM** - Maryland State Convention. Sharon Dobson N3QQC, 410-HAM-FEST (Box 3772), 1-800-HAM-FEST (Box 3772). E-Mail: n3qqc@amsat.org Web: http://www.gbhc.org

## APRIL 1999

**APRIL 10**

**NC - MORGANTON** - Hamfest & Computer Fair. Burke County Fairgrounds, Hwy. 181N (Exit 100 Eastbound, Exit 105 Westbound I-40). 8am-5pm. Talk-in: 147.15 (K4VLY repeater). Catawba Valley, Tom Tayler, 704-433-6205.
E-Mail: kc4qpr@vistatech.net

**APRIL 11**

**NC - RALEIGH** - RARSFest. State Fairgrounds. Raleigh ARS, Wilbur Goss WD4RDT, 919-266-9883

**APRIL 18**

**CT - HARTFORD** - 1999 Trinity College Fire-Fighting Home Robot Contest. Trinity College campus. Jake Mendelssohn, 190 Mohegan Dr., West Hartford, CT 06117.
E-Mail: JMENDEL141@AOL.COM
Web: http://www.trincoll.edu/~robot

## MAY 1999

**MAY 2**

**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053

## SEPTEMBER 1999

**SEPTEMBER 26**

**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053

# TECH FORUM

*Continued from page 44*

HFFAX reception. A good pointer is http://ourworld.compuserve.com/homepages/HFFAX/toc6.htm.

**G. L. Roylance**
**via Internet**

**ANSWER TO #109814 - OCT. 1998**

How you decompress your hard drive is entirely based upon which compression mechanism/program was used to compress it. There are many out there, such as Stacker, SuperStor, Doublespace, Drivespace, DriveMax, etc., and they each have different decompression methods.

**Kurt Richter**
**via Internet**

**ANSWER TO #10984 - OCT. 1998**

You requested a way to input/output data between two computers using the serial ports. I was somewhat confused by what exactly you wanted to do, but for simple commands, DOS has just what you asked for.

I think the CTTY command is available in DOS 5.0 and lower, but can be used with any version after it is added to the SETVER list (type HELP SETVER, and HELP CTTY at the DOS prompt for more info).

CTTY basically re-directs keyboard input and screen output to a serial port, or other device as directed. See below for more information.

To output commands from the second computer serial port to the first, just use the echo command with the re-director. The following is an old DOS trick for testing modems, but can be modified for your use.

This is a quick way to test a modem to see if you have interrupt or software conflicts. Boot DOS using F5 (loads nothing).

At the DOS prompt ENTER: (the following assumes the modem is on COM 2).

echo ATDT > com2 (you should hear dial tone).

echo ATH > com2 (should make the modem hang up).

**NOTE:** On some Pentium systems with the on-board serial ports, you may have to issue the first command twice (the first time will just wake up the port).

All you should need for an interconnection cable is a three-wire cable, ground, transmit, and receive with the last two crossed.

DB25 DB25 or on a DB9
RED TD 2 —— 2 3 TD
GREEN RD 3 —— 3 2 RD
BLACK GRD 7 —— 7 5 GRD

And from PC Mag info: The CTTY command. Purpose: Replaces the standard input and output (keyboard and screen or CON) with a different I/O device. Used rarely.

Syntax: CTTY device. Remarks: You must be sure that the specified device is both an input and output device. Use CTTY CON to reset for normal operations.

Example: CTTY AUX. All screen messages will be sent to the AUX device (the first serial port) and all keyboard input will come from that device.

You mentioned something about building a circuit to do something that would let you use two keyboards in parallel via the serial port. It would seem to me that you could do that with some simple C programming much easier.

**Randy Boettjer**
**Oakview, CA**

**ANSWER TO #10982 - OCT. 1998**

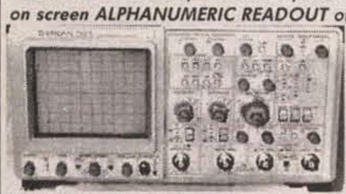
Blocking the unknowns with your Caller ID box is a very bad idea. You will block out all operator-assisted calls such as collect calls, possibly any calls from 911 (if such ever occurs), any calls from some cell-phone companies, any international calls, and possibly any call from a region of the US that doesn't support Caller ID.

There are probably other occasions as well. Unknown callers are a known backdoor to the Caller ID system, and this backdoor is there for

*Continued on page 85*

# MOVE IT! MOVE IT! MOVE IT!

## TEKTRONIX 2465, 4 Channel, 300MHz, O'Scope on screen ALPHANUMERIC READOUT of waveform stats.



One of the most popular & powerful scopes available at a reasonable cost. Features: 500ps/Div sweep, 2mV/Div. vertical sensitivity, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vert. & horiz. scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. Complete with 2 new probes, pouch, cover and manual.
Mint condition. Calibration and 90 day warranty. **$2295.00**

## ROTARY TABLE with PRECISE <0.02° RESOLUTION

Hard to find rotary motion base. This 13lb. unit includes a 9.25" diameter anodized aluminum platter with a toothed outside diameter. A toothed belt surrounds the O.D. and is driven by a 1/2"diam. toothed pulley attached to the output of a Bayside 5:1 ratio, right angle drive, powered by a Slosyn, M061-LF-504, 1.25V, 3.8A, 200 step per rev., 60 oz/in. stepper motor. By our estimate this should equate to about an 18500:1 final drive ratio! or about 0.0195 deg. per full step! Overall size is: 14.5"W x 17"L x 4.75"H Constuction is of anodized aluminum with a cast structural resin outer chassis. Removed from precision optical device. **$229ea. 2 for $399.**

## LENGTHLY LINEAR SLIDE, CAN GIVE YOU A LIFT as WELL !

Four different lengths available, all with similar construction. All units based on a heavy duty 1.5" wide, stainless steel, dual rails. Drive is via a toothed belt, powered by a SLO-SYN M061-LF-504, 1.25V @3.8A stepper motor with 200 steps per rev and 60 oz. in. hold. The "Medium unit" shown right, also includes a precise Z axis drive, providing 3.5 inches of precise travel by virtue of its' 4:1 ratio toothed belt drive. Powered is by another M061-LF-504 steper. The remaining three lengths have no Z drive. All units incorporate a superior quality, recirculating ball bearing slide with 3" x 3" x 1/2" thick mounting plate. "Z" unit size: 7"H x 2.5"W x 5.75D Very limited quantity. Also the "short" slide is mounted on a 1/4" thick anodized alum. plate. All have been carefully removed for precision optical equipment. The dimensions and travels are listed below:

| Model | Travel | Rail L" | Weight | Overall Size | Price |
|---|---|---|---|---|---|
| Ex Long: | 46" | 49" | 12lbs. | 51"L x 5"W x 3.5"H | $149ea. or $269 for pair. |
| Long: | 30" | 33" | 9lbs. | 39"L x 5"W x 3.5"H | $129ea. or $229 for pair. |
| Med.w/Z: | 20" | 23" | 12lbs. | 24"L x 2"W x 4.6"H | $139ea. or $249 for pair. |
| Short: | 11.5" | 16" | 7lbs. | 16"L x 4"W x 6.5"H | $69ea. or $119 for pair. |

## TWO MINI C-MOUNT CAMERAS, The super sensitive, GM410 or the general purpose GM412,

The GM-412 specs: B&W, size 1.5"sq. X 2.4"L, 250,000 Pixels, **380** Lines Resolution, Sensitivity **0.3** Lux, The GM410 specs: size only 1.5" SQ. x 1.6"L, >270,000 Pixels, **410** Lines Res., Sens. **0.05 LUX.**, Both cameras are 1/3" CCD with AGC & Electronic shutter. 12V @110mA power. NTSC out. IR SENSITIVE, BNC video out, Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform ***ANY*** camera in this magazine. Multi- lens options are available to exploit their superior performance. **GM412, less lens..$119, GM410, less lens..$169**

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**Model 117643-01 or 116643-02**

240VAC @2.5A or 120VAC @4A bypass, brushless type with isolated speed control. With a 0 to 10VDC signal applied to the control pin blower speed varies from 0 to 100%. Produces up to 120CFM. Can operate with static pressures up to 25" $H_2O$. Size: 5.9"diam x 5.2" w, With 1.75" O.D. output port.
**Reg. $165 NOW.......$39ea. or 2 for $69**

## C-MOUNT LENS OPTIONS to ENHANCE YOUR IMAGE:

**Fast Lenses for Low Light or General Purpose Normal Light**

| | |
|---|---|
| 16mm, f1.6, 15° FOV ........$39 | 4mm, 80° FOV ........$24 |
| 8mm, f1.3, 40° FOV ........$49 | 8mm, 40° FOV ........$24 |
| 4mm, f1.4, 78° FOV ........$49 | 12mm, 28° FOV ........$24 |

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Brand New, model GM550, Size: 1.6" x 1.6" x1.5"L, 1/3" CCD with SONY CCD & DSP technology. 4mm, f1.8 glass lens, 80° FOV. Resolution >350 lines, sensitivity, 0.3lux, AWB, AGC & auto electronic shutter 1/60 to 1/10,000 sec. Pwr. 12VDC @160ma. NTSC out. Budget color surveillance. **Reg. $269, SPECIAL GM550-STD.....$149ea. GM550-PH.......$149ea.**

## PRICE BUSTER, DSP, COLOR, MINI C-MOUNT, CAMERA,

Brand New, model GM859, Size only: 2" x 2" x2.5"L, Latest 1/4" CCD technology. Res. 350 lines, sens. , <3lux, auto white balance, AGC. Auto iris connector. 9-12VDC @150ma power. BNC video out. Switchable gain. Superior cast aluminum housing with top and bottom mounting. Perfect for general surveillance. Less lens. Lens options listed below. **Reg. $299**
**Save $100, GM859.....$199**

## NEW MICRO CAMERA, w/audio

1/3" CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Pwr. from 9 to 12VDC @100mA, 250k PIXELS, Std. model, 3.6mm, 92° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2 once! SENSITIVE to IR. Size Std: 1.25"sq. x 1"d. PH is 0.6"d, Both with 6" leads. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS.Six models to choose from.

| | |
|---|---|
| **GM-1000A-STD......$80** | **GM-1000A-STD/Aud....$85** |
| **GM-1000A-PH........$80** | **GM-1000A-PH/Aud......$85** |
| **GM-1000A-CMNT..$80** | **GM-1000A-CMNT/Aud.$85** |

**Micro Lenses for GM1000 series**

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|---|---|
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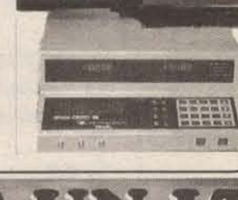

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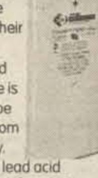

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# SECURITY ELECTRONICS SYSTEMS AND CIRCUITS — Part 10

*Ray Marston describes a variety of add-on automobile security circuits in this final episode of the series.*

by Ray Marston

## INTRODUCTION

All previous episodes of this series have dealt with security circuits that are designed for use in domestic, commercial, or industrial applications. By contrast, this concluding episode deals exclusively with fairly simple 'add-on' security circuits designed for use in automobiles fitted with normal 12V negative-ground electrical systems.

Modern automobiles virtually bristle with various 'security' devices and gadgets that are designed to enhance the vehicle's safety, reliability, mechanical efficiency, and immunity to theft.

If you own a reasonably modern (post 1994) automobile, it is probably already so well-equipped with good security devices that you will not need to add any more. If, on the other hand, your vehicle dates back beyond 1989, you may be able to gain by fitting one or more of the simple circuits that are described in this article, or by using one or more of the various commercial 'add-on' vehicle security units that are widely available.

The circuits described here include simple engine immobilizers and anti-theft alarms, ice-hazard, low-fuel-level, and 'lights-are-on' alarms, a headlight time-delay switch, and a timed auto-turn-off rear-screen heater controller.

## VEHICLE IMMOBILIZER CIRCUITS

Most immobilizers work by disabling the vehicle's engine, thus minimizing a thief's chances of starting or driving the automobile. The simplest and most effective way to immobilize a vehicle fitted with a normal petrol (gasoline) engine is to physically remove its ignition system's rotor-arm.

This task (which was compulsory in the UK during WW2) only takes half a minute to perform, and is recommended whenever a vehicle is left parked in a public area for more than a few days, but is too inconvenient a practice for every-day use.

Instead, simple and convenient immobilizers can take the form of a secret switch (or remotely-controlled relay contacts) wired into some vital electrical part of the vehicle's engine; *Figures 1* to *4* show some basic circuits of this type.

*Figures 1* and *2* show how immobilizers can be wired into the engine's ignition system. In *Figure 1(a)*, switch S1 is wired across the engine's contact-breaker (CB) points; when S1 is open, the ignition operates normally, but when it is closed, the CB points are shorted out and the engine is unable to operate. This simple circuit gives excellent protection, particularly if the wiring is carefully concealed at the CB end, but S1 must be able to handle the coil's high operating current when it is closed, and be able to withstand the CB point's typical 600V peak-to-peak 'ringing' voltages when the engine is operating normally.

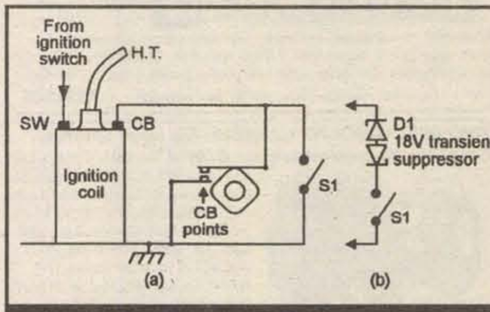


Figure 1. Contact-breaker immobilizer, operates when switch is closed.

The improved immobilizer circuit of *Figure 1(b)* does not suffer from the above snags. Here, an inexpensive and easily available 18V transient suppressor diode (D1) — which acts like a pair of back-to-back zeners — is wired in series with S1. This device passes no current until its applied voltage exceeds 18V, and acts like a near-short to voltages greater than 18V. Thus, in this circuit, S1 passes zero DC current when it is closed, but kills the ignition systems vital 'ringing' voltages when an attempt is made to start the engine. This circuit gives superb anti-theft protection.

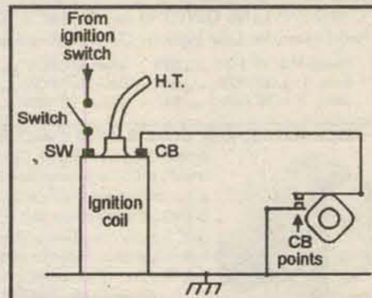


Figure 2. Ignition immobilizer, operates when switch is open.

In *Figure 2,* the immobilizer switch is wired in series with the vehicle's ignition switch, so that the engine operates only when the switch is closed. The protection offered by this widely-used type of circuit is not quite as good as that of *Figure 1*, since a moderately skilled thief can easily bypass the immobilizer and ignition switches by simply hooking a wire from the battery to the SW terminal of the ignition coil.

