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May 2000
Vol. 21 No. 5

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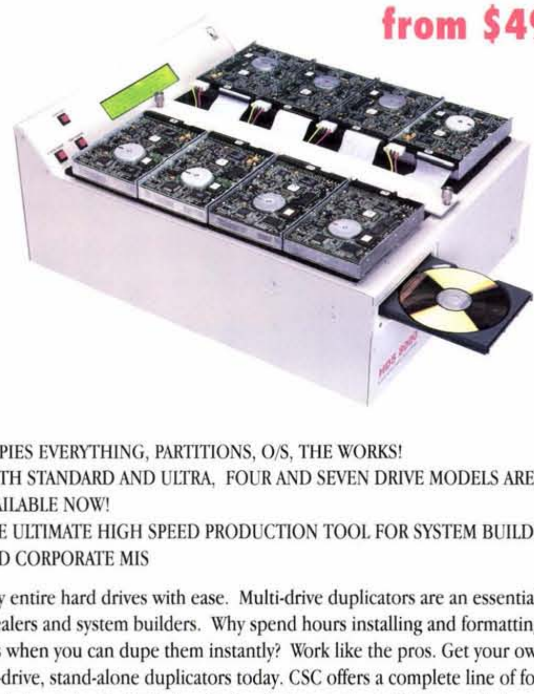

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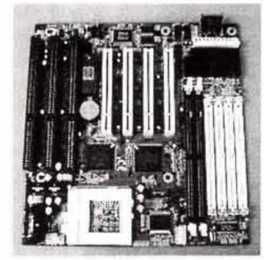

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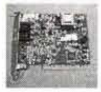

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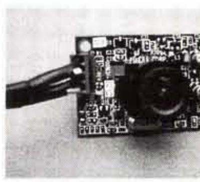
- Uses 4 - 5 VDC, only 150 mA! Three AA batteries would power it for over six hours!
- New in OEM pkg. (no box), 90-day HSC warranty



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HSC#18200 **$12.95**

- 101-key bargain keyboard -- rock-bottom price!
- Perfect for that startup system...or as a backup, get several at this price!
- Beige color, AT-style 5-pin DIN connector
- New, in box, 90-day warranty

HSC#18205 **$7.95**

- 104-key keyboard with AT-style 5-pin DIN connector
- Windows 95/98-ready, special-function menu keys
- Excellent starter or backup keyboard for those who want the extra keys
- Beige color, new in box, 90-day warranty
- Check the price/feature ratio!...another HSC Bargain!

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- IF in mixer marked CTR-60703R
- IF out mixer marked CTR-96070IR with SMA flex guide to a 7 place comb filter
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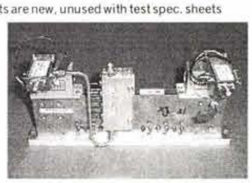

HSC# 80524 **$99.00**

Unique Project Base for Video Hackers!

- Perfect for experimenters, tinkerers and the just curious...Logitech Videoman videoconference camera system!
- These were sold with Hewlett Packard S-700 UNIX workstations for videoconference capability
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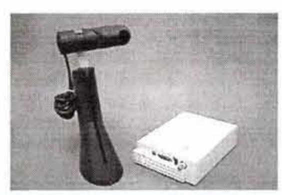
- The camera is on a weighted stand that extends from 13" tall to over 20" tall
- Color camera is digital output only (not NTSC as was previously believed)
- Note: HP and Logitech will provide no information on these items!
- Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video input (BNC), and the connector for the camera cable.
- Units are new!

HSC#17503	Lower Price for set!	$19.95
HSC#17503a	Camera Only	$12.50
HSC#17503b	Interface Only	$12.50



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Contents

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In this issue ....

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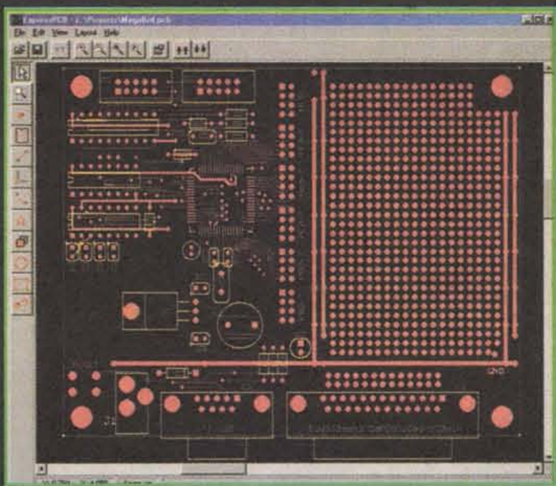
Electronics Design Contest

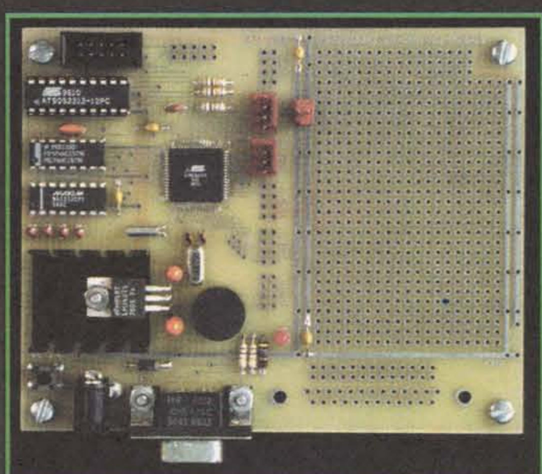
CONTEST ENTRY DEADLINE: JULY 19, 2000

1. **Go from this:**



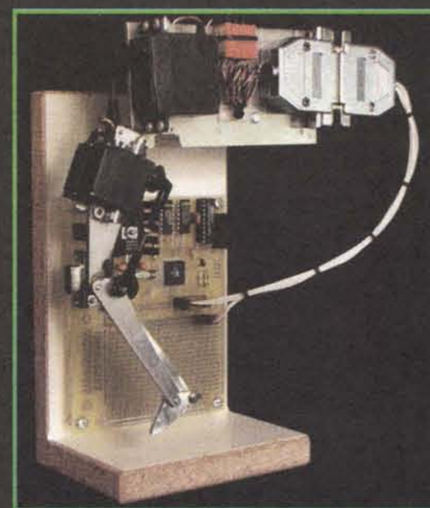
This is a sample project for our design contest. The first step is to lay out a circuit board using the ExpressPCB editor. Your project could be robotic like this one, or related to telecommunications, ham radios, PC computer devices, microcontrollers, scientific equipment, data logging, or almost anything else using an electronic circuit.

2. **To this:**



This circuit board controls three RC-servos. The heart of the electronics is a surface-mount Atmel ATMega microcontroller.

3. **To this:**



This robotic leg and foot was originally designed for movie special effects. It is a prototype mechanism used to animate small creatures.

1st Prize
Tektronix TDS-210 Digital Oscilloscope

2nd Prize
Palm Pilot V Organizer

3rd Prize
Palm Pilot V Organizer

Contest Rules:

- Enter the contest by submitting a written description and photographs of a working electronic project that you have designed.
- Each project must be built using an ExpressPCB circuit board.
- The circuit board must have been designed by you using the ExpressPCB layout program.
- One grand prize and two second prizes will be awarded to the most interesting projects.
- The winning projects will be announced in the September 2000 issue of *Nuts & Volts* and on the ExpressPCB website. Project photographs and descriptions will be published for each of the winners.
- All entries must be received on or before July 19th, 2000.
- Please note: The materials submitted with each contest entry will become the property of *Nuts & Volts Magazine* and will not be returned.

How to enter:

Each contest entry must include:

- Your name, address, phone number, and E-Mail address.
- A written description of your project, about 250 to 500 words.
- A close-up photograph showing your assembled circuit board.
- One or two photographs of your completed project shown in use.
- The confirmation number given when your ExpressPCB circuit boards were ordered.

To enter by mail, send a hardcopy of your contest entry to:

Nuts & Volts Magazine
Design Contest
430 Princeland Court
Corona, CA 92879

To enter by E-Mail, send a single PKZip attachment to: designcontest@nutsvolts.com. *PLEASE DIRECT ANY QUESTIONS TO:* support@expresspcb.com.

Note: Project descriptions must be Microsoft Word documents or text files and photographs must be high resolution .TIF or .JPG files (.TIF preferred).

reader FeedBack

Dear Nuts & Volts:

Although most of the theory in *Nuts & Volts* remains way over my head, I do assimilate more and more information with each passing month. I attribute that to good and consistent writing. Yours is one of the few information sources that is virtually devoid of typographical errors. That alone makes it a pleasure to read!

I am in the midst of taking Heathkit's Master Course in Electronics. When combined with your quality magazine, it has really helped me understand ideas that I could not understand previously. Thank you for helping to make me feel more at home in the technological wilderness.

John Branco

On March 25th, JRL wrote to Steve Parkis:

I am having a problem with the second part of the "Building a better mouse trap" articles. Part one is working fine. But when I download the minmouse.bs2 file from the *Nuts & Volts* site, the file actually is not a BASIC Stamp file at all, but looks like the SX28 interface file. There is no SX28 interface file for the STAMP program on the *Nuts & Volts* site. I tried to change the name of the minmouse.bs2 file to a .src file, but it does not assemble with the SX28 key. Lots of undefined symbols.

Looks like two files are missing for part 2. The SX28.src interface file and the minmouse.bs2 file. Is this the case?

Thanks for the articles, we are hoping to get both a keyboard and a mouse connected to one stamp.

JRL

Looks like the files got mangled somehow. Am attaching zip'ed copies of MINMOUSE.BS2, MOUSEMSNU.BS2 and bs2mouse.src for your convenience. Glad to hear somebody is looking at this closely enough to notice the problem, and I hope this helps!

As a former customer of clark.net (I've since escaped out west to Nevada), may I offer my condolences on your residing in the DC area.

Regards,
Steve

You can download these corrected files from the Nuts & Volts website at www.nutsvolts.com

Dear Nuts & Volts:

I have some new information on sources of used voltage dividers to update my article that appeared in your Jan. 2000 issue.

See below ...

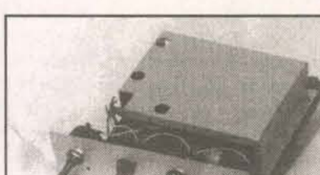


Fig 1 -- Kelvin-Varley divider

Continued on page 70

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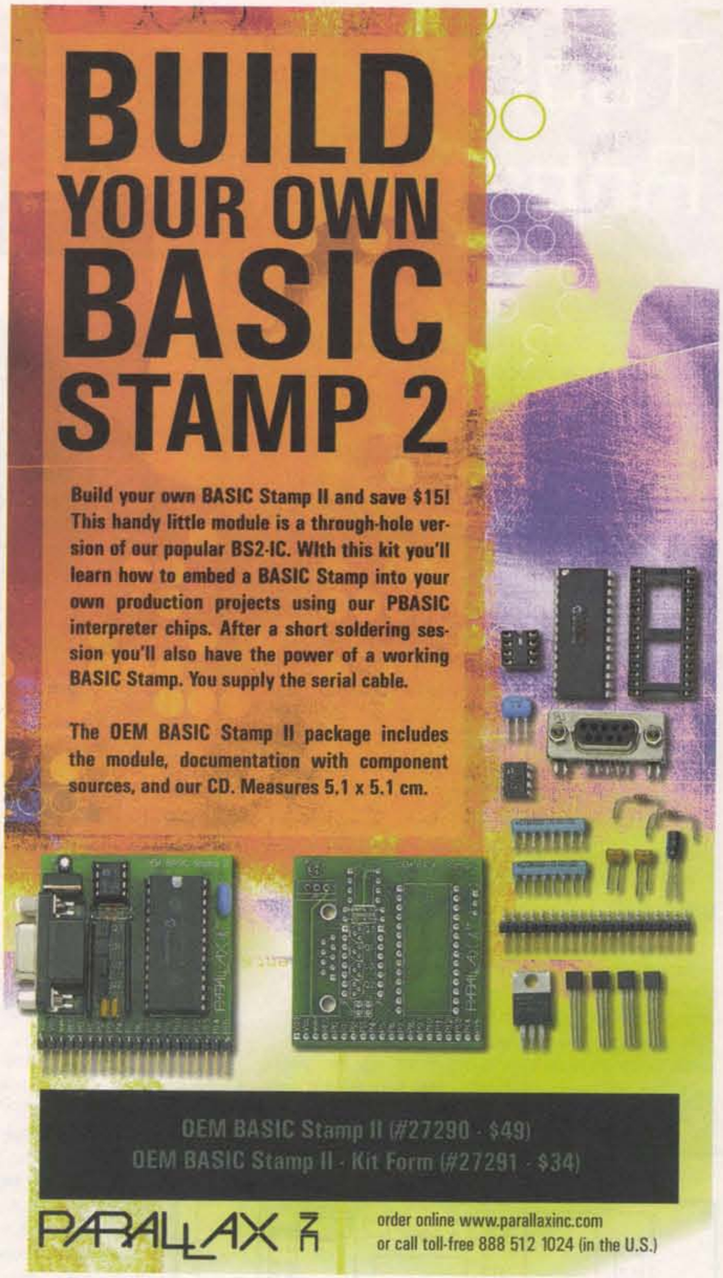

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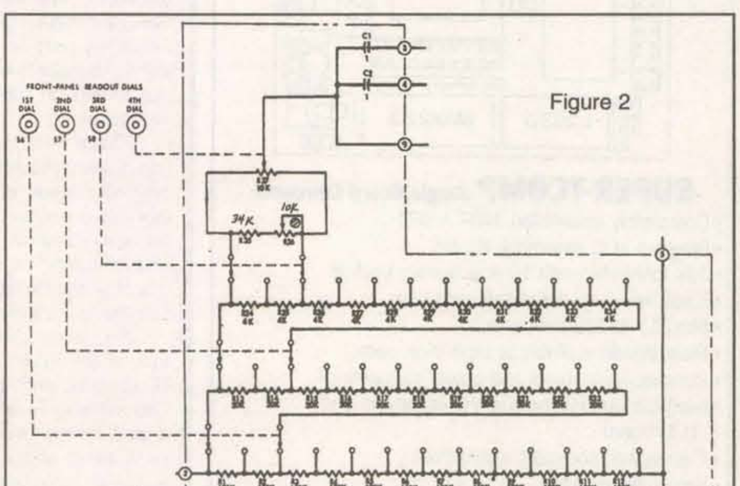


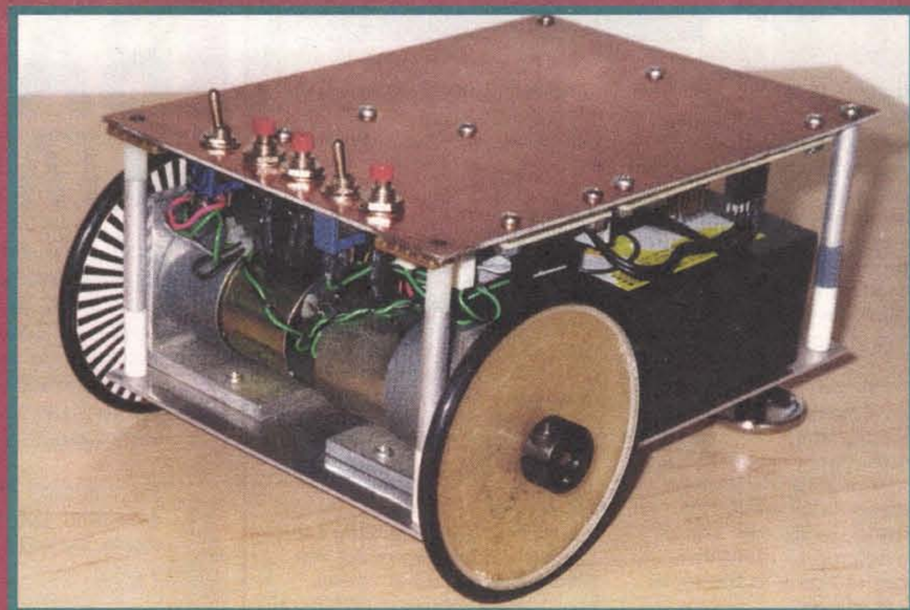
Figure 2

Tools and Techniques for Robot Builders

by Karl Lunt

You can blue-sky all kinds of ideas for a robot to build. It might be something simple, like a robopet, or a more challenging design, such as a six-legged walker. And it's great fun to daydream about all the different behaviors your robot will exhibit and the cool gadgets you can add to it.

But if you're truly serious about building your 'bot, you eventually have to start making a frame or electronics, or writing the code. Each of these elements has many pitfalls that can stall your progress, or make your robot more difficult to build than necessary. This article will describe some simple tools and techniques you can use to help get your robot going sooner.



Wheel mounts

The surplus outfits carry lots of DC gearhead or stepper motors that would be perfect for your next robot. Companies like Marlin P. Jones (www.mpja.com) or American Science and Surplus (www.sciplus.com) offer good deals on high-quality motors from makers such as Vexta, Pittman, Mabuchi, and others. It's pretty easy to find a gearhead motor with a rotation speed of 100-200 RPM and suitable torque, ideal for that line-follower or maze-runner. Let's assume you've found the perfect 12 VDC gearhead, and the ad tells you it comes with a 6mm diameter shaft. How do you mount a wheel onto your new motor?

I went through this same drill not long ago, designing my latest machine, MBot. This robot measures 7-1/2 inches long by 5 inches wide by 4 inches high, a fairly typical size. I had some nifty 12 VDC gearhead motors laying around that I wanted to use, but I had to mount a wheel 3 inches in diameter by 1/4-inch wide to each 6mm shaft.

My first attempt involved drilling a 6mm hole down the center of a 1/2-inch bolt, then drilling and tapping a hole into the bolt's shoulder for a 4-40 set screw. I've used this technique before, and readers of my past Amateur Robotics column will remember how I used this method to put wheels on robots such as BYRD and Tacklebot.

These were big machines, sporting heavy lawn-mower wheels, and they needed a beefy wheel mounting system. But this mounting method is overkill for a robot as small as MBot. The large bolts and matching nuts looked inelegant and out of place on my little 'bot, and I didn't like the extra weight they added.

So I described what I was looking for in a wheel mount to the guys at a recent Seattle Robotics Society (SRS) meeting. Lance Keizer — a club stalwar — gave me a neat idea for such a mount, and I'll pass along what I did. Refer to the accompanying diagram (Figure 1).

This wheel mount consists of a steel or aluminum split-ring shaft collar of the appropriate diameter, modified so you can attach a wheel to the wall of the collar at one point. When you mount the wheel/collar assembly onto the motor's shaft and tighten down the collar, you have a non-slip mechanical connection that is light, small, and inexpensive.

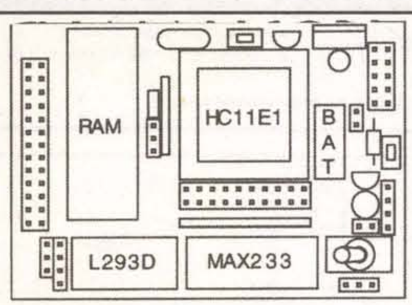
Since I needed a little help with the machining, I gathered up my parts and headed over to Dan Mauch's house. Dan — a long-time SRS member — has helped me many times with past projects; he is an experienced machinist with a garage full of tools and materials. As a rule, software people shouldn't operate heavy machinery, and I'm always grateful for Dan's help. (I know there are some software people who can use heavy machinery, but I'm not one of them.)

Dan had already told me which shaft collars to order from the extensive McMaster-Carr mail-order catalog, and at less than $2.00 each, I consider my 6mm steel shaft collars a bargain. You can dig through the McMaster-Carr catalog by hitting their web site with a Java-enabled browser (www.mcmaster.com).

I had already stopped by the local TAP Plastics store and scooped up some machined three-inch Plexiglass discs, also for less than $2.00 each. Each disc was made of 1/4-inch thick clear plastic, with protective peel-off paper, and with a smooth edge on the rim. If you have a TAP Plastics or similar store in your area, be sure to check them out. Besides stock items already machined for you, most such shops have a big bin of scraps, and you can find pieces of Sintra, ABS, Plexiglass, and other plastics at excellent prices.

My last stop took me to a local hardware store, where I picked up some 2-3/4 inch diameter by 1/4-inch thick black rubber O-rings. I had already decided to use these as the "tires" for my new wheels. They provide excellent traction, are fairly cheap and easy to get, and I figured they would look way cool on the new wheel design.

Dan began the wheel mount construction



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by drilling a centered 6mm hole in each of the plastic discs. Then he locked a disc and a steel shaft collar together by stacking them on a 6mm bolt and running a nut down on them. He clamped this assembly into a vise on his drill stand, then locked the vise into position on the drill's table. He drilled a hole into each steel shaft collar all the way through the plastic disc, sized to tap for a 4-40 screw. Then, he removed the shaft collar and drilled a hole in the plastic disc, sized to clear a 4-40 screw. Note that he drilled this second hole by running the bit into the smaller hole previously drilled for the 4-40 tap.

To make sure the O-ring would stay on the wheel's rim, Dan next took each disc, minus the shaft collar, and mounted it onto a 6mm bolt, then ran a nut down on it. He clamped this assembly into his metal lathe and spun it up, then used a cutting tool to cut a 3/8-inch groove into the center of the wheel's rim.

All that remained now was to put the assemblies together. I used a 3/8-inch 4-40 bolt through the hole in each disc to clamp it to a shaft collar, keeping the bores of the two units aligned. Then, I carefully stretched an O-ring onto the rim of each disc, seating the O-ring into the rim's groove. Finally, I applied a small drop of Super-Glue to the joint between the disc and the O-ring at one-inch intervals around the rim. When the glue set, my wheel was finished. I slipped the wheel assembly onto a motor shaft, with the shaft collar away from the motor's body, and used a hex wrench on the collar's set screw to clamp the collar to the shaft.

I really like the final product. The wheels have no side-to-side play as they rotate, which means the inner surface stays a fixed distance away from the frame. This is important for robots that need an optical encoder disc mounted to the wheel, for measuring distance traveled. I peeled the protective paper off of the outer surface of each wheel, but left the paper on the inner surface. Now I have a good mounting surface for my encoder discs, but the outer surface is shiny and polished.

The above steps may seem complicated, but they really take just a few minutes when done by an experienced machinist. You end up with sleek, high-quality robot wheels for about $5.00 each. If you don't own a garage full of machine tools, ask around at your next club meeting, or talk to people at the local vocational school or nearby machine shop. Wheels that look this good on your robot are worth a little trouble to make.

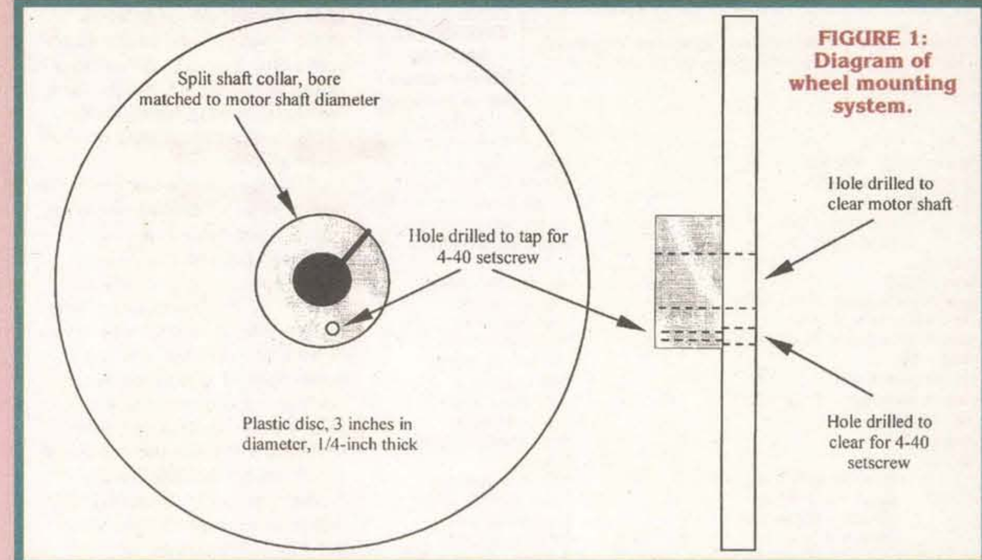

FIGURE 1: Diagram of wheel mounting system.

Cheap, efficient power

I use a pair of 12 VDC gel-cell batteries, wired in parallel, to power MBot. This gives me plenty of juice for the motors, but I have to convert this voltage to 5 VDC for the electronics. If you face a similar problem, resist the urge to grab a 7805 linear regulator. Sure, they work, but you will be losing a lot of operating time on your battery because the 7805 is so inefficient.

Linear regulators such as the 7805 generate 5 VDC from a higher voltage by wasting the difference between input and output voltages as heat; the more current you draw through the regulator, the hotter it gets. At 12 VDC input, it doesn't take a lot of current draw to get the regulator so hot that it thermally shuts down. A more efficient regulator, such as a switching power supply, lets you use more of that excess voltage to run your robot, instead of heating the room.

National Semiconductor has been offering the SimpleSwitcher® power supply chips for a few years now. I still have one of their free demo boards that they handed out through the mail some time ago. The LM2595 regulator built into this board can supply up to one amp of current at 5 VDC out, with an efficiency of nearly 85%. And National offers a whole range of package designs and current ratings, if you want to try rolling your own board. For details, stop by the National website at www.national.com.

While you're there, check out their LM2675 SimpleSwitcher demo board, available by mail-order for just $8.00 each for a one-amp switcher. This tiny board contains the full power supply, ready to hook up to your battery (8-40 VDC input). As of now, you can order this board only from the web site, and you must supply a credit card number to do so. Note that you will be giving your credit card info to a third party, contracted with National to handle web orders. I tried calling National's 800 phone number to place the order, and was told they aren't set up to handle this kind of business.

This little switcher board is the perfect addition to any robot design that uses a battery supply in the appropriate range. You can mount it on nearly any insulated surface using little more than double-sided foam tape or hot glue. And you'll really enjoy the longer running times that a switching supply gives you.

Line-following software

I built MBot as a multi-purpose robot. Among other tasks, MBot can carry a pod of phototransistors on its undercarriage, for use in a line-following contest. The line-following sensor array is pretty simple; just a set of five IR phototransistors and five bright red LEDs. Each LED is aimed so it illuminates the floor immediately underneath a matching, down-looking phototransistor. Each phototransistor's output is then fed into a separate analog input on my 68hc11 computer board.

I intentionally chose red LEDs, rather than IR LEDs, to eliminate long-standing problems with IR emitters and detectors. We think of IR as "light you can't see," but IR behaves very differently from conventional light. For example, a sheet of white paper is translucent (at least) to IR, and a line-following pod that uses IR can get fooled by designs on the underlying floor. I have seen more than one robot veer off-course during a contest, following the design of a floor tile below the maze's paper.

By using red LEDs, I can be sure of where the light will appear, what pattern it makes on the maze surface, and what the photodetector will see. The phototransistors have plenty of sensitivity to the red light to give me a wide signal swing between a white surface and a black line.

But it isn't enough simply to turn on the robot and let it run. The signal returned by a phototransistor can vary, based on parameters such as the whiteness of the paper, the color of the line, and even the consistency of the line's width and darkness. And each phototransistor/

To get details on Karl's book, including price and ordering information, contact the book's publisher, A. K. Peters, Ltd. Their web site is www.akpeters.com. You can also find it at other outlets, including Amazon.com.

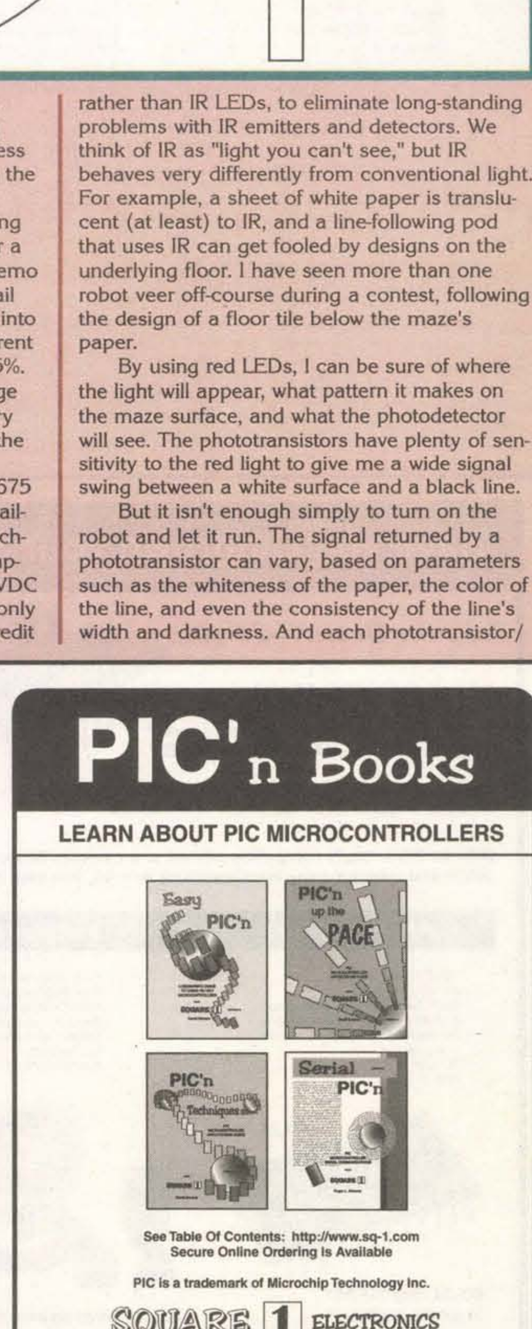

FIGURE 2: Sample SBasic code for scanning a line.

```
'
' Scan routine for determining light/dark thresholds
' for an array of phototransistors in a line-following
' pod.
'

scan:
rpwm = RSCANSPD                          ' right motor duty cycle
lpwm = LSCANSPD                          ' left motor duty cycle
for n = 0 to 4                           ' for all sensors...
        vmin(n) = $fff                   ' make min too high
        vmax(n) = 0                      ' and max too low
next n
wait = 100                               ' set 1/2 sec delay
gosub setmotors, FWD, REV                ' turn in an arc
do loop until wait = 0                   ' wait out delay
gosub setmotors, STOP, STOP              ' stop the motors
wait = 60                                ' set 1/4 sec delay
do loop until wait = 0                   ' wait out delay
gosub setmotors, REV, FWD                ' turn other way
wait = 200                               ' set 1 sec delay
swait = 0                                ' clear sample delay
do                                       ' loop...
        do loop until swait = 0          ' if time to sample...
        swait = LOOPDLY                  ' reset sample delay
        gosub read_sensor                ' read all sensors
        for n = 0 to 4                   ' for all sensors...
                if vmin(n) > eyes(n)     ' if new reading is low
                     vmin(n) = eyes(n)   ' save new low reading
                endif
                if vmax(n) < eyes(n)     ' if new reading is high
                     vmax(n) = eyes(n)   ' save new high reading
                endif
        next
loop until wait = 0                      ' do until delay is done

'
' compute the threshold for each eye as:
' threshold = (vmax - vmin) / 2 + vmin
'
for n = 0 to 4                           ' for each sensor...
        threshold(n) = rshft(vmax(n) + vmin(n))
next

gosub setmotors, STOP, STOP              ' stop the motors
return
```

LED pair will give a different value when looking at the exact same line, owing to differences in physical alignment, height from the floor, overlap from nearby LEDs, and ambient light on the maze surface.

You can take a few measurements in your lab and come up with a reasonable guess for a threshold between white and black, but your guess will only work in your lab and under conditions similar to your test set-up. Move that robot out into the harsh light of a club venue or auditorium, and your threshold values may be so far off that your 'bot can't see the line at all.

A simple solution to this problem involves sweeping all five sensors over the line when the robot first powers up. Software takes continuous samples of all five sensors, recording the highest and lowest readings for each. After the sweep is over, your code can compute a threshold for each sensor, based on these extremes.