*Figure 3* shows how a heavy-duty immobilizer switch can be wired into the vehicle's electric starter system, so that the starter only operates if this switch is closed. This system gives better protection than that of *Figure 2*, but is not as good as *Figure 1* because the starter solenoid can be operated manually on many old vehicles, and also because the starter and immobilizer switches can be bypassed by a single length of wire.

Finally, *Figure 4* shows how



 

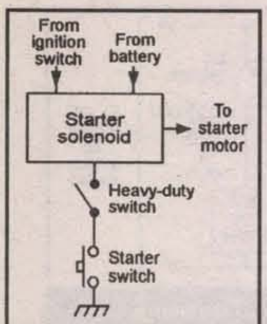

Figure 3. Starter-motor immobilizer, operates when switch is open.

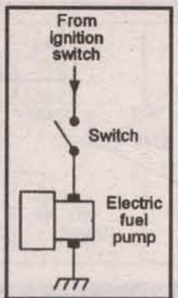

Figure 4. Fuel-pump immobilizer, operates when switch is open.

an immobilizer switch can be wired in series with the electric fuel pump on suitable vehicles, so that the pump only operates when this switch is closed. Note that this system lets a thief start the engine and drive for a short distance on the carburetor's residual fuel, which is quickly used up.

A weakness of the *Figure 1* to *4* circuits is that they must all be turned on and off manually, and thus only give protection if the owner remembers to turn them on. By contrast, *Figure 5* shows an immobilizer that turns on automatically when an attempt is made to start the engine, but can be turned off by briefly operating a hidden push-button switch. A small 'reminder' LED turns on when the engine is disabled by the immobilizer. This circuit thus gives a high level of protection, since it does not depend on the memory of its owner, and operates as follows.

The coil of 12V relay RLA is shunted by series-connected R1 and an LED, which illuminates when RLA is on, and this combination is wired in series with 1000µF capacitor C1, which is shunted by series-connected n.o. relay contacts RLA/1 and n.c. push-button switch S1. This RLA-C1 combination is wired between the ignition coil's SW terminal and ground, and the relay's RLA/2 n.o. contacts are wired across the vehicle's CB points (using a *Figure 1b* connection).

Normally, C1 is fully discharged; consequently, when the ignition switch is first closed a surge of current flows through RLA coil via C1, and the relay turns on and the LED illuminates. As the relay goes on, contacts RLA/1 close and lock the relay on via S1, and contacts RLA/2 close and short out the vehicle's CB points, thus immobilizing the engine. The relay stays on until S1 is briefly opened, at which point the relay unlatches and C1 charges up rapidly via the relay coil, and the relay and LED then turn off. As the relay turns off, it removes the short from the vehicle's CB points, and the engine is able to operate in the normal way.

## ANTI-THEFT ALARM CIRCUITS

Vehicle anti-theft alarms come in a variety of basic types, and the most reliable of these are the types that are switched on/off externally (rather than internally) and are activated via simple door-controlled microswitches or via a battery-voltage sensing circuit.

In modern vehicles, the external on/off control function is usually obtained via an IR remote-control system, but on older vehicles, it can be obtained cheaply and simply via a prominent key-switch (or a concealed toggle switch) fitted to the outside of the vehicle. *Figures 6* to *8* show practical alarm systems of these types that are designed for use in older vehicles; each of these circuits can also act as an immobilizer and, if required, operates the vehicle's horn and lights and immobilizes the engine under the 'alarm' condition.

In the *Figure 6* and *7* circuits, microswitches that are built into the vehicle are used (when the alarm system is enabled) to trip a pair of self-latching relays when any of the car doors, hood, or trunk are opened; these relays immobilize the engine and operate the horn and headlights either directly or via additional timing circuitry.

Two suitable front-door microswitches are built into most vehicles as standard fittings and are used to operate the courtesy or dome lights; additional dome-light-operating microswitches — which are readily available from specialist 'vehicle security' retailers — can easily be fitted to the rear doors. Similar microswitches can be used as 'auxiliary' switches to protect the hood and trunk (bonnet and boot).

The operation of the *Figure 6* circuit is very simple. The alarm is enabled by closing the external key switch. When the key switch is closed, current flows through both relays via D1 if any of the door switches close, or flows through them via D2 if any of the auxiliary switches close. In either case, both relays turn on.

As RLA goes on, contacts RLA/1 close and lock both relays on, and contacts RLA/2 close and short out the vehicle's CB points (using a *Figure 1b* connection), thus immobilizing the vehicle. Simultaneously, contacts RLB/1 close and switch on the car horn

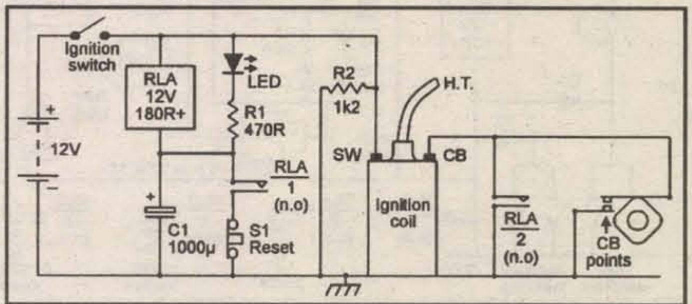

Figure 5. Self-activating immobilizer circuit.

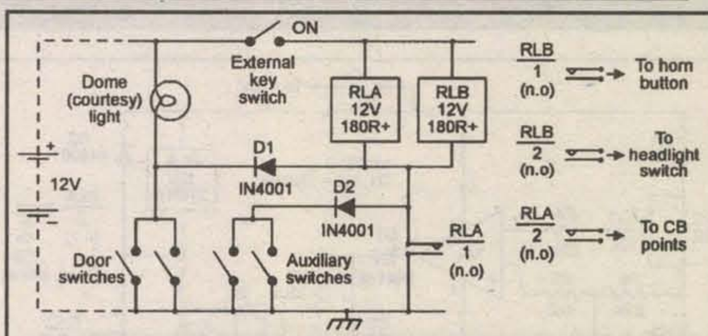

Figure 6. Basic microswitch-activated anti-theft alarm/immobilizer.

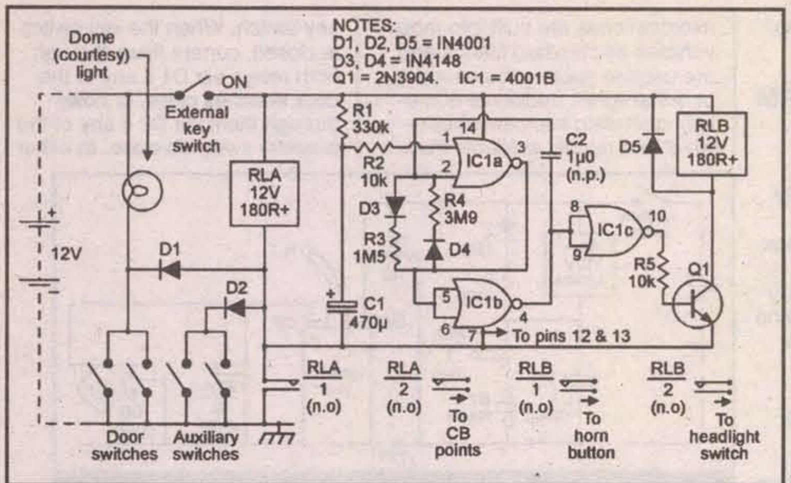


Figure 7. Improved anti-theft alarm/immobilizer has pulsed and time-controlled outputs.

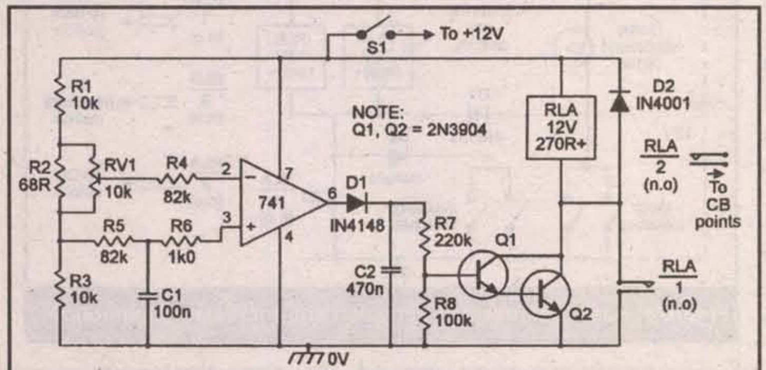


Figure 8. Basic voltage-sensing alarm circuit.

(or a siren unit), giving an audible indication of the intrusion, and contacts RLB/2 close and switch on the headlights (or activate a headlight flasher unit), giving a visual identification of the violated vehicle. The horn and light (etc.) remain on until the key-switch is opened.

Obvious weaknesses of the simple *Figure 6* circuit are that, if it is activated and is not switched off manually within a reasonable space of time (typically 15 minutes), it will probably break local noise-control regulations, will probably damage the horn, and will eventually flatten the vehicle's battery. *Figure 7* shows a way of modifying the *Figure 6* circuit so that the horn and lights turn off automatically after about four minutes, but the immobilizer stays active until turned off via the key switch, thus eliminating all of the above problems.

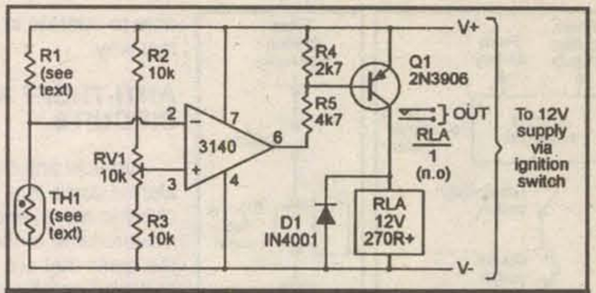


Figure 9. Relay-output ice-hazard alarm.

In *Figure 7*, RLA turns on and self-latches in the same way as in the *Figure 6* circuit, but as contacts RLA/1 close, they connect the full battery voltage across the RLB-driving timer-gated asymmetrical pulse generator formed from a 4001B CMOS IC and Q1. This generator is activated for about four minutes, via R1-C1, whenever RLA is turned on by a 'break-in' detector, and repeatedly pulses RLB (and thus the vehicle's lights and horn) on and off, for unequal periods, for the duration of this four-minute period.

During this 'pulsing' period, the 'off' time of RLB is controlled by C2-D3-R3 and approximates 1.5 seconds, and the 'on' time is controlled by C2-D4-R4 and approximates four seconds, and the vehicle's horn thus generates a distinctive and easily recognized warning signal. Note that C2 is a non-polarized (n.p.) capacitor.

Finally, to complete this look at anti-theft alarm circuits, *Figure 8* shows the practical circuit of a simple voltage-sensing type of alarm unit that can be used in place of the basic RLA-driving network used in the *Figure 6* and *7* designs. Circuit operation relies on the fact that (when the vehicle's engine is not operating) a small but sharp drop occurs in the vehicle's battery voltage whenever a courtesy light is automatically turned on by the opening of a front door, or when the ignition is switched on. This sudden drop in voltage is detected and made to operate RLA. The system has the advantage that its 'alarm' signals are derived directly from the vehicle's battery, rather than via various microswitches, but it is not quite as reliable as a conventional microswitch-activated alarm system.

The operation of the *Figure 8* circuit — which is connected across the vehicle's battery via S1 — is fairly simple. Here, potential divider R1-R2-R3 is wired across the circuit's supply lines, and the output of this divider is fed, via RV1-R4, to the inverting (pin 2) input terminal of the 741 op-amp, which is wired in the open-loop mode, but is taken to the non-inverting (pin 3) input via a simple (R5-C1-R6) time-delay 'memory' network. A small offset voltage can be applied between the two input terminals via RV1.

Suppose then that the RV1 offset control is adjusted so that the pin 2 voltage is fractionally higher than that of pin 3 under normal 'steady voltage' conditions and, that under this condition, the output of the op-amp is driven to negative saturation. Now if a small but abrupt fall occurs in the supply voltage, this fall is transferred immediately to pin 2 of the op-amp, but does not immediately reach pin 3 because of the time-delay or memory action of C1.

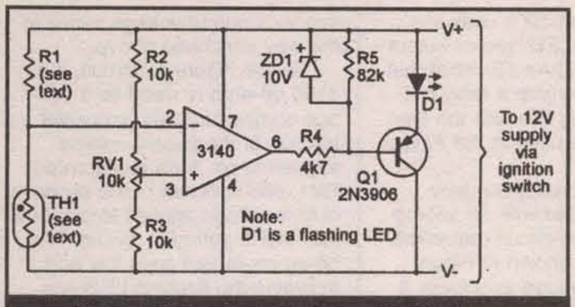


Figure 10. Ice-hazard alarm with flashing LED output.

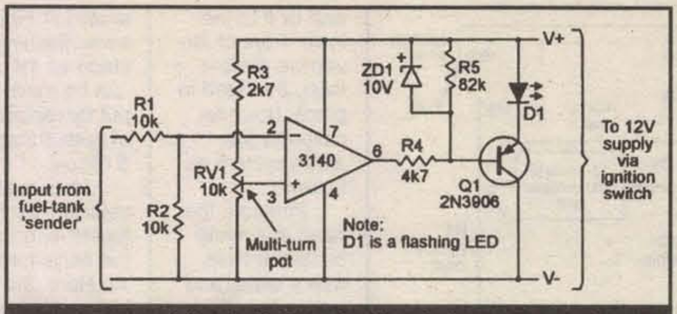


Figure 12. Low fuel level alarm.

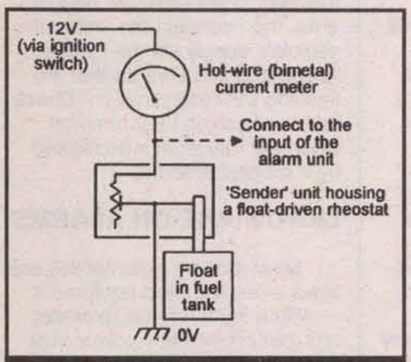


Figure 11. Basic circuit of a typical fuel level gauge.

Consequently, pin 2 briefly goes negative relative to pin 3, and as it does so, the output of the op-amp is driven briefly to positive saturation, thus giving a positive output pulse. This pulse is used to charge C2 via D1, and C2 drives Q1-Q2 and relay RLA on via R7. As RLA goes on, contacts RLA/1 close and self-latch the relay, and contacts RLA/2 close and immobilize the vehicle via its CB points.

Note that this circuit responds only to sudden drops in voltage, and is not influenced by stable absolute values of battery voltage.

The *Figure 8* circuit can be used directly in place of the RLA network in the *Figure 6* or *7* circuits. When installing the circuit in a vehicle, RV1 must be carefully adjusted so that the alarm turns on reliably when the courtesy (dome) light goes on, without being excessively sensitive to the small shifts that occur in the battery voltage due to its chemical action.

To find the correct setting of RV1, temporarily disable self-latching contacts RLA/1, and temporarily replace the courtesy lamp with one having roughly half its normal current rating.

Now adjust RV1 just past the point where RLA fails to activate when the lamp goes on, and then turn RV1 back a fraction, so that RLA is just activated by the courtesy light. Now refit the original courtesy light, and recheck the action. If reliable action is obtained, re-enable the RLA/1 contacts.

## INSTALLING ANTI-THEFT ALARMS

The anti-theft alarms described in the last section are all designed to be turned on and off via an externally mounted switch, which may take the form of a carefully hidden toggle switch or a prominently mounted key-switch. In either case, the switch must be mounted so that neither it or its wiring is vulnerable to damage by weather, dirt, or potential car thieves.

Once the alarm's external on/off switch has been fitted, the next installation job is to fit suitable microswitches to activate the system. Two suitable switches are already fitted to most vehicles, and are used to operate the dome or courtesy light. Additional switches must be fitted to the rear doors, and must also be fitted to the trunk and hood if full anti-theft protection is to be obtained.

Note that if your vehicle is fitted with a voltage-sensing type of alarm system, these microswitches must be used to switch a normal filament lamp; the higher the load current used, the more reliable will be the operation of the alarm circuit; the microswitches can all be wired in parallel and used to drive a single load. When installation is complete, give your system a complete functional check, taking care not to annoy your neighbors in the process.

## ICE-HAZARD ALARMS

Ice-hazard alarms activate when the vehicle's ignition is turned on and the air temperature several inches above the road surface is at or below the 0°C freezing point of water. The alarms thus indicate a risk of meeting ice under actual driving conditions. Two useful ice-hazard alarms are shown in this section, and can easily be fitted to most automobiles. Both units use a low-cost n.t.c. thermistor — mounted outside of the vehicle, near its front and several inches above the road surface — as a thermal sensor that gives a good indication of the actual road temperature.

The first circuit, shown in *Figure 9*, connects to the vehicle's 12V supply via its ignition switch, and turns-on relay RLA under the 'ice-hazard' condition; the RLA/1 contacts can be used to activate any desired type of external alarm device. In this circuit, the 3140 op-amp is used as a voltage comparator, in which a presettable reference voltage is applied to its pin 3 input via RV1, a temperature-sensitive variable voltage is applied to pin 2 from the R1-TH1 potential divider, and the action is such that the pin 6 output of the op-amp switches low and activates Q1 and RLA if the variable voltage exceeds the reference voltage.

In practice, the output voltage of the R1-TH1 divider rises as the TH1 temperature falls, and — if the circuit is correctly set up — trips relay RLA at a TH1 temperature of precisely 0°C.

This circuit's thermistor can be any n.t.c. disc or bead type that has a resistance in the range 1K5 to 5K0 at 25°C (the normally-specified 'nominal resistance value' temperature of most thermistors). Typically, the TH1 resistance at 0°C is about treble the 25°C value and, in this circuit, the R1 value should roughly equal TH1's '0°C' value; thus, if TH1 has a nominal 25°C value of 1K5, R1 needs a value of about 4K5.

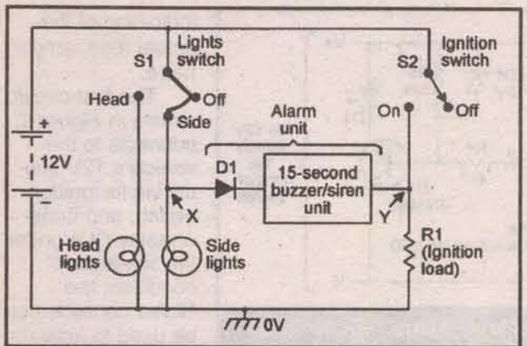


Figure 13. Basic Type-1 'lights-are-on' alarm circuit.

Note, however, that the precise R1 value is not critical, since balance-control RV1 can compensate for errors in the range -50% to +100% in the R1 value. The actual methods of mounting TH1 and setting RV1 are described later in this section.

In most practical ice-hazard alarm applications, the hazard condition may continue intermittently during several hours of driving, and it is thus best to use a flashing-LED type of 'hazard alarm' indicator, rather than a continuously-active audible-warning type. *Figure 10* shows the *Figure 9* circuit modified to give a flashing-LED alarm output directly, rather than via a relay. In this case, Q1 is wired as an emitter-follower, and drives on D1 — a low-cost flashing LED device — when the op-amp output switches low. Note that R4-ZD1 and Q1's base-emitter volt-drop limit D1's maximum applied voltage to a safe value of 9.4 volts.

When building either of these ice-hazard alarms, note that thermistor TH1 must be mounted in a small 'head' that is fixed to the lower front of the vehicle and connected to the main alarm-unit via twin flex. To make the head, solder the thermistor to a small tagboard and solder its leads to the twin flex. Coat the whole assembly with waterproof varnish, so that moisture will not affect its apparent resistance, then mount it in a small plastic or metal box and fix it to the lower front of the vehicle. Before fixing the head in place, however, calibrate the alarm system as follows.

Immerse the head in a small container filled with a water and ice mixture. Use a thermometer to measure the temperature of the mixture, and add ice until a steady reading of 0°C is obtained. Now adjust RV1 so that the alarm (RLA or the flashing LED) just turns on; raise the temperature slightly, and check that the alarm turns off again. If satisfactory, the head and the alarm system can now be fixed to the vehicle.

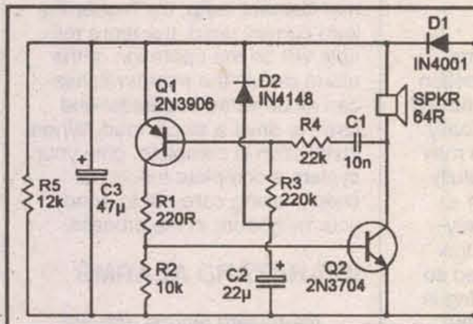


Figure 14. Practical Type-1 'lights-are-on' alarm unit.

## A LOW FUEL LEVEL ALARM

One of the most annoying things that can happen to a car driver is to run out of fuel after having failed to notice the advance-warnings shown on the vehicle's fuel gauge. This event can easily be avoided by fitting the vehicle with a simple circuit that monitors the fuel gauge and activates a flashing-LED alarm under potential 'danger' conditions. A circuit of this type is shown in *Figure 12*, it uses the same flashing-LED type of output stage as the *Figure 10* circuit, but can be made to give a relay output by replacing this with the type of output stage used in the *Figure 9* circuit.

Most reasonably-modern vehicles are fitted with an analog fuel-level gauge circuit that takes the basic form shown in *Figure 11*. Here, the gauge is actually a hot-wire (bimetal) current meter that is wired in series with a 'sender' unit that is mounted in the fuel tank and consists of a float-driven rheostat that presents a high resistance (and a low current meter reading) when the tank is empty, and a low resistance (and a high current meter reading) when the tank is full. Note that the output voltage of the sender rises as the fuel level falls, and a low fuel level alarm can thus take the basic form of a simple over-voltage alarm. A suitable 'flashing-LED' alarm circuit is shown in *Figure 12*.

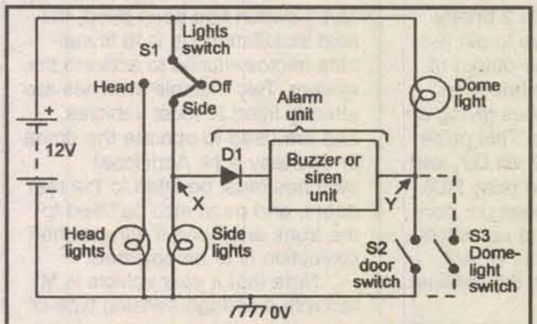


Figure 15. Basic Type-2 'lights-are-on' alarm circuit.

Before starting to build the *Figure 12* circuit, check that you can gain easy access to the tank-mounted sender unit or the rear of the fuel gauge, and that the sender's output voltage varies in the way described above.

In the *Figure 12* circuit, the 3140 op-amp is wired as a voltage comparator, with a pre-set fraction of the supply voltage applied to pin 3 via multiturn pot RV1, and with half of the sender's output voltage applied to pin 2 via the R1-R2 potential divider. The op-amp's output goes low and activates the flashing LED (via Q1) when the pin 2 voltage rises above the pre-set pin 3 value. To set up the circuit, wait until the fuel falls to the required 'danger' level, then connect the unit to the vehicle's supply via the ignition switch and trim RV1 so that the flashing LED just turns on. Check that the flashing LED turns off when the fuel level is increased by a modest amount.

## LIGHTS-ARE-ON ALARMS

Most modern automobiles are fitted — as standard equipment — with a lights-are-on reminder unit that emits a low-power audible alarm signal that warns the driver — as he/she opens the driver's door — if the car lights have been left on.

'Lights-are-on' alarm units of this basic type are easy to build and are fairly easy to add to most older types of vehicle, and come in two basic types. Type-1 is for use in very old vehicles that are *not* fitted with a courtesy light that is switched automatically via a conventional door-activated microswitch, and Type-2 is for use in vehicles that *are* fitted with such a courtesy light system.

*Figure 13* illustrates the basic operating principles of a Type-1 lights-are-on alarm circuit. Here, the actual alarm consists of a low-power 15-second buzzer or siren

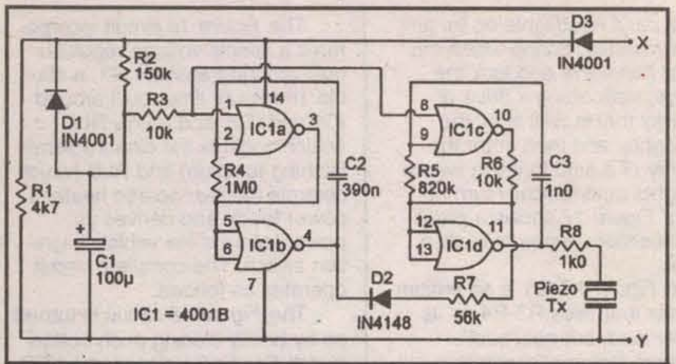


Figure 16. Practical warble-tone Type-2 'lights-are-on' alarm unit.

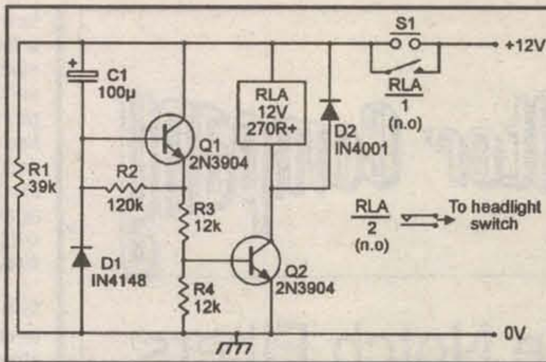


Figure 17. A headlight time-delay switch circuit.

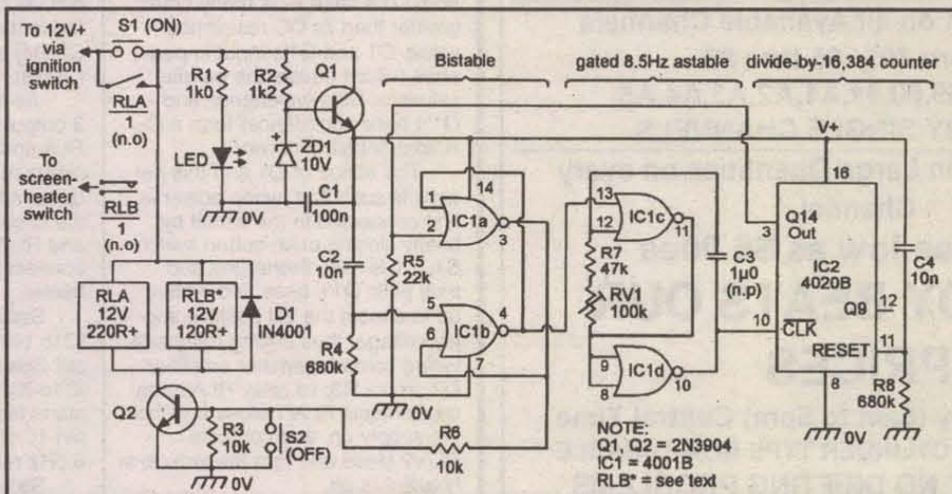


Figure 18. A rear-screen heater timer circuit.

unit that has its supply lines wired in series with diode D1 so that current can only flow through the unit (and thus activate the buzzer/siren) when point-X is many-volts positive to point-Y. And, in the diagram, this situation only occurs when 'lights' switch S1 is in the ON (Side or Head) position and 'ignition' switch S2 is turned OFF. Thus, if the lights are left on, the alarm unit sounds-off as soon as the ignition is switched off, but mutes automatically after 15 seconds.

*Figure 14* shows a simple but practical version of a Type-1 'lights-are-on' alarm unit. Here, Q1-Q2 are wired as a modified complementary astable multivibrator that has its power supplied via D1 and uses a 64R low-power speaker as the collector load of Q2, which is a 2N3704 type and has a peak collector current rating of 800mA.

The astable's action is such that it generates a loud and fairly high alarm tone when power is initially applied, but the volume and frequency then decay steadily down to zero over a period of about 15 seconds. The decay time is controlled by R3-C2, and the initial frequency is controlled by R3-R4 and C1. To use the unit, simply connect its 'X' and 'Y' points in the way shown in *Figure 13*.

*Figure 15* illustrates the basic operating principles of the Type-2 lights-are-on alarm. It is similar to the Type-1 system, except that the alarm unit is wired between 'lights' switch S1 and dome-light-activating door-switch S2, so that the alarm only sounds if the lights are on when the driver's door is open.

The above Type-2 system is used on most modern vehicles, in which the dome light uses separate circuits for its 'courtesy' and 'reading' lights. A snag with most older vehicles is that they use a single light-bulb to perform both of these functions, with the 'reading' switch wired in parallel with S2, as shown by S3 in *Figure 15* and, as a consequence, the alarm can be activated by either of these switches.

The easiest way around this snag is to use an auto-turn-off alarm unit that, like the Type-1 unit, only sounds for a dozen or so seconds when activated. The alarm unit can thus take the simple 'monotone' form shown in *Figure 14*, or can take the more attractive 'warble-tone' form shown in the *Figure 16* circuit.

The *Figure 16* circuit is based on warble-tone circuits shown in Part 3 of this series. In brief, however, IC1a-IC1b and R4-C2 are wired as a gated l.f. (low-frequency) astable and IC1c-IC1d and R5-C3 form a gated h.f. (high-frequency) astable. Both astables are gated via the R2-C1 time-constant network, and are on when C1's output is below half-supply volts and off when C1's output is above half-supply volts.

When the astables are gated on, the l.f. astable frequency-modulates the h.f. astable (via D2-R7-R6), which has its output fed to piezo output transducer Tx via R8.

When power is connected to the *Figure 16* circuit, C1 is initially fully discharged, so both astables are gated on and generate a warble-tone sound in the piezo Tx, but C1 then charges up via R2 and after a delay of about 15 seconds (determined by R2-C1) gates both astables off, silencing the piezo Tx.