Now your program will have a threshold that is tuned to the ambient conditions. Even if one of your sensors is jarred accidently during handling, your robot will still correct for the new alignment and derive the proper threshold.

I've included a sample SBasic routine that performs this scan operation, so you can see how the concept works (Figure 2). As usual, I've included a variable called WAIT, which acts as a down-counting timer. A piece of code, not shown here, services the computer's Real-Time Interrupt (RTI) every 4.1 msecs. In the service routine, code tests the value of WAIT and decrements it if WAIT is not zero. This means that anytime code writes a non-zero value to WAIT, WAIT "magically" begins counting down at the rate of about 250 counts per second, stopping when it hits zero. Thus, WAIT and a similar variable — SWAIT — act as timers for various operations in my program.

This isn't a complete program, but it contains enough detail so you should be able to modify it for your own use. I run it on a custom 68hc11 board, but it should work fine on nearly any 68hc11 computer, such as a BOTBoard. As long-time readers of my past columns already know, you can download the latest version of my 68hc11 SBasic compiler from my web site at www.seanet.com/~karllunt.

In closing ...

Speaking of my past columns, I have recently published a book containing some 50 articles from my past Amateur Robotics column for *Nuts & Volts* magazine. *Build Your Own Robot!* is nearly 600 pages long, has an extensive index, and features many of my favorites. I included material for beginner and intermediate hobbyists alike, and I left the column format unchanged. Personally, I think this makes the book good "grazing" material, and I hope you'll spend time browsing through the various articles for ideas for your next machine. **NV**

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Newsbytes

SEVEN STUDENTS ARE FIRST AND SECOND PLACE WINNERS IN 18TH ANNUAL DURACELL/NSTA CHALLENGE

100 Student Inventors receive $160,000 in Savings Bonds

US middle- school and high-school students have demonstrated their innovative skills with an impressive array of practical and entertaining battery-operated devices addressing educational, health, sports, and safety needs in the 18th Annual Duracell/NSTA Invention Challenge.

The first and second place winners invented a portable communications tool, a device for hearing-impaired athletes, a useful home health aid, an important safety device for school buses, a handy home/office organizer, and a piano learning device.

Duracell and the National Science Teachers Association announced first through fifth place winners who are recipients of $160,000 in savings bonds in the 18th annual challenge — the nation's largest and oldest competition for middle school and high-school inventors.

Over 1,900 students submitted photos and plans for 1,436 prototype entries — in two categories, 6th through 9th grade and 10th through 12th grade.

In judging at Duracell headquarters, 100 finalist entries were awarded savings bonds ranging from $20,000.00 to $500.00. The seven first and second place winners, with their parents and sponsoring teachers, were honored in Orlando on April 5th during the annual convention of the National Science Teachers Association (NSTA).

First Place Winners

First place winners of $20,000.00 savings bonds are a New Jersey High School senior, Stephen Cosenza, and a team of New York state sixth graders, Michael Marsal and Margaret Winter.

Cosenza invented the One-Hand Mobile Keyboard, an alternative communications system, which is a wearable keyboard. The invention is a new idea for data input or which Cosenza has developed both the hardware and software. A user can enter text while walking down the street and either immediately transmit it using radio waves or store it for processing later. Cosenza says, "practical uses for my invention are to equip soldiers in the military for secret communications, or for disabled persons who have limited mobility." The language is a new chording system which Cosenza calls Orderly Character Expansion, or OCE. Cosenza lives in Ocean, NJ and attends Ocean Township High School. His sponsor is Gilbert Lloyd, an electronics teacher.

Marsal and Winter, first place winners in the middle school category, invented the S3: Sports Signaling System designed to let hearing-impaired persons play hockey. The S3 attaches to a helmet and signals a green light when the coach wants a player's attention, such as for a line change, or a red light when the referee blows the whistle to stop play. The Hackley School students said, "We got the idea from ice hockey camp last summer where one of the campers was hearing-impaired." Marsal lives in Rye, NY and Winter lives in Purchase. Their sponsor is science and geology teacher, Ed Zapson.

Second Place Winners

Four second place winners of $10,000.00 savings bonds are Ana Lucia Ybarra Berry of The Woodlands, TX for the Asthmalyzer; Bari Spielfogel of Jericho, NY for Busguard; Gregory

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Eden of Columbia, MD for SNAP — The Sight-Reading Notation Acceleration Program; and Advay Mengle of Carmel, IN for SmartRack — a CD Locator.

Berry's Asthmalyzer is a practical self-monitoring device for people with asthma. It measures and reports peak exhaled breath flow, the total volume of air exhaled, and the average air flow rate. "It's vital to monitor the breathing patterns of asthmatics," Berry says. "I've had asthma for seven years and I thought of making this device when I was monitoring a new medication and needed to know if it was working." Berry is a junior at the Academy of Science and Technology in Conroe, TX. Her sponsor is Scott Rippetoe, a physics and electronics teacher.

Spielfogel developed Busguard, an important safety device to monitor children as they enter and exit school buses which ensures that no child is left on a bus at the end of a route. "I got the idea because of hearing about the problems of children who fell asleep and were left on school buses after they were parked for the night." Spielfogel says. She is in 10th grade at Jericho High School, Jericho, NY and her sponsor is Allen Sachs who teaches independent research.

Eden created SNAP — Sight-Reading Notation Acceleration Program, an educational tool to help musicians increase their sight-reading skills. "It is useful for pianists with varying skills because it offers six learning speeds and from one to five notes per screen," says Eden. "My device is entertaining and makes sight-reading a SNAP!" Eden is in 7th grade at Burleigh Manor Middle School in Ellicot City, MD. His sponsor is science teacher, Kathleen McLaughlin.

Mengle invented SmartRack to help organize his computer CDs. SmartRack is a time-saving locator system that quickly identifies with a light where an individual CD is in a large rack. "This prototype locates CD-ROMs or audio CDs, but could easily be extended to identify other jacketed items such as audiotapes, videocassettes, and DVDs," Mengle says. He attends Carmel Junior High School in Carmel, IN where he is in 7th grade. His sponsor is general science teacher, Beth Lehner.

Every Entry is a Winner

The Duracell/NSTA Invention Challenge is awarding 10 third place \$3,000.00 savings bonds, 24 fourth place \$1,000.00 bonds, and 60 fifth place \$500.00 bonds. All 1,953 students who entered the 2000 Challenge will receive a gift and a certificate of participation. Sponsoring teachers of the 100 finalists also receive gifts.

The Challenge

The Duracell/NSTA Invention Challenge rewards 6th through 12th grade students for designing and creating battery-powered devices which are educational, useful, and entertaining. Judging is based on creativity, practicality, and energy efficiency of each invention, and clarity of an explanatory essay.

Sponsored by Duracell and administered by the National Science Teachers Association, the Duracell/NSTA Invention Challenge has awarded over one million dollars in scholarships, savings bonds, and cash awards to more than 1,000 students since 1983. Student inventors retain all rights to their devices.

The National Science Teachers Association has 53,000 members and is the largest organization in the world dedicated to promoting excellence in science teaching and learning.

•

The Internet Doesn't Do Security ... *Building Linux and OpenBSD Firewalls*

The Internet was originally designed to distribute research papers, getting information to as many people as possible, as quickly as possible. Preventing people from reading someone else's E-Mail, acquiring his or her credit card number, or altering a company's payroll information just wasn't the major consideration.

Clearly — say security experts Wes Sonenreich and Tom Yates — the design criteria of the past is inadequate for the modern Web. Security and IT professionals need to learn how to protect today's fastest growing, freely-distributed operating systems with simple, secure, and inexpensive firewalls.

Their new work, *Building Linux and OpenBSD Firewalls* (Wiley Computer Publishing; available now for \$44.99, paper; ISBN 0-471-35366-3) is the only book to focus exclusively on Linux and OpenBSD firewall security issues.

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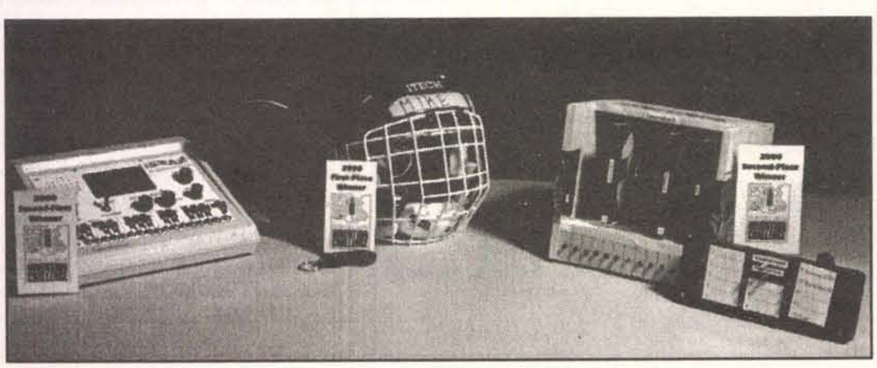
Wiley books are available at your local bookstore or by calling 1-800-225-5945. In Canada, call 1-800-567-4797.



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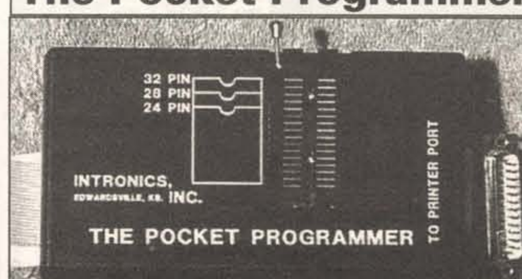

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FET PRINCIPLES AND CIRCUITS

Part 1

Field-Effect Transistors

by Ray Marston

Ray Marston explains FET (Field-Effect Transistor) basics in this opening episode of this new four-part series.

Field-Effect Transistors (FETs) are unipolar devices, and have two big advantages over bipolar transistors: one is that they have a near-infinite input resistance and thus offer near-infinite current and power gain; the other is that their switching action is not marred by charge-storage problems, and they thus outperform most bipolars in terms of digital switching speeds.

Several different basic types of FETs are available, and this opening episode looks at their basic operating principles. Parts 2 to 4 of the series will show practical ways of using FETs.

FET BASICS

An FET is a three-terminal amplifying device. Its terminals are known as the source, gate, and drain, and correspond respectively to the emitter, base, and collector of a normal transistor. Two distinct families of FETs are in general use. The first of these is known as 'junction-gate' types of FETs; this term generally being abbreviated to either JUGFET or (more usually) JFET.

The second family is known as either 'insulated-gate' FETs or Metal Oxide Semiconductor FETs, and these terms are generally abbreviated to IGFET or MOSFET, respectively. 'N-channel' and 'p-channel' versions of both types of FET are available, just as normal transistors are available in npn and pnp versions. *Figure 1* shows the symbols and supply polarities of both types of bipolar transistor, and compares them with both JFET versions.

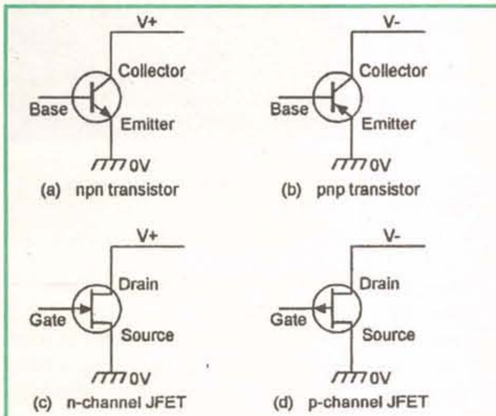

Figure 1. **Comparison of transistor and JFET symbols, notations, and supply polarities.**

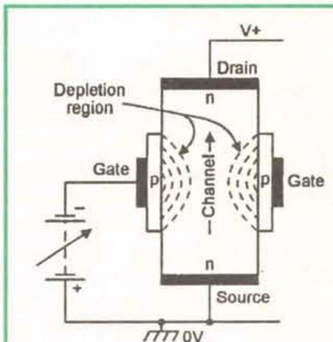

Figure 2. **Basic structure of a simple n-channel JFET, showing how channel width is controlled via the gate bias.**

Figure 2 illustrates the basic construction and operating principles of a simple n-channel JFET. It consists of a bar of n-type semiconductor material with a drain terminal at one end and a source terminal at the other. A p-type control electrode or gate surrounds (and is joined to the surface of) the middle section of the n-type bar, thus forming a p-n junction.

In normal use, the drain terminal is connected to a positive supply and the gate is biased at a value that is negative (or equal) to the source voltage, thus reverse-biasing the JFET's internal p-n junction, and accounting for its very high input impedance.

With zero gate bias applied, a current flow from drain to source via a conductive 'channel' in the n-type bar is formed. When negative gate bias is applied, a high resistance region is formed within the junction, and reduces the width of the n-type conduction channel and thus reduces the magnitude of the drain-to-source current. As the gate bias is increased, the 'depletion' region spreads deeper into the n-type channel, until eventually, at some 'pinch-off' voltage value, the depletion layer becomes so deep that conduction ceases.

Thus, the basic JFET of *Figure 2* passes maximum current when its gate bias is zero, and its current is reduced or 'depleted' when the gate bias is increased. It is thus known as a 'depletion-type' n-channel JFET. A p-channel version of the device can (in principle) be made by simply transposing the p and n materials.

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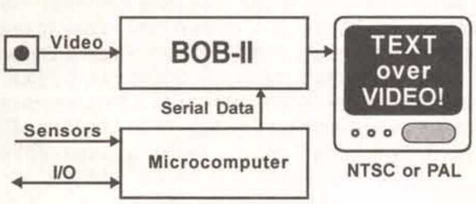

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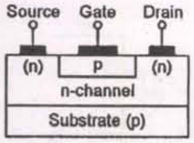


Figure 3. Construction of n-channel JFET.

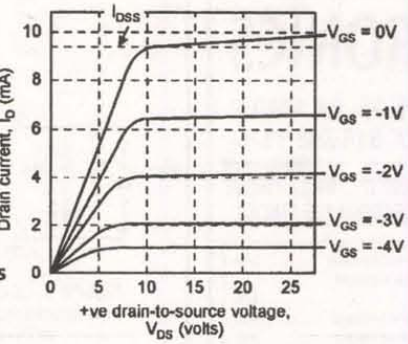


Figure 4. Idealized transfer characteristics of an n-channel JFET.

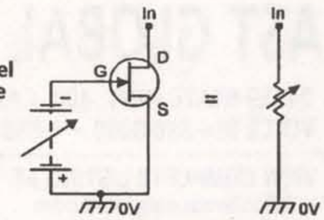


Figure 5. An n-channel JFET can be used as a voltage-controlled resistor.

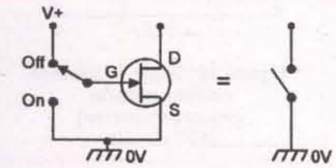


Figure 6. An n-channel JFET can be used as a voltage-controlled switch.

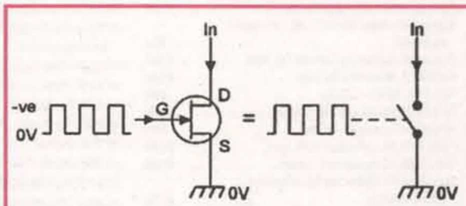


Figure 7. An n-channel JFET can be used as an electronic chopper.

JFET DETAILS

Figure 3 shows the basic form of construction of a practical n-channel JFET; a p-channel JFET can be made by transposing the p and n materials. All JFETs operate in the depletion mode, as already described. *Figure 4* shows the typical transfer characteristics of a low-power n-channel JFET, and illustrates some important features of this type of device. The most important characteristics of the JFET are as follows:

(1). When a JFET is connected to a supply with the polarity shown in *Figure 1* (drain +ve for an n-channel FET, -ve for a p-channel FET), a drain current (I_D) flows and can be controlled via a gate-to-source bias voltage V_{GS}.

(2). I_D is greatest when V_{GS} = 0, and is reduced by applying a reverse bias to the gate (negative bias in an n-channel device, positive bias in a p-type). The magnitude of V_{GS} needed to reduce I_D to zero is called the 'pinch-off' voltage, V_P, and typically has a value between 2 and 10 volts. The magnitude of I_D when V_{GS} = 0 is denoted I_{DSS}, and typically has a value in the range 2 to 20mA.

(3). The JFET's gate-to-source junction has the characteristics of a silicon diode. When reverse-biased, gate leakage currents (I_{GSS}) are only a couple of nA (1nA = .001µA) at room temperature. Actual gate signal currents are only a fraction of an nA, and the input impedance of the gate is typically thousands of megohms at low frequencies. The gate junction is shunted by a few pF, so the input impedance falls as frequency rises.

If the JFET's gate-to-source junction is forward-biased, it conducts like a normal silicon diode. If it is excessively reverse-biased, it avalanches like a zener diode. In either case, the JFET suffers no damage if gate currents are limited to a few mA.

(4). Note in *Figure 4* that, for each V_{GS} value, drain current I_D rises linearly from zero as the drain-to-source voltage (V_{DS}) is increased from zero up to some value at which a 'knee' occurs on each curve, and that I_D then remains virtually constant as V_{DS} is increased beyond the knee value. Thus, when V_{DS} is below the JFET's knee value, the drain-to-source terminals act as a resistor, R_{DS}, with a value dictated by V_{GS}, and can thus be used as a voltage-variable resistor, as in *Figure 5*.

Typically, R_{DS} can be varied from a few hundred ohms (at V_{GS} = 0) to thousands of megohms (at $V_{GS} = V_P$), enabling the JFET to be used as a voltage-controlled switch (*Figure 6*) or as an efficient 'chopper' (*Figure 7*) that does not suffer from offset-voltage or saturation-voltage problems.

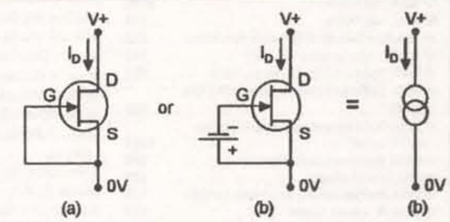
Also note in *Figure 4* that when V_{DS} is above the knee value, the I_D value is controlled by the V_{GS} value and is almost independent of V_{DS}, i.e., the JFET acts as a voltage-controlled current generator. The JFET can be used as a fixed-value current generator by either tying the gate to the source as in *Figure 8(a)*, or by applying a fixed negative bias to the gate as in *Figure 8(b)*. Alternatively, it can (when suitably biased) be used as a voltage-to-current signal amplifier.

(5). FET 'gain' is specified as transconductance, g_m, and denotes the magnitude of change of drain current with gate voltage, i.e., a g_m of 5mA/V signifies that a V_{GS} variation of one volt produces a 5mA change in I_D. Note that the form I/V is the inverse of the ohms formula, so g_m measurements are often expressed in 'mho' units. Usually, g_m is specified in FET data sheets in terms of mmhos (milli-mhos) or µmhos (micro-mhos). Thus, a g_m of 5mA/V = 5-mmho or 5000-µmho.

In most practical applications, the JFET is biased into the linear region and used as a voltage amplifier. Looking at the n-channel JFET, it can be used as a common source amplifier (corresponding to the bipolar npn common emitter amplifier) by using the basic connections in *Figure 9*.

Alternatively, the common drain or source follower (similar to the bipolar emitter follower) configuration can be obtained by using the connections in *Figure 10*, or the common gate (similar to common base) configuration can be obtained by using the basic *Figure 11* circuit. In

Figure 8. An n-channel JFET can be used as a constant-current generator.



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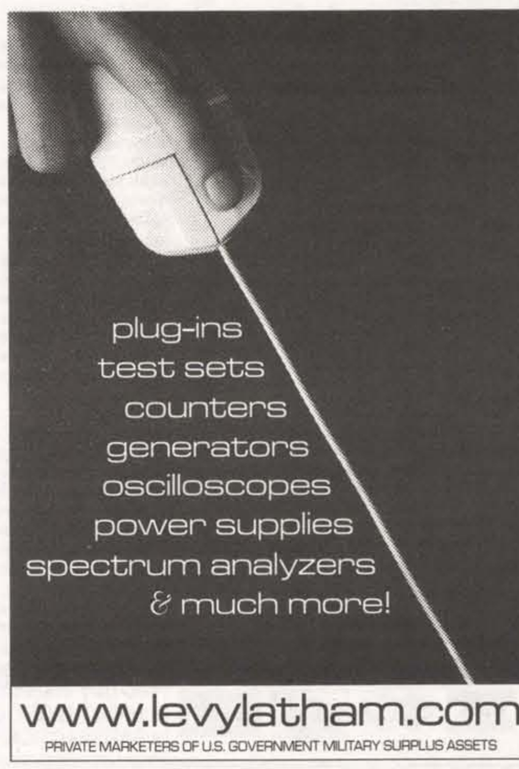

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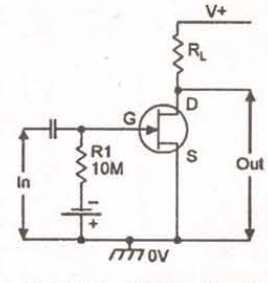

Figure 9. **Basic n-channel common-source amplifier JFET circuit.**

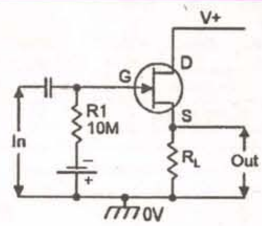

Figure 10. **Basic n-channel common-drain (source-follower) JFET circuit.**

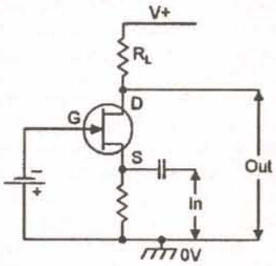

Figure 11. **Basic n-channel common-gate JFET circuit.**

practice, fairly accurate biasing techniques (discussed in Part 2 of this series) must be used in these circuits.

THE IGFET/MOSFET

The second (and most important) family of FETs are those known under the general title of IGFET or MOSFET. In these FETs, the gate terminal is insulated from the semiconductor body by a very thin layer of silicon dioxide, hence the title 'Insulated Gate Field Effect Transistor,' or IGFET. Also, the devices generally use a 'Metal-Oxide Silicon' semiconductor material in their construction, hence the alternative title of MOSFET.

Figure 12 shows the basic construction and the standard symbol of the n-channel depletion-mode FET. It resembles the JFET, except that its gate is fully insulated from the body of the FET (as indicated by the *Figure 12(b)* symbol) but, in fact, operates on a slightly different principle to the JFET.

It has a normally-open n-type channel between drain and source, but the channel width is controlled by the electrostatic field of the gate bias. The channel can be closed by applying suitable negative bias, or can be increased by applying positive bias.

In practice, the FET substrate may be externally available, making a four-terminal device, or may be internally connected to the source, making a three-terminal device.

An important point about the IGFET/MOSFET is that it is also available as an enhancement-mode device, in which its conduction channel is normally closed but can be opened by applying forward bias to its gate.

Figure 13 shows the basic construction and the symbol of the n-channel version of such a device. Here, no n-channel drain-to-source conduction path exists through the p-type substrate, so with zero gate bias there is no conduction between drain and source; this feature is indicated in the symbol of *Figure 13(b)* by the gaps between source and drain.

To turn the device on, significant positive gate bias is needed, and when this is of sufficient magnitude, it starts to convert the p-type substrate material under the gate into an n-channel, enabling conduction to take place.

Figure 14 shows the typical transfer characteristics of an n-channel enhancement-mode IGFET/MOSFET,

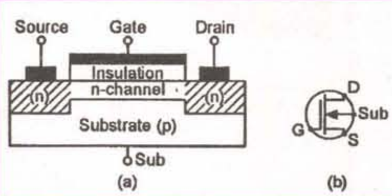

Figure 12. **Construction (a) and symbol (b) of n-channel depletion-mode IGFET/MOSFET.**

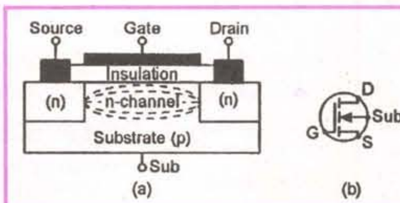

Figure 13. **Construction (a) and symbol (b) of n-channel enhancement-mode IGFET/MOSFET.**

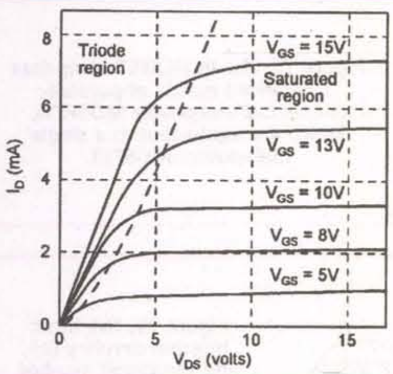

Figure 14.
Typical transfer characteristics of n-channel enhancement-mode IGFET/MOSFET.

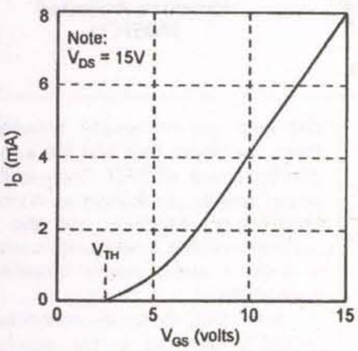

Figure 15.
Typical V_{GS}/I_D characteristics of n-channel enhancement-mode IGFET/MOSFET

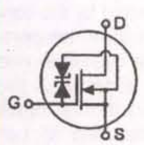

Figure 16.
Internally-protected n-channel depletion-mode IGFET/MOSFET.

and *Figure 15* shows the V_{GS}/I_D curves of the same device when powered from a 15V supply. Note that no I_D current flows until the gate voltage reaches a 'threshold' (V_{TH}) value of a few volts, but that beyond this value, the drain current rises in a non-linear fashion.

Also note that the transfer graph is divided into two characteristic regions, as indicated (in *Figure 14*) by the dotted line, these being the 'triode' region and the 'saturated' region. In the triode region, the device acts like a voltage-controlled resistor; in the saturated region, it acts like a voltage-controlled constant-current generator.

The basic n-channel MOSFETs of *Figures 12* and *13* can – in principle – be converted to p-channel devices by simply transposing their p and n materials, in which case their symbols must be changed by reversing the directions of their substrate arrows.

A number of sub-variants of the MOSFET are in common use. The type known as 'DMOS' uses a double-diffused manufacturing technique to provide it with a very short conduction channel and a consequent ability to operate at very high switching speeds. Several other MOSFET variants are described in the remainder of this opening episode.

Note that the very high gate impedance of MOSFET devices makes them liable to damage from electrostatic discharges and, for this reason, they are often provided with internal protection via integral diodes or zeners, as shown in the example in *Figure 16*.

VFET DEVICES

In a normal small-signal JFET or MOSFET, the main signal current flows 'laterally' (see *Figures 3, 12,* and *13*) through the device's conductive channel. This channel is very thin, and maximum operating currents are consequently very limited (typically to maximum values in the range 2 to 40mA).

In post-1970 times, many manufacturers have tried to produce viable high-power/high-current versions of the FET, and the most successful of these have relied on the use of a 'vertical' (rather than lateral) flow of current through the conductive channel of the device. One of the best known of these devices is the 'VFET,' an enhancement-mode power MOSFET which was first introduced by Siliconix way back in 1976.

Figure 17 shows the basic structure of the original Siliconix VFET. It has an essentially four-layer structure, with an n-type source layer at the top, followed by a p-type 'body' layer, an epitaxial n-type layer, and (at the bottom) an n-type drain layer. Note that a 'V' groove (hence the 'VFET' title) passes through the first two layers and into the third layer of the device, and is electrostatically connected (via an insulating silicon dioxide film) to the gate terminal.

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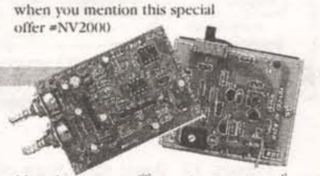

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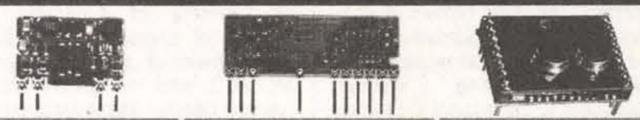

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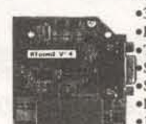

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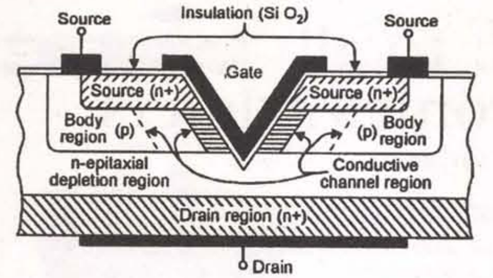


Figure 17. **Basic structure of the VFET power device.**

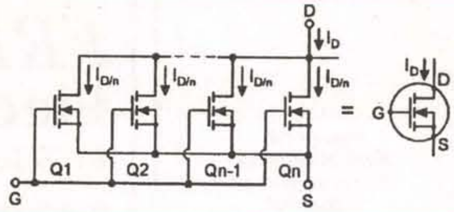


Figure 18. **The IR HEXFET comprises a balanced matrix of parallel-connected low-power MOSFETs, which are equivalent to a single high-power MOSFET.**

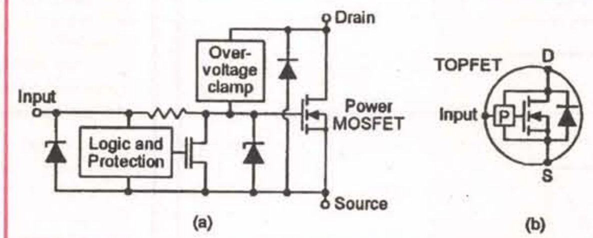


Figure 19. **The basic internal circuitry (a) and the circuit symbol (b) of the TOPFET (Temperature and Overload Protected MOSFET).**

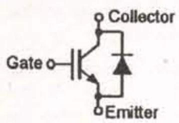


Figure 20. **Normal circuit symbol of the IGBT (Insulated Gate Bipolar Transistor).**

tive, no drain-to-source current flows, because the diode formed by the p and n materials is reverse-biased. But if the gate is made positive to the source, the resulting electrostatic field converts the area of p-type material adjacent to the gate into n-type material, thus creating a conduction channel in the position shown in *Figure 17* and enabling current to flow vertically from the drain to the source.

As the gate becomes more positive, the channel width increases, enabling the drain-to-source current to increase as the drain-to-source resistance decreases. This basic VFET can thus pass reasonably high currents (typically up to 2A) without creating excessive current density within the channel regions.

The original Siliconix VFET design of *Figure 17* was successful, but imperfect. The sharp bottom of its V-groove caused an excessive electric field at this point and restricted the device's operating voltage. Subsequent to the original VFET introduction, Intersil introduced their own version of the 'VMOS' technique, with a U-shaped groove (plus other modifications) that improved device reliability and gave higher maximum operating currents and voltages. In 1980, Siliconix added these and other modifications to their own VFET devices, resulting in further improvements in performance.

OTHER POWER FETs

Several manufacturers have produced viable power FETs without using 'V'- or 'U'-groove techniques, but still relying on the vertical flow of current between drain and source. In the 1980s, Hitachi produced both p-channel and n-channel power MOSFET devices with ratings up to 8A and 200V; these devices were intended for use mainly in audio and low-RF applications.

Supertex of California and Farranti of England pioneered the development of a range of power MOSFETS with the general title of 'vertical DMOS.' These featured high operating voltages (up to 650V), high current rating (up to 16A), low on resistance (down to 50 milliohms), and very fast operating speeds (up to 2GHz at 1A, 500MHz at 10A).