When the unit's power connections are removed, C1 rapidly (in a second or so) discharges via D1-R1, and the unit is then ready to repeat its operating sequence when power is connected again.

## A HEADLIGHT TIME-DELAY SWITCH

Headlight time-delay switches are simple add-on units that, when activated by a push switch, turn a car's headlights on for just a few minutes, during which the owner can leave and lock the vehicle, walk along a drive or pathway that is well lit by the headlights, and then enter the security of a safe building before the lights automatically turn off again. *Figure 17* shows a practical transistor version of such a circuit.

In *Figure 17*, Q1 is an emitter follower that uses R3-R4 as its emitter load, but has 'bootstrapped' resistor R2 wired between its base and emitter, so that R2's impedance — as seen from Q1's base — is many times greater than its DC resistance value. C1 and Q1's input impedance (which equals the parallel values of R2's *impedance* and Q1's base impedance) form a C-R time-constant network.

The action of Q1 and this network is such that, when power is first connected to the circuit by briefly closing push-button switch S1, C1 is fully discharged and thus pulls Q1's base and emitter up to almost the full positive supply voltage, thus driving relay-activating common-emitter amplifier Q2 on via R3; as relay RLA turns on, contacts RLA/1 close and lock the supply on, and contacts RLA/2 close and turn the vehicle's headlights on.

As soon as power is connected to the circuit, C1 starts to charge up via the very high parallel impedances of R2 and Q2's base, and Q2's emitter voltage (and the current fed into Q2's base via R3) starts to decay exponentially until, after a delay of about two minutes, these values fall so low that RLA turns off, thus breaking the supply connection as RLA/1 opens and turning off the headlights as RLA/2 opens. C1 discharges rapidly via R1-D1 when the circuit's power connection is broken.

## A REAR-SCREEN HEATER TIMER

Automobile rear-screen heaters draw typical operating currents of about 15 amps and thus place a heavy strain on the vehicle's electrical generating system. If the heater is inadvertently left on for long periods, this strain can greatly reduce the generator's reliability and working life.

Consequently, most modern automobiles are fitted with push-button operated rear-screen heater controllers that turn the heater off automatically after an operating period of about 16 minutes. Reliability-enhancing units of this basic type can easily be added to older vehicles and, to conclude this series, *Figure 18* shows a practical add-on circuit of this type.

The *Figure 18* circuit incorporates a simple voltage regulator built around transistor Q1, a stable 16-minute timer built around IC1 and IC2, and relays RLA (which controls the circuit's semi-latching function) and RLB (which controls the rear-screen heater's power feed), and derives its power feed via the vehicle's ignition switch. The complete circuit operates as follows.

The *Figure 18* circuit is turned on by briefly closing push button switch S1. As S1 closes, the LED illuminates, a stable 9.4V supply is applied to the IC1-IC2 timer circuit via Q1, and 'reset' pulses are fed to the IC1a-IC1b bistable (via C2-R4) and the IC2 counter (via C4-R8).

As the bistable resets, its pin 3 output flips high and turns on RLA and RLB via Q2; as the relays turn on, the RLA/1 contacts close, shunting S1 and locking-on the circuits supply connection, and RLB/1 contacts close and connect power to the rear-screen heater.

Simultaneously, as the IC1a-IC1b bistable resets, its pin 4 output flips low and turns on the IC1c-IC1d gated astable, which starts feeding clock pulses into pin 10 of the IC2 counter at an 8.5Hz rate.

Sixteen minutes later, in the arrival of the astable's 8192nd clock pulse, the pin 3 output of IC2 flips high and changes the state of the IC1a-IC1b bistable, which simultaneously gates off the astable and removes Q2's base drive, thus turning off both relays; as RLA turns off, it removes the timer's supply connection, and as RLB turns off, it removes power from the rear-screen heater.

Thus, when the vehicle's ignition is turned on, the *Figure 18* circuit connects power to the rear-screen heater as soon as S1 is closed, but removes it again automatically after 16 minutes. If desired, the timing period can be ended prematurely by briefly closing S2, thus turning off both relays.

The circuit's timing period can, if you wish, be set to exactly 16 minutes by temporarily connecting an LED and 2K7 series resistor between pins 12 and 8 (0V) of IC2 and trimming RV1 so that the LED operates with precise 30-second on and off periods.

When building this circuit, note that RLA's contacts have to pass maximum currents of less than 200mA, and RLA can thus be almost any general-purpose relay, but that RLB's contacts have to pass the full operating current of the rear-screen heater (typically 15A), and RLB must thus be a dedicated heavy-duty 'automobile' relay. **NV**

Don Lancaster's

# RESOURCE BIN

number eighty two

# New secrets of military surplus (Part 2).

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

## Uh, Where Were We?

Last month, we started to look into superb new opportunities in military surplus electronics. We saw that your key website is *www.drms.com* and that you can now bid online and pay with VISA. We also looked at the types of sales, condition codes, and the typical prices you might expect. More details at *www.tinaja.com/resbn01.html.*

Continuing ...

## Winners and Losers

How could you find out who paid how much for what? Those national sales and their RCP sale results are detailed on their main website. They even show you how much the losers bid, the number of bidders, the cost percentage, and their spread between high and low bids for any item. It is rare for there to be more than four or so bidders. Except for a few obviously popular items.

Local sealed bid sale results are not yet on the web. Although they were promised someday. You can get these on an item-by-item basis with a phone call, by viewing printouts on the base, or by paying $5.00 for their printed and mailed listings.

Do note that there are two sets of national web listings. The *bid abstracts* is "raw data" that gives you a full list of all the bidders for any item, along with the total percentage return. The *bid results* gives you only their actual winners. Along with items that were withdrawn, unbid, or rejected.

Their abstracts and results are not necessarily on line at the same time. So you just might have to save certain abstracts of interest. Files more than two weeks old get dropped.

How much to bid? Chances are that six cents on the dollar will more than get your gem for you. Unless it's very popular and in mint condition. But I prefer to bid much lower and wait till it comes around again. Unlike most regular auctions, the sale never ends. If you hit every time, you are paying way too much.

**NEXT MONTH: Don looks at some exciting new integrated circuits.**

There's a near infinite supply of this stuff. Round and round.

## The "Never be Underbid" Ploy

There's at least one company with an unusual surplus bidding strategy. They always seem to make absolutely certain they are the *lowest* bidder on any item. Every time. As a matter of professional pride, they'll make sure they are *never* underbid.

Naturally, they are also the lowest bid on items that nobody else bid on. Otherwise known as the winner. As you might suspect, their hit rate ends up kinda low. I estimate it at a few percent overall. But they still seem to get great heaping mountains of stuff. Just by bidding on nearly everything that does not eat.

The results would seem rather akin to the "send your wife to the top name on the list" chain letter. Where sheer quantity takes precedence over quality. But a few absolute gems are virtually certain.

For this low bid ploy to work, you will have to continuously run around the country in a large truck. You also must have a very definite storage and disposal plan.

Plus a good feel for what you can get away with.

The feds often require minimum bids (typically $5.00 or $10.00) on the local auctions. So do be sure to ask. Other minimums (such as $2,400.00 for a RRboxcar) are carefully spelled out. As far as I know, rejecting a high token bid on a local sale is very rare.

But on national sales, the feds do reserve their right to throw out any bids that "unfairly take advantage" of either themselves or other bidders. The criteria for an "insufficient price" rejection seems sorta bizarre.

Apparently, the cost percentage, the number of *other* token bidders, former item bids, and how bad it makes the rest of the sale look all get taken into account. There is some evidence that anything under 25 cents per thousand dollars acquisition cost of high value items usually gets rejected outright. But $2.00 per thousand awards on lower demand items seem routinely accepted.

Accepted low price bids seem less generous on obvious values such as machine tools or aircraft parts.

On the other hand, I have seen the feds reject bids which were 10 times higher what a sane individual would spend for core memory or paper tape punches. Old electronics often has a *negative* value. The rejected bids are shown on the bid result pages. The message here is that *token bids work.* So long as your items are either not much in demand, hard to get to, need heavy rework, or are obscurely described. And so long as the market remains erratic rather than efficient. The trap to watch out for is hitting on only one token bid at a site that is a long or inconvenient trip away.

Needless to say, the feds do not take lightly to "no show" bids. They get even more upset if you stiff them on a VISA card. And if you don't pick up your stuff by "pumpkin time," you can lose all rights to it.

*Even if paid for.*

Normal pickup interval is 10 days. They tend to get *very* upset if you try for even a slight extension.

## The Bidding Process

A useful surplus strategy might be based on buying for a penny on the dollar, selling for a dime, and trying to make a nine percent profit in the process. But note that there is a total glut in the electronic test equipment market. Lean and mean is your *only* ploy that works. So, your best bet is to buy surplus to build up a dream lab. Or for other personal uses.

It is best to take your time about the process. I grab the dynamic listing as soon as it comes up and throw it in a time-ordered box. I then try to find out what each item is along with its acquisition cost. The official catalog is finally added, and bid prices are then worried over for one week before the actual bid. I do try to bid a day or two before the deadline. Note that their fax machines tend to jam up near the bid closing time.

Most of the bidding can be done online. Simply use mouse clicks and follow the instructions.

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Lakehurst NJ 08733
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Fax: 732-323-7374

**DRMO LeJeune**
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Camp LeJeune NC 28547
Phone: 910-451-3477
Fax: 910-451-3306

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Letterkenny Army Depot
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Fax: 253-967-2049

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Little Rock AFB AR 72099
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Fax: 501-988-6205

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Glendale AZ 85307
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1220 Desert Home
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McConnell AFB KS 67221
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Fax: 813-828-4689

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Fax: 903-334-4232

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Fax: 717-895-7454

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Fax: 707-424-4447

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Phone: 513-257-4203
Fax: 513-257-7974

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(*) Scheduled to close in the next few months.

If an end-user certificate will be needed (this is fairly rare), then it is best sent via fax at the time your bid is accepted.

Winners only are usually notified with a phone call, followed by fax and mail. Payment is easiest with VISA over the fax. At DRMO, VISA, certified checks, or *exact* cash. Any personal checks above $25.00 are not allowed.

Payment must, of course, preceed any pickup.

### Getting the Goods

Getting on a military base can be somewhat of a hassle. But the process usually will go something like this: Somewhere near the main gate will be a visitor contact area. You'll go there and show them your driver's licence, registration, the rental contract (if any), and proof-of-insurance. They'll issue you a *day pass*.

Patience and extreme politeness are essential. So is a resonable demeanor. Those "mad bomber," "dirty hippy," or "flamingly accessorized" looks don't seem to set all that well. It is also very important to pay *extreme* attention to *all* details. Every time.

Access ease depends upon the base. Huachucha opts for the full drill. D-M Tucson just waves you through. And Luke's DRMO is outside the gate.

The DRMO will often be a fenced area in an obscure corner of the base. Be certain to listen to *all* directions. Otherwise, you may get run over by a tank. You should park outside the DRMO office and then make contact with them. They then should tell you exactly where to go for pickup.

Banker's hours seem the DRMO norm. Weekdays only with most sites closed by 2 p.m..

The feds will help you load to your *open conveyence only*. Whatever they can safely do with a forklift. *No other loading help is normally provided.*

If you have someone else pick up your stuff for you, you are supposed to prefile an authorized shipper form to the DRMO ahead of time. But so far, I've gotten away with the loader having a carefully detailed printout of an authorization E-Mai, or faxing a suitable sheet of paper.

Remember, it is their gig. They can make up any rules they like.

### $24.00 Jeeps?

One of the most persistent urban lore myths of all time is the $24.00 Jeep. Surprisingly, it turns out that these WW II derelicts have (and extremely rarely continue) to be sold. The only little kicker is that these are not street legal. So they always are carefully *cut in half* before each sale.

These make great bookends if you have a big enough library.

It does turn out that at least one Yuppy direct mail reseller has newly been buying these up and dropping usable parts into new frames and then upgrading them to street legal. The final cost is high enough, though, that you would really want to have one of these real bad. You can find a much better Jeep in a local shopper.

The feds have a big time recycling program on Humvees, so these are virtually *never* sold surplus.

Once.

Lots of street legal trucks and other military vehicles do get sold surplus. Many of these tend to be badly worn or have other serious problems. For some obscure reason, a lot of these ride like an army truck. Very careful inspection is the key. Be especially wary of that word "residue." Also if an "approximate quantity one" ever shows up in the description. Bidding tends to end up rather competitive on these, and they often may go for way more than they are really worth.

### Free Surplus?

Most of the stuff on the sales is also available *free. If* you are a part of a military, government, state, or local agency. Your local city government could, say, request camping gear for sponsored Boy Scout use. Or athletic items for the city park. Or an Indian res can (and recently did) get a horse. Or a struggling volunteer fire group could try and score used turnout gear, tankers, and even crash trucks.

These uses take precedence over public sales. Full details appear on the "insider" half of the fed's mil surplus website. Needless to say, if you try to personally profit from any such scam, they will stake you to an anthill. And leave you there till the next meeting of the steering committee.

Your secret is to scan the fed's raw inventory property search to find the stuff *before* they get locked into any specific public sale. There are a lot of bureaucratic hassles involved.

### For More Help

Your usual starting point here is at *http://www.drms.com*. Everything you need is theoretically on this site. Note the ".com." *Not* ".gov" or ".mi,l" but it does take some digging and practice to get to all the really useful stuff.

One thing you might consider is to find an *agent*. A relative or friend or whoever who just happens to live across the street from a remote DRMO office. Having them preview, pick up, triage, and stash the stuff can greatly simplify the process.

Conversely, when you are properly positioned and want to be an agent (for a reasonable fee or part of the stash), give me a call or E-Mail me at *don@tinaja.com*. I particularly could use Barstow and Edwards help.

My resource sidebars here give you the address, phone, and fax number for most of the DRMO offices. Those with an asterisk are on a hit list and have received serious death threats.

You can get your own online copies at *www.tinaja.com/resbn01.html*. Lots of samples of gotten goodies at *www.tinaja.com/bargte01.html*. The best stuff here includes Tek 2213 scopes, giant HP pen plotters, great AC motors, complete and like-new printed circuit plate thru labs, lots of Tek, HP, and Fluke premium gear, and (yup — you guessed it) a humongous 50 KW load bank. The latter FOB Thatcher.

I'll be happy to answer mil surplus questions as per our helpline. And more structured help is found at my *www.tinaja.com/info01.html*.

## This Month's Contest

For our contest this month, just tell me your mil surplus story. Preferably as a tragedy or farce.

There should be a largish pile of my new *Incredible Secret Money Machine III* 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 get written and submitted via snail mail. Send all your *written* entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 35 books and countless tech articles.

Don is the webmaster of his Guru's Lair found at http://www.tinajacoml/tinaja. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to **don@tinaja.com**.



*Continued from page 74*

these and other emergency occasions. Don't deadbolt the emergency escape.

**Kurt Richter**
**via Internet**

### ANSWER TO #10989 - OCT. 1998

Innotech Systems, Inc. makes a broad line of remote control ICs. Their IC4001 is a universal transmitter that can control up to four devices.

Their IC1001 IR is a remote control receiver IC. Data sheets for these and other similar devices are available in .PDF format and their web page is http://www.innotechsystems.com/shrtfrm.htm.

**Tom Tillander**
**Bay village, OH**

### ANSWER TO #9981 - SEPT. 1998

Use very thin copper foil, backed with adhesive (aluminum oxidizes too soon) or conductive paint on the inside of the case, greatest leakage remaining is around the ports and keyboard.

Fashion a metallic cover for any unused I/O port, and be sure all current external connecters mate metal to metal, and maintain electrical continuity on all shield components.

The keyboard is tricky if not already shielded by OEM. Each laptop design requires some ingenuity to prevent shorting your system board against the EMI shielding. Always remember if your plug-in items are using fully shielded cables.

**Rick Kajander**
**via Internet**

### ANSWER TO #9982 - SEPT. 1998

The SAFE 250 is probably a 24-volt operation. Typically, the UPS is higher voltage for higher output for the same reason autos went from six volts in the pre-1960s to 12 volts.

By having a higher source voltage, the current is lowered. The key to the voltage of operation aside from some of the frequencies may vary due to lower voltage, is the transformer used to transform the chopped 24 volts up to a 110-volt squarewave output.

The turns ratio of the transformer is typically 5:1, to give a 5 tomes increase in the input voltage. Using 12 volts to get the 110-volt squarewave will require a transformer with a turns ratio of 10:1. So, if your SAFE 250 is a 24 volt input, then it will not operate from 12 volts without a major transformer modification.

There are several UPSs that are 12-volt operated. Some of the smaller Triplite are ones I have worked with. If yours happens to be one designed for 12-volt operation, then the only thing you have to do is get it to switch into UPS Mode, and normally this is accomplished by removing the 110-volt input supply. However, they will not usually switch into the backup mode without first having the 110-volt source then disconnecting.

You can look in the unit and find the switching relay — and manually operate — or supply voltage to the coil to operate it. You can also wire a mechanical switch across the contacts. The configuration can vary from one to another. Could be single pole or double pole as needed.

**Ed Pruitt**
**Keller, TX**

### ANSWER TO #109812 - OCT. 1998

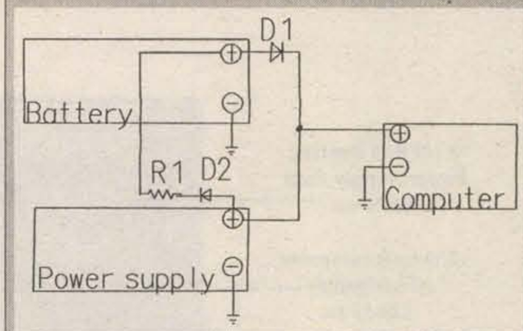
The easiest way to accomplish the switching that you require is to use a single diode as a switch.

You place the power supply parallel with the battery pack and place a diode on the battery positive lead so that the battery feeds the computer through this diode.

When the wall power runs the computer, it has a slightly higher voltage than the battery pack which means the battery won't flow through the diode to the computer until the wall power fails.

When the wall power fails, the diode will switch into conduction within a few microseconds, or nanoseconds, and will power the computer from the battery without the characteristic surge that most relays cause.

You can still add a trickle charger to the back side of the battery pack using a small diode (4001) and resistor combination to regulate the current flow to the battery from either a separate transformer or from the original power supply that runs the computer.




There will be a voltage drop across the battery feed diode, so choose a diode that has the lowest possible drop. Choose one with the lowest recover time and correct amperage also.

**Chris**
**Bieber, CA**

# Open Channel

by Joseph J. Carr

# Flipping Out Over Flip-Flops

Digital logic functions can be made from combinations of AND, OR, and NOT gates. Even the NAND and NOR functions are only variants of NOT-OR and NOT-AND configurations.

One of the problems with gates is that they are transient circuits; that is, they are incapable of storing information even for a short period of time. Flip-flops, on the other hand, are circuits that can store single-bits of information. Many forms of solid-state computer memory devices are little more than arrays of flip-flops organized in a manner that allows storage of digital words in a computer.

Most flip-flops are bistable devices, i.e., they have two stable output states. The flip-flop is not particularly concerned which state is in existence at any given time. Being bistable, it is happy in either state. If the output is labeled Q, we find that either Q = HIGH or Q = LOW is an acceptable state, and will be stable. Some flip-flips are equipped with two complementary outputs, labeled Q and NOT-Q (or bar-Q).

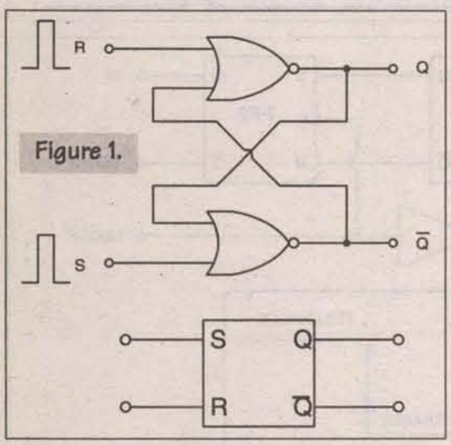


Figure 1.

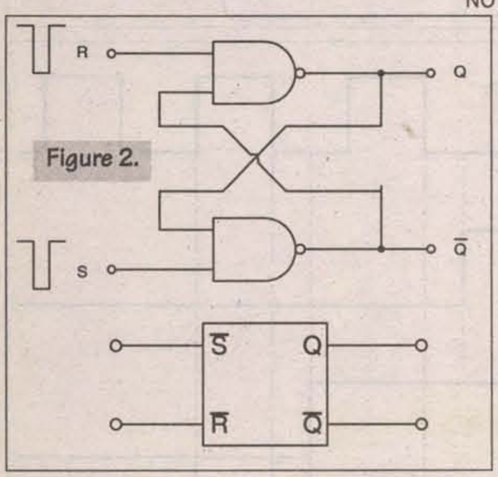


Figure 2.

## R-S Flip-Flops

One of the simplest flip-flops is the reset-set (R-S) flip-flop. These circuits can be made from either NAND or NOR gates, although the performance attributes are different for the two different forms. The NOR-logic configuration and the associated symbol is shown in Figure 1. Note that the circuit has two outputs: Q and NOT-Q. This is an example of a complementary output flip-flop. These outputs always have the opposite state. If Q = HIGH, then NOT-Q = LOW, and vice versa.

In the NOR-logic R-S flip-flop, the output changes state when an appropriate input is momentarily brought HIGH from its resting LOW position. Only a brief pulse at the input is needed to effect the change. The rules of operation of the NOR-logic R-S flip-flop are summarized below:

**1.** When both S and R inputs are LOW, no change occurs in the output.

**2.** If both S and R are simultaneously brought HIGH, this is a disallowed state. This input condition should be avoided.

**3.** Bringing the S input momentarily HIGH will set the output, i.e., makes Q = HIGH and NOT-Q = LOW.

**4.** Bringing the R input momentarily HIGH resets the flip-flop, i.e., makes Q = LOW and NOT-Q = HIGH.

The basic NOR gate R-S flip-flop can be constructed from either TTL, CMOS, or other logic family NOR gate arrays.

The NAND-logic R-S flip-flop uses inverted logic, i.e., the output state changes are caused by bringing the appropriate input LOW. An example of a NAND-logic R-S flip-flop and its symbol are shown in Figure 2.

Because the inputs are active-LOW, this circuit is sometimes called a NOT-R-S flip-flop. In this text, however, it is more convenient to simply refer to both NAND-logic and NOR-logic circuits as simply R-S flip-flops. The NAND/NOR distinction is made in the text, where necessary, or by the schematic.

The output conditions of the NAND-logic R-S flip-flop are shown below.

**1.** If the S and R inputs are simultaneously LOW, then a disallowed state exists. This state must be avoided.

**2.** If both S and R inputs are made simultaneously HIGH, then no change in the inputs will occur.

**3.** If the S input is momentarily brought LOW, while the R input remains HIGH, then Q = HIGH and the NOT-Q = LOW. The flip-flop is in the "set" state.

**4.** If the R input is momentarily brought LOW, while the S input remains HIGH, then the flip-flop is reset, i.e., Q = LOW and NOT-Q = HIGH.

The R-S flip-flop is used frequently in applications where a pulse applied to the S or R input sets a condition, and then a subsequent pulse is used to reset the circuit to its initial condition.

## Clocked R-S Flip-Flops

The operation of the two previous R-S flip-flops – the NAND-logic and NOR-logic – was unconditional. The output state changed immediately when an appropriate input pulse was received. This is called asynchronous operation.

The clocked R-S flip-flop in Figure 3 is able to operate synchronously; i.e., the output will change state only when the input pulse coincides with a clock pulse. This behavior is obtained by adding a pair of NAND gates to the NAND-logic R-S flip-flop circuit.

The commonly used schematic diagram circuit symbol for the clocked R-S flip-flop is shown in

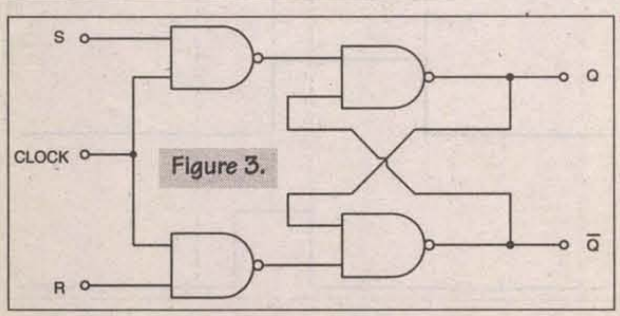


Figure 3.

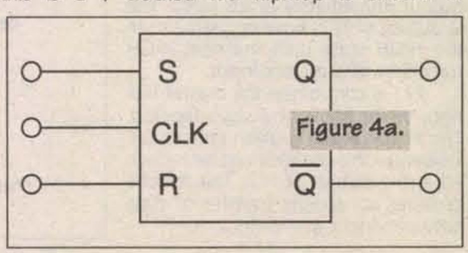


Figure 4a.

Figure 4A, while the timing diagram is in Figure 4B. The clock circuit produces a chain of squarewaves at the CLK input (also called "C" in some cases). Note that the Q output does not change state immediately when the S input pulse goes HIGH. The output waits until the clock input is also HIGH. Similarly, the output is not reset until the clock pulse and R input pulses are coincident. Because of this feature, the literature for some scientific instruments calls the clocked R-S flip-flop a coincidence detector.

## Master-Slave Flip-Flops

It is often difficult, or impossible, to transfer data through a circuit in an orderly manner. We often get into high-speed digital analogies of the old-fashioned "relay race" problem. Recall that type of problem in circuits where two electromechanical relay switches are supposed to close simultaneously. If one relay is a little sluggish, or the other is a little snappier than the other (or both!), then there is a brief instant where one is open and the other is still closed, or vice versa. This condition often produces unpredictable or even disastrous results. The same action exists in digital circuits where the culprit is differences in device propagation time, i.e., the time required for a pulse to travel through the circuit to effect an output change.

Note that two clocked R-S flip-flops and an inverter can be used to synchronize data transfer. The circuit, which is shown in Figure 5, is called a master-slave flip-flop, also sometimes called the RST flip-flop.

In Figure 5, the inputs to FF1 are the inputs to the circuit as a whole, i.e., the inputs to the master-slave FF. The outputs of the master-slave FF are the outputs of flip-flop FF2. Also, the clock affects FF2 directly, but must be inverted before being applied to FF1. Both flip-flops only go active when their respective clock inputs are HIGH.

A timing diagram for this circuit is shown in Figure 6. Recall from above that FF1 is enabled when the overall clock pulse is LOW, and FF2 is enabled when it is HIGH (because of the inverter action).

When the pulse is applied to the S input, nothing happens at Q1 (the Q output of FF1) until the clock pulse drops LOW again. At that time, Q1 snaps HIGH, thereby making the S input of FF2 HIGH also. But at this time the block pulse is LOW, so no change occurs at the FF2 output terminal. When the next clock pulse arrives, however, the FF2 clock input goes HIGH (Q1 and S2 are still HIGH), so the Q output of FF2 goes HIGH.

Similarly, the reset pulse arrives when the clock is LOW, so the Q1 output immediately drops LOW. The Q output of FF2, however, remains in the HIGH state until the next HIGH transition of the clock input.

FF1 is considered the master flip-flop, while FF2 is the slave flip-flop. The action at FF1 is given time to settle before the changes can be reflected in the output of FF2. This feature provides an orderly transfer of data between input and output.

## Type-D Flip-Flops

A Type-D flip-flop is a modified RST flip-flop that has only one input (labeled D for "data"). See Figure 7. The type-D flip-flop will transfer data (HIGH or LOW) from the D input to the Q output only when the clock terminal is HIGH. The following rules govern the behavior of the type-D flip-flop.

**1.** When the clock input goes HIGH, the data (HIGH or LOW state) present on the D input is transferred to the Q output.
**2.** If the clock input remains HIGH, then the Q output will follow changes in the data at the D input.
**3.** If the clock input remains LOW, then the Q output will retain the last data that was present on the D input at the instant the clock dropped LOW.

Because of the behavior presented in the above rules, the type-D flip-flop is sometimes called a data latch, or simply latch. The circuit symbol for the type-D flip-flop is shown in

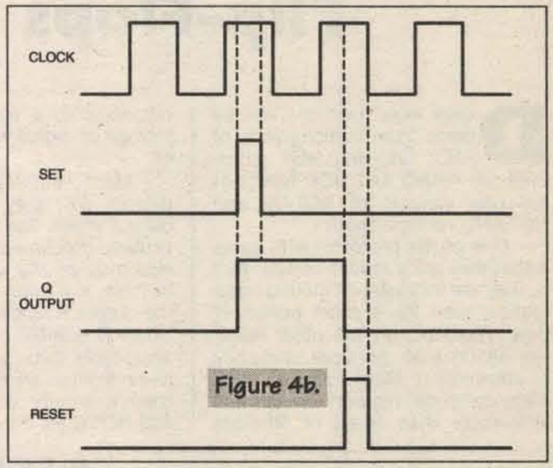



Figure 4b.

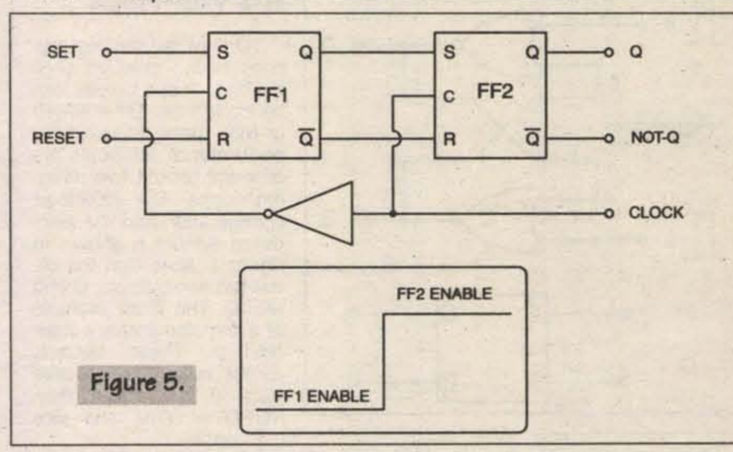



Figure 5.