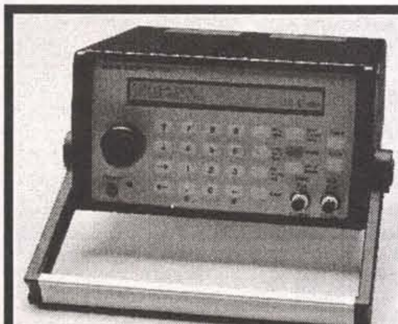
Siemens of West Germany used a modified version of DMOS, known as SIPMOS, to produce a range of n-channel devices with voltage ratings as high as 1kV and with current ratings as high as 30A.

One International Rectifier solution to the power MOSFET problem is a device which, in effect, houses a vast array of parallel-connected low-power vertical MOSFETs or 'cells' which share the total current equally between them, and thus act like a single high-power MOSFET, as indicated in *Figure 18*. These devices are named HEXFET, after the hexagonal structure of these cells, which have a density of about 100,000 per square centimeter of semiconductor material.

Several manufacturers produce power MOSFETs that each comprise a large array of parallel-connected low-power lateral (rather than horizontal) MOSFET cells that share the total operating current equally between them; the device thus acts like a single high-power MOSFET. These high-power devices are known as *lateral* MOSFETs or L-MOSFETs, and give a performance that is particularly useful in super-fi audio power amplifier applications.

Note that, in parallel-connected MOSFETs (as used in the internal structure of the HEXFET and L-MOSFET devices described above), equal current sharing is ensured by the conduction channel's positive temperature coefficient; if the current in one MOSFET becomes excessive, the resultant heating of its channel raises its resistance, thus reducing its current flow and tending to equalize it with that of other parallel-connected MOSFETs. This feature makes such power MOSFETs almost immune to thermal runaway problems.

Today, a vast range of power MOSFET types are manufactured. 'Low voltage' n-channel types are readily available with voltage/current ratings as high as 100V/75A, and 'high voltage' ones with ratings as



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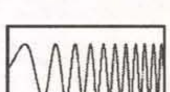
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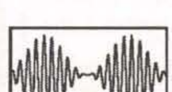
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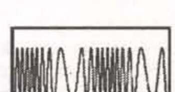
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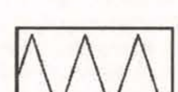
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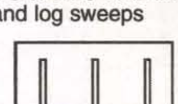
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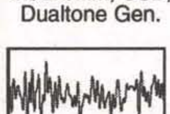
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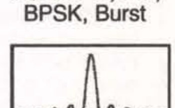
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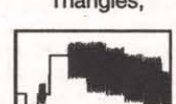
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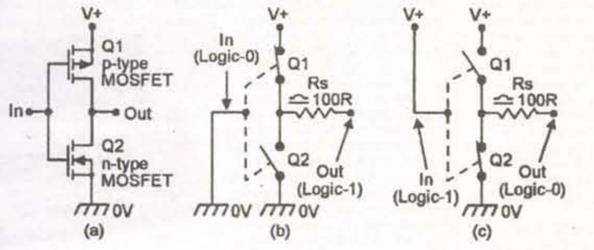

Figure 21. **Basic CMOS circuit (a), and its equivalent with (b) a logic-0 input and (c) a logic-1 input.**

high as 500V/25A.

One of the most important recent developments in the power-MOSFET field has been the introduction of a variety of so-called 'intelligent' or 'smart' MOSFETs with built-in overload protection circuitry; these MOSFETs usually carry a distinctive registered trade name. Philips devices of this type are known as TOPFETs (Temperature and Overload Protected MOSFETs); *Figure 19* shows (in simplified form) the basic internal circuitry and the circuit symbol of the TOPFET.

The Siemens version of the smart MOSFET is known as the PROFET. PROFET devices incorporate protection against damage from short circuits, over temperature, overload, and electrostatic discharge (ESD). International Rectifier produce a range of smart n-channel MOSFET known as SMARTFETs; these incorporate protection against damage from short circuits, over temperature, overvoltage, and ESD.

Finally, yet another recent and important development in the n-channel power MOSFET field, has been the production – by various manufacturers – of a range of high power devices known as IGBTs (Insulated Gate Bipolar Transistors), which have a MOSFET-type input and an internally protected high-voltage high-current bipolar transistor output. *Figure 20* shows the normal circuit symbol of the IGBT. Devices of this type usually have voltage/current/power ratings ranging from as low as 600V/6A/33W (in the device known as the HGTD3N603), to as high as 1200V/520A/3000W (in the device known as the MG400Q1US51).

CMOS BASICS

One major FET application is in digital ICs. The best known range of such devices use the technology known as CMOS, and rely on the use of complementary pairs of *MOSFETs*. *Figure 21* illustrates basic CMOS principles. The basic CMOS device comprises a p-type and n-type pair of enhancement-mode MOSFETs, wired in series, with their gates shorted together at the input and their drains tied together at the output, as shown in *Figure 21(a)*. The pair are meant to use logic-0 or logic-1 digital input signals, and *Figures 21(b)* and *21(c)*, respectively, show the device's equivalent circuit under these conditions.

When the input is at logic-0, the upper (p-type) MOSFET is biased fully on and acts like a closed switch, and the lower (n-type) MOSFET is biased off and acts like an open switch; the output is thus effectively connected to the positive supply line (logic-1) via a series resistance of about 100R.

When the input is at logic-1, the MOSFET states are reversed, with Q1 acting like an open switch and Q2 acting like a closed switch, so the output is effectively connected to ground (logic-0) via 100R. Note in both cases that the entire signal current is fed to the load, and none is shunted off by the CMOS circuitry; this is a major feature of CMOS technology. **NV**

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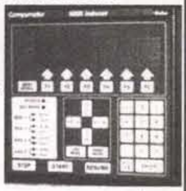
WOW! COMPUMOTOR, 4000 MOTION CONTROLLER PLUS, TWO, SERIES LE, STEPPER MOTOR DRIVERS.



Motion, 1 to 4 axes of step & direction control. Accepts encoder position feedback.
I/O, Optically isolated programmable inputs (24) and outputs (24) compatible with industry standard signal conditioning products.
Features, 4000 Programmer/Operator Panel, Detachable can be mounted remotely. Dedicated jog function for each axis. Four-line, backlit, Liquid Crystal Display (LCD). Six soft-function keys labeled by the LCD change definition as needed. Sealed membrane keypad.
Language, Simple BASIC-like motion control program language. (No software supplied.) Multiple programs may be entered and saved. Feedrate override allows operator interaction. Insert, edit, copy & delete functions. User-defined operator prompts. Linear interpolation on up to four axes. Teach mode uses analog joystick (not supplied) inputs or operator panel jog keys.
Interface Capability, Remote programming capability over RS-232C and IEEE-488; remote program downloading and uploading. Second RS-232C port for operator messages or control of other devices. **Special System,.....COMP4000/LE....$1495 Ltd.Qty.**

DOVER AIR BEARING X/Y TABLE, is ULTRA PRECISE,

Like New. The ultimate in precision motion control. Leadscrew operated air bearing tables with 1-20 Microns typical repeatability. Straightness, <1 micron each axis, angular error, <1 arc/sec. Squareness, <5 arc/sec. Unit has 4"x5" travel with two Compumotor LE57-51-MTR steppers attached. Ready to play with our Compumotor 4000 series system above. **DOVER-B45..$949**

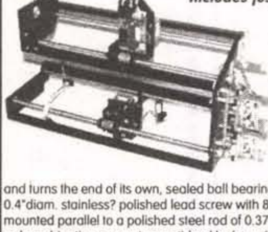
DAEDAL / COMPUMOTOR, MODEL 3002-P, X-Y INDEXER,

The 3000 is a programmable indexer capable of controlling up to four axes at one time. (supplied with 2 axes installed) It can be programmed via the front panel or via a remote computer or terminal. RS-232 and IEEE488 ports are supplied as well as PIO. Specifications include: Step accy., ±0 from preset, Velocity accy., ±0.02% of max. rate., Veloc. repeatability, ±0.02% of set rate. Veloc. range, 0.017 steps/sec to 1,092,000 steps/sec. System includes two MD2302-2020 stepper motor drivers as well. Very compact and rack mountable. Size: 8.5"H x 16"W x 6.5"D, 120VAC powered. Used, excellent condition. With operation manual. **Limited Qty.,....................COMP3002-P........$895**

NEW, LINEAR SLIDE, GOES to EXTREME LENGTHS, Very high quality, Techno-Isel, series one, German made.

This is the slide you have been looking for! Did we say it was LONG? How does 4 feet sound? Actually 49 and 1/4" to be precise and we know you are. Very sturdy, based on a heavy duty 1.5" wide, extruded aluminum and 1/2 diam. steel, dual rail. The slide carriage incorporates superior quality, recirculating ball bearings. Size of carriage is 3" x 3" with a solid 1/2" thick aluminum mounting plate. Limited quantity. The dual rails are new or have been carefully removed from precision optical equipment. The slider carriages are all brand new & unused. Each rail includes one slide carriage. Extras are available.
LONG-ISEL - 48"......9lbs...................$149ea. or $279 for pair.
EXCAR-1, addtl. carriage only,..........$69ea. or $129 for pair.

VERY UNUSUAL, MULTI AXIS DRIVE SYSTEM, Includes just a few goodies!

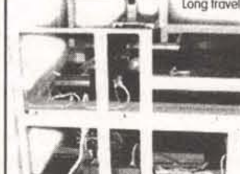


This is a tough one to describe so try to follow. Lets start with TWO SLO-SYN steppers type: MO61-LF-504 mounted at one end on a 3/8" thick, black anodized aluminum plate. Each stepper has a 1/2"d. toothed belt drive pulley. Each belt rides over a spring loaded tensioner and turns the end of its own, sealed ball bearing mounted, 14" L x 0.4"diam. stainless? polished lead screw with 8TPI. Each lead screw is mounted parallel to a polished steel rod of 0.375" diam. Each lead screw/ rod combination support an anti-backlash carriage. One carriage (slide) can be considered an Z or Y axis with mini linear slide. Providing a stepper driven 3" of travel perpendicular to the long axis. Driven by a 1.5" cube sized, 4 wire stepper with 1.8deg/step and 8ohm coils. Got that so far? The second long axis supports a stepper driven "3/4" travel "elevator" which is also oriented perpendicular to the long axis. Same cube size stepper as previous. Most axis have optical end of travel sensors as well. Overall size of assembly is: 6.5"W x 19"L x 10.5"W. Removed from equipment, very good condition. All of this can be reconfigured to suit many applications. Whew! That's a lot to think about. Don't think too long as we have, as usual, a limited quantity.
MAY SPECIAL, QUADRIVE..........$69ea. or 2 for $129

WIRELESS MOBILE WORKSTATION is a Hackers Bonanza! Itronix T5000 mobile terminal with 2Meg. PCMCIA Mem card.

Well this is a device we would really like to know more about. Our people are working on it and this is what we know so far: This unit is built like a brick pizzeria. Polycarbonate case sealed from rain, dust and repeated drops. It has a 75 key QWERTY keyboard which curiously seems to be mapped one key off. These units were just replaced by a fortune 500 company that was using them in the daily operations. Therefore they must require some external input for the correct keyboard mapping. Probably a security measure? The flip up cover holds a transflective Samtron UG24D02 monochrome LCD display that we think is 640 x 240 pixels. Size:7.3"W x 2.75"H and displays 16 shades of gray also has a white E/L backlight. The unit has an internal Motorola Type RPM4051 Radio Packet Modem with built in flip up antenna. We believe it operates on the ARDIS or similar network. There is also an RS-232 serial port / bar code wand port. Also there is a port for a hand held laser scanner. Power required: At the external connector, 10VDC @ up to 800mA, The unit only draws about 175ma after boot. The battery packs were 7.2V. They were originally powered by a NICAD pack which has been removed. The battery compartment is external and could easily hold an alternate power source. We believe there is an internal modem as the unit sports an RJ-11 style connector as well tip and ring connections. Upon the application of power the 80C552 processor boots MS DOS ROM Version 5.00 to an A: > prompt. The screen indicates an internal memory of 640K. A 2meg. PCMCIA memory card is also supplied. Operating temp from -4 to +140F. From there on your on your own. All units are tested for boot up otherwise sold as an experimenters package. **T5100............$49ea., or 3 for $129**

IT WILL MOVE YOU! PRECISION, XY TABLE.



Long travel, Really nice and like new, (removed from a $100K film scanner) Super X-Y table offers approximately 24"x 24"of travel. The system is shock mounted to a rugged tubular steel, wheeled base with a creme colored powder coat finish. Dual, heavy duty, Berger RDM-566-50, 1.3A, 1.4ohm stepper motors are attached. Heidenhain 500ppr encoder on one axis. stepper drivers are not included. Perfect for laser system. Overall size is 55" x 44" x 39" Ships via truck. **Limited Qty..................$1295**

TREK- 678 or 676, HIGH VOLTAGE POWER SUPPLY / AMPLIFIERS

• TREK-678, 0 to -30KVDC ,high voltage , high speed "amplifier" provides high voltage output which follows a 0-10VDC control voltage with fast response and settling time. Rack size. Like new.
• TREK-676, 0-20KVDC ,high voltage , high speed "amplifier" provides high voltage output which follows a 0-10VDC control voltage with fast response and settling time. Rack size. Like new.

TREK-678, -30KV............$795ea. TREK- 676, -20KV.............$695ea.

SUPER VACUUM PUMP, LEYBOLD, TRIVAC B, type D16, #91266-2

Dual stage, oil sealed, rotary vane pump with a 11.7cfm pumping capacity and an ultimate vacuum of $8x10^{-5}$ mbar.

This brand new pump is powered by a three phase, 1HP, AC motor with built in thermal protection. The motor can operate on 200 / 230 or 460 VAC. Completely modular construction for easy maintenance. Pump weighs 78lbs.
LEYBOLD D16..............$1395

GENERAL SCANNING, TYPE M3, CLOSED LOOP, GALVANOMETER, LASER SCANNER.

Innovative motor design coupled with an advanced capacitive position detector, provides high speed, wide angle and improved stability. Using moving magnet technology this scanner provides low inertia, rigidity and low inductance. Specs. include, +/-30° excursion, wobble: 1.5urad., Repeatability: 2urad.,Coil Res.: 4.8 Ohms, Peak current: 10Amps, Angular sensor sens.: 8.1uA/o. A high quality galvo for demanding laser displays. Galvos only, you provide the drivers. Very limited quantity.
M3 GALVO....$299ea. or $549 for a pair.

$5000 HI-TECH SURVEILLANCE SYSTEM, 90%OFF!

THIS SUPER SYSTEM INCLUDES:
- *MOTORIZED, 6X ZOOM LENS*
- *MOTORIZED, 360 ° PAN*
- *MOTORIZED, TILT up to 90°*
- *PHILIPS HIGH RES. 1/2" CCD CAM.*
- *OPAQUE BLACK INNER DOME*
- *CLEAR ACRYLIC OUTER DOME*
- *ZOOM LENS CONTROLLER with A/I*
- *PAN and TILT CONTROLLER*

Walk into any major department store and you will see these fully integrated systems. Manufactured by Sensormatic, the same company who supplied the Atlanta Olympics! These are late model, new in the box systems. Virtually ready to use. All you add is power and cable. A quality Philips, 1/2", B&W CCD camera provides 450 lines resolution and 0.5 Lux sensitivity! Anodized aluminum construction. Camera plus Pan & Tilt are powered by external 24VAC via the included Pan & Tilt controller. Super 6X, f1.2 motorized, Zoom, Focus and Iris lens provides the capability of "close up" inspections. Zoom lens controller with auto iris control included. Size of dome: 14"diam. Includes mounting kit for drop ceiling installation. Sensormatic price $5000ea.
MAY SPECIAL, SENSORMATIC..............$529ea.

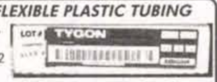
GEAR MOTOR, METAL CONSTRUCTION, HIGH TORQUE, BUEHLER PRODUCTS, type 127K01880

These are brand new, very rugged gearmotors. They offer a 5mm diameter x 9mm long, flatted output shaft, located off-center (approximately 10mm from the edge of the 35mm diameter gearbox.) Overall size: 35mm d x 73 mm L (including the shaft) with 2" red and black leads. The motors are rated at 17VDC nominal and provide the following speeds:

	@VIN	INOLOAD	RPM
	12V	60mA	360
	15V	62mA	457
	17V	64mA	523

MAY SPECIAL, BUEHLER 127K.........$10ea. or 4 for $35

NEW, TYGON FLEXIBLE PLASTIC TUBING

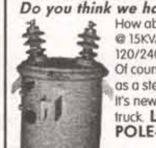


Norton type B-44-4X, factory boxed, 50ft. roll of 3/32 I.D. x 5/32 O.D. with 1/32 wall thickness. Very high grade, Tygon is recognized as the finest product of its kind. Unmatched rigid quality control.
TYGON-50.....$10ea., or 3 for $25

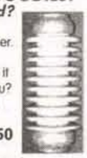
6V@12AH SEALED, RECHARGEABLE, GEL CEL, BATTERY,

New Panasonic, LCR6V12PI. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects.
Size: 5.9"L x 3.7"H x 1.9"D **2 for $20, or 10 for $89**

TWO MORE NEW ESOTERIC GOODIES? Do you think we have gone mad?



How about an 8313VAC @ 15KVA Pole Transformer. 120/240 VAC output. Of course you could use it as a step up couldn't you? It's new and its ships by truck. **Limited qty. POLE-FMR........$350**



"For High Tension Relief"
how does a giant ceramic insulator sound? Now you can insulate yourself from anything you want.... say your mother or father in law? This baby weighs 42lbs! and its size 18"L x 8" diam. with cast steel ends each with four 1/2" threaded mounting holes. We have only a few available. Would make a nice lamp...... Hmmmm maybe coffee table legs? Limited Quantity. **INSULATOR...$69ea., 4 $239**

NEW, 3 POLE CONTACTOR, Fasco, type: 30E030 with 208/230VAC Coil,

NEW, Rated for:

	240VAC	480VAC	600VAC
FLA/POLE	30A	30A	30A
RES/POLE	40A	40A	40A
LRA/POLE	180A	180A	180A
LRA 3PHASE 3 POLE		150A	120A

Size: 3"H x 2.5"W x 3.7" D and UL approved.
FASCO 30E030.............$20ea. 3 for $49

NEW, CURRENT TRANSFORMER, 500:5AMPS, Instrument Transformer CAT 5, type, SFT-501

NEW, Rated for ± 1% Accuracy, 600volt insulated.Usable from 50 to 400HZ. Size: 4.2"H x 3.5"W x 1" Thick. UL approved too.
SFT-501 XFMR.........$29ea.

NEW, 3M ELECTRICAL TAPE, Type, 471 Plastic tape, Two colors Blue and Yellow!

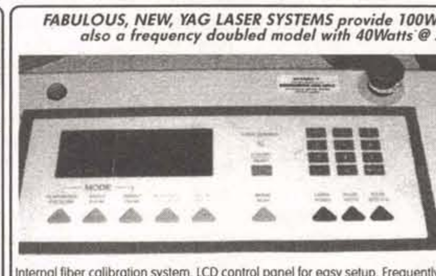
You get five of each color, total 10 rolls each 3/4" x 108ft. Until we run out of one of the colors! **3M TAPE....10 rolls for $5**

HP OPTICAL ENCODER, HEDS-7500,

NEW, 1000 ppr quadrature, 256 ppr direct TTL compatible, A & B output for count and direction, 5VDC @20mA

power. Shaft has a 1.1"diam., anodized aluminum, removable gear and mounting bracket. Perfect for do it yourself motion control. Size : 1.13"diam. x 87"d. Supplied with data. Removed from new equipment.
HEDS-7500....$15ea. or 2/$25

FABULOUS, NEW, YAG LASER SYSTEMS provide 100Watts, CW @1.064um, also a frequency doubled model with 40Watts @ .532um (green)



Laser Photonics Type YCO-1003M, adjustable output power from 100mW to 100Watts ± 2%. Modes include: CW, Single pulse adjustable from 0.1 to 9.9 seconds in 0.1 sec increments. Repeat pulse with adjustable duration as previous and adjutable rate from 0.1 to 9.9 seconds in 0.1 sec. increments. Beam delivery via a 4 meter length quartz fiber optic. Internal fiber calibration system. LCD control panel for easy setup. Frequently used program settings can be saved to memory. Internal graphics printer. Pulsed laser diode aiming laser. Two stage microprocessor system monitoring. Key switch access with foot switch laser activation. Internal liquid to air cooling. Power required: 220VAC, single phase @40A, 60Hz. Mechanical: 38"H x 33"W x 22"D, weighs 325lbs., Wheel around cabinet. The Dual mode system in addition to the YAG specifications above includes frequency doubling on demand. The green output is Q-switched at 10KHz producing an output beam of 6mJ @ 200ns or 60W average with 2 to 40 watts delivered at the fiber. Pulse mode operation for the dual mode is different as well: Single pulse mode is adjustable from 0.1 to 600 seconds in 0.1 sec. increments. Repeat pulse mode has the same adj. pulse width and an adjustable pulse interval of 0.1 to 9.9 seconds in 0.1 sec. increments. These numbers apply to the 1.064 wavelength only. Cabinet size: 40"H x 33"W x 23"D weight 500lbs. Both models are NEW. Must ship via truck.
SINGLE YAG SYSTEM.......$18K, DUAL FREQUENCY YAG SYSTEM.......$25K

NEW, GEN III, INTENSIFIED GOGGLES, STATE of the ART, U.S. MADE.

The NQ5001, the world's most rugged and reliable, high performance night vision goggle for ground operations. Extensively used by the U.S. Army, it is the State-of-the-Art in mono-tube Night Vision Goggles. Utilizing the MX-10130 Gen III intensifier, it can be used in the darkest of conditions, headstrap mounted or handheld. Engineered for maximum comfort and simple to use. The system contains an IR illuminator, low battery indicator & high light sensor for automatic power off to image tube. Soft Case, headstrap, demist shields, sacrificial filter, eye cups, 2 AA batteries, and operators manual.

Specifications:

Photocathode Gallium Arsenide	**Battery Type** 2 AA Life 20Hrs.
Resolution 45 lp/mm	**Magnification** 1x
Photo Response 1200 Ma/lu	**Objective Lens** 25mm F/1.2
Tube Gain 35,000x	**Field Of View** 40°
System Gain 3,200x	**Focus Distance** 2.5m To Infinity
Signal To Noise 18:1	**Size** 14.9 x 14.9 x 9.1 cm
	Weight 680 gm

MAY SPECIAL.....2495ea.

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CO_2 LASER SYSTEM is SELF CONTAINED and MOBILE ! Fabulous 20Watt Laser with flexible, hand held, beam delivery.

True plug and play operation. Simple 120VAC @3amp power and "BAM, kick things up a notch". This unit is specifically designed for "cutting, coagulation and ablation". Laser functions are controlled by a user friendly control panel. Self contained & air cooled, CW or pulsed mode operation. Sealed CO_2 technology for long life & low maintenance. A simple foot switch energizes the laser, leaving you free to use the focusing hand piece. Selection of power & duration are made through the control panel with LED display. Accuracy of the delivered power is maintained through an internal calibration feature. A 1.5mW, 635nm, red aiming laser diode is visible at the precise focal plane of the CO_2 output. Maximum operating time at full out put is 10 minutes. CO_2 laser is class 4 with output at 10.6 microns. Output power is selectable from 1 to 20 watts. Spot size 0.3mm at tip. Super pulse mode offers 1 to 10 Watts, 600usec. pulse width at up to 750Hz rate. Single pulse width of 0.1 to 1.0 sec., Pulse train of 0.1 to 1.0 sec. with 50% duty. Internal air purge system. Heavy duty industrial construction with integral wheels for one handed portability. Size: 38"H x 25"D x 12"W. Weight is 80lbs. Includes operation manual. Slightly used in mint condition. Don't miss this one.

SPECIAL Limited Qty., CO2-CS1..........$3500ea.

MINIMOTOR SA, SWISS GEARMOTOR, Soooo TINY

State of the art "ironless" type, mini motor. Model: 1219E-012G-400. Includes a 104:1 Planetary gearbox. Size: 12mm d x 44mm L with 2mmd x 6mm L, flatted shaft, solder terminals.

@VIN	INL	RPM
6V	5mA	68
12V	5mA	145

LIMITED QUANTITY
TYPE A: $22ea. or 5 for $99

NEW, TELECONFERENCING MIC, Super high quality construction, PictureTel, system mic 200,

Was used on the "Venue 2000 Video conferencing system. The handsome desk top unit includes 25ft. of cable. The internals include a noise cancelling electret microphone with preamp and gain control. Operates on 12VDC @50mA.

MIC200.................$12ea. or 3 for $25

SEIKO INTELLIGENT ROBOTS, D-TRAN RT-2000 Cylindrical Coordinate Servo Robot with Controller.

The robot is based on a four axis, closed loop servo system. The provided teach terminal allows for programming and direct robot operation. Programs can also be downloaded from a PC. The included controller requires 220VAC @0.5KVA. Controller Size: 17"W x 10"H x 21"D. The robot offers high precision, repeatability and speed. Some specifications include: Max. Swing area: 20.6" radius. Base plate dim: 13" x 8.6". Repeatability: +0.0006". Speed: 63"/ sec. Payload @ max. speed: 5.5lbs. Overall dimensions. 11"W x 24.6"D x 21"H. Robot only weight: 110lbs. System also includes: 1" thick solid steel base plate, I/O interface module, Dual RS-232 comm. ports and printer port.

Specs:	Rotation	Resolution	Speed	Reach	Stroke	Max. Torque.
A AXIS	290°	0.005°	240°/s	N/A	N/A	30 Kg. cm
R AXIS	N/A	0.0003"	47"/s	20"/16"	9.84"	30 Kg. cm Vert.
T AXIS	290°	0.0009°	110°/s	N/A	N/A	2Kg. force on T
Z AXIS	N/A	0.0001"	15"/s.	N/A	3.94"	6Kg. @250mm

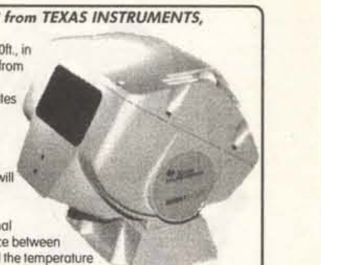
Only one chance to own this robot. Removed from working lab. Sold as is. Software available from Seiko. Original cost >$36K

Ships via truck. D-TRAN, RT2000................$2895

A FLEXIBLE, ARTICULATED MANIPULATOR what wild uses can you think of for this?

What we have here is a 40" long X 3/8" diameter remotely controlled end effector. The probe tube is protected by a steel sheath covered in a flexible plastic jacket. This particular model was intended to hold an ultrasonic transducer for inserted into the body for diagnostic purposes. (Not by aliens as far as we know!) The inside of the tube is hollow and about 1/4" in diameter. All manor of wiring and sensor hookups could be manipulated through this channel. The last 2.5" of the device, the "business end" is linked to the hand piece via a system of four steel mini cables. Two knobs on the hand piece cause the tip to move ± 90 degrees in a 360 degree area about the tip. It is quite amazing to see. It looks "alive" Operates on similar principal to those hand controlled animetronic devices used in movies except on a smaller scale. So use your imagination, connect something interesting to the tip and start being an articulate manipulator. These were removed from evaluation lab and may not have cover for handpiece. Does not effect operation. **MANIPULATOR.......$225ea.**

WOW! THERMAL IMAGER from TEXAS INSTRUMENTS, NIGHTSIGHT 100.



Detects a human sized image at up to 800ft., in complete darkness. Yes, it is tough to hide from a thermal imager. (You have seen them in action on "COPS" This like new unit generates a real time, black and white video output, compatible with any standard monitor or VCR. Unlike "Night Vision" systems which require some available light or added external illumination, the thermal imager will operate in TOTAL darkness. Also ambient lighting such as street lights or bright auto headlamps have no blinding affect. Thermal imagers function by detecting the difference between the background ambient temperature and the temperature of the objects being observed. Completely self contained, apply 12VDC and it works. Specifications: Temperature stabilization via internal thermo-electric cooler. FOV 27H x 18V degrees, Power required: 12VDC @2Amps max., Video output standard NTSC/Composite, Auto brightness and contrast, Selectable image polarity, <30 seconds from turn on to operation. Operating temp. range: -40 to +122F. Waterproof package is only 8"H x 7.4"W x 8"D. Weight: 6.5 lbs. FANTASTIC don't miss out.

Regular Price >$8500, SPECIAL, NIGHTSIGHT 100..............$5549ea.

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- 270k pixels
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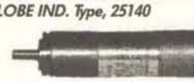
We were fortunate to obtain a small quantity of these first quality units. They were destined for use in a 100W YAG laser. See our "YAG DECKS" previous page. No specifications at press time. Water cooled. A limited number of matching RF drivers for these Q-switches are available.

Q-SWITCH......Q5100..................$225ea.
RF DRIVER.......RFMHZ-5100.......$350ea.

PRECISION GEARMOTOR with GOVERNOR TRW, GLOBE IND. Type, 25140



VIN	INL	RPM
6V	160mA	600
9V	180mA	1180
12V	210mA	1675

New and very high quality MIL SPEC. mini motor with a pletary gearbox (ratio unknown) and governor output. Size: 18mm d x 72mm long not including the 2.6mm diam. x 11mm long, flatted shaft, with attached 3" wire leads.

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BS01-02	BEAM SPLITTER	AR @45deg. for 1064nm	YAG or CO_2
DUAL-01	MIRROR/HT-HR	HT @45deg. for 532nm, HR for 1064nm	High Power
PLCV-01	DUAL FREQ LENS	HT for 1064 and 6328nm >98.5%, 113mm	Focus C02 & HeNe ZnSe

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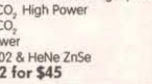

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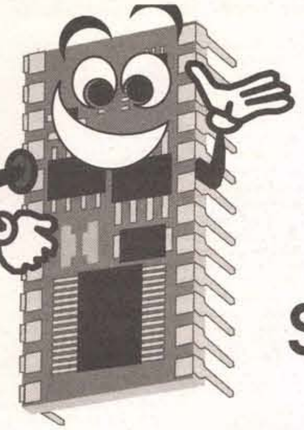

Stamp Applications

by Jon Williams

Stamping Myself Into Better Shape

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

It's hard to believe, but the BASIC Stamp has been around for almost seven years now. While this column isn't quite that old, it's been around awhile too, and the three of us that have written it have delved into some reasonably sophisticated projects. Parallax has made terrific efforts in the way of getting Stamps into the hands of youngsters through their "Stamps in Class" program. What this means is a whole new crop of young Stampers. This month, we're going to take a step back in sophistication and focus on the process of program development. It's a simple project and yet, might even teach the "old dogs" a few new tricks.

One of the best things about doing electronics as a hobby or profession is the ability to design something useful that doesn't currently exist. Case in point:

Some of you know that I'm a part-time actor. Yes, really, an actor — I have an agent, go on auditions, and even get hired from time-to-time. I was recently lamenting to a friend about some great auditions I'd had that didn't result in bookings. It is the worst part of being an actor: the unexplained rejections. My friend reminded me that — especially in commercials — most of the time it's about appearance, and that almost everyone being called in to audition can act. It made me think long and hard. I've spent the last two and a half years training with the best acting coaches in Dallas and, sad to say, have not dealt much with my appearance. I guess I could blame my advancing age for my advancing waistline, but the fact is I really should make an effort to drop a few pounds. I just saw myself on tape from my last stage appearance and was not happy.

I study with an actor named Tim who is in great physical shape. On a class break, I approached Tim about his exercise regimen, expecting to hear about how he spends a couple hours a day in the gym and eats next to nothing. Not so. Tim told me how he entered a 12-week contest and dropped an amazing amount of weight and completely transformed his physique. He even showed me his driver's license photo to prove it. He had made an amazing transformation and had spent less that three hours per week in the gym! Hey, I can live with that.

Well, I don't really want to enter a contest, I just want to drop 10 or 15 pounds and improve my physical appearance. As luck would have it, I found a book that detailed the diet and exercise regimen that Tim follows. To my very happy surprise, the diet and exercise plan is not difficult, yet it is regimented and needs to be followed with some discipline.