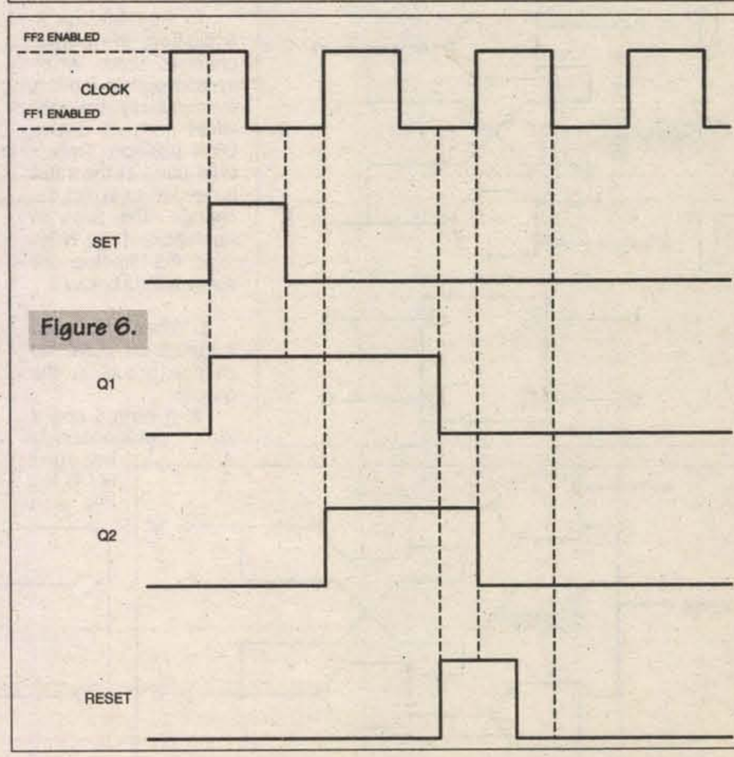



Figure 6.

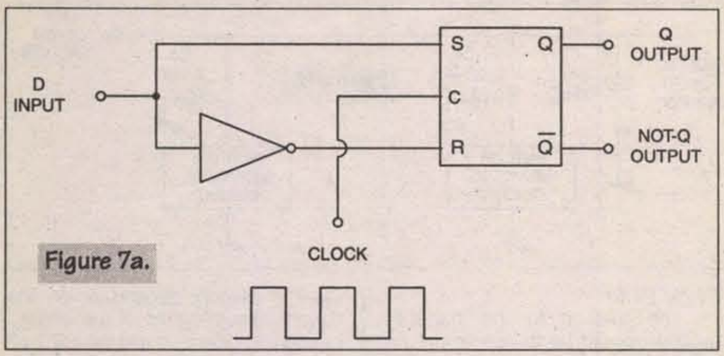


Figure 7a.

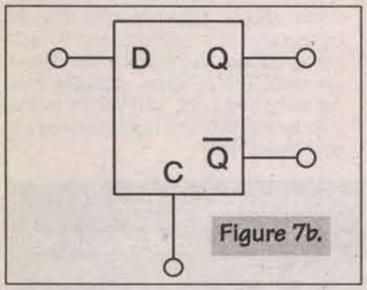


Figure 7b.

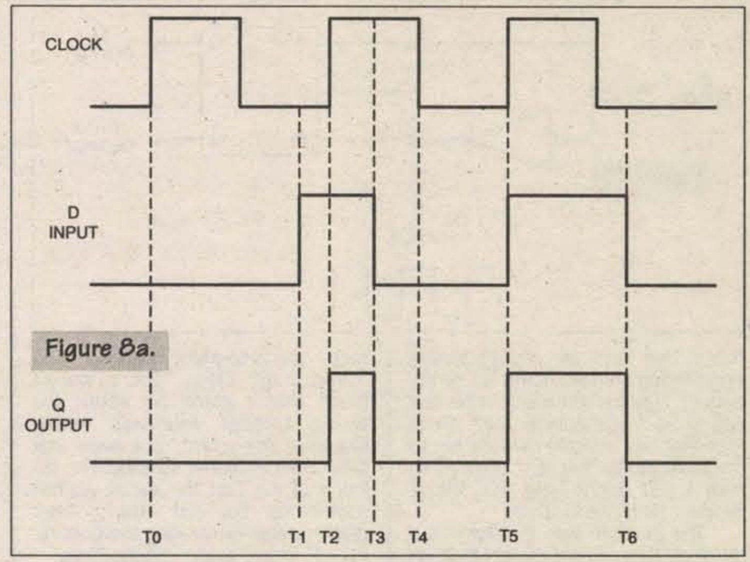


Figure 8a.

Figure 7B.

We can see these rules more graphically in Figures 8A through 8C. Consider first Figure 8A. Recall that the data on the D input will be transferred to the Q output only when the clock terminal is HIGH. At time T0 in Figure 8A, the clock goes HIGH, and the D input is LOW, so the Q output is also LOW.

At time T1, the D input goes HIGH, but cannot affect the Q output because the clock is LOW. The clock goes HIGH at T2, so the output will also goes HIGH. The output pulse exists only for the interval T2-T3 because the HIGH condition on the D input only coincides with that interval.

At time T5, both the D and clock inputs go HIGH, but note that the D line remains HIGH even after the block pulse disappears. By the third rule, then, the output must remain HIGH after the clock pulse passes.

Another situation is described by Figure 8B. In this case, the clock line goes HIGH and remains HIGH. The Q output, therefore, is in an unlatched condition, so will follow the data applied to the D input. Because the D input data is a squarewave, the output will also be a squarewave.

Still another condition is shown in Figure 8C. Again the D input data is a squarewave or pulse train, but the block is not permanently HIGH in this example. At time T1, both the clock and the D input are HIGH, so the Q output is also HIGH. At time T2, the clock drops LOW, but since D is HIGH at that instant, the output will remain in the HIGH condition. Note that the D input can change at will, without affecting the output, as long as the clock input remains LOW. But at the time T5, the clock goes HIGH, and since the D line is LOW, the output goes LOW also. At time T6, however, the D line goes HIGH, while the clock is still HIGH, so the output goes HIGH.

## Digital Circuit Power Supplies

When I was in grad school, I worked for the university as an electronics technician repairing medical equipment (which paid three times what a graduate teaching assistant made!). One day, there was a knock on my workshop door, and a fellow was standing there with a rat's nest wired homebrew digital project in his

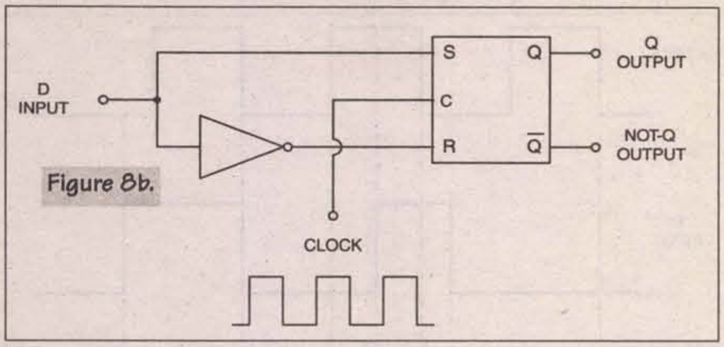


Figure 8b.

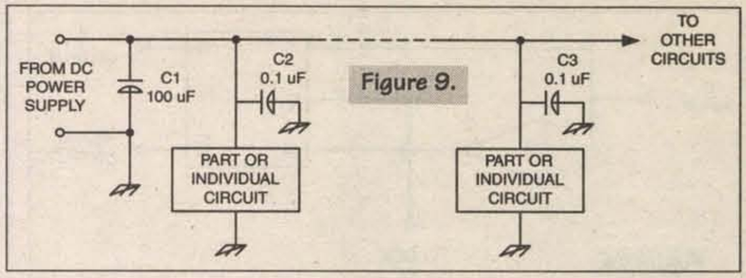


Figure 9.

hands. He was an undergraduate engineering student doing his senior project. "Doctor Frabbitz [not his real name] said you'd help me." Since Prof. Frabbitz basically held the key to my professional future, I allowed as how I just might help this fellow. Besides, he looked forlorn.

The problem was that he had a relatively large digital project built on perf-board with an odd combination of wire-wrap (poorly done), solder-tack, point-to-point wiring, and "dead bug" chips. There wasn't much that I could do about the wiring (proper wire-wrap wiring would've been best, but even that falls down at higher speeds). The fellow told me that the circuit worked sometimes, but not others. After painstakingly eliminating the possibility of loose solder connections, I noticed that there were a lot of TTL devices on the card and NOT ONE CAPACITOR!

The solution to the student's problem would be to re-wire the circuit properly, and then use an adequate number of bypass capacitors in the DC power supply circuitry. Figure 9 shows the usual approach. At the point where the DC power supply is connected to the board, a high value electrolytic capacitor is used. Different textbooks recommend values anywhere from 100 µF to 1,000 µF for the capacitor (C1 in Figure 9).

The point of using the capacitor is to form a local current reservoir to handle instantaneous needs, so I tend to use values in the lower end of the range (the correct value is partially dependent on the current re-quirements of the circuit). In addition, there should be a 0.1 µF capacitor at each device or other active circuit. This capacitor should be as close as possible to the V+ terminal on the individual chip. There are small 0.1 µF units available that are quite compact, and will fit in the standard 0.100-inch hole spacings on perf-board. **NV**

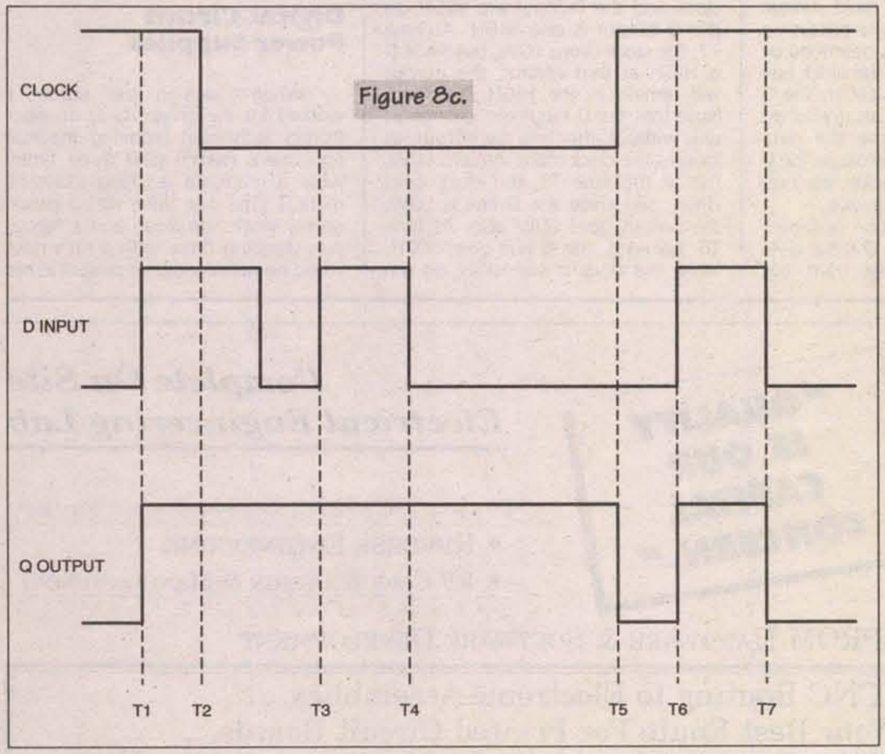


Figure 8c.

## 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.**

## Reading List: RF Exposure to Hams (A Balanced Approach)

There are some new regulations from the FCC regarding RF radiation exposure from ham rigs. Some hams must file paperwork with the FCC. In addition, if you live near any radio transmitting antenna, you will want to be aware of the problems so that you can guard against affecting your own health.

There is a lot of baseless talk about this subject. Both sides are about equally shrill and equally baseless. The problem is not as severe as the pro side would have you believe, but it's also not a "no problem" situation either. If you are concerned with this potential problem, and how the problem can be cured, then I recommend that you obtain a copy of a new book published by ARRL.

The ARRL has been active in this issue for quite a long time, and has — what I believe — is a common sense approach that wisely walks a middle ground (the science is too soft to be certain about either extreme). It is called *RF Exposure and You* (ISDN 0-87259-662-1) by Ed Hare (W1RFI).

Hare breaks the subject down in a way that ordinary people can understand. The price is $15.00, which is certainly cheap for that size book (especially one that contains information that may help you retain your health). It is available from ham radio stores, or direct from ARRL at http://www.arrl.org. I also found it listed at Amazon Books, so check out http://www.amazon.com.



# New Product News

*Continued from page 4*

## AUDIO NOISE REDUCTION SYSTEM

The model NRS1500 noise reduction system assumes that a signal below a predetermined amplitude is noise. It also senses and attenuates noise by measuring the frequency content of the audio signal and then filters noise that occurs above the highest signal frequency. Combining both of these techniques can achieve 25 dB noise reduction by using "single-ended" operation which eliminates the need for the encode decode process.

The NRS1500 circuitry combines a dynamic filter and downward expander to provide a high level of effectiveness without sonic artifacts normally associated with noise reduction systems.

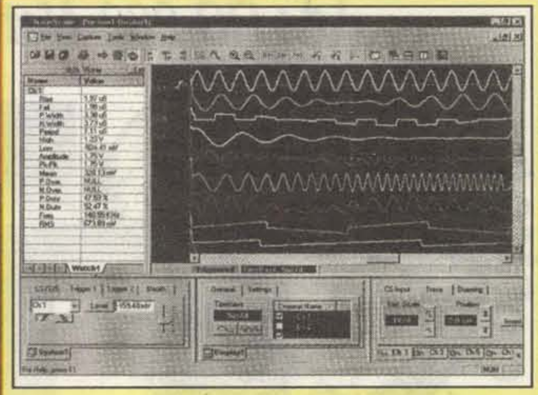
The user switchable volume compression is useful for fast automatic leveling. It attenuates large amplitude signals, such that signals above the adaptive threshold are scaled by 0.2 dB/dB, while the signals below the externally set threshold remain essentially unchanged. Instead of attempting to attenuate all large amplitude signals, the selectable volume leveling circuit attenuates the audio signal when the overall signal amplitude has increased for a considerable amount of time (less than one second).

The NRS1500 is an ideal choice for broadcast studios, commercial recording studios, radio amateurs, and other consumer and professional audio applications while preserving full signal fidelity and transparency.

The NRS1500 is priced at $189.00.

For more information, contact:

**C & S ELECTRONICS**
**P.O. BOX 2142, DEPT. NV**
**NORWALK, CT 06852-2142**
**203-866-3208 FAX: 203-854-5036**
**E-MAIL: CANDSELECT@worldnet.att.net**



## GAGESCOPE FOR WINDOWS

GageScope for Windows supports up to 32-channel oscilloscope systems and gives the user complete control of the CompuScope card.

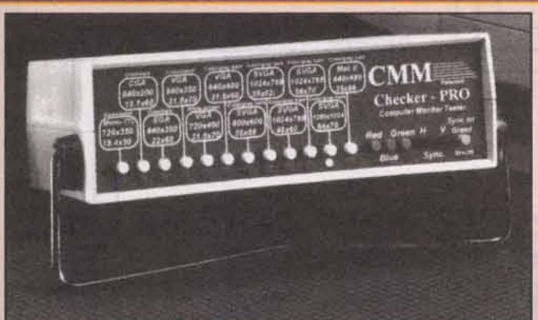
The stand-alone software includes waveform cursors, multiple windows with different timebases, the ability to save and load signals, compatibility with SIG files used with our CompuGen arbitrary waveform generator, and more.

With the optional waveform parameters plug-in, users can automatically calculate rise time, fall time, pulse width, frequency, and many other signal characteristics.

With the optional FFT plug-in, users can perform spectral analysis with up to one million point FFTs.

For more information, contact:

**GAGE APPLIED SCIENCES, INC.**
**1233 SHELBURNE RD., STE. 400, DEPT. NV**
**SOUTH BURLINGTON, VT 05403**
**1-800-567-GAGE FAX: 1-800-780-8411**
**WEB: www.gage-applied.com**




## CHECKER PRO

Computer & Monitor Maint., Inc. announces the Checker Pro.

The Checker Pro is an AC or battery-operated computer color monitor pattern generator. With sweep rates to 64 KHz, various patterns, and gray scale, you can check out almost any monitor.

The Checker pro fills a need in both the field service and shop maintenance areas. By connecting the Checker Pro to the monitor, problems can be isolated. No more swapping video cards or monitors, or even opening the computer for diagnosis. Also, by using the Checker Pro, you no longer need to tie up a computer systems to test or burn in a monitor. with its support of mono, CGA, EGA, MAC, VGA modes from 31.5 KHz to 64 KHz you can easily test and evaluate almost any monitor.

On the bench, the Checker Pro allows a great deal of flexibility. The technician can quickly switch modes using the push buttons, add sync on green, turn off any of the colors, and turn off either horizontal or vertical sync. The Checker Pro provides various test patterns for VGA monitors. Its unique color bar/eight-step gray scale pattern allows color balance and tracking to be quickly evaluated and/or adjusted.

The suggested retail price is $499.95 US.

For more information, contact:

**COMPUTER & MONITOR MAINT., INC.**
**6649-N1 PEACHTREE IND. BLVD., DEPT. NV**
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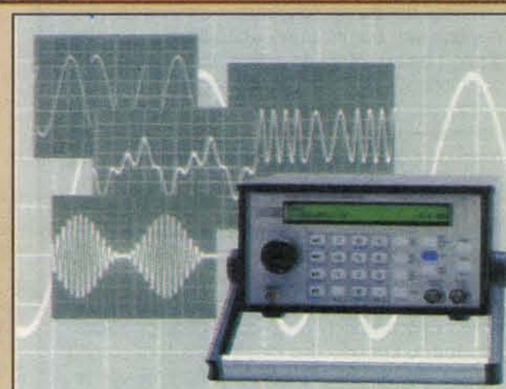

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# The Computer Controlled World: RS-232 Network Control Methods and Applications

# Mixed Control for the Masses

by Ryan Sheldon, National Control Devices (404) 244-2432 http://members.aol.com/ncdcat

In the past couple of months, I have discussed Graphic LCDs and how they can be controlled from a Visual Basic application. This month, I want to go back a little further and tie together some of my earlier articles to demonstrate a powerful computer control system.

This month's control system is based on technologies outlined in previous months of "The Computer Controlled World." This article demonstrates how heating and cooling systems can be controlled using the serial port of your desktop computer.

The hardware may seem overkill for the application, but its true capabilities are only limited by software. In effect, increasing the sophistication of the software greatly enhances the capabilities of the hardware. As many users have already discovered, the hardware is relatively universal and is ideally suited for both complicated and simple control applications.

The technologies illustrated are designed to be networkable components of a larger control system such as a desktop PC. A networkable control system such as this offers upgradability and modularity by allowing you to choose the electronics that closely match the needs of your specific application.

Later in this article, I will discuss software issues that make the whole system work. I think you will be surprised at how little software is actually involved. But for now, I want to talk about the networking and its role in our thermostat on steroids.

## Rules for RS-232 Networking

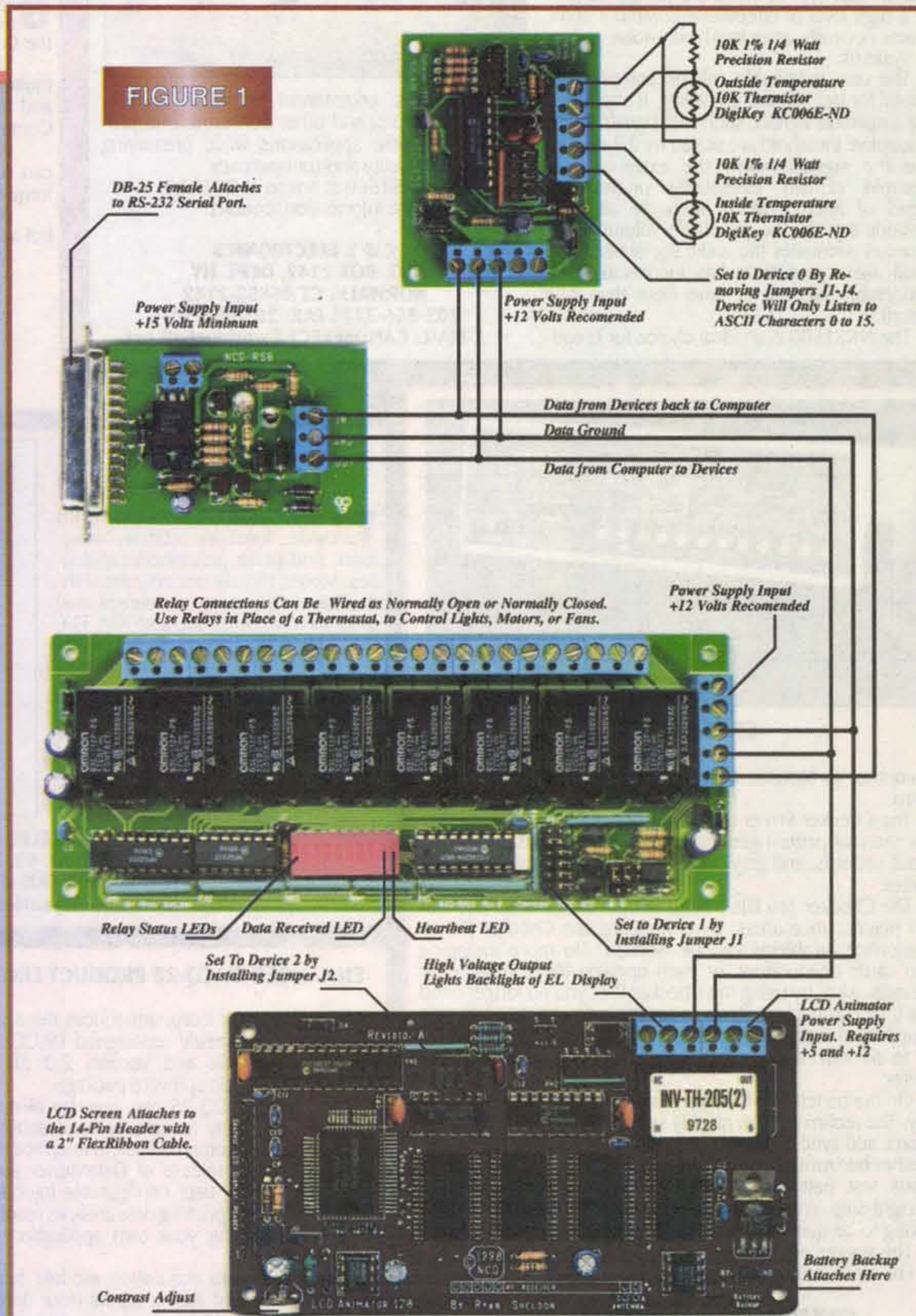
If you have been reading my articles, you know that you can attach up to 16 RS-232 networkable devices on a single RS-232 serial port in any combination. Controlling these devices is very easy if you know the following rules:

1) Your serial port can send or receive ASCII characters 0 to 255.

2) Each device attached to a single RS-232 serial port listens to a range of 16 ASCII characters:

a) A device set to address 0 listens to

FIGURE 1

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ASCII characters 0 to 15.

b) A device set to address 1 listens to ASCII characters 16 to 31.

c) A device set to address 2 listens to ASCII characters 32 to 47.

d) A device set to address 15 listens to ASCII characters 240 to 255.

3) The device number is always set in hardware using a set of four jumpers.

4) The device number is always set in software using a number from 0 to 15.

You can mix and match A/D converters, relay drivers, graphic and character LCD displays, as well as input scanners, output modules, and all the other things discussed in previous articles ... all on a single serial port. Just remember that each device should be set to a different device number and each device number is referred to in software as a number from 0 to 15.

Project1 - Form1 (Code)

Form | Load

```
Private Sub Form_Load()
                                  'Show Image on the PC's Screen
    Form1.Visible = True
                                  'Open Communications to the Serial Port
    MSComm1.Settings = "19200, n, 8, 1"
    MSComm1.CommPort = 2
    MSComm1.PortOpen = True
                                  'Define the Device Numbers on the Network
    AD8_Device = 0                'Remove Jumpers J1-J4 on AD8 Device
    Relay8_Device = 1             'Install Jumper J1 only on Relay8 Device
    LCDA128_Device = 2            'Install Jumper J2 only on LCD Animator
    LCDA128.Setup64 LCDA128_Device 'Setup LCD Animator for 64 Frames
                                  'of Text and Graphics
    LCDA128.LIGHT LCDA128_Device, 1 'Turn On the Backlight
    LCDA128.CLRTXT 0              'Clear the Text Screen

                          'Main Loop
    Do
                          'Read AD Channel 1 for Inside Temperature
        InsideTemp = AD8.ReadAD(AD8_Device, 1)
                          'Read AD Channel 2 for Outside Temperature
        OutsideTemp = AD8.ReadAD(AD8_Device, 2)
                          'Convert AD Values (0 to 255) to Temperature Values
        InsideTemp = AD8.Temperature#(InsideTemp)
        OutsideTemp = AD8.Temperature#(OutsideTemp)
                          'Adjust Relay Status based on Temperatures
                          'If Temperature is too Low then activate heater
        If InsideTemp < 65 Then
                          'Make Sure Cooling System is Turned Off
            Relay8.Turn_Relay_Off Relay8_Device, 1
                          'Turn On Heating System
            Relay8.Turn_Relay_On Relay8_Device, 2
                          'Set Display Mode for Heating System
            Mode$ = "Heating System: On"
        Else
            If InsideTemp > 78 Then
                          'Turn Cooling System On
                Relay8.Turn_Relay_On Relay8_Device, 1
                          'Make Sure Heating System is Off
                Relay8.Turn_Relay_Off Relay8_Device, 2
                          'Set Display Mode for Cooling System
                Mode$ = "Cooling System: On"
            Else
                          'If Temperature is not too hot and not too cold
                          'Turn off heating and cooling system to conserve power
                Relay8.Turn_Relay_Off Relay8_Device, 1
                Relay8.Turn_Relay_Off Relay8_Device, 2
                          'Set Display Mode for Energy Saver
                Mode$ = "Energy Saver Mode"
            End If
        End If
                          'Create a Graphic with Current Time, Temperature,
                          '& Display Mode
        Draw_Temperature_Screen InsideTemp, OutsideTemp, Mode$
                          'Send Graphic to the LCD Display
        LCDA128.SendPicture LCDA128_Device
    Loop
End Sub
```

FIGURE 2

## The Project

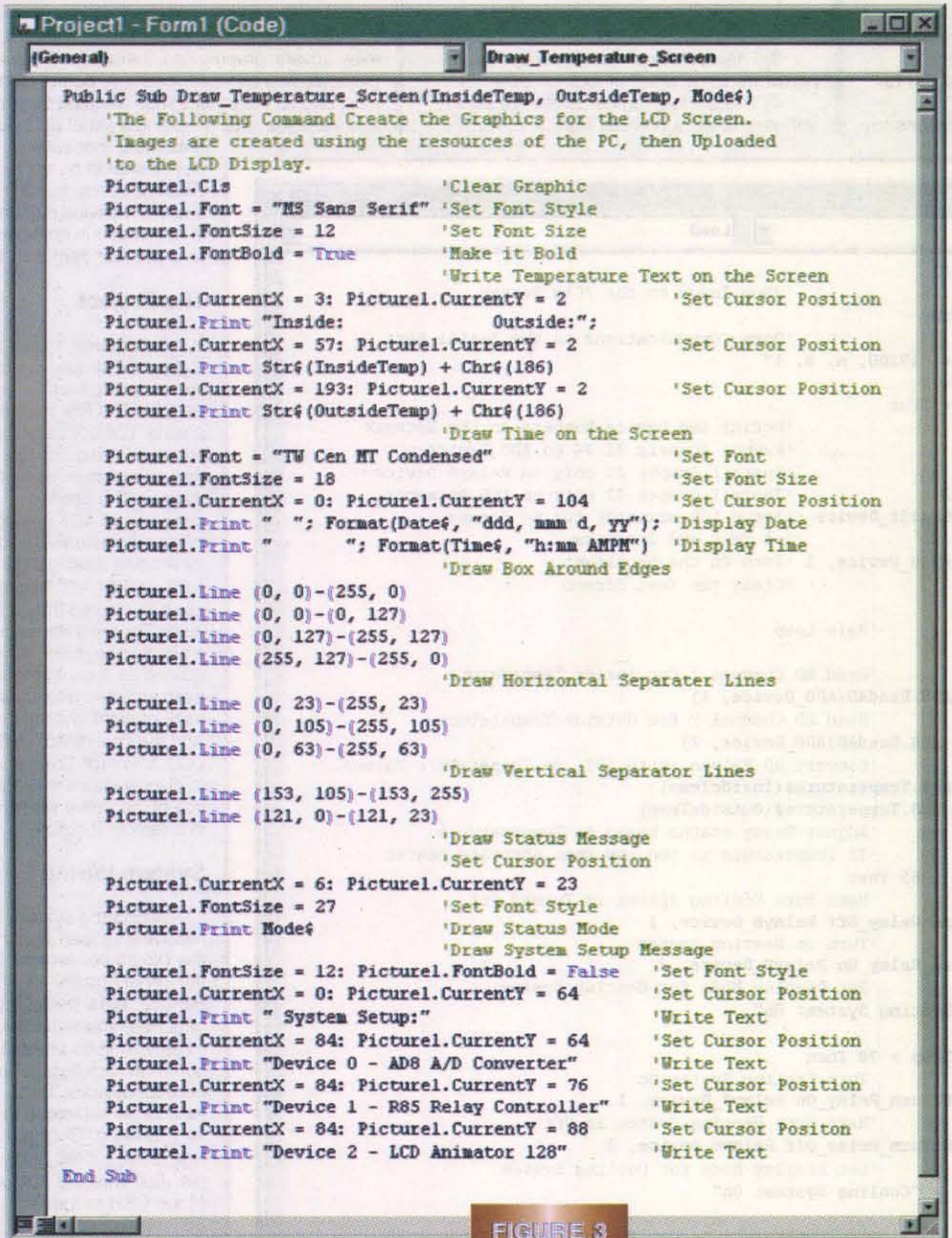
This month, I want to highlight a simple control system using four devices. The first device is a serial booster used for communicating RS-232 data to and from multiple devices. The second device is an AD8 analog-to-digital converter used for reading analog data such as light and temperature levels into the computer. The third device is an R85 relay driver, which is used as a general-purpose software controlled bank of eight switches. And the final device is the LCD Animator 128, used to display status information of the entire system in a remote location.