Specific to the exercise plan is the timing. While the aerobic part of the plan calls for only 20 minutes of exercise every other day, it must be done is a specific manner: four cycles of five minutes each, with each cycle divided into four stages (two minutes, one minute, one minute, then one minute).

I turned to my cool digital wristwatch. Darn! The timer has only three stages, and between the overhead TVs, the radio blaring, and the other treadmills, I can't hear the watch beeping in the noisy environment of the gym, anyway. Sounds like a good opportunity to build a custom circuit. Sounds like a great opportunity to use the BASIC Stamp!

So, I want a little exercise timer that will time four cycles of five stages and give me both visual indicators for use in the noisy gym and an audible indicator for those days that I'm on the jogging trail and the unit is strapped to my arm.

Before we jump in, let's talk a bit about the "process." What I mean by this are the steps that we will follow to develop our project. Don't make the mistake of thinking that you can just jump right into small projects without planning them — like dogs, small projects can bite you as badly as big ones.

Here's a good process to use for Stamp project development:

1. Define the project/product
2. Design the hardware
3. Write test code to verify hardware design
4. Write software
5. Test software to requirements
6. Field-test project
7. Refine software and re-test

Define the Project

The first step, "define the project," is the trickiest and causes the most amount of trouble because it is usually taken for granted. I'm sure you've heard the phrase "Plan your work, work your plan." That's what Step 1 is all about. You'll save a lot of time and — especially if you enter the professional ranks — a lot of development money if you commit

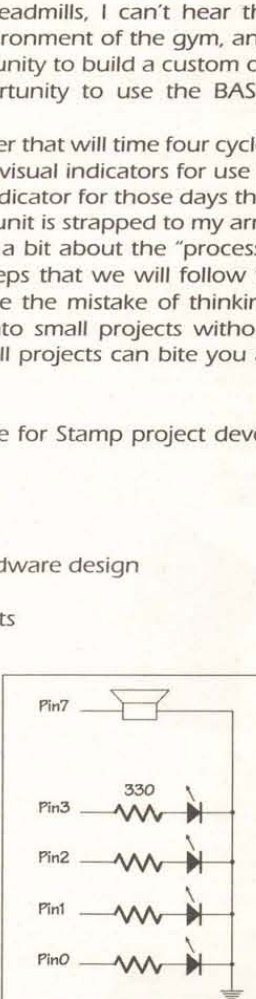

Figure 1: Exercise Timer schematic

to Step 1.

How do we do this? The answer is simple and yet, it's not always easy: We must fully understand our customer's wants and needs. So take the time to do this step well. Ask a lot of questions. Sometimes the customer will be you. That's okay and doesn't excuse you from the step. And if the customer is someone else — especially if that someone will be paying you for the product — you really need to be diligent. If you don't, you may find yourself delivering a product that is missing features or, worst of all, is nothing close to what your customer actually wants.

Okay, I've already described our little exercise timer, and we're just going to leave the definition as-is for the moment. Let's move on to the hardware (Step 2).

Hardware

Our timer needs four stages, so we'll use an LED for each. Since we have a little bit of Stamp experience, we'll connect the LEDs to the lower bits of the output and use positive logic (output high will light the LED). This will be fine since we're only going to turn on only one LED at a time. We can get a little more current out of the Stamp if we use inverted logic (output low turns on LED), but this makes the code a little more difficult to read. The last thing we need is something to make sound. A small piezo speaker will take care of that nicely. See Figure 1 for the schematic of the exercise timer.

Testing

With the hardware designed, we need to test it. This is especially important since there is a lot of hardware interacting with the Stamp. While that's not the case with this project, we still need to test it, and we'll use this opportunity to develop a little bit of the code for the final project.

Listing 1 is the test code. To some, this code may look a little more refined that what one would generally consider "test" code, but it's best to have neat code from the start. That way, we're not cleaning up our test code to put into production; it's usable as-is.

For you beginners, I can't stress enough the importance of using SYMBOLs. Using SYMBOLs will save you time by making your code somewhat self-documenting. This allows you to focus on the code instead of the comments. And don't forget that PBASIC allows you to assign more than one SYMBOL to the same variable (this is called aliasing). You can do this when you're running out of variables and want to use the same one in different parts of the program. Just keep in mind that PBASIC variables are global and you'll want to make sure that using a variable in one part of a program under a given alias does not interfere with its operation in another part of the program. Here again, planning will keep you out of these sticky spots.

The test program is pretty basic. We want to make sure that the LEDs work and that the beeper sound is pleasing. To that end, we've decided to structure the code like a shortened exercise cycle. One thing that I know I'm going to need is some sort of delay routine. We can't get away with a simple PAUSE command because the first stage is two minutes long. Since the maximum PAUSE value is 65535 — just over a minute — it won't work.

We could choose to use PAUSE 60000 twice for the first stage, but this doesn't give me much flexibility or re-use in this project or others. A delay routine that works in seconds would be a little more flexible and easier to apply elsewhere. In the Subroutines section, you'll find "DlySec." This works by setting the variable "secs" to the value we want and calling the routine with GOSUB. By using byte-sized variables, this routine will give us a delay of four minutes, 15 seconds (255 seconds). If you want to modify this to run longer, you'll need to change both "secs" and "loops" to word-sized variables.

Software

Okay, the LEDs work and the beeper sounds great, so let's start the production code (Step 4). Listing 2 is our first attempt. You see that it's really not too much of a change from the test code. In fact, the only thing necessary to get us from the test code to meeting the basic specification was to create a loop in the main body of code so that the program will run four cycles.

The code works — great! Now we could stop here, but what we've noticed is that there's a big chunk of code that has redundant sections that we may be able to refine. If we look at the operation of each stage, it goes like this: Turn on the stage LED, sound the beeper, time the stage. Yeah, we can clean this up a bit.

Take a look at Listing 3. What we've done is added an inner loop to handle the four stages of each cycle. We're able to deal with the discrete differences between each stage by using

```
' Stamp Applications - May 2000
' Listing 1


' -----[ Title ]-----------------------------------------------------------
'
' File...... XTIMER1.BAS
' Purpose... Exercise Timer - Hardware test code
' Author.... Jon Williams


' -----[ Program Description ]---------------------------------------------
'
' Hardware test code for exercise timer project


' -----[ I/O Pins ]--------------------------------------------------------
'
SYMBOL  BprPin = 7


' -----[ Constants ]-------------------------------------------------------
'
SYMBOL  BprTone = 75
SYMBOL  BprLen = 16                            ' 0.192 secs


' -----[ Variables ]-------------------------------------------------------
'
SYMBOL  secs = B2
SYMBOL  loops = B3


' -----[ Initialization ]--------------------------------------------------
'
Init:   Pins = %00000000                        ' LEDs off to start
        Dirs = %10001111                        ' LEDs and Piezo outs


' -----[ Main Code ]-------------------------------------------------------
'
Main:   Pins = %0001                            ' stage 1 LED on
        SOUND BprPin,(BprTone, BprLen)          ' sound start of stage
        secs = 120                              ' 2-minute stage
        GOSUB DlySec

        Pins = %0010                            ' stage 2
        SOUND BprPin,(BprTone, BprLen)
        secs = 60
        GOSUB DlySec

        Pins = %0100                            ' stage 3
        SOUND BprPin,(BprTone, BprLen)
        GOSUB DlySec

        Pins = %1000                            ' stage 4
        SOUND BprPin,(BprTone, BprLen)
        GOSUB DlySec

Done:   Pins = %0000                            ' LEDs off
        SOUND BprPin,(0,12,50,12,75,12,110,12)  ' sound end

        END ' of program


' -----[ Subroutines ]-----------------------------------------------------
'
DlySec: FOR loops = 1 TO secs
          ' PAUSE 1000                          ' pause 1 second
          PAUSE 10                              ' quick pause for testing
        NEXT
        RETURN
```

Stamping Myself Into Better Shape

LOOKUP to get the values we need for the LED output and for the stage timing. Notice that our stage loop is zero-based (goes from zero-to-three instead of one-to-four). This is necessary to conform to the requirements of LOOKUP. The first element in the LOOKUP table corresponds to the control variable value of zero.

Software Testing

All right, time for testing. Everything seems to be working fine and we even used less code space by adding the stage loop. That's good, it means there's more room for future features. Then something happened. I got up to get a drink of water and, while walking away, the beeper sounded. Cool, the next stage. But what stage? While I'm out on the jogging trail I don't want to think about where I am — I just want to be told what to do next.

What we need to do is have a distinct audio indication for each stage, just as each stage has its own LED. Take a look at Listing 4. What we've done is replace the single SOUND command that's embedded in our loop with a call to a subroutine named — appropriately enough — "Beep." Beep takes advantage of another great PBASIC command: BRANCH. We use BRANCH to route the routine to the appropriate sound commands. Stage 1 uses one low-frequency beep, Stage 2 uses two low-frequency beeps, Stage 3 uses one high-frequency beep, and Stage 4 uses two high-frequency beeps.

That's much better. Now it's time to move from the breadboard to a device that can be "field tested" (Step 6). It's one thing to conform to specifications in the lab, but it's in actual use where we really find out how well we've done our job.

Field Testing

Okay, I put on some gym shorts, laced up my favorite jogging shoes, and hit the trail. So far, so good. I'm thinking, "Yeah, baby, I can feel the pounds melting away." Then, just as I was so proud of myself, I tripped over an untied shoelace. To make matters worse, the lace breaks as I'm re-tying it, and then the beeper indicates it's time for the next stage. Shoot! This isn't working out — I need a Hold switch on the timer.

To be fair, we can't always foresee these problems in the design stage — that's why we do field testing. That said, we would minimize the chances of major problems arising during field test by asking a lot of questions up front; especially questions on how the device will be used. Field testing, as we've just seen, will catch all the final "gotchas."

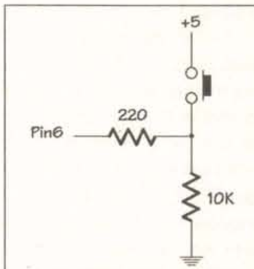

Figure 2: Hold Switch

Refining

Adding the hardware for the Hold switch is the easy part (see Figure 2); the software to support it is going to require a little more work. The reason is that we've kept things very simplistic. I'm not criticizing what we've done so far because it does work. The simplicity, however, does not support much in the way of flexibility and now we have to take a step back and re-design our code. Now you see why it's so important to know — to the extent we can — all of your project requirements up front.

Our Hold switch will work by suspending the current stage until pressed again. The device will tell us it's on Hold by flashing the current stage LED. Finally, we'll start the program in Hold mode since it's just a bit easier to press the Hold button than to flip the power switch when we want to get started.

You may remember from last month that I suggested we could give our programs a lot of flexibility by breaking them up into small chunks and using a "task switcher" or "time slicing" approach. Since the concept as it applies to this project may not be immediately obvious, let's just jump into the final code and see how we got there. Once you understand the concept, you should find it reasonably easy to apply to your time-oriented programs.

What you'll immediately notice is that the delay routine is gone and we've added quite a few variables. The approach of this program takes advantage of the fact that most programs run in a loop. What we're going to do is keep the loop simple and somewhat constant, allowing us to use it as a time base.

Did you know that the first PCs didn't have real-time-clock

```
' Stamp Applications - May 2000
' Listing 2


' -----[ Title ]-----------------------------------------------------------
'
' File...... XTIMER2a.BAS
' Purpose... Exercise Timer - Version 2 (4 cycles, full time)
' Author.... Jon Williams

' -----[ Program Description ]---------------------------------------------
'
' This program serves as a multi-stage exercise timer.  The program runs
' four cycles of four stages, with an LED and audio indication for each
' stage.

' -----[ I/O Pins ]--------------------------------------------------------
'
SYMBOL   BprPin = 7

' -----[ Constants ]-------------------------------------------------------
'
SYMBOL   BprTone = 75
SYMBOL   BprLen = 16                          ' 0.192 secs

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

SYMBOL   cycle = B2
SYMBOL   secs= B3                           ' stage timing (minutes)
SYMBOL   loops = B4                         ' counter for long delay

' -----[ Initialization ]--------------------------------------------------
'
Init:    Pins = %00000000                   ' LEDs off to start
         Dirs = %10001111                   ' LEDs and Piezo outs

' -----[ Main Code ]-------------------------------------------------------
'
Main:    FOR cycle = 1 TO 4

           Pins = %0001                     ' stage 1 LED on
           SOUND BprPin,(BprTone, BprLen)   ' sound start of stage
           secs = 120                       ' 2-minute stage
           GOSUB DlySec

           Pins = %0010                     ' stage 2
           SOUND BprPin,(BprTone, BprLen)
           secs = 60
           GOSUB DlySec

           Pins = %0100                     ' stage 3
           SOUND BprPin,(BprTone, BprLen)
           GOSUB DlySec

           Pins = %1000                     ' stage 4
           SOUND BprPin,(BprTone, BprLen)
           GOSUB DlySec

         NEXT ' cycle

Done:    Pins = %0000                       ' LEDs off
         SOUND BprPin,(0,12,50,12,75,12,110,12)  ' sound end

         END ' of program


' -----[ Subroutines ]-----------------------------------------------------
'
DlySec:  FOR loops = 1 TO secs
           PAUSE 1000                       ' pause 1 second
           ' PAUSE 10                       ' quick pause for testing
         NEXT
         RETURN
```

chips? They kept time, at their lowest level, by keeping a tic counter. Tics were then converted into the appropriate time format. That's what we're going to do. Our code will run in a continuous loop and each pass through the loop will cause the tic counter to be updated. Actual loop timing is a bit of a trade and some projects will require experimentation to get the best results. We have an additional requirement: to monitor and debounce the Hold switch. Yes, we could just use the PBASIC BUTTON command, but it's not my favorite and can be a little confusing. What we'll find is that loop-based architecture of our code will support monitoring and debouncing the switch with fairly simple code.

For the moment, we'll arbitrarily decide to run our loop at 20 times per second, or 50 milliseconds per loop iteration. Since our stage delay is in seconds, we'll want to count 20 tics (loops) and then update a seconds counter. When the seconds counter reaches the stage timing value, we'll move on to the next stage.

Take a look at the main body of code. The beginning of each stage is noted with the stage LED lit and an audio indication. This will only occur when our seconds timer (timing the current stage) and the tic counter (time base for seconds) are zero. We also need to load the stage timing when we start a new stage.

At the heart of our loop is the PAUSE command that pads it to 50 milliseconds. We need this because even the Stamp 1 can zip through its code pretty quickly. Now you'll notice that the SYMBOL called "LoopTm" is not set at 50 (it's 46 in the final code). It did, indeed, start at 50 and was fine-tuned during testing. I'll explain how at the end.

Now we get to the switch monitoring and debouncing. The

```
' Stamp Applications - May 2000
' Listing 3

' -----[ Title ]-----------------------------------------------------------
'
' File...... XTIMER2b.BAS
' Purpose... Exercise Timer - Version 2 (refined main loop)
' Author.... Jon Williams

' -----[ Program Description ]---------------------------------------------
'
' This program serves as a multi-stage exercise timer.  The program runs
' four cycles of four stages, with an LED and audio indication for each
' stage.

' -----[ I/O Pins ]--------------------------------------------------------
'
SYMBOL  BprPin = 7

' -----[ Constants ]-------------------------------------------------------
'
SYMBOL  BprTone = 75
SYMBOL  BprLen = 16                     ' 0.192 secs

' -----[ Variables ]-------------------------------------------------------
'
SYMBOL  cycle = B2                      ' cycles counter
SYMBOL  stage = B3                      ' stage counter
SYMBOL  secs= B4                        ' stage timing (seconds)
SYMBOL  loops = B5                      ' counter for long delay

' -----[ Initialization ]--------------------------------------------------
'
Init:   Pins = %00000000                ' LEDs off to start
        Dirs = %10001111                ' LEDs and Piezo outs

' -----[ Main Code ]-------------------------------------------------------
'
Main:   FOR cycle = 1 TO 4
          FOR stage = 0 TO 3
            LOOKUP stage,(%0001,%0010,%0100,%1000),Pins
            SOUND BprPin,(BprTone, BprLen)
            LOOKUP stage,(120,60,60,60),secs
            GOSUB DlySec
          NEXT ' stage
        NEXT ' cycle

Done:   Pins = %0000                                ' LEDs off
        SOUND BprPin,(0,12,50,12,75,12,110,12)      ' sound end

        END ' of program

' -----[ Subroutines ]-----------------------------------------------------
'
DlySec: FOR loops = 1 TO secs
          PAUSE 1000                    ' pause 1 second
          ' PAUSE 10                    ' quick pause for testing
        NEXT
        RETURN
```

```
' Stamp Applications - May 2000
' Listing 4

' -----[ Title ]-----------------------------------------------------------
'
' File...... XTIMER2c.BAS
' Purpose... Exercise Timer - Version 2 - Final
' Author.... Jon Williams

' -----[ Program Description ]---------------------------------------------
'
' This program serves as a multi-stage exercise timer.  The program runs
' four cycles of four stages, with an LED and audio indication for each
' stage.

' -----[ I/O Pins ]--------------------------------------------------------
'
SYMBOL  BprPin = 7

' -----[ Constants ]-------------------------------------------------------
'
SYMBOL  BprTone = 75
SYMBOL  BprLen = 16                     ' 0.192 secs

' -----[ Variables ]-------------------------------------------------------
'
SYMBOL  cycle = B2                      ' cycles counter
SYMBOL  stage = B3                      ' stage counter
SYMBOL  secs= B4                        ' stage timing (seconds)
SYMBOL  loops = B5                      ' counter for long delay

' -----[ Initialization ]--------------------------------------------------
'
Init:   Pins = %00000000                ' LEDs off to start
        Dirs = %10001111                ' LEDs and Piezo outs

' -----[ Main Code ]-------------------------------------------------------
'
Main:   FOR cycle = 1 TO 4
          FOR stage = 0 TO 3
            LOOKUP stage,(%0001,%0010,%0100,%1000),Pins
            GOSUB Beep
            LOOKUP stage,(120,60,60,60),secs
            GOSUB DlySec
          NEXT ' stage
        NEXT ' cycle

Done:   Pins = %0000                                ' LEDs off
        SOUND BprPin,(0,12,50,12,75,12,110,12)      ' sound end

        END ' of program

' -----[ Subroutines ]-----------------------------------------------------
'
Beep:   BRANCH stage,(Beep1,Beep2,Beep3,Beep4)
Beep1:  SOUND BprPin,(50,12)
        GOTO BeepX
Beep2:  SOUND BprPin,(50,12,0,8,50,12)
        GOTO BeepX
Beep3:  SOUND BprPin,(90,16)
        GOTO BeepX
Beep4:  SOUND BprPin,(100,16,0,8,100,16)
BeepX:  RETURN

DlySec: FOR loops = 1 TO secs
          PAUSE 1000                    ' pause 1 second
          ' PAUSE 10                    ' quick pause for testing
        NEXT
        RETURN
```

way this will work is by incrementing a counter whenever the switch is pressed. If the switch is released, the counter is cleared. When the counter reaches the threshold that indicates a valid switch press, some action will be taken.

By taking advantage of the Stamp's architecture and the fact that pins can be treated like variables, the switch variable updating or clearing can be done with one line of code. This works because a pin is a bit-sized variable and can have a value of zero

```
' Stamp Applications - May 2000
' Listing 5

' -----[ Title ]-----------------------------------------------------------
'
' File...... XTIMER3.BAS
' Purpose... Exercise Timer - Version 3 - "Time Slicer"
' Author.... Jon Williams

' -----[ Program Description ]---------------------------------------------
'
' This program serves as a multi-stage exercise timer.  The program runs
' four cycles of four stages, with an LED and audio indication for each
' stage.
'
' The timer includes a pause switch so that a stage can be interrupted and
' restarted.  The timer begins in "Hold" mode.  Pressing the Hold switch
' starts the timer

' -----[ I/O Pins ]--------------------------------------------------------
'
SYMBOL  BprPin = 7                          ' beeper pin
SYMBOL  SWin = Pin6                         ' Hold switch input

' -----[ Constants ]-------------------------------------------------------
'
SYMBOL  LoopTm = 46                         ' 1/20 second loop (tuned)
SYMBOL  TixMax = 20                         ' 20 x 50 ms = 1 second
SYMBOL  SwMax = 5                           ' switch debounce value

SYMBOL  Up = 0                              ' Hold switch released
SYMBOL  Down = 1                            ' Hold switch pressed

' -----[ Variables ]-------------------------------------------------------
'
SYMBOL  cycle = B2                          ' 4 cycles per workout
SYMBOL  stage = B3                          ' 4 stages per cycle
SYMBOL  tix = B4                            ' timing counter
SYMBOL  secs = B5                           ' stage seconds counter
SYMBOL  sMax = B6                           ' max time for stage
SYMBOL  swtch = B7                          ' switch debounce

' -----[ Initialization ]--------------------------------------------------
'
Init:   Pins = %00000001                    ' light stage one at start
        Dirs = %10001111                    ' LEDs and Piezo outs

        cycle = 0                           ' first cycle
        stage = 0                           ' first stage
        tix = 0                             ' clear tix timer
        secs = 0                            ' clear seconds

        GOTO OnHold                         ' start in Hold mode

' -----[ Main Code ]-------------------------------------------------------
'
Main:    IF secs > 0 THEN Pad                                  ' beep only when secs and
         IF tix > 0 THEN Pad                                   '   tix are zero
         LOOKUP stage,(%0001,%0010,%0100,%1000),Pins           ' stage LED
         GOSUB Beep
         LOOKUP stage,(120,60,60,60),sMax                      ' get stage timing (secs)

Pad:     PAUSE LoopTm                                          ' pad the loop for timing

ChkSw:   swtch = swtch + SWin * SWin                           ' check pause switch
         IF swtch >= SwMax THEN OnHold                         ' debounce; call Hold if
                                                               '   held down

Test:    tix = tix + 1 // TixMax                               ' increment with rollover
         IF tix > 0 THEN Main                                  ' still in same second
         secs = secs + 1 // sMax                               ' increment seconds
         IF secs > 0 THEN Main                                 ' still in stage
         stage = stage + 1 // 4                                ' increment stage
         IF stage > 0 THEN Main                                ' still in cycle
         cycle = cycle + 1 // 4                                ' increment cycle
         IF cycle > 0 THEN Main                                ' still running

Done:    Pins = %0000                                          ' LEDs off
         SOUND BprPin,(0,12,50,12,75,12,110,12)                ' sound end

         END ' of program

' -----[ Subroutines ]-----------------------------------------------------
'
Beep:    BRANCH stage,(Beep1,Beep2,Beep3,Beep4)
Beep1:   SOUND BprPin,(50,16)
         GOTO BeepX
Beep2:   SOUND BprPin,(50,16,0,8,50,16)
         GOTO BeepX
Beep3:   SOUND BprPin,(90,16)
         GOTO BeepX
Beep4:   SOUND BprPin,(90,16,0,8,90,16)
         GOTO BeepX
BeepX:   RETURN

OnHold:  IF SWin = Down THEN OnHold                            ' wait for release
         swtch = 0                                             ' clear switch check
Hold1:   Dirs = %00000000                                      ' turn of LED
         PAUSE 65
         Dirs = %10001111                                      ' back on
         PAUSE 65
         swtch = swtch + SWin * SWin                           ' check switch
         IF swtch < 2 THEN Hold1                               ' debounce
         swtch = 0                                             ' reset timers/counters
         tix = 0
         secs = 0
         GOTO Main
```

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or one. Our hardware design supports the code design by pulling the Hold pin low (value of zero) when the switch is released. Pressing the switch brings the pin up to five volts, which is read as one. So, when the switch is pressed, we will add one to our counter and then multiply by one (which has no effect on the counter). When the switch is released, we add zero (no change), but then multiply by zero, which immediately clears the counter. This trick saves a potentially tedious IF-THEN construct in the code.

The next line checks the switch value. If it reaches five (corresponding to 250-millisecond press; the reason our loop time is less than one second), the code will jump to the routine called "OnHold." This routine flashes the current stage LED by setting the Dirs register to inputs then back to outputs. The same switch monitoring and debouncing technique is used to release the timer from hold.

The final part of the loop is testing and updating the various timers and counters. Once again, we save code by taking advantage of Stamp math and by adopting zero-based counters. By using the Modulus (//) operator (remainder of a division) and counting from zero to our max value minus one, we considerably simplify the code. Any number MOD itself is zero. By using this technique, a value of zero indicates a rollover and the need to update our next level counter.

So you see that in the section called "Test," the counters are tested from the inside out. First, we check the tic counter. If it rolls over to zero, a second has elapsed; otherwise we go back to the main loop. The same process works for the seconds counter, the stage counter, and the cycles counter. When the cycle counter rolls over to zero, we've completed all four cycles and are done. I'm sure that you can see how easy it would be to synthesize a real-time clock using this technique to generate seconds, minutes, and hours.

The last step is testing and fine-tuning. We'll find that with a "LoopTm" value of 50, the timer will run long. That shouldn't come as a surprise since we know that the code itself will take some time to run. Here's how to determine the final value for "LoopTm." Start a stopwatch and time the first stage. We get a value of about 129 seconds — nine seconds too long. If we take 120 (the desired time) and divide by 129 (tested time) we get 0.93. Now we multiply 0.93 by 50 (loop pad) and get 46.5. We'll round down to 46 for our "LoopTm" value. We run the stopwatch test again and find that it's dead on. Perfect — time to hit the jogging trail.

Even if this timer project is of no value to you, the technique used in the final program can be when you apply it to your projects. This timing technique, especially when combined with task-switching techniques, is terrific for Stamp-based robotics. Give it a try, because we will be using it more frequently in future articles. Until then, Happy Stamping. **NV**

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KEPCO BOP 20-20M Bipolar Op Amp/Power Supply, ... $675.00
to 20 V 20 A
KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, ... $400.00
to 50 V 2 A
TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, ... $200.00
0-50 V, 0-15 A, 100 Watts max.

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP 5314A-001 100 MHz/100 nS Universal Counter; $250.00
TCXO reference option
HP 5315A 100 MHz/100 nS Universal Counter $350.00
HP 5315A-001 100 MHz / 100 nS Universal Counter, ... $400.00
TCXO reference
HP 5315A-002,003 100 MHz/100 nS Univ. Counter; $550.00
batt. power & 1 GHz C-ch.
HP 5315A-003 100 MHz/100 nS Univ. Counter, ... $450.00
1 GHz C-channel option
HP 5315B 100 MHz/ 100 nS Universal Counter $375.00
HP 5316A 100 MHz/100 nS Universal Counter, HPIB $450.00
HP 5316A-001,003 100 MHz/ 100 nS Univ. Counter, ... $600.00
HPIB, TCXO, 1 GHz C-ch.
HP 5316B 100 MHz/ 100 nS Universal Counter, HPIB $550.00
HP 5335A-10,30,40 200 MHz/2 nS Universal Counter, ... $950.00
OCXO ref., 1.3 GHz C-ch
HP 5370B 100 MHz/ 20 pS Universal Counter, 11 digits $1,200.00
PHILIPS PM6672/411 120 MHz/100 nS Universal Counter, ... $375.00
C-channel 70-1000 MHz
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, ... $200.00
TM5000 series
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, ... $350.00
TM5000 series
TEK DC5010 350 MHz / 3.125 nS Universal Counter, ... $750.00
TM5000 series
TEK DC503A 125 MHz/100 nS Universal Counter, ... $275.00
TM500 series
TEK DC509 135 MHz/ 10 nS Universal Counter, TM500 series $275.00

FREQUENCY COUNTERS

EIP 545A 18 GHz Frequency Counter $750.00
FLUKE 7220A-010,131,351 1.3 GHz Counter; $500.00
battery power, OCXO, and res. mult.
HP 5342A 18 GHz Frequency Counter $1,000.00
HP 5343A-001 26.5 GHz Frequency Counter, ... $3,000.00
OCXO reference
HP 5343A-001,011 26.5 GHz Frequency Counter, ... $3,500.00
OCXO reference, HPIB
HP 5345A/5355A/5356B $3,500.00
26.5 GHz CW/Pulse Frequency Counter
HP 5364A Microwave Mixer / Detector, ... $2,000.00
for modulation domain an.

MISCELLANEOUS

HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power $1,100.00
HP 5087A-opt.032 Distribution Amplifier, ... $1,750.00
12 outputs at 5 MHz

AUDIO & BASEBAND

SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, ... $1,200.00
50 Hz-32.5 MHz, 50 & 75 ohms

DISTORTION ANALYZERS

HP 8903A Audio Analyzer, 20 Hz-100 kHz $1,200.00
HP 8903B-001 Audio Analyzer, ... $1,650.00
20 Hz-100 kHz; rear input option

RMS VOLTMETERS

FLUKE 8922A True RMS Voltmeter, ... $450.00
180 uV-700 V, 2 Hz-11 MHz

OSCILLATORS

HP 3336C-004,005 21 MHz Synthesizer/ Level Gen., ... $1,400.00
OCXO & hi accuracy att.
TEK SG502 Sine/Square Osc., ... $200.00
5 Hz-500 kHz, 70 dB step atten.,TM500

MISCELLANEOUS

HP 3575A Phase-Gain Meter, 1 Hz-13 MHz, single display $650.00
HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display $850.00
HP 461A Amplifier, 20 dB or 40 dB gain, 1 kHz-150 MHz $125.00
HP 467A Power Amplifier, ... $375.00
X1/X2/X5/X10, DC-1 MHz, 10 W output
KROHN-HITE 3103 High/Low Pass Filter, ... $350.00
10 Hz-3 MHz, 24 dB/octave
KROHN-HITE 3200 High Pass / Low Pass Filter, ... $275.00
20 Hz-2 MHz, 24 dB/octave
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, ... $450.00
20 Hz-2 MHz, 24 dB/octave
KROHN-HITE 3342R Dual HP/LP Filter, ... $900.00
0.001 Hz-99.9 kHz, 48 dB/octave
ROCKLAND 852 Dual Highpass/Lowpass Filter, ... $650.00
0.1 Hz-111 kHz
TEK AM502 Differential Amplifier, ... $475.00
0.1 Hz-1 MHz, TM500 series
WAVETEK 716 Brickwall Filter $1,500.00

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90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION

TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

VISA MasterCard

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, ... $500.00
12.4-40.0 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 11971A WR28 Harmonic Mixer, for HP 8569B ... $800.00
HP 11971K WR42 Harmonic Mixer, for HP 8569B ... $800.00
HP 70620B Preamplifier, 1.0-26.5 GHz, ... $3,900.00
for 70000 series
HP 8559A/853A-001 Spectrum An., ... $3,750.00
0.01-21 GHz, 1 kHz res.,w/rackmount frame
HP 85640A Tracking Generator, ... $5,000.00
300 kHz-2.9 GHz, for HP 8560 series
HP 8568B Spectrum Analyzer, ... $8,500.00
100 Hz-1.5 GHz, 10 Hz min. res.
HP 8569B Spectrum Analyzer, ... $5,500.00
10 MHz-22 GHz, 100 Hz min.res.bw.
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz ... $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 ... $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 ... $250.00
HP 85054A Type N Calibration Kit, for HP 8510 series ... $1,800.00
HP R85026A WR28 Detector, ... $1,200.00
26.5-40 GHz, for HP 8757 series

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., ... $1,650.00
0.1-1050 MHz, 10 Hz res., GPIB
FLUKE 6060A/AN Synthesized Signal Generator, ... $950.00
10 kHz-520 MHz, 10 Hz res
FLUKE 6060B/AK Synthesized Signal Gen., ... $1,900.00
0.1-1050 MHz, 10 Hz res.
GIGATRONICS 600/6-12 Synthesized Source, ... $2,500.00
6-12 GHz, 1 kHz res., GPIB
GIGATRONICS 875/50 Levelled Multiplier, ... $2,500.00
x4, 50.0-75.0 GHz output, -3 dBm
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., ... $2,500.00
2-8 GHz, 1 MHz res.,GPIB
GIGATRONICS GT9000-opt.26A Synthesized Signal Gen., ... $6,000.00
0.01-20 GHz, 1 kHz res.
HP 11707A Test Plug-in for HP 8660 series ... $500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio ... $450.00
HP 3335A Synthesizer/ Level Gen., ... $3,000.00
200 Hz-81 MHz, -87 to dBm
HP 85100V Frequency Mult., ... $3,750.00
10-15 GHz in / 50-75 GHz out >0 dBm
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM, ... $950.00
pulse modulation
HP 8656A-001 Signal Generator, ... $1,600.00
0.1-990 MHz, 100 Hz res., HPIB, OCXO
HP 8657A-002 Signal Generator, ... $2,750.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8660C/86602A/86632B Synth. Sig. Gen., ... $2,500.00
1-1300 MHz, AM / FM
HP 8660C/86603A/86633B Synthesizer, ... $3,250.00
1-2600 MHz, 1 Hz res., AM / FM
HP 8672A Synthesized Signal Generator, ... $5,000.00
2-18 GHz, dBm output
HP 8684B Signal Generator, ... $3,000.00
5.4-12.5 GHz, AM/ WBFM/ Pulse

SWEEP GENERATORS

HP 8340B Synthesized Sweep Generator, ... $20,000.00
10 MHz-26.5 GHz, AM, FM
HP 8350A/83540A-002,004 Sweep Oscillator, ... $4,000.00
2.0-8.4 GHz, 70 dB step attenuator
HP 8350A/83545A-002 Sweep Oscillator, ... $4,000.00
5.9-12.4 GHz, 70 dB step attenuator
HP 8350B/83522A Sweep Oscillator, ... $4,000.00
10-2400 MHz, dBm levelled
HP 8601A Generator/Sweeper, 0.1-110 MHz, dBm levelled ... $400.00
HP 8620C Sweep Oscillator Frame ... $550.00
HP 86222A RF Plug-in, 10-2400 MHz, dBm levelled ... $1,200.00
HP 86222A-E69/8620C Sweep Oscillator w/RF Plug-in, ... $1,500.00
10-4000 MHz, dBm out
HP 86230B RF Plug-in, 1.8-4.2 GHz, dBm unlevelled ... $375.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, dBm levelled ... $300.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, dBm unlevelled ... $500.00
HP 86290A-004 RF Plug-in, ... $1,250.00
2.0-18.0 GHz, dBm levelled, rear output
HP 86290B RF Plug-in, 2.0-18.6 GHz, dBm levelled output ... $1,750.00
WAVETEK 962 Sweep Generator, ... $1,250.00
1.0-4.0 GHz, markers, dBm unlvld.

POWER METERS

BOONTON 42B/41-4E Analog Power Meter, ... $450.00
with 1 MHz-18 GHz sensor
HP 432A/478A Power Meter, -30 to dBm, 10 MHz-10 GHz ... $300.00
HP 435B/8481A Power Meter, -30 to dBm, 10 MHz-18 GHz ... $900.00
HP 435B/8482B Power Meter, 0 to dBm, 100 kHz-4.2 GHz ... $1,500.00
HP 435B/8482H Power Meter, -10 to dBm, 100 kHz-4.2 GHz ... $900.00
HP 436A-022/8481A Power Meter, -30 to dBm, ... $1,200.00
10 MHz-18 GHz, HPIB
HP 436A-022/8484A Power Meter, ... $1,200.00
-70 to -20 dBm, 10 MHz-18 GHz, HPIB
HP 8477A Power Meter Calibrator, for HP 432 series ... $500.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, ... $1,500.00
for 435/6/7/8
HP R8486A WR28 Power Sensor, 26.5-40 GHz, ... $1,500.00
for HP 435/6/7/8

RF MILLIVOLTMETERS

RACAL-DANA 9303 RF Millivoltmeter, ... $750.00
10 kHz-2 GHz, -70 to dBm

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, ... $950.00
4 Watts, 1-1000 MHz
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz ... $2,250.00
HP 415E SWR Meter ... $200.00
HP 8406A Comb Generator, ... $500.00
1/ 10/ 100 MHz increments, to 5 GHz
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, ... $375.00
5 dB NF, dBm output
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, dBm output ... $750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz ... $1,750.00
HP 8901B-1,2,3 Modulation An., ... $2,250.00
0.15-1300 MHz, rear input, OCXO, ext.LO
HP 8970A Noise Figure Meter ... $4,000.00
HUGHES 1177H10F000 TWT Amplifier, >30 dB gain, ... $2,500.00
1.4-2.4 GHz, 20 Watts
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, ... $2,500.00
3-8 GHz, 10 Watts
HUGHES 8020H01F000 TWT Amplifier, >30 dB gain, ... $4,250.00
2-4 GHz, 20 Watts
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, ... $350.00
50 Watts, metered, 28V
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz ... $3,750.00

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, ... $300.00
10 dB, 26.5-40 GHz
AMERICAN NUCLEONICS AM-432 ... $95.00
Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
AVANTEK AMT-400X2 WR28 Active Doubler, ... $450.00
dBm in/ dBm out 26-40 GHz
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), ... $650.00
with wattmeter
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz, N(f) ... $350.00
BIRD 8251 1 kW Oil Dielectric Load, DC-2.4 GHz, N(f) ... $500.00
BIRD 8325-30 30 dB Attenuator, 500 Watts, DC-500 MHz ... $400.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, ... $125.00
100 Watts max., N(m/f)
FXR/MICROLAB SL-03N Stub Stretcher, ... $75.00
0.3-6.0 GHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance Trombone Line, ... $400.00
0-44 cm, DC-2 GHz
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) ... $300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... $800.00
HP 33321K Programmable Step Atten., ... $475.00
0-70 dB, DC-26.5 GHz, 3.5mm
HP 33327L-006 Programmable Step Attenuator, ... $1,000.00
0-70 dB, DC-40 GHz, 2.9mm
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz ... $275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 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 83017A Amplifier, 25 dB gain, 0.5-26.5 GHz, > dBm ... $3,250.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) ... $150.00
HP 8472B Crystal Detector, 10 MHz-18 GHz, ... $225.00
negative polarity, SMA
HP 8494G-002 Programmable Step Attenuator, ... $350.00
0-11 dB, DC-4 GHz, SMA
HP 8495H-001 Programmable Step Attenuator, ... $400.00
0-70 dB, DC-18 GHz, N
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA ... $375.00
HP 8497K-004 Programmable Step Attenuator, ... $750.00
0-90 dB, DC-26.5 GHz
HP K382A WR42 Direct Reading Attenuator, ... $2,750.00
0-50 dB, 18.0-26.5 GHz
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz ... $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... $450.00
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz ... $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz ... $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz ... $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
HP R382A WR28 Direct Reading Attenuator, ... $2,250.00
0-50 dB, 26.5-40 GHz
HP R422A WR28 Crystal Detector, 26.5-40 GHz ... $400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz ... $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz ... $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz ... $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz ... $650.00
HP X870A WR90 Slide Screw Tuner ... $150.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz ... $900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz ... $900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, ... $1,000.00
0-50 dB, 26.5-40 GHz
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, ... $1,000.00
0-50 dB, 33-50 GHz
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, ... $1,000.00
0-50 dB, 50-75 GHz
HUGHES 45732H-1200 WR22 Level Set Attenuator, ... $250.00
0-25 dB, 33-50 GHz
HUGHES 45772H-1100 WR22 Thermistor Mount, ... $400.00
-20 to dBm, 33-50 GHz
HUGHES 45773H-1100 WR19 Thermistor Mount, ... $650.00
-20 to dBm, 40-60 GHz
HUGHES 45774H-1100 WR15 Thermistor Mount, ... $750.00
-20 to dBm, 50-75 GHz
HUGHES 45776H-1100 WR10 Thermistor Mount, ... $700.00
-20 to dBm, 89-99 GHz
HUGHES 47316H-1111 WR10 Tuneable Detector, ... $600.00
75-110 GHz, positive polarity
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., ... $2,000.00
32.000 GHz, dBm
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., ... $2,750.00
42.000 GHz, dBm
HUGHES 47974H-1000 WR15 SPST PIN Switch, ... $375.00
250 MHz speed, 60-62 GHz response
KRYTAR 201020010 Directional Detector, ... $200.00
1-20 GHz, SMA(f/f)/SMC
KRYTAR 2616S Directional Detector, ... $200.00
1.7-26.5 GHz, K(f/m)/SMC
M/A-COM 3-19-300/10 WR19 Directional Coupler, ... $450.00
10 dB, 40-60 GHz
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) ... $75.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, ... $25.00
19.5 dB, 1-1000 MHz, SMA(f)
NARDA 3000-SERIES Directional Couplers ... $150.00
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz, N ... $475.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz ... $375.00
NARDA 3090-SERIES Precision High Directivity Couplers ... $225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, ... $500.00
2.0-18 GHz, N(m)
NARDA 3752 Coaxial Phase Shifter, ... $1,000.00
0-180 deg./GHz, 1-5 GHz
NARDA 3753B Coaxial Phase Shifter, ... $1,000.00
0-55 deg./GHz, 3.5-12.4 GHz
NARDA 4000-SERIES ... $75.00
SMA Miniature Directional Couplers
NARDA 4226-10 Directional Coupler, ... $275.00
10 dB, 0.5-18.0 GHz, SMA(f)
NARDA 4227-16 Directional Coupler, ... $325.00
16 dB, 1.7-26.5 GHz, 3.5mm(f)
NARDA 4242-20 Directional Coupler, ... $100.00
20 dB, 0.5-2.0 GHz, SMA(f)
NARDA 4247-20 Directional Coupler, ... $200.00
20 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 4247B-10 Directional Coupler, ... $200.00
10 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 5070-SERIES Precision Reflectometer Couplers ... $300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) ... $65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) ... $165.00
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz ... $600.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz ... $375.00
NARDA 794FM Direct Reading Variable Attenuator, ... $375.00
0-40 dB, 4-8 GHz
OMNI-SPECTRA 2085-6010-00 Crystal Detector, ... $50.00
1-18 GHz, negative polarity, SMA(m/f)
PAMTECH KYG1014 WR42 Junction Circulator, ... $250.00
18.0-26.5 GHz
SONOMA SCIENTIFIC 21A3 WR42 Circulator, ... $75.00
20 dB, 20.6-24.8 GHz
TEKTRONIX 2701 Step Attenuator, ... $175.00
0-79 dB, DC-1 GHz, AC or DC coupled
TRG B510 WR22 Direct Reading Attenuator, ... $1,000.00
0-50 dB, 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 Terminated Crossguide Coupler, ... $200.00
30 dB
WEINSCHEL 150-110 Programmable Step Attenuator, ... $450.00
0-110 dB, DC-18 GHz, SMA
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) ... $150.00
WEINSCHEL DS109LL Double Stub Tuner, ... $150.00
0.2-2.0 GHz, N(m/f)

COMMUNICATIONS

HP 3780A-001 Pattern Generator / Error Detector, ... $1,000.00
1 kb/s - 50 Mb/s
HP 4935A Transmission Impairment Measuring Set ... $600.00
HP 59401A HPIB Bus Analyzer ... $375.00
MICRODYNE 1200MR 215-320 MHz Telemetry Receiver, ... $600.00
PSK demodulation
TEK 1410R NTSC Gen., w/SPG2 sync. generator, ... $800.00
TSG7 color bars
TEK 1411R PAL Gen., ... $750.00
w/SPG12 sync;TSG11 color bars; TSG13 linearity
TEK 1411R PAL Test Gen., ... $1,000.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., ... $1,100.00
w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16
TEK 1411R-opt.04 PAL Test Gen., ... $1,400.00
w/SPG12,TSG11,TSP11,TSG13,TSG15,TSG16
TEK 147A NTSC Test Signal Generator, ... $800.00
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

MISCELLANEOUS

FLUKE 2180A RTD Digital Thermometer ... $500.00
HP 7090A Measurement Plotting System ... $1,200.00
P.A.R. 5206-95,98 Two-Phase Lock-in Amp., ... $1,500.00
2 Hz-100 kHz, GPIB
TEK TM5003 5000-series 3-slot Programmable Power Module ... $450.00
TEK TM5006 5000-series 6-slot Programmable Power Module ... $500.00
TEK TM504 500-series 4-slot Power Module ... $175.00
TEK TM506 500-series 6-slot Power Module ... $250.00
TEK TM515 500-series 5-slot Traveller Power Module ... $250.00

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Events CALENDAR

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.

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Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

MAY 2000

MAY 5-6

LA - BATON ROUGE - State Convention. Baker Civic Auditorium, 3325 Groom Rd. VE Testing. Baton Rouge ARC, Herb Ramey W5LSU, 225-654-6087. E-Mail: W5GIX@AOL.COM
Web: http://www.brarc.org

MAY 6

AR - SILOAM SPRINGS - Hamfest. St. Mary's Catholic Church,1996 Hwy. 412 E. 8am-3pm. Talk-in: 146.67. Siloam Springs ARC, Matt Hyde N5UYK, 501-524-4797. E-Mail: kengelke@cox-internet.com
AZ - SIERRA VISTA - Hamfest. Cochise ARA, Raymond Berger W1LYT, 520-378-4214
CANADA - ONTARIO - OTTAWA - Hamfest. Ottawa Valley Mobile Radio Club, John J. Barnhardt VE3ZOV, 613-521-8910. E-Mail: ve3zov@rac.ca Web: http://www.ovmrc.on.ca
CO - MONUMENT - Hamfest. Lewis-Palmer High School, 1300 Higby Rd. 8am-2pm. Talk-in: 146.970 (100Hz) or 146.520 simplex. Pikes Peak RAA, Robert Ryals KI0GF, 719-265-9950.
E-Mail: rryals@pcisys.net
Web: http://www.qsl.net/ppraa/swapfest.htm
KY - LOUISA - Hamfest. Louisa Middle School. Talk-in: 147.390+ repeater. Big Sandy ARC, Fred Jones WA4SWF, 606-638-9049. E-Mail: wa4swf@arrl.net Web: http://qsl.net/wa4swf/
MD - GRASONVILLE - Hamfest. Kent Island & Anne Arundel ARCs, Ray Allen W2KBR, 410-969-8042. E-Mail: w2kbr@arrl.net
MI - CADILLAC - Hamfest. Wexaukee ARC, Alton McConnell NU8L, 231-862-3774.
E-Mail: amcconnell3@hotmail.com
NY - OWEGO - Hamfest. Tioga County's Marvin Park Fairgrounds. Talk-in: 146.76. BARA, Bill Coleman N2BC, 607-748-5232.
E-Mail: rmess@binghamton.edu
Web: http://www.wtsn.binghamton.edu/bara
OR - EUGENE - Hamfest. Up The Crick Radio Club, Karl Fuller K7ARL, 541-942-1624
WI - CEDARBURG - Hamfest. Ozaukee RC, Joe Holly AA9HR, 262-377-2137; E-Mail: aa9hr@execpc.com. Skip Douglas, 262-284-3271
WI - SUPERIOR - Hamfest. Arrowhead RAC, Jim Nielson KB9RQD, 715-392-3697.
E-Mail: jnielson@bresnanlink.net

MAY 6-7

AL - BIRMINGHAM - Hamfest. Glenn Glass KE4YZK, 205-681-5019.
E-Mail: ke4yzk@bellsouth.net Web: http://www.bro.net/barc/fest.html
NJ - EDISON - Trenton Computer Festival. NJ Convention & Exposition Center, Raritan Center. KGP Productions, Inc., 1-800-631-0062.
E-Mail: kgp@mail.com Web: http://pcshow.com
TX - ABILENE - Hamfest. Abilene Civic Center. Sat: 8am-5pm, Sun: 9am-2pm. VE Testing. Talk-in: 146.160/760. The Key City ARC, Peg Richard KA4UPA, 915-672-8889. E-Mail: ka4upa@arrl.net

MAY 7

FL - ST. PETERSBURG - Hamfest. St. Petersburg ARC, Gerald Dee Turner N2MNC, 727-548-7474.
E-Mail: n2mnc@netzero.net
IL - SANDWICH - Hamfest. Sandwich Fairgrounds. 8am-2pm. Talk-in: 146.730- or 146.52 simplex. Kishwaukee ARC, Bob Yurs W9ICU, 815-895-3219.
E-Mail: w9icu@tbcnet.com Web: http://www.tbcnet.com/~jleonard/hamfest.htm
MD - HAGERSTOWN - Hamfest. Hagerstown Community College Recreation Center. VE Testing. Talk-in: 146.94 & 147.09. Antietam RA, Inc., Tina Jones KB8ZQM, 304-728-7769.
E-Mail: kb8zqm@intrepid.net
Web: http://www.qsl.net/w3cwc
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.
E-Mail: wb2slq@juno.com
Web: http://www.metro70cmnetwork.com
PA - WRIGHTSTOWN - Hamfest. Middletown Grange Fairgrounds. Talk-in: 147.09 and 443.950. Warminster ARC, Roy Conners K3TEN, 215-974-9373. E-Mail: k3ten@arrl.net
Web: http://www.voicenet.com/~k3dn

MAY 12-13

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe, 207-469-3492

MAY 13

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
WI - MANITOWOC - Hamfest. Mancorad RC, Dick Swanson N9QFY, 920-682-9264. E-Mail: rswanson@lakefield.net

MAY 13-14

CA - FERNDALE - Hamfest. Humboldt ARC, Marcy Campbell KE6IAU, 707-442-3866.
E-Mail: marcidon@quik.com
Web: http://www.humboldt.com
WA - YAKIMA - State Convention. Masonic Center, 510 N. Naches Ave. Sat: 9am-4pm, Sun: 9am-1pm. VE Testing. Yakima ARC, Jack Wrenn N7KNO, 509-249-0897. E-Mail: n7kno@arrl.net
Web: http://eagle.ykm.com/~w7aq/hamfest.html

MAY 19-20-21

OH - DAYTON - ARRL National Convention. Dayton ARA, Dave Coons WT8W, 937-849-0604.
E-Mail: wt8w@arrl.org
Web: http://www.hamvention.org

MAY 20

ID - CALDWELL - Hamfest. Snake River ARC, Don Ingram KK7VM, 208-459-2459. E-Mail: ingramde@cyberhighway.net
RI - FORESTDALE - Hamfest. RI Amateur FM Repeater Service, Rick Fairweather K1KYI, 401-725-7507. E-Mail: k1kyi@arrl.net

MAY 20-21

IL - ELGIN - CoCoFEST. Elgin Plaza Hotel, 345 W. River Rd. Tony Podraza 847-428-3576.
E-Mail: tonypodraza@juno.com

MAY 21

CA - FAIR OAKS - Hamfest. Bella Vista High School, 8301 Madison Ave. 6am-12pm. North Hills RC, Earl Mead K6ESM, 916-331-1115.
E-Mail: nhrc@k6is.org Web: http://www.K6IS.org
MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
NY - FARMINGVILLE - Hamfest. Radio Central ARC, Neil Heft KC2KY, 516-737-0019.
E-Mail: nheft@ibm.net

MAY 26-27

MS - PASCAGOULA - Hamfest. Civic Center, Jackson County Fairgrounds. Fri: 5-9pm, Sat: 8am-2pm. VE testing. Talk-in: W5WA 145.110-. Jackson County ARC, Charles F. Kimmerly N5XGI, 228-826-5811.
E-Mail: montehat@datasync.com

MAY 27

CT - VERNON - Hamfest. Natchaug ARC, Wayne Rychling N1GUS, 860-487-1921.
E-Mail: warych@neca.com
Web: http://users.neca.com/warych/narcfest.htm
KY - DAWSON SPRINGS - Pennyrile Area Tailgatefest 2000. Dawson Springs ARC, Princeton ARS, Hopkins County ARA, & Pennyroyal ARS, Curt Beshear KE4UZE, 270-797-9117. E-Mail: ke4uze@spis.net
NC - DURHAM - Hamfest. South Square Mall. 8am-3pm. FCC Exams. Talk-in: 147.225+. Durham FM Assn., Joseph Fields KF4QYY, 919-596-3738. Web: http://www.vramp.net/~dfma/
PA - WINFIELD - Hamfest. Milton ARC, Ray Grant K3COD, 570-568-1727. E-Mail: rgrant@csrlink.net

MAY 27-28

WY - CASPER - State Convention. Radisson Inn. Casper ARC, Warren (Rev) Morton WS7W, 307-235-2799 or 307-237-9301. E-Mail: mortonwg@aol.com
Web: http://w3.trib.com/~carc/hamfest.html

MAY 28

IL - CHICAGO - Hamfest. DeVry Institute of Technology, 3300 N. Campbell. 8am-2pm. Chicago ARC, George 773-545-3622 or Dean 708-331-7764
MD - WEST FRIENDSHIP - Hamfest. Howard County Fairgrounds. 8am-2:30pm. Talk-in: 146.76, 224.76, 444.00. Maryland FM Assn., Mike WA3TID, 410-923-3829

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Web: ncshows.com

Peter Trapp Computer Shows
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Web: www.petertrapp.com

JUNE 2000

JUNE 2-3

GA - MARIETTA - Convention. Jim Miller Park. Fri: 3pm-6:30pm, Sat: 8:30am-3pm. VEC testing. Talk-in: 148.82-. Atlanta RC, Ben Dasher KE4YZX, 404-869-6959.
E-Mail: bendasher@mindspring.com
Web: http://www.saf.com/arc/
NE - SOUTH SIOUX CITY - Midwest/Dakota Convention. 3900 Club & Sooland ARA, Leroy Baldwin W0OFY, 319-395-7183.
E-Mail: lgbw0ofy@aol.com

JUNE 2-3-4

NY - ROCHESTER - Convention. Monroe County Fairgrounds, Rt. 15A. Fri: 12pm-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Harold Smith K2HC, 716-424-7184.
E-Mail: rochfst@frontiernet.net
Web: http://www.rochesterhamfest.org

JUNE 3

IL - SPRINGFIELD - Hamfest. State Fairgrounds, Gate 11. VE Testing. Talk-in: 146.685-. Sangamon Valley RC, Edmund Gaffney KA9ETP, 217-628-3697. E-Mail: egaffney@family-net.net
Web: http://www.w9dua.net
ME - HERMON - Hamfest. Pine State ARC, Edward Richardson K1DTW, 207-825-4417.
E-Mail: edandglo@earthlink.net
MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. VE Testing. Talk-in: 147.16. Independent Repeater Assn., Kathy KB8KZH, 616-698-6627 between 4-7pm Eastern.
Web: http://www.iserv.net/~w8hvg
NJ - TEANECK - Hamfest. Fairleigh Dickinson University. 8am-2pm. Talk-in: 146.19/79. Bergen ARA, James Joyce K2ZO, 201-664-6725. E-Mail: hamfest@bara.org Web: http://www/bara.org

JUNE 3-4

NE - CHADRON - Hamfest. Pine Ridge ARC, Phil Cary WA0PZA, 308-432-3956. E-Mail: philcary@bbc.net
OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. VE testing. Talk-in: 146.660 (-600). SEAPAC, Randy Stimson KZ7T, 503-297-1175. Web: www.seapac.org

JUNE 4

CT - NEWINGTON - Hamfest. Newington High School, Willard Ave. (Rt. 173). 9am-1pm. FCC exams. Talk-in: 145.45, 146.52 simplex, 224.84, 443.05. Newington Amateur Radio League, Inc., Thomas Ponte WB1CZX, 860-666-4539.
E-Mail: wb1czx@arrl.net
IL - PRINCETON - Hamfest. Bureau County Fairgrounds. Talk-in: 146.955 -600 PL 103.5. Starved Rock Radio Club, Alan Erbrederis N9PIB, 815-498-9675. E-Mail: erb.n9pib@junol.com
Web: http://www.qsl.net/w9mks/hamfest/htm
NY - QUEENS - Hamfest. NY Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. VE exams. Talk-in: 444.200 repeat, PL 136.5, 146.52 simplex. The Hall of Science ARC, Stephen Greenbaum WB2KDG, 718-898-5599, eves only. E-Mail: WB2KDG@Bigfoot.com or Andy Borrok N2TZX, 718-291-2561. E-Mail: N2TZX@webspan.net
PA - BUTLER - Hamfest. Butler Farm Show Grounds. 8am-4pm. Talk-in: 147.96/36. Breezeshooters ARC, H. Rey Whanger W3BIS,

Events CALENDAR

412-826-8006. E-Mail: w3bis@breezeshooters.net
Web: http://www.breezeshooters.net
VA - MANASSAS - Hamfest. Prince William County Fairgrounds. Talk-in: 146.97-, 224.660-, 442.200+. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-335-9139.
E-Mail: N4YIC@arrl.net or patnjack@erols.com
Web: http://www.qsl.net/olevahams/

JUNE 9-10

TX - ARLINGTON - State Convention. HAM-COM, Maury Guzick W5BGP, 214-804-0680.
E-Mail: chairman@hamcom.org
Web: http://www.hamcom.org

JUNE 9-10-11

WA - DRYDEN - Hamfest. Apple City ARC, Roger Eckhardt WB7SHL, 509-782-4977. E-Mail: dmeck hardt@juno.com Web: http://www.qsl.net/w7td

JUNE 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
MA - EAST FALMOUTH - Hamfest. Barnstable County Fairgrounds, Rt. 151. 9am-2pm. VE sessions. Falmouth ARA, Ralph K. Swenson 508-548-6405. E-Mail: DEPSHER911@AOL.COM
MO - MACON - Hamfest. Macon Vo-Tech School. 8am-12pm. FCC Exams. Talk-in: 146.805(-). Macon County ARC, Dale Bagley K0KY, 660-385-3629. E-Mail: n0pr@arrl.net Web: http://www.cyberusa.com/~kfoster/hamfest.htm
NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm
NY - CORTLAND - Hamfest. Skyline ARC, Andrew Slaugh KB2LUV, 607-753-0597.
E-Mail: kb2luv@clarityconnect.com
PA - BLOOMSBURG - Eastern PA Section Convention. Bloomsburg Fairgrounds. 8am-3pm. VEC Testing. Talk-in: 147.225 (+600) and 146.52 simplex. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. E-Mail: n3kyz@epix.net Web: http://www.bafn.org/~cmarc

JUNE 11

IL - WHEATON - Hamfest. DuPage County Fairgrounds, 2015 Manchester Rd. VE testing. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961.
E-Mail: wa9rij@mc.net
Web: http://cyberconnect.com/orion/smcc.html
KY - INDEPENDENCE - Hamfest. Northern KY ARC, Robert Blocher N8JMV, 513-797-7252.
E-Mail: nkarc@juno.com
NY - BETHPAGE - Hamfest. Briarcliffe College, 1055 Stewart Ave. 8:30am-1pm. VE testing. Talk-in: W2VL 146.85 repeater (136.5 PL). Long Island Mobile ARC, Ed Muro KC2AYC, 516-520-9311.
E-Mail: hamfest@limarc.org
Web: http://www.limarc.org
OH - CANFIELD - Hamfest. Twenty Over Nine ARC, Don Stoddard N8LNE.
E-Mail: n8lne@juno.com
OH - SUFFIELD - Hamfest. Goodyear ARC, Fred Mealy KC8BQX, 330-665-4563.
E-Mail: fmealy@earthlink.net
TN - KNOXVILLE - Convention. National Guard Armory, 3330 Sutherland Ave. 9am-4pm. VE Exams. Talk-in: 147.30+, 224.50-, 444.575-. RAC of Knoxville, David Bower K4PZT, 423-670-1503.
E-Mail: rack@kornet.org
Web: http://www.kornet.org/rack

JUNE 17

CT - GOSHEN - Hamfest. Southern Berkshire ARC, Lee Collins K1LEE, 860-435-0051.
E-Mail: lee@leecollins.com
MI - MIDLAND - Hamfest. Midland County Fairgrounds, Gerstacker Fair Center. 8am-1pm. Talk-in: 147.000+. Midland ARC, Del Lafevor WB8FYR, 517-689-3477.
E-Mail: lafevordel@aol.com
Web: http://www.qsl.net/w8kea/MARCSWAP.htm
MO - HOUSTON - Hamfest. Ozark Mountain Repeater Group, Blanche White N0FLR, 417-967-3000
NJ - DUNELLEN - Hamfest. Columbia Park. 7am-2pm. Talk-in: 146.025/625, 447.250/442.250, PL 141.3, 146.520 simplex. Raritan Valley Radio Association, Fred Werner KB2HZO, 732-968-7789 before 8pm. E-Mail: wb2njh@aol.com or Doug Benner W2NJH, 732-469-9009.
Web: http://www.w2qw.org
OH - MILFORD - Hamfest. Milford ARC, Chris Reinfelder KB8SNH, 513-753-5066
TN - NASHVILLE - Hamfest. Nashville ARC, Bob Malone WB5ZDS, 615-865-6225.
E-Mail: bmalone5@juno.com

JUNE 18

IN - CROWN POINT - Hamfest. Lake County Fairgrounds. VE testing. Talk-in: 147.00 repeater, 146.520 simplex. Lake County ARC, Jim Harney KF9EX, E-Mail: kf9ex@arrl.net
MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MI - MONROE - Hamfest. Monroe County Radio Communications Assn., Fred VanDaele KA8EBI, 734-587-2250 or 734-242-9487. E-Mail: ka8ebi@arrl.net Web: http://www.mcrca.org
OH - MACEDONIA - Hamfest. Nordonia High School. 8am-1pm. Talk-in: 146.82(-) repeater. Cuyahoga ARS, Rich James N8FIL, 1-800-404-2282. E-Mail: n8fil@aol.com
Web: http://www.cars.org

JUNE 24-25

CA - FERNDALE - Hamfest. Humboldt ARC, Marcy Campbell KE6IAU, 707-442-3866.
E-Mail: marcidon@qnik.com
Web: http://www.humboldt.com

JULY 2000

JULY 2

PA - WILKES-BARRE - Hamfest. Murgas ARC, Bob Michael N3FA, 570-288-3532.
E-Mail: wb3faa@aol.com

JULY 7-8-9

UT - BRYCE CANYON - State Convention. UT Hamfest Committee, Kathy Rudnicki N7JSH, 801-547-9218. Web: http://www.utahhamfest.org

JULY 8

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
GA - GAINESVILLE - State Convention. Georgia Mountains Center. 8:30am-3pm. VE Testing. Talk-in: 146.67(-). Lanierland ARC, Ken Johnson NZ4Q, 706-335-9658. E-Mail: nz4q@aol.com Web: http://www.mindspring.com/~w4tl/hamfest.htm
IN - INDIANAPOLIS - Central Division Convention. Indianapolis Hamfest Assn., Rick Ogan N9LRR, 317-257-4050.
E-Mail: oganr@in.net
Web: http://www.indyhamfest.com
MI - PETOSKEY - Hamfest. 4-H Bldg. Emmet County Fairgrounds. 8am-12pm. VE testing. Talk-

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Write in 54 on Reader Service Card.

Events CALENDAR

in: 146.68-. Straits Area ARC, Tom W8IZS, 231-539-8459 or Dirk KG8JK, 231-348-5043, E-Mail: kg8jk@qsl.net

MO - KANSAS CITY - Hamfest. PHD ARA, Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@worldnet.att.net Web: http://members.tripod.com/~PHDARA/

NC - SALISBURY - Hamfest. Salisbury Civic Center. VE Testing. Talk-in: 146.73 tone 94.8 and 146.52 simplex. Rowan ARS, Jim Morris KA4MPP, 704-278-4960 or Carol Maher W4CLM, 704-633-6603. E-Mail: rbrown@salisbury.net

WI - OAK CREEK - Hamfest. The American Legion Post 434, 9327 S. Shepard Ave. 6:30am-4pm. Talk-in: 146.52 simplex. South Milwaukee ARC, Bob Kastelic WB9TIK, 414-762-3235 days & early eves.