## System Wiring

Wiring the system is relatively simple. Attach the DB-25 connector of the serial booster to your RS-232 serial port. Once attached, you will have three terminals used to communicate data to and from all devices. Their function is self-explanatory: Ground, Output, and Input ... pretty simple. Just wire the output of the RSB to the RS-232 input of all three devices. Wire the input of the RSB to the output of the R85 and the AD8 controllers. The LCD Animator 128 does not send data back to the computer, so only two wires are required for complete operation. Please see Figure 1 for a detailed wiring diagram.

## System Jumpering

Setting up the jumpers is very simple. All devices should be set to receive data at 19200 baud. The AD8 should



Project1 - Form1 (Code)

(General) | Draw_Temperature_Screen

```
Public Sub Draw_Temperature_Screen(InsideTemp, OutsideTemp, Mode$)
 'The Following Command Create the Graphics for the LCD Screen.
 'Images are created using the resources of the PC, then Uploaded
 'to the LCD Display.
   Picture1.Cls                      'Clear Graphic
   Picture1.Font = "MS Sans Serif"  'Set Font Style
   Picture1.FontSize = 12            'Set Font Size
   Picture1.FontBold = True          'Make it Bold
                                     'Write Temperature Text on the Screen
   Picture1.CurrentX = 3: Picture1.CurrentY = 2          'Set Cursor Position
   Picture1.Print "Inside:          Outside:";
   Picture1.CurrentX = 57: Picture1.CurrentY = 2         'Set Cursor Position
   Picture1.Print Str$(InsideTemp) + Chr$(186)
   Picture1.CurrentX = 193: Picture1.CurrentY = 2        'Set Cursor Position
   Picture1.Print Str$(OutsideTemp) + Chr$(186)
                                     'Draw Time on the Screen
   Picture1.Font = "TW Cen MT Condensed"                 'Set Font
   Picture1.FontSize = 18                                'Set Font Size
   Picture1.CurrentX = 0: Picture1.CurrentY = 104        'Set Cursor Position
   Picture1.Print " "; Format(Date$, "ddd, mmm d, yy"); 'Display Date
   Picture1.Print "       "; Format(Time$, "h:mm AMPM")  'Display Time
                                     'Draw Box Around Edges
   Picture1.Line (0, 0)-(255, 0)
   Picture1.Line (0, 0)-(0, 127)
   Picture1.Line (0, 127)-(255, 127)
   Picture1.Line (255, 127)-(255, 0)
                                     'Draw Horizontal Separater Lines
   Picture1.Line (0, 23)-(255, 23)
   Picture1.Line (0, 105)-(255, 105)
   Picture1.Line (0, 63)-(255, 63)
                                     'Draw Vertical Separator Lines
   Picture1.Line (153, 105)-(153, 255)
   Picture1.Line (121, 0)-(121, 23)
                                     'Draw Status Message
                                     'Set Cursor Position
   Picture1.CurrentX = 6: Picture1.CurrentY = 23
   Picture1.FontSize = 27            'Set Font Style
   Picture1.Print Mode$              'Draw Status Mode
                                     'Draw System Setup Message
   Picture1.FontSize = 12: Picture1.FontBold = False    'Set Font Style
   Picture1.CurrentX = 0: Picture1.CurrentY = 64        'Set Cursor Position
   Picture1.Print " System Setup:"                      'Write Text
   Picture1.CurrentX = 84: Picture1.CurrentY = 64       'Set Cursor Position
   Picture1.Print "Device 0 - AD8 A/D Converter"        'Write Text
   Picture1.CurrentX = 84: Picture1.CurrentY = 76       'Set Cursor Position
   Picture1.Print "Device 1 - R85 Relay Controller"     'Write Text
   Picture1.CurrentX = 84: Picture1.CurrentY = 88       'Set Cursor Positon
   Picture1.Print "Device 2 - LCD Animator 128"         'Write Text
End Sub
```

FIGURE 3

be set to device 0 by removing jumpers J1 to J4. The R85 relay controller should be set to device 1 by installing jumper J1. The LCD Animator 128 should be set to device 2 by installing jumper J2. See the user's manual of each device for an explicit explanation of jumpers and other hardware options.

### Theory of Operation

Once the hardware has been attached to your computer, you will use simple commands to communicate to and from the attached devices. The demonstration program will read the inside and outside temperature using the AD8 analog-to-digital converter. The AD8 will use a thermistor on each of its two input channels to read temperature information. The AD8 will send two numbers (each from 0 to 255) back to the computer representing the current indoor and outdoor temperatures. The program will then pass this number into a look-up table used to convert the numbers 0 to 255 into actual temperatures.

The program will then evaluate the current temperature and determine if the heating or cooling system needs to be turned on. If the current temperature is within an acceptable temperature range, both the heating and cooling systems will be deactivated.

If the temperature is too low, a heater will be activated. Similarly, if the temperature is too high, the cooling system will be activated. The heating and cooling system is controlled using the R85 relay controller. This general-purpose relay driver serves as a universal software-controlled switch, perfect for controlling lights, heaters, coolers, fans, and other real-world hardware. Never exceed 5 amps per relay on the R85, or 10 amps per relay on the R810.

At this point, a subroutine will be used to generate a graphic image on the screen of your PC. This screen will make use of the PC's fonts and drawing commands to generate a 256x128 pixel graphic image of the inside and outside temperatures, as well as the current date and time. In addition, the graphic will display the status of the heating and cooling system. Once generated, the graphic will be sent to the LCD Animator 128 display, indicating the current status of the system to a remote location.

### System Programming

Programming these devices under Visual Basic is very easy because I have done most of the programming for you. For simplicity, you should probably use my subroutines to control the individual devices. Later, you can modify my programs for

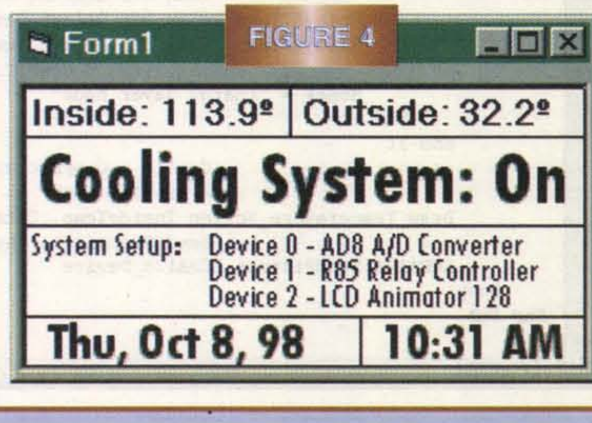



FIGURE 4

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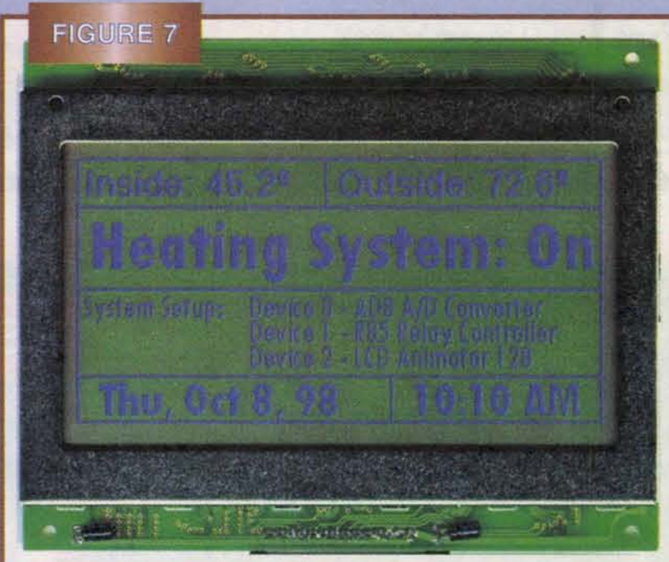
FIGURE 6


FIGURE 5


FIGURE 7




your specific application. If this sounds a little intimidating, let me reassure you that using these devices only requires a few lines of code. So follow along, and I will explain what I have done that makes these devices so easy to control.

I have been working hard to create a series of modules that allow you to do just about anything with a single line of code. Once modules are loaded into your program, you can easily access my subroutines for controlling each individual device.

For example, three devices will be outlined in this article. So, three modules will be used to control each of the three devices. I have named each of these three control modules to identify the product name of each device.

For example, if you wanted to talk to the relay driver, you would use the Relay8 module. To turn on a relay, you would use the command:

```
Relay8.Turn_Relay_On Device, Relay
```

Device is a number from 0 to 15. Since the relay will be configured in this article as device 1, you could use the following command:

```
Relay8.Turn_Relay_On 1, Relay
```

More appropriately, we have defined the constant "Relay_Device = 1" so to control the relay driver, you should use the following statement (just to maintain good programming practice):

```
Relay8.Turn_Relay_On Relay_Device,
Relay
```

Relay is a number from 1 to 8 identifying which relay should be activated.

Table 1 shows some other example calls to my subroutines, just so you can more easily read what I am doing in the programming example in Figure 2.

If you don't want to use constants, you can directly send the device number to control each device as shown in Table 2.

Figure 2 illustrates the main program used to read temperature data, control the relays, and the graphic LCD display. The main program starts by opening COM2 at 19.2K baud. Next, device numbers are assigned in software to each of the three attached devices. The AD8 is set to 0, the R85 is set to 1, and the LCD Animator is set to device 2.

The LCD Animator is initialized by calling the Setup64 subroutine within the LCDA128 module. Once initialized, the backlight is turned on and the text layer of the LCD is cleared.

The entire program repeats in an endless cycle within the Do/Loop statements. The cycle begins by reading the inside temperature, then the outside temperature. The Inside/OutsideTemp variables now hold an A/D value from 0 to 255. The AD8.Temperature# function converts this number to an actual temperature value.

The temperature is then evaluated. If the inside temperature is less than 65 degrees, a heater is activated by turning on relay 2. The cooling system is turned off at the same time by turning off relay 1.

If the temperature is greater than 78 degrees, the cooling system is turned on by activating relay 1. The heater is turned off by turning off relay 2.

If the temperature is within 65 to 78 degrees, both the heating and cooling systems are deactivated. The Mode$ variable stores the current status of the heating/cooling system in user-readable text. The current Mode will be later displayed on the LCD displays.

Next, the program calls the Draw_Temperature_Screen subroutine. This subroutine takes advantage

**TABLE 1**

| | |
|---|---|
| Print AD8.ReadAD AD8_Device, 1 | 'Print A/D Value of Channel 1 on AD8 |
| Print AD8.ReadAD AD8_Device, 2 | 'Print A/D Value of Channel 2 on AD8 |
| Relay8.Turn_Relay_On Relay_Device, 1 | 'Turn on Relay 1 on Relay 8 controller |
| Relay8.Turn_Relay_Off Relay_Device, 7 | 'Turn off Relay 7 on Relay 8 controller |
| LCDA128.Light LCDA128_Device, 1 | 'Turn on Backlight of LCD Animator 128 |
| LCDA128.Light LCDA128_Device, 0 | 'Turn off Backlight of LCD Animator 128 |

**TABLE 2**

| | |
|---|---|
| Print AD8.ReadAD 0, 1 | 'Print A/D Value of Channel 1 on AD8, Device 0 |
| Print AD8.ReadAD 0, 2 | 'Print A/D Value of Channel 2 on AD8, Device 0 |
| Relay8.Turn_Relay_On 1, 1 | 'Turn on Relay 1 on Relay 8 controller, Device 1 |
| Relay8.Turn_Relay_Off 1, 7 | 'Turn off Relay 7 on Relay 8 controller, Device 1 |
| LCDA128.Light 2, 1 | 'Turn on Backlight of LCD Animator 128, Device 2 |
| LCDA128.Light 2, 0 | 'Turn off Backlight of LCD Animator 128, Device 2 |

of Visual Basic's powerful graphics and text capabilities to generate a 256x128 graphic that holds the current time, date, temperature, and heating/cooling status. Figure 3 illustrates the commands used to generate this screen. Figure 4 shows the graphics on the screen of the PC. Once the graphics are generated, the command LCDA128.SendPicture LCDA128_Device sends the status information to the LCD Animator 128.

Figure 5 illustrates an example image uploaded to the LCD Animator when the temperature falls too low.

Figure 6 illustrates an example image uploaded to the LCD Animator when the temperature is within an acceptable range.

Figure 7 illustrates an example image uploaded to the LCD Animator when the temperature raises too high.

As you can see, programming these devices is really very simple and the applications are unlimited. Some people are using the R85 relay controller for controlling lights, gates, alarms, and even opening and closing windows. The AD8 is used to read data into the computer such as light and temperature levels. In many cases, people often use multiple AD8s to read multiple signals into the computer from several locations. The RSB serial booster allows you to attach up to 16 devices to a single serial port at baud rates up to 38.4K over a distance of 800+ feet.

### Expandability

You can attach other devices to this network as well. You could add more AD8 A/D converters, LCD Animators, and relay drivers. You could also add new devices to this network such as audio/video switchers, stepper motor controllers, servo motor controllers, and DC motor controllers. Each device needs its own device number in software from 0 to 15, and a corresponding device number set using jumpers J1-J4 on each individual device.

I hope you have enjoyed this month's Computer Controlled World. Please feel free to call or write with your questions or comments. All Visual Basic source code is available directly from me, just send me an E-Mail at ncdryan@aol.com and I will return your mail with source code attached. **NV**

# Bring a drained battery back to life without opening your hood

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*by Chris Murdock*

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