JULY 9

IL - PEOTONE - Hamfest. Will County Fairgrounds. Talk-in: 146.94 (-600). Kankakee Area Radio Society, Don Kerouac K9NR, 815-939-7548. E-Mail: k9nr@juno.com Web: http://www.w9az.com

PA - PITTSBURGH - Hamfest. North Hills ARC, Keith Ostrom KB3ANK, 412-821-4135. Web: http://www.nharc.pgh.pa.us

JULY 14-15-16

MT - EAST GLACIER - State Convention. Glacier/Waterton Int'l Hamfest Committee, Frank Phillips AC7AY, 406-273-2894. E-Mail: ac7ay@bigsky.net Web: http://www.tlatech.com/hamfest/

JULY 15

CO - LOVELAND - Hamfest. Larimer County Fairgrounds, 700 Railroad Ave. 9am-4pm. VE exams. Talk-in: 145.115 (- offset) or 146.52 simplex. NCARC, 970-352-5304

MD - BRUNSWICK - Hamfest. Mid-Atlantic DX & Repeater Assn., Roy Bates N2CSQ, 301-834-9351. E-Mail: 74163.200@compuserve.com

OH - WELLINGTON - Hamfest. Lorain County Fairgrounds. 8am-2pm. VE Exams. Talk-in: 146.10/70. Northern Ohio ARS, John Shaaf KC8AOX, 216-696-5709. E-Mail: kc8aox@qsl.net

TX - SHERMAN/DENISON - Hamfest, Wilmer O. Kinsey WB5DCU, 903-893-5872. E-Mail: wb5dcu@gte.net

TX - TEXAS CITY - Hamfest. Tidelands ARS, Joe Wileman AA5OP, 409-945-6794. E-Mail: aa5op@aol.com

JULY 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MO - WASHINGTON - Hamfest. Zero Beaters ARC, Keith Wilson K0ZH, 636-629-2264. E-Mail: jwpubl@fidnet.com Web: http://zbarc.usmo.com/

NJ - AUGUSTA - Hamfest. Sussex County Fairgrounds, Plains Rd. Talk-in: 147.90/30. Sussex County ARC, Dan Carter N2ERH, 973-948-6999. E-Mail: n2erh@email.com Web: http://www.scarcnj.org

PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. E-Mail: gem@op.net Web: http://www.marc.org/hamfest.html

JULY 21-22

FL - MILTON - Hamfest. Santa Rosa County Auditorium. Fri: 5pm-9pm, Sat: 8am-2pm. FCC Exams. Talk-in: 146.70. Milton ARC, Bill Couch W4VY, 850-623-0592. E-Mail: billcouch@sprintmail.com Web: http://home.att.net/~k4ozl/marc.htm

JULY 22

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

NY - FRANKFORT - Hamfest. Utica ARC, Bob Decker AA2CU, 315-797-6614. E-Mail: ktrnd@borg.com

OH - CINCINNATI - Hamfest. Diamond Oaks Development Campus, 6375 Harrison Ave. 7am-2pm. VE Exams. Talk-in: 146.67 and 146.925. OH-KY-IN ARS, Gene McCoy N8KOJ, 513-541-6935. E-Mail: n8koj@arrl.net Web: http://www.qsl.net/k8sch

JULY 23

IL - SUGAR GROVE - Hamfest. Waubonsee Community College, Rt. 47 Harter Rd. VEC Exams. Talk-in: 147.210 (+600) PL 103.5/107.2. Fox River Radio League, Maurice Schietecatte W9CEO, 815-786-2860. E-Mail: w9ceo@arrl.net Web: http://www.frrl.org/hamfest.html

JULY 28-29

OK - OKLAHOMA CITY - State Convention. OK State Fair Park (Hobbies, Arts & Craft Bldg.). Fri: 5-8pm, Sat: 8am-5pm. Talk-in: 146.82. Central OK Radio Amateurs, Harold Miller KB1ZQ, 405-672-7735 or 405-650-9963. E-Mail: n1lpn@swbell.net Web: http://www.geocities.com/heartland/7332

TX - AUSTIN - Convention. Austin ARC, Austin Repeater Group, Texas VHF-FM Society, Joe Makeever W5HS, 512-345-0800

JULY 28-29-30

AZ - FLAGSTAFF - State Convention. Ft. Tuthill. Fri: 12pm-5pm, Sat: 9am-5pm, Sun: 9am-2pm. VE Testing. Talk-in: 146.980 MHz with 100.0 Hz PL Tone. ARCA, Norm Martin K7OLD, 520-297-9562. E-Mail: norm@hamsrus.com Web: http://www.hamsrus.com/tuthill.html

CANADA - BC - VANCOUVER - Pacific Northwest DX Convention. BC DX Club & Fraser DX Club, Dave Johnson VE7VR, 604-438-8715. E-Mail: ve7vr@rac.ca Web: http://www.bcdxc.org

JULY 29

OR - BANDON - Hamfest. Coos County RC, Brian Howard W7MLT, 541-572-5623. E-Mail: w7mlt@usa.net

JULY 30

MD - TIMONIUM - Hamfest. Timonium Fairgrounds. Talk-in: 147.03+ and 224.96-. BRATS, Mayer Zimmerman W3GXK, 410-461-0086.E-Mail: w3gxk@arrl.net Web: http://www.smart.net/~brats

OH - RANDOLPH - Hamfest. Portage ARC, Joanne Solak KJ3O, 330-274-8240. E-Mail: ljsolak@apk.net Web: http://parc.portage.oh.us

AUGUST 2000

AUGUST 5

MI - TAWAS - Hamfest. Iosco County AR Enthusiasts, John Hanley KA8AIP, 517-756-2845. E-Mail: ka8aip@centurytel.net Web: http://www.oscoda.net/icare/

NM - ROSWELL - Hamfest. Pecos Valley ARC, Vernetta Verasso KC5WKA, 505-627-7777. E-Mail: kc5wka@dfn.com Web: http://www.pvarc.com

NY - ITHACA - Hamfest. Tompkins County ARC, Richard Spingarn AA2UP, 607-387-5251. E-Mail: richard@eagleprint.com Web: http://www.compcenter.com/~tcarc

OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, James Morton KB8KPJ, 614-846-7790. E-Mail: kb8kpj@cs.com

AUGUST 6

IN - ANGOLA - Hamfest. Land of Lakes, Bill

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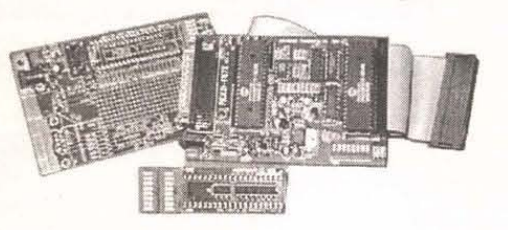

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PB-87X probe for RICE17A now shipping
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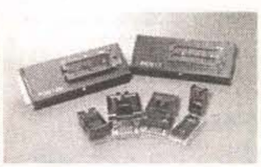

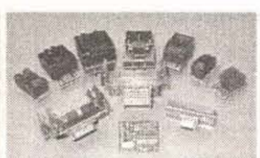

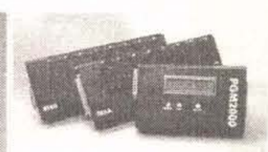

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Events CALENDAR

Brown WD9DSN, 219-475-5897.
E-Mail: sharon.l.brown@gte.net

VA - BERRYVILLE - Hamfest. Clarke County Ruritan Fairgrounds. VE Exams. Talk-in: 146.82-. Shenandoah Valley ARC, Irvin Barb W4DHU, 540-955-1745. E-Mail: ibarb@visuallink.com Web: http://www.vvalley.com/svarc/hamfest

AUGUST 12

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

IL - QUINCY - Hamfest. Eagles Alps Grounds, 3737 N. 5th St. 8am-2pm. VEC Testing. Talk-in: 147.63/147.03. Western IL ARC, Jim Funk N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: http://www.qsl.net/w9awe

NY - ROME - Hamfest. Rome RC, Russell Schorer KB2MAS, 315-853-8739. E-Mail: w4bny@juno.com

WV - HUNTINGTON - Hamfest. Tri-State ARA, Dwight D. Smith, Sr. WB8JPJ, 304-522-7865. E-Mail: wb8jpj@home.com

AUGUST 13

IA - AMANA - Hamfest. Amana Outdoor Convention Center. VE Exams. Talk-in: 146.745/.145 and 146.520. Cedar Valley ARC, Chuck Bassett N0UTS, 319-378-0448. E-Mail: n0uts@rf.org Web: http://cvarc.rf.org

IN - GREENTOWN - Hamfest. Greentown Lions Club Fairgrounds. Kokomo & Grant County ARCs, L.B. (Nick) Nickerson KA6NQW, 765-668-4814. E-Mail: ka6nqwnick@netusa1.net Web: http://www.netusa1.net/~ka6nqwnick/hamfest.html

MA - ORANGE - Hamfest. Mohawk ARC, John Dould AE1B, 978-249-5905. E-Mail: ae1b@gis.net

MI - JACKSON - Hamfest. Cascade ARS, Dennis Byrne KC8IJZ, 517-522-4058 or 517-796-6966. E-Mail: byrneda@voyager.net

MN - ST. JOSEPH - Hamfest. St. Cloud ARC, Linden Scott Hall KA0DAQ, 320-252-4498. E-Mail: lscotth@aol.com Web: http://www.w0sv.org/hamfest.html

NJ - BAYVILLE - Hamfest. Bayville Fire House, Rt. 9. VE Testing. Talk-in: 146.910 out, 146.310 in, PL 127.3. Jersey Shore ARS, Bob Murdock WX2NJ, 732-269-6379. E-Mail: jsarsfest@aol.com Web: http://members.aol.com/jsarsfest/jsarsfest.html

NY - DEPEW - Hamfest. Hearthstone Manor, 333 Dick Rd. VE Testing. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667 or 716-683-8880. E-Mail: lcalianno@freewwweb.com Web: http://hamgate1.sunyerie.edu/~larc

PA - YORK - Hamfest. VE testing. Talk-in: 146.700. York ARC, Southern PA Comm. Group, & Hilltop Transmitting Assn., Cecil Mundorff K3DCU, 717-927-6662

AUGUST 18-19-20

CANADA - BC - PRINCE GEORGE - Hamfest. Prince George ARC, Brent Lyons E-Mail: lyonsden@saintmail.net Web: http://www.pghamfest.dhs.org/

AUGUST 19

KS - CHANUTE - Hamfest. Chanute Area ARC, Charlie Ward WD0AKU, 316-431-6402

WA - LONGVIEW - Hamfest. Cowlitz County Expo Center. 9am-1pm. Talk-in: 147.26+. Lower Columbia ARA, Bob Morehouse KB7ADO, 360-425-6076. E-Mail: kb7ado@aol.com Web: http://www.qsl.net/nc7p/swapmeet.htm

AUGUST 20

IN - LAFAYETTE - Hamfest. Tippecanoe ARA, Bob Martin W9YE, 765-423-1035

KY - LEXINGTON - Hamfest. National Guard Armory, adjacent to Lexington airport. 8am-4pm. VE sessions. Talk-in 146.760-. Bluegrass ARS, John Barnes KS4GL, 606-253-1178. E-Mail: KS4GL@juno.com Web: http://www.qsl.net/k4kjg

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

AUGUST 25-26-27

MA - BOXBOROUGH - Convention. Holiday Inn Conference Center. Tony Penta W1ABC, 617-248-6996 or 978-887-8887. E-Mail: w1abc@arrl.net Web: http://www.boxboro.org

AUGUST 27

IL - DANVILLE - Hamfest. Vermilion County ARA, Gary Denison KA9SKS, 217-759-7389. E-Mail: gdenison@danville.net

KS - SALINA - State Convention. Central KS ARC, Ron Tremblay WA0PSF, 785-827-8149. E-Mail: tremblay@midusa.net Web: http://www.qsl.net/w0cy

Write in 57 on Reader Service Card.

Questions & Answers

TECH FORUM

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

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

I am looking for a schematic for a Motorola GP300 radio interface box.

5001 — **E. Herudl, Germany**

I am looking for the "*Common Core*" series of books on electricity, electronics, servos, and radar. I believe these were around the 1970s and were geared towards the military (Navy).

I immigrated to the US from the UK two years ago, having retired from the Royal Navy (we used those books for some of our electronics theory).

5002 — **Michael Irving, Pendleton, OR**

I've been trying to locate a very simple circuit for a pulse train transmitter where I can vary the pulses and that will operate at 230 MHz.

5003 — **A. J. Anzevino, Wappingers Falls, NY**

I need to find information on the Internet or how to do my own circuit to display scrolling electronics messages on 4 x 12 characters. It has two different colors on 5 x 7 matrix display. I am using a PIC 12C74A controller for the project.

5004 — **Student, EM5G@aol.com**

I need to add a time delay circuit on my RF power amplifier so the 110-volt AC cooling fan will continue to blow air on the final amplifer tubes for about three minutes after the amplifier is turned off. I would like to avoid using an expensive thermal time delay relay, if possible.

5005 — **Allan, via Internet**

I need to know the serial number and stats for the laser in the Sony CD player CDP-C20.

5006 — **Ian Bruce, via Internet**

I recently bought a pair of 900 MHz wireless headphones which are meant to connect to an audio device through an RCA jack.

The manual indicates that the unit could be damaged if connected to a speaker output, presumably because of level.

Has anyone got a simple design for an AGC amplifier with 1V P-P output, so that I may use this with a speaker output?

5007 — **Jack Rebman, Fairfax Station, VA**

A friend of mine is a shoe maker that wants to test electrical safety shoes. He needs an 18KV, 1mA AC power supply with a voltmeter and ammeter on the output.

The ability to manually ramp up the voltage at about 1KV/sec and maintain at full voltage for one minute is required.

How can I make this, or is there a product like this already available?

5008 — **Anthony Tekatch, Ontario, Canada**

I want to use my Motorola TalkAbout walkie-talkies for motorcycle-to-motorcycle communications. The TalkAbout 250 has a VOX (voice activated transmission) feature, and so, one would think this would be ideal for my hands-free application.

The optional Motorola Earbud with Inline Mic, which is supposed to work with the VOX feature, doesn't. I either have to shout at the top of my lungs, or have to hold the Mic to my lips, in order to trip the VOX.

No, there is no Mic gain or VOX trip adjustment.

I am looking therefore, for a better Earbud-type microphone/speaker (that will fit under a helmet) that is or can be made to be compatible with the TalkAbout.

I think I saw Clint Eastwood with what I'm looking for in "In the Line of Fire" and I'm pretty sure Muldar and Scully used them in the episode where the veteran was able to sort of become invisible.

The stuff Jabra makes is close to what I'm looking for, but they don't offer anything that is compatible with the TalkAbout. Any Suggestions?

5009 — **Tom Tillander, via Internet**

How would I go about retrieving an HTML document from the Internet on a DOS-based computer?

I want my DOS-based home-automation controller to be able to access the National Weather Service forecast for my area, and automatically parse this report to schedule lawn watering.

I plan to get cable modem service to my house. I'm a programmer, but have limited experience with TCP/IP other than surfing. I have seen DOS- based TCP/IP stacks for sale, but don't know how to proceed. Any suggestions?

50010 — **Jeff Bowles, Columbus, OH**

Does anyone know how to easily and inexpensively make your own PC boards? I have tried transferring laser printed layouts to copper, but can't get the whole circuit to stick. The sensitized copper clad available from Digi-Key requires a negative, but my layout program only prints black on white.

50011 — **Russell Kincaid, via Internet**

I would like to set up a small network of one-five computers using a KVM (Keyboard Video Mouse) switch. I purchased an inexpensive two-way switch but often as not it loses the mouse and rebooting is necessary. I'm guessing that better switches involve some circuitry that maintains communication between the devices and the motherboard. Can anyone explain how this works? A design would be great.

50012 — **Carl Camper, Colstrip, MT**

I need a schematic for a broadband UHF (50 MC to 500 MC approximately), one transistor, battery-operated impedance matching circuit that will match the high impedance of a random long-wire antennna to the low impedance whip antennas used on small radios, using an alligator clip to connect to the short whip on portable radios.

50013 — **Donald R. Smith, Palm Springs, CA**

Is there a simple way to relocate or extend a 2.4 GHz antenna? It's the tiny antenna mounted on a digital, spread spectrum telephone base unit.

The best operating location of my base unit is the one that is terrible for communicating. The good choice would be to have the antenna relocated about 10 feet vertically to a floor above.

50014 — **Don Fuller, West Chester, PA**

There are several companies pushing 900 MHz and 2.4 GHz video/audio transmitter and receiver units commercially.

Isn't there a simple and legal transmitter circuit that can be purchased or constructed that would use an unoccupied UHF channel that

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. Be sure to include your mailing address if responding by E-Mail.
- 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.
- The question number and a short summary of the original question will be printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

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

1) Circuit Design
2) Electronic Theory
3) Problem Solving
4) Other Similar Topics

INFORMATION/RESTRICTIONS

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

HELPFUL HINTS

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

could be tuned by any TV or VCR without adding another box to the audio/video clutter.

50015 **Dan Scheftner**
via Internet

I'm a radio serviceman and I need manuals and service parts for two-way CB, ham, military aircraft, FM, public service, civilian avionics.

I am also looking for an OEM distributor that has OEM obsolete parts, such as coils, tubes, transistors, capacitors, inductors, etc.

50016 **David N. Duerksen**
Hesston, KS

I have several LED scrolling signs that were made by Innovative Signs (Color Cells). They use a nine-pin serial interface to program and what looks like a small IC board to control.

I am looking for any info on how to obtain a keypad or a schematic in order to program these signs.

50017 **Jay Hughes**
Hampden, MA

I am looking for a service manual for a LINK communications unit. The unit was made in the early 1940s. It is a type 250-UFS. The receiver is a type 12-UF (Ed.6) and the transmitter is a (250-UFS (Ed.6) covering the 30-50 MHz.

Any help with a person or place for this information would be great. By the way, this is a restoration project.

50018 **Charlie Tipton**
Ellicott City, MD

I'm trying to find a seven-segment LED display driver chip that shows hexadecimal, that is 0-F.

50019 **Mark Phillips**
via Internet

ANSWERS

ANSWER TO #1001 - JAN. 2000

I need any information available (hardware, software, programming) on HP 75D vintage laptop. Also accessories, printer, and mini-cassette.

I have the HP 75 manual including virtual FD/modem. Also HP 75s, HP printer for same, and other information. I can be contacted at: hilltop@webtv.com or call 760-726-6291.

Don Waters
via Internet

ANSWER TO #4007 - APRIL 2000

I need help with an Ultrasonic cleaner. Mostly, the oscillator to produce 40 to 60 KHz 1,000V sinewave to the piezoelectric transducers. I have a 1,000V transformer (1,500mA) with 110 VAC input.

Ultrasonic cleaners utilize circuits that look more like RF devices than audio. Most commercial circuits utilize either an oscillator with an output stage, or a multi-vibrator type power oscillator.

The 1000V 60 Hz transformer you have will be of no help to you, as it will not pass much of the 40-60 KHz signal you will be generating.

The output transformers of most cleaners are like RF transformers, usually air core, with litz wire. Most often, the commercial designs using the standard (about 1/8" thick) transducers develop 35-45 watts per transducer.

The trick will be to match the output impedance of your circuit to the impedance of your transducers when mounted to the tank.

By the way, the transducers do generate a bit of heat, which must be transferred to the tank or they will crack in use. Regular epoxy is not very heat conductive. I recommend Loctite 383, which is a heat-conductive bonding agent usually used for permanent mounting of heatsinks to semiconductor devices.

Phil Shewmaker
Louisville, KY

ANSWER TO #4008 - APRIL 2000

I want to build a simple RF power amp. The approximate specs would be 12 VDC, a few hundred micro watts in, 3-5 watts out.

For years, I have looked for a simple schematic for a simple single or maybe two transistor amps that will amplify up to about five watts in the 30 MHz to 100 MHz range.

Is there a schematic that's simple to build, using only a transistor or two, a few caps and coils, no baluns or transformers?

Please provide values and transistor number.

A simple two transistor circuit without baluns and transformers probably does not exist. Minicircuits sells a ZHL-5W-1 amplifier with 40 dB of gain and 5W out, but it uses 24V power, consumes 75 watts (4% efficiency), and doesn't have enough gain. It also costs $1,000.00.

All these numbers reflect on the difficulty of the design. Here's a closer look.

Your specifications are too demanding. One hundred microwatts in (-10 dBm) and five watts out (37 dBm) implies a gain of 47 dB. A single transistor stage will provide about 10 dB of gain, so you will need four or five stages.

Even low power MMICs only have about 13 dB of gain. If you want linear gain, then the power stages should use push-pull designs — but they require two transistors and a couple of transformers.

The alternative for linear gain is to burn lots of power. Power stages also require close attention to impedance matching. Narrowband designs can use reactive networks for the impedance match, but broadband designs (your specifications are for almost two octaves) use transformers and baluns.

There may be other things to fix. You may not be driving the LPA1 to its full output power (what is the input power and what is the gain of the LPA1?). Adding a MMIC in front of the LPA1 would help that problem.

Increasing a transmitter from 1W to 4W only doubles its range. A directional antenna can supply the same benefit with no power increase.

Gerald Roylance
Mountain View, CA

ANSWER TO #4009 - APRIL 2000

I want to run the feed from my satellite dish about 150 feet under the lawn, but I have been unable to identify the types of coax that are suitable for burial. Is there some marking (like the UF for power cables)?

None of the references I have on coax mention burying the cable. Why?

I'm not sure there is a requirement for direct burial coaxial cable. The satellite feed is less than 24V, so it does not have the stringent requirements for (lethal) 120V cables — for example 18 inch burial depth and rigid anchors at the ends. If you don't have rodents with perverse appetites, then you should be able to bury any low voltage plastic cable.

I would stay away from all aluminum shields because of galvanic corrosion. RG-6 usually has a foil shield, so you cannot get away from that aluminum, but some cables have an aluminum braid. Get a cable with a copper braid.

In spite of the above, I would put the cable in plastic electrical conduit. The big expense is digging the trench, and you only want to do that once.

Plastic conduit is less than 10 cents/foot. The primer and cement are a few dollars more. That cost is a small part of the installation. Thread the conduit with twine as you lay it — 150 foot fish tapes are uncommon. You may want to run two coax cables while you're at it. You should also check if you will need an inline amplifier somewhere in the run.

Gerald Roylance
Mountain View, CA

ANSWER TO #4001 - APRIL 2000

I'm designing a device to provide some data while I'm bike riding. I think I've figured out speed, acceleration, and distance.

I'm looking for a way to measure grade — how steep a hill I'm going up. Is anyone aware of a sensor, or other way to measure this?

The simplest way to measure pitch is a pendulum bob. A weight on

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the end of a rod provides a vertical reference, and an angle sensor (such as a potentiometer or rotary encoder) measures the angle between that vertical and the bike.

Unfortunately, the sensor is also sensitive to acceleration, but you can compensate for that. An interesting variation of this sensor uses a high dielectric constant fluid between two 90-degree sector electrodes. At 0 degrees, the electrode capacitance match; a tilt increases one capacitance and decreases the other by the same amount.

The combination makes a linear capacitive divider. The fluid also damps the measurement.

A more involved technique would measure difference in height between the front of the bike and the back. You can do this with water and plastic tube. Imagine a U-tube almost filled with water with one end attached at the front, and the other end at the back. Put a ruler next to one end to measure the slope. You can measure the water heights optically or with pressure sensors. There is (or was) a commercial electronic level based on this idea.

Airplanes use gyroscopes, but that is probably too involved.

Gerald Roylance
Mountain View, CA

ANSWER TO #4002 - APRIL 2000

How is the current held reasonably constant in MIG welders?

I've got everything I need to put one together, but I can't figure out what is needed to achieve the constant current requirement. Transistors, SCRs, or what? And with what circuitry?

There are several ways to control the current in a welder. Older welders that were made in the 50s used the carbon block method which was nothing more than a very large variable resistor, in line with the transformer. According to Ohm's Law, when you vary the voltage of any circuit, the current must follow, and vice versa.

Some welders use the "variac" method of a variable transformer where the current remains constant while the voltage output varies within the transformer, as you adjust the knob. A third method is the chopper method using a SCR circuit (or three) similar to a light dimmer circuit commonly used in household lighting.

The cost factor of a control circuit will vary greatly based upon several factors.

The most expensive method will probably be the variac transformer, then the carbon block method followed by the solid-state system which is by far the cheapest method. But there is a drawback to this order of cost and that is duty cycle, ripple, and starting current or surge.

If you chop the circuit using the SCR method, you then need to get out the ripple caused by the chopping action of the circuit, and that requires very large caps and chokes which can, in some instances, raise the price significantly back up.

Shopping around at a surplus store should control this added expense and still make the project a reasonable alternative.

You can also manufacture your own choke because they are crude and large consisting of nothing more than 10 or 20 feet of 1/2" copper bar stock formed around a 3" or 4" form. Testing them, however, requires some experimenting on your part and you can even place a variable tap on the choke for adjustable performance.

The next greatest cost of the control circuit depends upon your input or primary transformer. Is it single phase or three? If it's three phase, then triple all of your costs because you have to control each of the phase windings to a matched and balanced tolerance of 5% or less.

When you get into three-phase control, the circuit has to be precisely balanced at each output level because of overheating problems. If the adjacent phase windings are out of balance with each other, they tend to fight each other and produce excess heat instead of usable current.

Creating or purchasing a control circuit that keeps this balance through-out the power range can add significantly to the cost of any design. Because not only do you have to have the balance, each of the 10 steps also have to be balanced to the 5% requirement which requires setting up, testing, and calibrating each of the 10 stages for each of the three-phase windings.

This requires one fixed resistor and two potentiometers at each stage, times 10.

You have to calibrate each step not only to the tolerance, but also to the preset voltage which translates into the amperage steps that you require. Depending on the size of your welder, the steps will control anywhere from 10 to 20 amps per stage but, if your welder is a large one, you may need a 15- or 20-step switch in order to cover a wider usable range.

Most 150 amp (or less) welders have at least a 10-step controller which gives you a 30 amp minimum, followed by a 10 or 12 amp increase between settings. However, you can add as many steps as you like.

On the single-phase welder, this multiple switch is replaced by a potentiometer which gives you a (almost) linear sweep which means that the current is infinitely adjustable between the low and highs. Overrate your SCRs by at least 50% of the maximum amperage used by the welder, and use "more than adequate" heatsinks and fans for a performance that won't vary in time, as things start to heat up.

You can purchase a full sweep three-phase controller (non-step) which consists of matched pairs of SCRs with complimentary matched and balanced potentiometers. These give you a linear and infinite variable, but these units usually cost upwards of several hundred dollars.

You can also purchase multiple variacs in pairs, triples, and quad configurations and they are matched and balanced to each other via a single shaft, but with the amperage requirements that you need to run a welder, this can easily exceed $500.00.

The third method of the variable carbon block has been phased out mostly and I'm not even sure where to purchase such a large element of the size and wattage that you would need.

However, a single large element is all that is required because it is placed on the output lead going to the wire feeder cable (spool) and thus only one controller is required. I'm sure they still make them, but with their usage being mostly replaced by solid-state devices these days, the number of manufacturers have diminished over the years and so the price accordingly has gone up. Last time I saw one in a catalog was many years ago, and it was around $200.00 for a 200 amp unit.

Chris
Bieber, CA

ANSWER TO #4005 - APRIL 2000

I need information on cable TV cable connectors. I am not sure how to tell the difference between various types of CATV cables and their connectors.

I have a 15 ft. cable (not sure what kind) running from a wall jack. I attempted to install a RadioShack CF-56 connector to one end so I could hook it up to my VCR. After crimping and screwing the cable to the back of my VCR, the signal was dirty.

There are only two common CATV cables used in homes, and they are RG-6 and RG-59.

The cable connectors are called 'F' connectors, and there is a different 'F' connector for each cable. You should find the cable type printed on the side of the cable. You can also tell from the cable dimensions, but the dimensions vary with manufacturers and materials.

RG-6 has an outside diameter of 0.266 inches and the inner dielectric diameter is about 0.180. RG-59 has an outside diameter of 0.242 and a dielectric diameter of 0.146.

The dielectric thickness is the quick way to tell. If you compare them side by side, the RG-6 dielectric looks much bigger.

The F connectors for the different cables must accommodate the different dielectric sizes, so the RG-6 connector has a bigger through-hole than the RG-59 connector. The inner dielectric should fit snugly. If it is loose or does not go in, then you have the wrong cable/connector.

RadioShack is good about providing assembly instructions on the blister pack, many vendors don't. The inner dielectric should be flush with the seating face of the connector.

The connector may or may not be responsible for your poor reception. If you can jiggle cable close to the connector and get good reception, then it is probably the cable and the connector — especially if the cable has been flexed a lot or has a sharp bend.

You might also notice a bubble on the cable jacket close to the connector. In that case, cut a few inches off the end of the cable and put a new connector on. If jiggling the connector does not improve reception, then there is a problem further up the cable.

Gerald Roylance
Mountain View, CA

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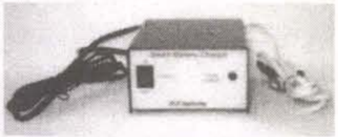

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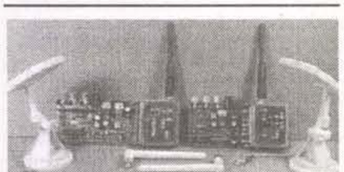

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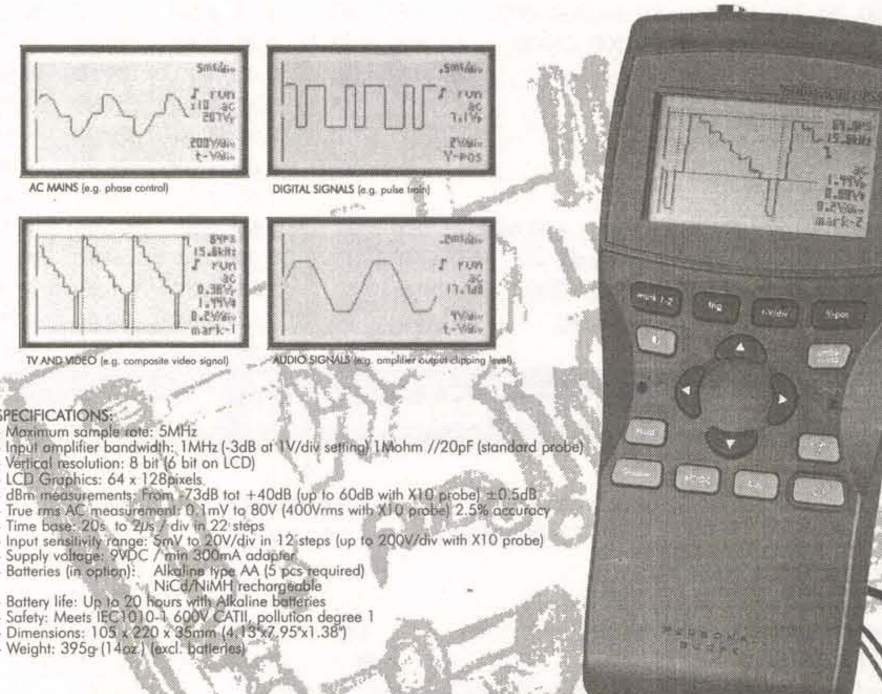
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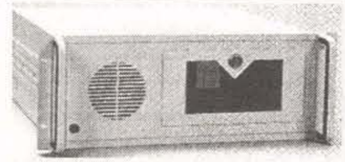

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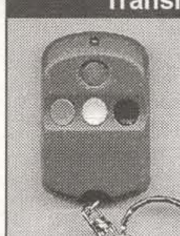

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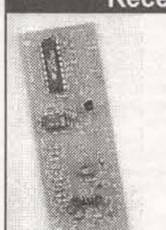

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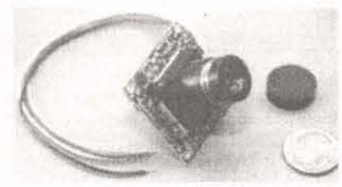

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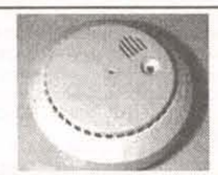

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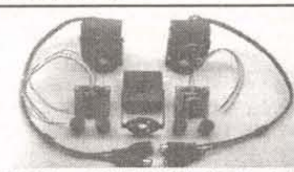

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The CCD Camera Cookbook
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CCD Camera Cookbook

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LEVITRON
"The Amazing Anti-Gravity Top"

This spinning top floats in mid air, supported by opposing magnetic forces. Includes floating top, levitron magnetic base, assortment of adjustment weights, lifter plate, levelling shims, and instructions. It takes some practice and a lot of patience to keep the top afloat, but the results are truly amazing!
Levitron Floating Top $39.95

Lightwave 2000 Flashlight
$29.95

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Geophone
vibration sensing kit

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At first glance, this appears to be an ordinary screwdriver, but press a button on the base and two lights illuminate the area you are working on. Nifty, huh? But wait, there's more! The seven interchangeable bits are stored right there at the base of the screwdriver (6 storage slots) for easy access. No handles to unscrew or tool boxes to dig through. Hey, you ain't seen nothin' yet...remove the bit and the magnetic retrieval tool telescopes from the screwdriver shaft! Incredible!!! Of course, the comfort grip handle and rugged construction are icing on the cake! Definitely a 'gotta have it' tool!

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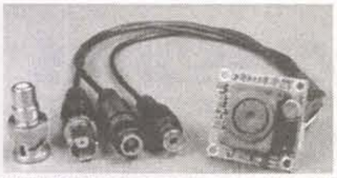

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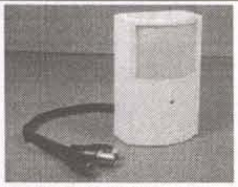

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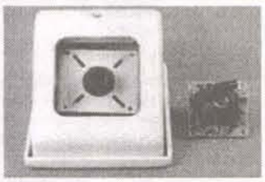

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Track down jammers and hidden transmitters with ease! This is the famous WA2EBY DF'er featured in April 99 QST. Shows direct bearing to transmitter on compass style LED display, easy to hook up to any FM receiver. The transmitter - the object of your DF'ing - need not be FM, it can be AM, FM or CW. Easily connects to receiver's speaker jack and antenna, unit runs on 12 VDC. We even include 4 handy home-brew "mag mount" antennas and cable for quick set up and operation! Whips can be cut and optimized for any frequency from 130-1000 MHz. Track down that jammer, win that fox hunt, zero in on that downed Cessna - this is an easy to build, reliable kit that compares most favorably to commercial units costing upwards of $1000.00! This is a neat kit!!

DDF-1, Doppler Direction Finder Kit $149.95

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C-2000, Basic Video Transmitter..............$89.95 C-2001, High Power Video Transmitter...$179.95

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Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

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CCDPH-2, B&W CCD Camera, slim fit pin-hole lens.. $69.95
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AM Radio Transmitter

Operates in standard AM broadcast band. Pro version, AM-25, is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 is tunable, runs FCC maximum 100 mW, range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set that dresses up the unit. Great sound, easy to build - you can be on the air in an evening!

AM-25, Professional AM Transmitter Kit..... $129.95
AM-1, Entry level AM Radio Transmitter Kit... $29.95
CAM, Matching Case Set for AM-1.......... $14.95

Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast receiver which has subcarrier output for hook-up to our SCA adapter. The SCA-1 will tune in commercial-free music and other 'hidden' special services when connected to FM receiver. Add our snazzy matching case and knob set for that smart finished look!

AR-1, Airband 108-136 MHz Kit.................. $29.95
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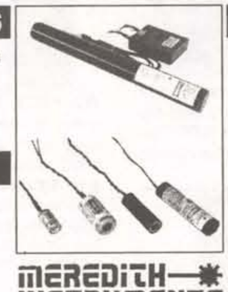

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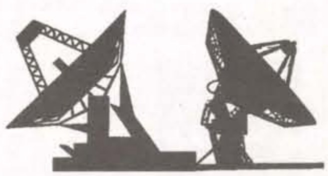

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Build a Watchdog Timer Using the PC Speaker Output

by Mike Keryan

I am in the process of configuring a stand-alone, dedicated PC that will monitor environmental conditions in various rooms in my house and control the heating/air-conditioning system.

The PC consists of a mixture of bargain-basement new parts, like a $10.00 keyboard, $14.00 ethernet board, and $25.00 case/power supply, and some old, outdated parts that were replaced during upgrades (motherboard/CPU, 170 MB hard drive, a bunch of 4 MB SIMMs) that were either free or nearly free.

While this PC will never be able to run the new Windows 2000 OS, it will function fine as a dedicated controller. I have seen other people throwing together similar junk-part PCs for other purposes, such as firewalls between their cable modem and PCs, or as print servers on their home PC networks.

One requirement of a stand-alone system like this is that it should always be up and running, at least when the house has power. It is easy to have the PC automatically boot up and autostart a control program in case of a power failure.

For most uses, it really isn't necessary to have a battery-backup (UPS system) on the PC because it is controlling something that needs power anyway, like the HVAC system or the PC network. But it is important that when power is restored, the PC always starts up and continues to do whatever it was doing.

Momentary glitches in the powerline can cause your PC program to crash, even when the power doesn't drop out enough to cause a PC reboot. As a PC user, you know that many other things can cause your PC to crash.

When a crash happens, the PC just sits there, doing nothing until someone reboots it. For your desktop PC, this is merely an annoyance, and may cause some data loss, but it gets rebooted quickly because staring at a screen on a locked-up PC isn't a whole lot of fun.

However, you won't be sitting at the dedicated control PC. There must be some way for the PC to recover from a locked-up condition all by itself.

To automatically recover from lock-up, the PC must first know that it is locked-up, and then it must do something about it. There exists software-only watchdog programs that attempt to do this, but many times when a PC locks up, the entire system is dead, and the only way to recover is by external means, by pushing the reset switch.

The only foolproof way to reboot the PC is by way of some external system that is not dependent on the PC itself detecting the lockup and triggering the reboot.

You can buy watchdog timer PC cards that do just that. They continuously monitor a certain I/O address, usually set by jumpers, and trigger a reboot if nothing has written to that address within a preset time, also set by jumpers.

However, these cards cost about $100.00 — more than any other single part in my stand-alone PC — and I just couldn't justify one. So I decided to build one using some inexpensive parts. In addition to low-cost, an additional design goal was being easy to program. I didn't want to mess around with I/O addresses.

What I came up with was a watchdog timer circuit that costs about $10.00 to build. It monitors the PC speaker output, rather than an I/O address. If no output to the speaker has been made in five minutes, it generates a reset signal, which reboots the computer.

Programming is easy. Your program merely has to output a beep every couple minutes so that the watchdog circuit knows everything is okay and the PC isn't locked up. If the PC does happen to lock up, no beeps will be output, and five minutes later, the PC will reboot.

What I came up with was a watchdog timer circuit that costs about $10.00 to build. It monitors the PC speaker output, rather than an I/O address.

The circuit is shown in Figure 1. It consists of two inexpensive CMOS ICs, four diodes, and a few resistors and capacitors. IC1-E and IC1-D, C4, R4, and R5 function as a squarewave oscillator whose period is about five seconds (actually about 4.7 sec for the prototype).

This 0.21-Hz squarewave is fed to

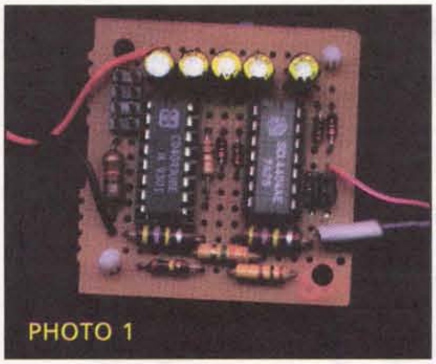

PHOTO 1

the clock input of IC2, a seven-stage binary counter. The output (Q7) of this IC is thus 0.21 Hz divided by two to the seventh power (128), for a 0.00166-Hz squarewave. The period of this squarewave signal is about 600 sec.

For the first half (300 sec), this signal is at zero volts, while the last half is at five volts. The change in state from low to high is detected by C5 and R6, which produce a five-sec positive pulse, which is inverted by IC1-F producing a five-sec negative pulse. This causes the reset pin of the PC to be set to near ground through D4, which reboots the PC.

IC1-C, R2, and C2 form a power-on reset. When power to the PC is initially turned on, the voltage across C2 is zero volts, so the output of the inverter is high, five volts. The time constant of R2/C2 is such that it takes about five seconds to charge C2 to the point that the inverter will switch so that the output is at zero volts.

This five-sec reset pulse is passed to the reset pin of IC2 through D2. The power-on reset ensures that all the counter states in IC2 are initially set to zero, so a full five minutes is required to trigger a reboot.

The speaker output pins on the PC motherboard consist of two pins: one of these is always at the +5-volt level, while the other pin outputs a negative-going pulse at a few hundred Hz when a beep signal is sent to the speaker. This negative-going pulse train is inverted by IC1-B to form positive pulses.

The positive pulses pass through diode D1 and are smoothed somewhat by R3/C3. These pulses reset IC2 similarly to the power-on reset, so that any signal sent to the speaker resets the timer. As long as the speaker output is not dead for as long as five minutes, this circuit will never send a reboot signal to the PC.

The pulses from the speaker output are inverted once more by IC1-A, producing negative pulses again. These are passed through R7 and then to the real speaker in the PC. R7 is used to reduce the volume of the PC speaker so that you can just barely hear it. Since it will be beeping every minute or so, full volume could get very annoying. Of course, you could just not connect the speaker, but I wanted to be able to hear the beeps to make sure it was working okay.

The reset switch to the front panel is fed through D3 to the reset pin on the motherboard. This allows the real switch to function normally. The +5 volt and ground signals to power the watchdog timer circuit are stolen from the motherboard pins, so there was no need to connect a four-pin power cable like you do with your fan and drives. The +5-volt signal is taken from the motherboard output to the speaker; the ground is taken from the motherboard pins that normally connect to the reset switch.

Something I added recently to the circuit is SW1, an SPST switch that is normally 'on,' but allows you to disable the watchdog circuit from resetting the PC. When would you switch this 'off?' When you are doing some work on the PC, such as installing software or hardware, or at any other time when your program generating the beep/minute output is not running.

I built the prototype on a 1.75x1.75 inch RadioShack PC board, as shown in Photo 1. I used IC sockets for both ICs. I wired everything using point-to-point wiring with wire-wrapping wire cut to 1.5-inch lengths. I soldered all connections. J1 and J2 are 1x4 pin and 1x2 pin, 0.1 inch male headers. However, I used 2x4 and 2x2 headers on the prototype because I didn't have the smaller ones.

I used a spare CD-ROM audio cable for both P1 and P2 and their cables. I cut the audio cable in two. One end has a four-pin connector, which goes to the speaker connector on the motherboard. The other end may be four-pin also, but depending on the CD-ROM drive, it may be two or three pins. If it has more than two pins, only use the two adjacent pins.

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Lambda LQ531, Digital Pwr Sup, 0-20V@8.6A $125
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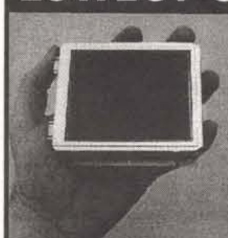

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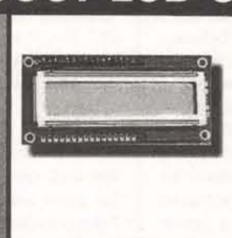

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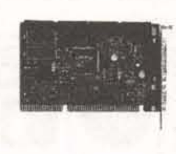

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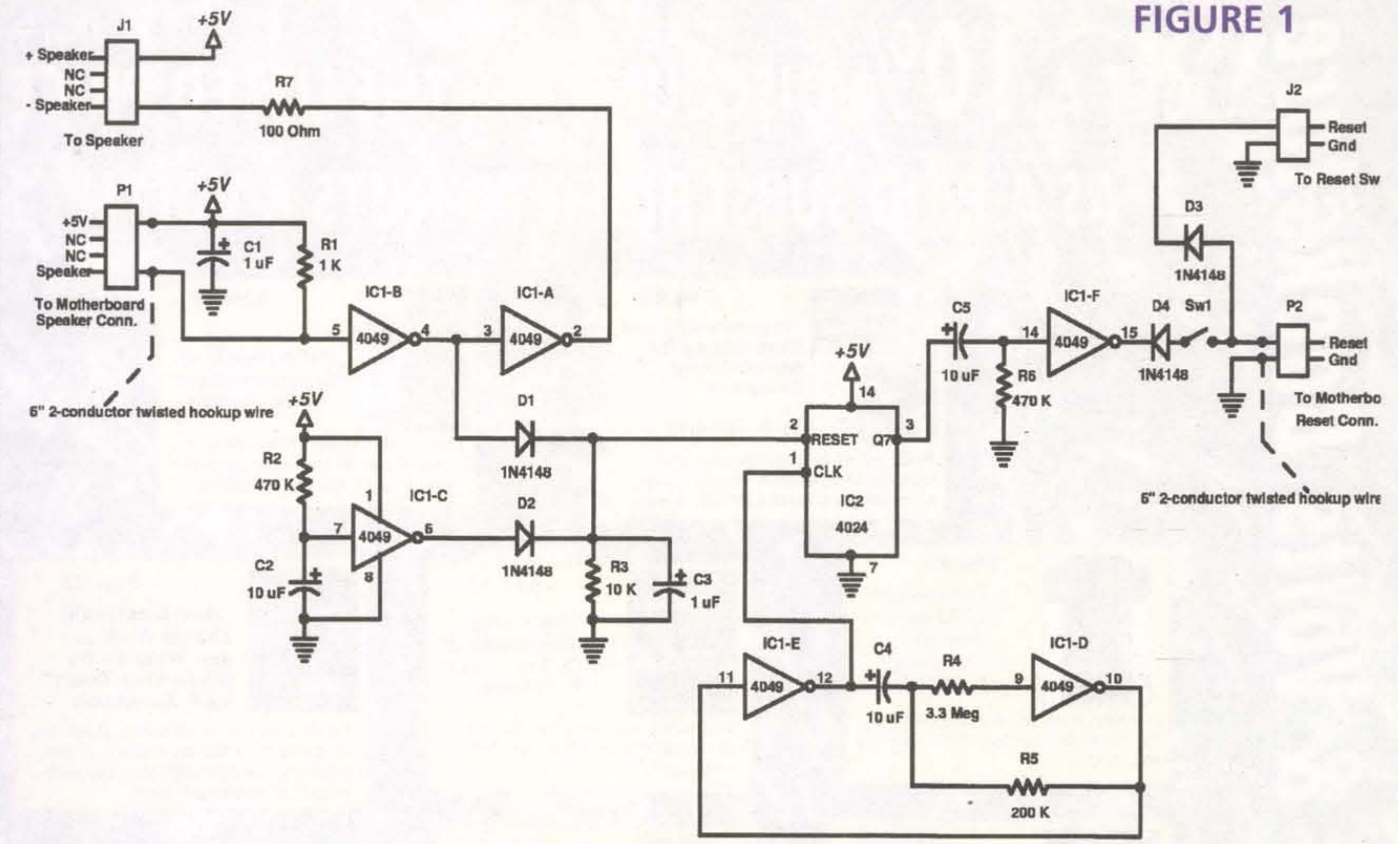
FIGURE 1



After you build the board, it is wise to test it first before hooking it up to the PC. Connect a nine-volt battery (+ to +5V pin on P1, - to the Gnd pin on P2). With a voltmeter, monitor pin 1 (Clk) of IC2. It should go from 0V to 5V with each state lasting about two to three seconds. Then monitor pin 3 (Q7) of IC2. It should stay at 0V for about five minutes, then jump to 5V for five minutes. When Q7 is high, momentarily grounding the 'Speaker' pin of P1 should result in Q7 jumping back to 0V as a result of the reset.

When installing it in the PC, mount it somewhere midway between the speaker, the reset switch, and the motherboard headers. Unplug the PC from the powerline. Use the motherboard manual to make sure you fiddle with the correct wires. Unplug the two-conductor plug that comes from the front-panel reset switch. Note where this cable was plugged in.

Plug the cable onto J2 (orient it either way). Then determine which of the two pins on the motherboard is really the ground. If you don't have the manual, use an ohmmeter to see which pin has very low resistance to the metal chassis. Then plug your P2 onto these two pins so that your ground wire connects to the ground pin.

Unplug the four-pin speaker connector from the motherboard. Again, note the location from which you just unplugged the speaker cable. Plug the speaker cable onto J1, the red wire to +5V end. Then plug P1 onto the same four pins that the speaker was plugged into.

Make sure the +5V end of the cable is connected to the pin that really has +5V. If you are unsure, use the voltmeter to find the correct pin (you must power up the PC and turn it on) prior to plugging in P1.

Mount SW1 somewhere on the front panel. The most convenient place is on one of the plastic covers that are removed when installing disk drives. Pop off one of these panels and drill a hole to hold the switch. It is probably a good idea to stick on labels (made with a labelmaker) that indicate something like 'Watchdog off,' 'Watchdog on.' Then push the plastic panel back on.

That's it for the hardware. For the software end, your programs must generate a beep every minute or so to keep it from rebooting. Details of how to do this vary for each OS and language. Most of the time, your program can send a control-G character to the console to get it to beep.

If you are running Linux, you can easily set up a cron job that generates the beep. As root, create a file called crontab as below:

```
SHELL=/bin/sh
PATH=/home/root
MAILTO=""
# beep every minute
* * * * * echo -e -n "\a"
  >/dev/console
```

The MAILTO line as above is required to keep cron from sending you mail every minute. Then, install the file by entering this line:

```
crontab crontab
```

Of course, it is preferred to have your custom program generate the beep rather than the operating system itself generate the beep. However, the PC may possibly be used as some sort of server or firewall and it may be running no custom software, whatsoever. In this case, the crontab method is just as effective as custom software.

I have found this watchdog circuit to function reliably. I have it working on two PCs that are left on 24 hours a day, seven days a week. Both of these have AT-style motherboards with AT-style power supplies.

It is possible that this circuit is incompatible with some of the newer ATX-style systems. However, I've reviewed the manuals of a number of AT systems and am convinced that the circuit should work on most, if not all of them.

You can test it in your PC by killing the software that generates the beep and waiting five minutes. The only potential failure would be if the PC would fail and lock up when sending out a continuous 'beep.' This is rather unlikely. **NV**

PARTS LIST FOR PC-SPEAKER WATCHDOG TIMER

SEMICONDUCTORS
IC1 - CD4049 hex inverter CMOS integrated circuit
IC2 - CD4024 (or CD4404) seven-stage binary counter CMOS integrated circuit
D1, D2, D3, D4 - 1N4148 (or 1N914) silicon switching diode 75-PRV 10 mA

RESISTORS
(All resistors are 1/4 watt, 5% units)
R1 - 1000 ohm
R2, R6 - 470,000 ohm
R3 - 10,000 ohm
R4 - 3.3 megohm
R5 - 200,000 ohm
R7 - 100 ohm

CAPACITORS
C1, C3 - 1.0 uF, 25 WVDC, electrolytic
C2, C4, C5 - 10 uF, 25 WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
J1 - 0.100" male header four conductor (1x4) or (2x4)
J2 - 0.100" male header two conductor (1x2) or (2x2)
P1 - 0.100" female socket four conductor (1x4) with 6" two-conductor twisted hook-up wire (red/black)
P2 - 0.100" female socket two conductor (1x2) with 6" two-conductor twisted hook-up wire (red/black)
SW1 - SPST switch

IC sockets (1 14-pin, 1 16-pin), 1.75" square PC board: one-half of RadioShack 276-148A, wire, mounting hardware.

Note: The two plugs (P1 and P2) with their connecting wires that plug onto the motherboard can be made by cutting in half a general-purpose CD-ROM audio cable. One end will be have the four-pin plug for the speaker connector. The other end may be two-pin, three-pin, or four-pin, of which only the first two are used.

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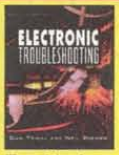

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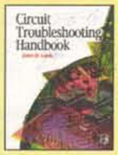

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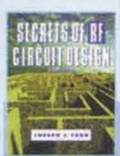

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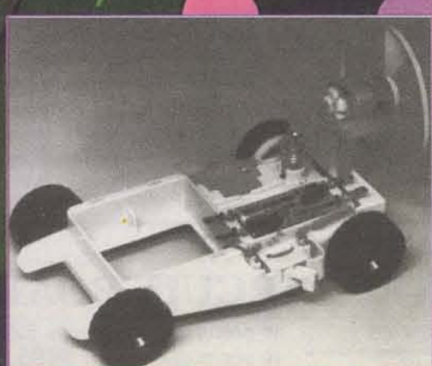

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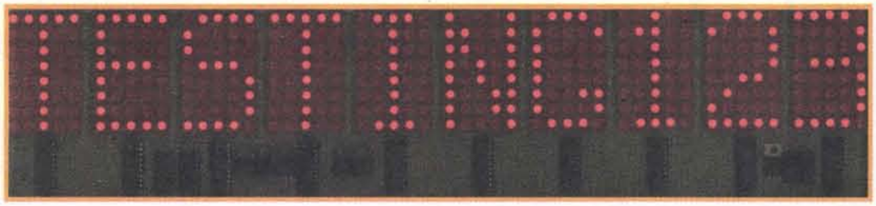
Make Your Own Printer Port LED ARRAY SIGN For Around $50.00

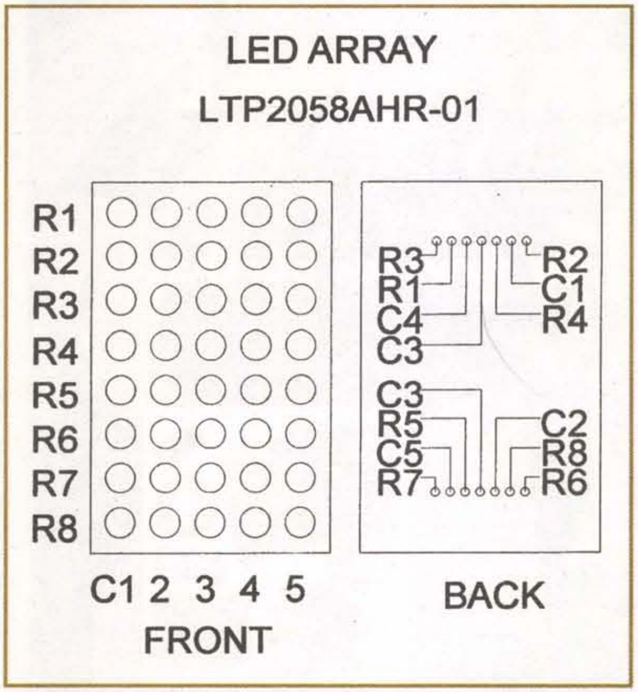


by Robert Davis

I have always wanted to play with some LED arrays. So, when Electronics Goldmine advertised them at 10 for only $18.00, I quickly bought some. Their part number G7295 gets you 40 bright red LEDs arranged as five columns by eight rows. These displays are over two inches tall by 1-1/2 inches wide. They can be used for all kinds of fun projects and fun devices.

There were two things that I planned to make using the LED arrays. One was an "ON THE AIR" sign, and the other a multiple channel LED VU meter. The VU meter had already been made using a computer as the Printer Port VU meter. The problems with it were that the monitor was taking up too much room in the sound control booth and that the computer seemed like overkill for a 16-channel VU meter.

This article is about a programmable sign that connects to a computer's printer port. It is one of the neatest, most versatile, and most useful LED array projects you'll come across.



Somehow the sign idea grew into two versions: a fixed one and a programmable one using a computer. The VU meter also grew into two versions: one that uses four of the five columns in each display and the other uses all five columns.

This article is about the programmable sign that connects to a computer's printer port. It is the neatest, most versatile, and most useful of the LED array projects.

Initially, the easiest method of lighting up the arrays that comes to mind would be to arrange them as one giant matrix and pass a rather large current through them. To see the problems that would arise, consider 10 of the eight by five arrays arranged as an eight row by 50 column matrix. A counter and decoder could rapidly select the 50 columns to make it appear like they are all lit. Since each is only lit 1/50 of the time, it would need 50 times the normal current during that time to reach normal brightness. Considering 10 mA per LED as sufficient, then we would need eight (LEDs in the column) times 10 milliamp times 50 or a total of four amps!

The current-limiting resistors would need to be large and, if the counter stopped, any lit LED would likely smoke. If it was instead broken down into 10 separate LED arrays, the same current would be 1/5 of four amps or a much more manageable 8/10 of an amp.

Even 8/10 of an amp exceeds the maximum rating of ordinary transistors like the 2N2222. I have tried using 2N2222s, but they get very hot. For the columns, my preference is to use a more powerful driver like the TIP120 or TIP125. These Darlington power transistors can easily drive 10 or more LED array columns with all LEDs lit and only get warm to the touch. If they do get too hot, a small heatsink can easily be attached, but none proved necessary in any of my designs.

Some designers will use individual drivers for

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both the rows and columns for every LED array. Neither is required. On the rows, something like the ULN2803 driver would be used. But is that powerful of a driver really necessary? For instance, a 74LS373 can easily deliver 30 mA per output. If that is divided between five LEDs in the row, it gives 6 mA of current per LED. This will generally provide sufficient brightness with no high current driver.

My conclusion is that it is practical to share column drivers between multiple arrays, but not practical to share row drivers between multiple arrays. That means that a separate 74LS373 will be required for each LED array that is used. These drivers only deliver 30 mA, so there is little chance of damage to the LEDs if something goes wrong. The column drivers can be controlled by a counter that counts to 10 and then resets. A 4017 will work fine for this purpose. The 4017 delivers only about 1 mA, so a TIP120 driver transistor will be used to supply the needed current. The Darlington transistor reduces the load on the 4017 to where it can easily handle it.

Another problem is finding a circuit board big enough to hold 10 of the LED arrays.

Jameco has one that is 4-1/2 inches by 17 inches. That is enough room to fit 10 displays with about 2/10 of an inch between each of them. If you are into graphics, the space between them can be omitted, but the software to produce the graphics would be much more complicated than what I have provided.

The printer port sign is relatively simple to make. Most designs that I have seen use a latch to hold the next byte to display, then a latch for the currently displayed byte, and a current driver for each LED array. With some simple tricks, I was able to do all three of these things with just one IC — a 74LS373. I have tested 74F373, 74S373, 74HCT373, and the 74LS373, and did not notice any difference in brightness or performance. The 74XX374 eight-bit latches do create a timing difference that can be corrected in software.

The trick to doing all of these things with one latch is to turn the display off while the latches are being loaded. This prevents a dim echo of the next or previous byte from appearing. A 4017 is used, but only every other output is connected to turn on the columns. This way the 10 latches can be loaded, then the columns turned on, then turned back off, and then load the latches with the next 10 bytes.

The current-limiting resistors for the printer port sign need to be smaller because there is only five volts to light up the LEDs instead of 10 or 12. This will prevent frying the 74LS373's output transistors. A value of 47 ohms works best,

Parts List For the Printer Port Sign

Qty	Part	Number/Price		Total	Source
10	LED arrays	G7295	10/$18	$18.00	Electronic Goldmine 1-800-445-0697
1	Board 4x17	37604	10.95	10.95	Jameco 1-800-831-4242
10	74LS373	47600	.39	3.90	Jameco
2	CD4017	12749	.35	.70	Jameco
1	LM7805	51262	.29	.29	Jameco
5	TIP120	32993	.65	3.25	Jameco
1	1.5A bridge	145429	.59	.59	Jameco
1	1000uF/16V	30015	.19	.19	Jameco
1	470uF/16V	93817	.19	.19	Jameco
1	9 VAC	119204	4.95	4.95	Jameco
80	47 ohm 1/4W	29946	100/.89	.89	Jameco
3	2.2K 1/4W	29946	100/.89	.89	Jameco
10	20 pin sockets	112248	.12	1.20	Jameco
2	16 pin sockets	112221	.12	.24	Jameco
1	26 pin header	53495	.35	.35	Jameco
1	25 pin Male to header socket cable (from parts pile)				
		Total cost of parts purchased		**$46.58**	

This is the software listing for a sign that will display four lines of text.

```
CLS : PRINT "Printer port sign, Copyright 1999 BY Robert J Davis"
'INPUT "Use Printer Port Number: ", lpt
'Hardcoded to lpt2 for higher speed - needed for a 486.
'Make these changes for using other printer ports;
IF lpt = 2 THEN dout = &H378: cout = &H37A: cin = &H379
IF lpt = 1 THEN dout = &H3BC: cout = &H3BE: cin = &H3BD
IF lpt = 3 THEN dout = &H278: cout = &H27A: cin = &H279
PRINT "Press q to quit displaying sign ——"; ""
INPUT "What do you want line 1 to say? ", line1$
INPUT "What do you want line 2 to say? ", line2$
INPUT "What do you want line 3 to say? ", line3$
INPUT "What do you want line 4 to say? ", line4$
new = 1
getline:
IF new > 300 THEN new = 1
IF new = 1 THEN message$ = line1$
IF new = 100 THEN message$ = line2$
IF new = 200 THEN message$ = line3$
IF new = 300 THEN message$ = line4$
DIM array, byte(50)
FOR I = 1 TO 10
  letter$ = MID$(message$, I, 1)
  letter$ = UCASE$(letter$)
  SELECT CASE letter$
  CASE IS = "A": RESTORE a
  CASE IS = "B": RESTORE b
  CASE IS = "C": RESTORE c
  CASE IS = "D": RESTORE d
  CASE IS = "E": RESTORE e
  CASE IS = "F": RESTORE f
  CASE IS = "G": RESTORE g
  CASE IS = "H": RESTORE h
  CASE IS = "I": RESTORE i
  CASE IS = "J": RESTORE j
  CASE IS = "K": RESTORE k
  CASE IS = "L": RESTORE l
  CASE IS = "M": RESTORE m
  CASE IS = "N": RESTORE n
  CASE IS = "O": RESTORE O
  CASE IS = "P": RESTORE p
  CASE IS = "Q": RESTORE q
  CASE IS = "R": RESTORE r
  CASE IS = "S": RESTORE s
  CASE IS = "T": RESTORE t
  CASE IS = "U": RESTORE u
  CASE IS = "V": RESTORE v
  CASE IS = "W": RESTORE w
  CASE IS = "X": RESTORE x
  CASE IS = "Y": RESTORE y
  CASE IS = "Z": RESTORE z
  CASE IS = "1": RESTORE 1
  CASE IS = "2": RESTORE 2
  CASE IS = "3": RESTORE 3
  CASE IS = "4": RESTORE 4
  CASE IS = "5": RESTORE 5
  CASE IS = "6": RESTORE 6
  CASE IS = "7": RESTORE 7
  CASE IS = "8": RESTORE 8
  CASE IS = "9": RESTORE 9
  CASE IS = "0": RESTORE O
  CASE IS = "-": RESTORE minus
  CASE IS = "+": RESTORE plus
  CASE IS = "=": RESTORE equal
  CASE IS = "<": RESTORE less
  CASE IS = ">": RESTORE great
  CASE IS = "#": RESTORE num
  CASE IS = "^": RESTORE up
  CASE IS = "~": RESTORE down
  CASE IS = "?": RESTORE ques
  CASE IS = "*": RESTORE star
  CASE IS = "!": RESTORE excl
  CASE IS = " ": RESTORE blank
  CASE IS = ":": RESTORE colon
  CASE ELSE: RESTORE blank
  END SELECT
  READ byte(0 + I)
  READ byte(10 + I)
  READ byte(20 + I)
  READ byte(30 + I)
  READ byte(40 + I)
NEXT I

start:
IF INKEY$ = "q" THEN END
OUT &H37A, 7: OUT &H37A, 3          'reset
FOR a = 1 TO 50
  OUT &H378, byte(a)
  IF a MOD 10 = 0 THEN
    OUT &H37A, 2: OUT &H37A, 0      'next column
    FOR t = 1 TO 50: NEXT t        'delay to display (50 = 486)
    OUT &H37A, 2: OUT &H37A, 0      'next column
  END IF
  OUT &H37A, 3: OUT &H37A, 2        'next byte
NEXT a
new = new + 1
IF new MOD 100 = 0 THEN GOTO getline
GOTO start
END

a: DATA 003,237,238,237,003
b: DATA 000,118,118,118,137
c: DATA 129,126,126,126,189
d: DATA 000,126,126,126,129
e: DATA 000,118,118,118,126
f: DATA 000,246,246,246,254
g: DATA 129,126,126,094,157
h: DATA 000,247,247,247,000
i: DATA 255,126,000,126,255
j: DATA 159,127,127,127,128
k: DATA 000,231,219,189,126
l: DATA 000,127,127,127,127
m: DATA 000,253,251,253,000
```

Continued

```
n: DATA 000,249,231,159,000
O: DATA 129,126,126,126,129
p: DATA 000,246,246,246,249
q: DATA 129,126,126,062,001
r: DATA 000,230,214,182,121
s: DATA 121,118,118,118,142
t: DATA 254,254,000,254,254
u: DATA 128,127,127,127,128
v: DATA 240,207,063,207,240
w: DATA 192,063,207,063,192
x: DATA 126,145,231,145,126
y: DATA 252,243,015,243,252
z: DATA 030,078,102,114,120
1 : DATA 255,125,000,127,255
2 : DATA 030,110,110,110,113
3 : DATA 118,118,118,118,137
4 : DATA 240,247,247,000,247
5 : DATA 112,118,118,118,142
6 : DATA 129,118,118,118,142
7 : DATA 254,254,254,014,240
8 : DATA 137,118,118,118,137
9 : DATA 249,246,246,054,193
star: DATA 213,227,128,227,213
excl: DATA 255,064,064,255,255
blank: DATA 255,255,255,255,255
great: DATA 255,190,221,235,247
less: DATA 255,247,235,221,190
equal: DATA 255,235,235,235,255
up: DATA 247,251,253,251,247
down: DATA 247,239,223,239,247
minus: DATA 247,247,247,247,247
plus: DATA 247,247,193,247,247
num: DATA 235,193,235,193,235
ques: DATA 254,078,238,238,241
colon: DATA 255,153,153,255,255
```

This is the software listing for a sign that displays a countdown to midnight. This version was written for and tested on New Years eve December 31 1999. Note that much of the code is the same as the previous version.

```
CLS : PRINT "Printer port sign, Copyright 1999 BY Robert J Davis"
PRINT "press q to quit"
'INPUT "Use Printer Port Number: ", lpt
'Hardcoded to lpt2 for higher speed - needed for a 486.
'Make these changes for using other printer ports;
IF lpt = 2 THEN dout = &H378: cout = &H37A: cin = &H379
IF lpt = 1 THEN dout = &H3BC: cout = &H3BE: cin = &H3BD
IF lpt = 3 THEN dout = &H278: cout = &H27A: cin = &H279
newtime:
new = 1
hours$ = STR$(23 - VAL(MID$(TIME$, 1, 2)))
hours$ = MID$(hours$, 2, 2)
IF VAL(hours$) < 10 THEN hours$ = "0" + hours$
minutes$ = STR$(59 - VAL(MID$(TIME$, 4, 2)))
minutes$ = MID$(minutes$, 2, 2)
IF VAL(minutes$) < 10 THEN minutes$ = "0" + minutes$
seconds$ = STR$(59 - VAL(MID$(TIME$, 7, 2)))
seconds$ = MID$(seconds$, 2, 2)
IF VAL(seconds$) < 10 THEN seconds$ = "0" + seconds$
message$ = " " + hours$ + ":" + minutes$ + ":" + seconds$
IF hours$ = "00" AND minutes$ = "00" THEN
  IF seconds$ = "59" OR seconds$ = "58" THEN message$ = "* HAPPY *"
  IF seconds$ = "57" OR seconds$ = "56" THEN message$ = " NEW YEAR"
END IF
LOCATE 3, 2: PRINT "TIME: " + TIME$
PRINT "COUNT:" + message$

seconds$ = MID$(TIME$, 7, 2)
DIM array, byte(50)
FOR I = 1 TO 10
  letter$ = MID$(message$, I, 1)
  letter$ = UCASE$(letter$)
  SELECT CASE letter$
  CASE IS = "A": RESTORE a
  CASE IS = "B": RESTORE b
  CASE IS = "C": RESTORE c
  CASE IS = "D": RESTORE d
  CASE IS = "E": RESTORE e
  CASE IS = "F": RESTORE f
  CASE IS = "G": RESTORE g
  CASE IS = "H": RESTORE h
  CASE IS = "I": RESTORE i
  CASE IS = "J": RESTORE j
  CASE IS = "K": RESTORE k
  CASE IS = "L": RESTORE l
  CASE IS = "M": RESTORE m
  CASE IS = "N": RESTORE n
  CASE IS = "O": RESTORE O
  CASE IS = "P": RESTORE p
  CASE IS = "Q": RESTORE q
  CASE IS = "R": RESTORE r
  CASE IS = "S": RESTORE s
  CASE IS = "T": RESTORE t
  CASE IS = "U": RESTORE u
  CASE IS = "V": RESTORE v
  CASE IS = "W": RESTORE w
  CASE IS = "X": RESTORE x
  CASE IS = "Y": RESTORE y
  CASE IS = "Z": RESTORE z
  CASE IS = "1": RESTORE 1
  CASE IS = "2": RESTORE 2
  CASE IS = "3": RESTORE 3
  CASE IS = "4": RESTORE 4
  CASE IS = "5": RESTORE 5
  CASE IS = "6": RESTORE 6
  CASE IS = "7": RESTORE 7
  CASE IS = "8": RESTORE 8
  CASE IS = "9": RESTORE 9
  CASE IS = "0": RESTORE O
  CASE IS = "-": RESTORE minus
  CASE IS = "+": RESTORE plus
  CASE IS = "=": RESTORE equal
  CASE IS = "<": RESTORE less
  CASE IS = ">": RESTORE great
  CASE IS = "#": RESTORE num
  CASE IS = "^": RESTORE up
  CASE IS = "~": RESTORE down
  CASE IS = "?": RESTORE ques
  CASE IS = "*": RESTORE star
  CASE IS = "!": RESTORE excl
  CASE IS = " ": RESTORE blank
  CASE IS = ":": RESTORE colon
  CASE ELSE: RESTORE blank
  END SELECT
  READ byte(0 + I)
  READ byte(10 + I)
  READ byte(20 + I)
  READ byte(30 + I)
  READ byte(40 + I)
NEXT I
start:
IF INKEY$ = "q" THEN END
OUT &H37A, 7: OUT &H37A, 3           'reset
FOR a = 1 TO 50
  OUT &H378, byte(a)
  IF a MOD 10 = 0 THEN
    OUT &H37A, 2: OUT &H37A, 0       'next column
    FOR t = 1 TO 300: NEXT t          'delay to display (50 = 486)
    OUT &H37A, 2: OUT &H37A, 0       'next column
  END IF
  OUT &H37A, 3: OUT &H37A, 2         'next byte
NEXT a
IF seconds$ <> MID$(TIME$, 7, 2) THEN GOTO newtime
GOTO start
END

a: DATA 003,237,238,237,003
b: DATA 000,118,118,118,137
c: DATA 129,126,126,126,189
d: DATA 000,126,126,126,129
e: DATA 000,118,118,118,126
f: DATA 000,246,246,246,254
g: DATA 129,126,126,094,157
h: DATA 000,247,247,247,000
i: DATA 255,126,000,126,255
j: DATA 159,127,127,127,128
k: DATA 000,231,219,189,126
l: DATA 000,127,127,127,127
m: DATA 000,253,251,253,000
n: DATA 000,249,231,159,000
O: DATA 129,126,126,126,129
p: DATA 000,246,246,246,249
q: DATA 129,126,126,062,001
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t: DATA 254,254,000,254,254
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w: DATA 192,063,207,063,192
x: DATA 126,145,231,145,126
y: DATA 252,243,015,243,252
z: DATA 030,078,102,114,120
1 : DATA 255,125,000,127,255
2 : DATA 030,110,110,110,113
3 : DATA 118,118,118,118,137
4 : DATA 240,247,247,000,247
5 : DATA 112,118,118,118,142
6 : DATA 129,118,118,118,142
7 : DATA 254,254,254,014,240
8 : DATA 137,118,118,118,137
9 : DATA 249,246,246,054,193
star: DATA 213,227,128,227,213
excl: DATA 255,064,064,255,255
blank: DATA 255,255,255,255,255
great: DATA 255,190,221,235,247
less: DATA 255,247,235,221,190
equal: DATA 255,235,235,235,255
up: DATA 247,251,253,251,247
down: DATA 247,239,223,239,247
minus: DATA 247,247,247,247,247
plus: DATA 247,247,193,247,247
num: DATA 235,193,235,193,235
ques: DATA 254,078,238,238,241
colon: DATA 255,153,153,255,255
```

but a smaller value might be used for more brightness. That is a limitation resulting from using the 74LS373; a higher voltage would damage the ICs. The 10-volt source does get connected to the TIP120s because the base of the transistors only rises to five volts and the transistor will not deliver any higher voltage in the emitter follower configuration. If the five-volt source is used instead, then the voltage regulator will get very hot due to the current that will be needed.

Assembly Hints

1. Mount electrolytic capacitors under the board laying flat against it.

2. Mount the TIP120's flat on the board and fasten them down with a copper wire or screws and nuts through their tabs.

3. The 47-ohm resistors fit best under the board soldered directly to LED arrays.

4. Pull-up resistors on the printer port control lines are not critical, they can be 1k to 10k.

The frame for the sign is made out of a one by three inch board with a 3/8-inch groove cut into it. I did not miter the corners, but that might have helped the appearance. I had to chisel a notch into the back side of the frame for the header that is used to connect to a ribbon cable that has a 25-pin male connector on its other end. A 25-pin printer type extension cord then goes to the computer's printer port.

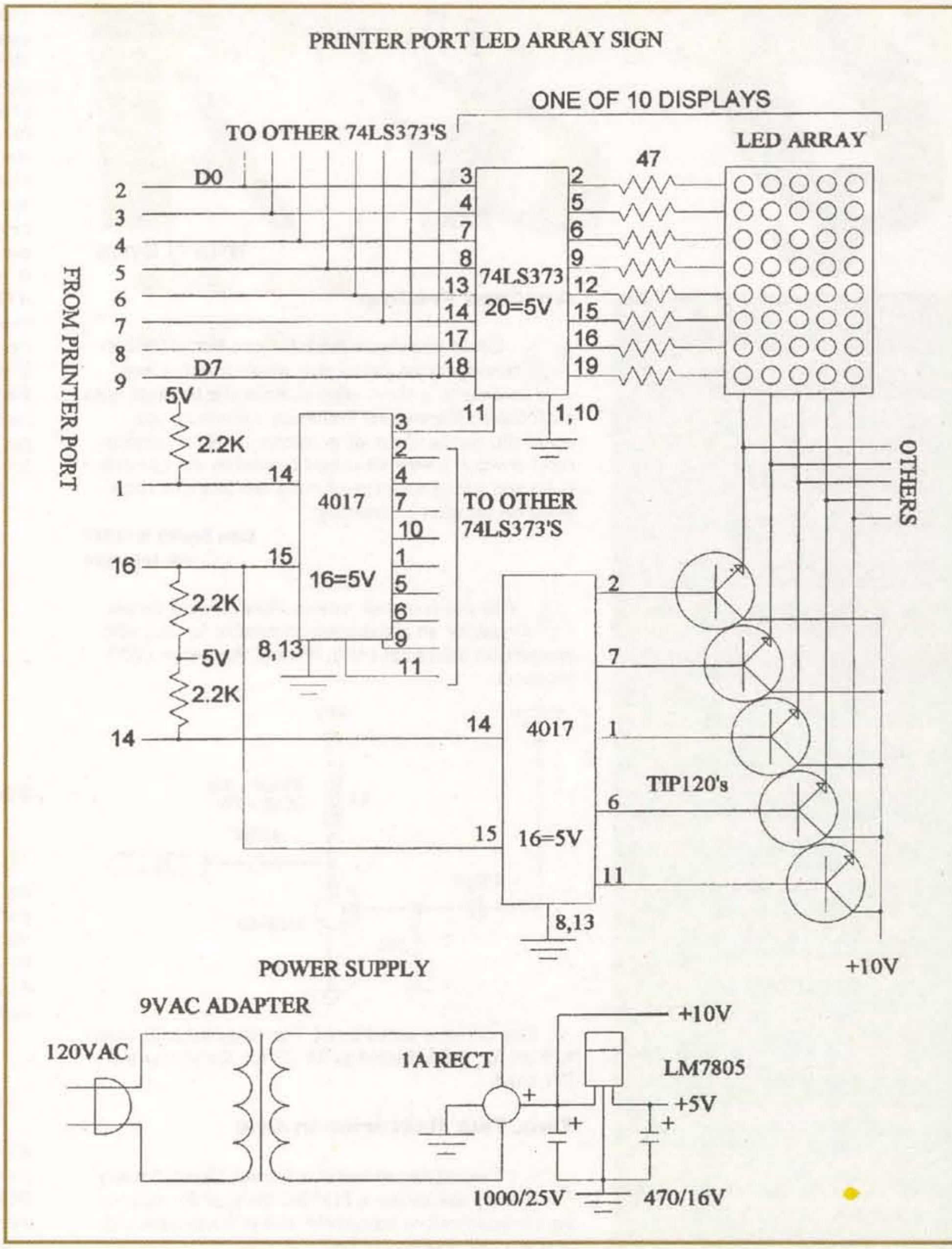
The software was used on an old 486 laptop at first. The problem is that the 486 takes too long to load the 10 latches and lacks display time afterwards. This results in a dimmer display or one that blinks in a well-lit room. The software works best on a 100 MHz or faster Pentium computer. On such a computer, the delay for display setting can be set to 500 or even 1,000 on a faster computer.

The program has many "case" statements that seem like they could be replaced with a loop. The problem is that line titles must be identified for the restore statements. It is all right to use letters of the alphabet for line titles, but you cannot use punctuation for line titles. Hence, the punctuation lines have to be spelled out to work properly.

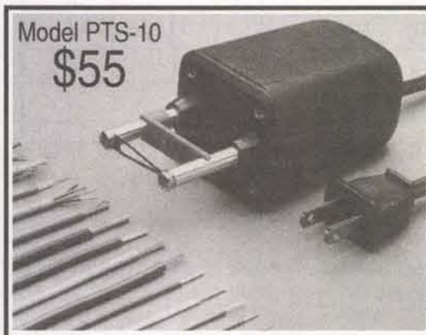
Another long part of the code is the data statements. They define what LEDs to light in order to produce the desired character. The confusing thing about the bytes used is that they are actually inverted. To light an LED, you need a zero or a low on the row drivers. Hence, a zero is a lit LED and a one does not light the LED.

To create the data statements, I drew out the pattern on graph paper then converted the lit LEDs to binary, then octal, and subtracted the value from 255.

After a while, you might be able to do it in your head, or remember that the same bit pattern is used elsewhere and just copy it. **NV**



If you would like to download the software listing, go to www.nutsvolts.com.



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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, as well as comments and suggestions.

You can reach me at:

TJBYERS@aol.com

or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

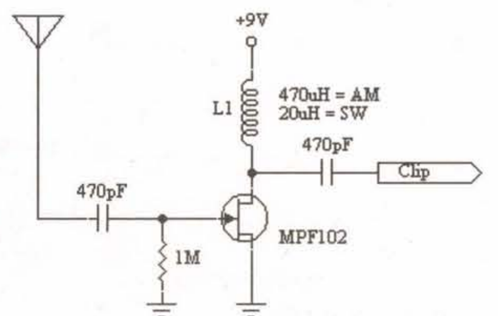
Two really useful preamps for your turntable and receiver, adding a utility battery to RV, and more on the magneto tach. Recycling old power transformer cores, PC software questions, some cool Web sites, and reader feedback on 70-volt audio.

Antenna Preamp

Q - Could you please publish a one-transistor, battery-operated circuit that would match a long wire antenna to a short whip antenna like the kind used on FM/aircraft/scanners? Preferably, something you could clip on the short whip antennas with an alligator clip. I envision a very small box clipped to the portable radio and a long wire strung out a window of a room while on vacation or traveling.

Don Smith K6CHS
via Internet

A - Ask and you shall receive. Here's a very simple circuit for an active antenna suitable for use with inexpensive broadcast (AM), FM, and shortwave (SW) receivers.



The circuit is tuned by L1. The range extends from 470 uH for the AM band to 20 uH for the shortwave SW band.

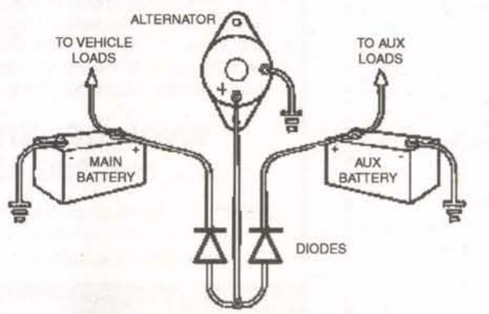
Two, Two Batteries In One

Q - I would like to install a second 12-volt battery in my van to run a 115 VAC inverter for operating communications equipment, computer, printer, and maybe a cell phone with fax.

It should be able to operate independently of the van's battery — even to the point of running it to death, but not the starter battery. The circuit I am interested in is how to charge this second battery without burning out the alternator or interfering with the normal operation of the van. I'm surprised nobody wants an item like this.

Tom Reel
Milan, OH

A - Actually, this is a popular request. Isolation of the batteries is fairly straightforward using just two diodes. The hook-up looks like this



This places the diodes back-to-back, which prevents current from flowing from one battery to the other. When the batteries are being charged, both diodes conduct in a forward manner, and both receive a charge proportional to their needs. The appliance, on the other hand, can only draw power from the utility battery, not the van's battery — and the van can only draw current from the starter battery, not the utility battery. For this application, the diodes have to be heavy-duty alternator diodes that can handle the charging current of the battery, like the 8AF2R from International Rectifier, which is available from **Arrow Electronics (1-800-524-4735; www.arrow.com)** for a couple of bucks. Be aware that these diodes have to be mounted on a heavy-duty extrusion heatsink made by Avvid and Wakefield, among others (also available from Arrow Electronics). If this sounds like more than you want to tackle, you can buy battery isolators from most RV supply houses, like **Camping World (www.camping-world.com)**, and all marine supply outlets.

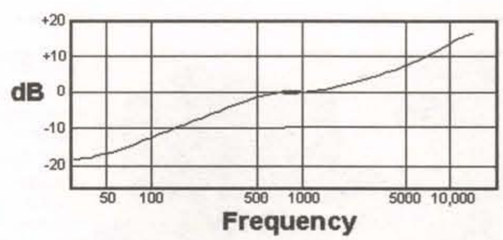
Sure Power Multi-Battery Isolator

Phono Preamp

Q - I have over 600 vinyl discs and would like to record them to CD. However, the sound card in my computer requires line input and the turntable output will not drive the sound card. What I require is a stereo phono preamp, like the kind RadioShack used to stock but no longer sells. I was wondering if you could supply a nifty circuit, or perhaps know of a dealer that may have such a device ready-assembled?

Marshal D. Landers
via Internet

A - **Velleman Kits (817-284-7785; www.velleman.be/)** sells an RIAA stereo phono preamp K2572 kit for $13.82. Velleman Kits are stocked by many electronic supply stores, including **Jameco (1-800-831-4242; www.jameco.com)** and **Tech America (www.radioshack.com)**, and several hobby shops. Unlike a universal microphone preamp, the kind often used for karaoke mikes, the K2572 has frequency compensation to match the frequency response of a phono pick-up cartridge, which needs the lower frequencies attenuated and the upper frequencies emphasized, as shown below.

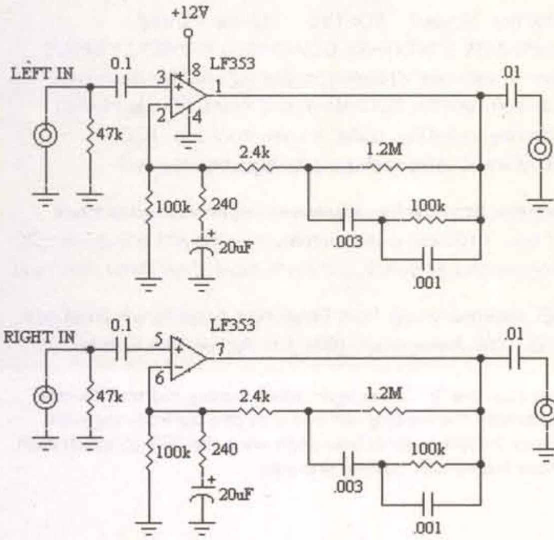


RIAA Phono Equalization Curve

The technical specifications of the RIAA curve are specified at the following conditions.

- Amplification (1 kHz): 0 dB
- Input impedance: 47k
- RIAA curve
- Input signal: 5 mV to 10 mV

You can also build your own RIAA equalized phono preamplifier using this circuit.



Basically, it's an active filter with a ladder-T feedback loop. While any op-amp should work in this circuit, I chose an FET op-amp over a BiCMOS or biploar op-amp because it has characteristics similar to those found in vacuum tube amplifiers — traits that many audiophiles find desirable. The gain of the amplifier is about 35 dB, which is plenty enough to drive your sound card. For best operation, the 12-volt power source should be stabilized using an LM7812 voltage regulator.

Notebook Contacts

Q. I have a GRiD Model 2050 GridPad SLI that has a 17.5 VDC, 1.5 A charger with a four-pin connector. Do you have any information or can you lead me to a Web site that can give me the information to the pinout of this product? I'd like to build a power supply capable of recharging its battery. I've put a surface charge on the battery, installed it, and then used my DDM to probe the four-pin connector for the presence of voltage. What I found were two pins that had some DC presence, but I wasn't sure if it would be safe to just hit them with a charging current without knowing what the other two pins did.

Larry Fostano
via Internet

A. Two pins connect to the battery terminals (plus and minus) and the other two connect to a thermistor that's in physical contact with the battery. To make a long story short, you can determine the charge in a battery simply by monitoring the battery's temperature. Call it a battery thermometer. When the battery's temperature is low, it's safe to apply full charge to it — typically C/2 or C/4, depending on the battery's chemistry. As the charge accumulates in the battery, its temperature rises and the charge current has to be reduced to C/10 or less. Unfortunately, I can't find a pinout for this connector, but I can tell you that it has a twin — the Tandy 2050, and you may be able to wrangle a pinout from their RadioShack repair services. A good Web site for notebook repairs and parts is **National Computer Support (281-734-1348; http://www.laptop-notebook.com/index.html)**.

Motorbike Tachometer Revisited

Q. I have two questions regarding the Motorbike Tachometer article in the Jan. 2000 issue.

1) What kind of transformer (ratings, part number, etc.) would you use to pre-test the tach circuit before hooking up the sensor coil? The article doesn't say.

2) Instead of an analog (i.e., needle) current meter for the RPM display, can a digital voltage or current meter be connected to the circuit to get a digital RPM display instead?

Bruce Morgenstern
via Internet

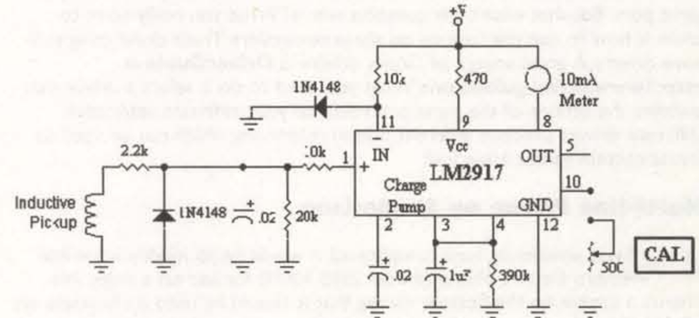
Q. I haven't been able to find this SMD. Any thoughts as to a source?

Tony Serra
via Internet

A. The Jan. 2000 answer wasn't intended to be a full-blown tachometer solution, but it seems to have gone that direction. So let me fledge it out the best I can in this limited space. For those readers who missed that installment, here's a brief recap of the question.

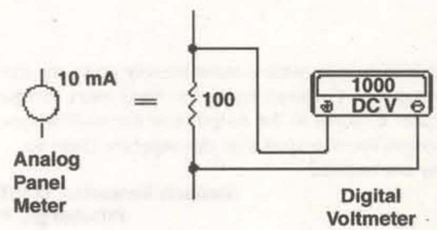
Q. I have a motorized bicycle powered by a small two-stroke gasoline engine that I'm having a problem with. It keeps cutting in and out. Is there a circuit (or a commercial product) to tell whether or not the spark is still there when the engine cuts out, thereby indicating a fuel problem?

A. How about a tachometer? Not only will it tell you if there's a spark or not, but it'll display the RPM speed of the engine. Here's a simple 12-volt (actually, 8 to 16 volts) circuit built around an LM2917 frequency-to-voltage converter chip.



Okay, now that we're up-to-date, let me fill in the blanks. The transformer used to test and calibrate the circuit is nothing more than a small 12-volt transformer, like the RadioShack 273-1385 (12.6 volts at 300 mA). For this test, you simply rectify the output of the transformer using a 1N4001 diode and input the signal to the tachometer. The output frequency is equal to 60 (Hz) x 60 sec = 3600 RPM (revolutions per minute).

The original design specifically called for an analog meter, but you're welcome to substitute a DMM or DVM as you like using the following modification.



As for the inductor, it's a J.W. Miller PM40-101K, which is stocked by **Digi-Key (1-800-344-4539; www.digikey.com)** and **Mouser Electronics (1-800-346-6873; www.mouser.com)**.

When 16MB RAM was King

Q. I have an AT Memory Expansion card that plugs into the computer expansion slots.

On the board, I read "8 meg AT RAM." There are 36 memory chips on the board with 18-pin chip sockets to add 18 more chips. Most chips are numbered AAA1M200P-08H, but two are numbered KM41C1000AP-8. I find no FCC ID number and no manufacturer ID on the board, but there's an IC labeled

"M60030-1009J"
BOCA RESEARCH
PN 1945
038100

I installed the board in my NEC PowerMate Portable SX, but my computer doesn't recognize the board. I suspect that I need a driver or other software to implement this expansion. I called BOCA, but they weren't able to tell me anything. Can you tell me what I need and where to find it?

Oliver Curtis Powell
wb4waa@coastalnet.com

A. Boy, this question takes me back to the days of old when 16 MB of RAM was the absolute limit. Fortunately, I now have 128 MB of RAM and yearn for more, but back to your problem. Yes, you're right: you need a software driver. Specifically, it's an extended memory manager (EMM) from Boca Research to access the BIOS chip on this card. Unfortunately, I don't have a copy of that driver anymore, but maybe one of our readers has one they'd like to share. It can be found bundled with most Zeos systems sporting an 80286 CPU.

No Joy without Pinout

Q. Do you know the pinouts for the Gravis GamePad, Gravis Phoenix, and the Gravis XTerminator?

Cory
via Internet

A. Sure, the GamePad pinout is either a 15-pin game plug or a four-pin USB connector. Both the Phoenix and Xterminator plug into a 15-pin game port. But that wasn't the question, was it? What you really want to know is how to use the buttons on these controllers. That's done using software drivers. A good source of Gravis drivers is **DriverGuide** at **http://www.driverguide.com**. What you need to do is select a driver that matches the actions of the game controller to your software application. Different drivers produce different button responses, which can be used to create custom games. Have fun!

Multi-line Phone on Single Line

Q. I was wondering how complicated it would be to modify a five-line Western Electric phone (model 2565 HKM) for use on a single line. There's a sticker on the bottom stating that it should be used on business systems only, or there is risk of electrical shock.

Peter Stratigos
via Internet

A. The Western Electric 2565 and its kin, the ITT 2568M, are high-quality desk telephones that plug into a standard 50-pin "telephone" connector or are hard-wired into a phone wire closet. Phone cable generally contains two wire pairs, which are color-coded. The first pair is green and red, and the second is black and yellow. A way to remember this is by the holidays Christmas and Halloween. After that, the wires are generally color-striped. What does this have to do with you? Everything, in that your 50-pin connector has more than just phone signals — there's power there, too, which is why Western Electric posts the warning. As for the modification, I'd sell the phone to someone who can use it (current market price is $49.00).

Magnetic "E"

Q. I'm an electronic repair technician who is quite literally up to my ears in old switching power supplies. I've been trying for many years to figure out how to separate the double "E" cores in the output transformers without success. Is there any magic potion/Voodoo spell that can separate them so that I can rewind them for my own needs?

Stephen Varmecky W3IOD
Pittsburgh, PA

A. They are held together with varnish, which you can dissolve using any of the acute solvents. Back in the days of old, I would use MEK (methyl-ethyl keytone), but I doubt you can buy it over the counter today. Try a paint or varnish stripper. Simply soak the "E"s overnight and they will slip apart.

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BTW, you need to coat the "E" leaves again when putting the transformer back together, otherwise the winding will see it as one big iron-ring with about zero efficiency. In other words, you don't want the "E"s to touch each other, which is what the varnish coating prevents.

Mailbag

Thanks for the response to my question ("Two, Two Batteries in One," above). I purchased the isolator from Camping World, and I'm in the process of installing the second battery system. However, I now find that since I have a 1998 Ford Van, the alternator needs an isolator with "excitation" to operate, which I should obtain shortly. There are other considerations that I discovered while doing this conversion that I'd like to share with the readers. Such as vapors from the battery, battery tie downs (it would be no fun having battery acid flying around inside the van), proper wire size, and circuit breakers in case the wires become frayed or exposed. See **www.surepower.com/pdfs/180012.pdf** for more details on various installation options.

Tom Reel
Milan, OH

Dear TJ:

I read your Q & A response to 70-volt line audio today and need to point out a potentially serious error. At the end of the answer, you suggest that reversing a 70-volt speaker transformer will make a suitable "output" transformer for converting a conventional amp to 70 volts. The problem is that the eight-ohm winding's impedance is actually lower than eight ohms — more on the order of one ohm. This is because it "sources" the eight-ohm speaker. I have seen amps "burn up" from doing just this.

If you add a series eight- or four-ohm resistor (depending on the amp) with the secondary winding of the 70-volt transformer, it will protect the amp from overload. Yes, it is inefficient, but it's a lot cheaper than a new amp.

On occasion, I have driven both 25- and 70-volt lines with a standard eight-ohm output amp (of sufficient power) with no transformer. A 100-watt, 70-volt load is only a 50-ohm load in the eyes of the amp, while a 75-watt, 25-volt load is six ohms.

I've been installing and servicing sound systems for over 20 years, and other than this one issue, you gave a very good explanation of the subject.

Chris Snyder KD4OGD
Cosby, TN

Dear TJ:

I suppose I'm not the first to point out the glaring mis-calculation on page 25 of the Mar. 2000 issue concerning the 70-volt audio question. In the example cited, you said that a 100-watt amplifier would only deliver 50 watts to an eight-ohm speaker through eight ohms of cable. But, if you do the math, you'll find that a 100-watt amplifier will only deliver 25 watts to an eight-ohm speaker through eight ohms of cable. While it's true that the voltage in the scenario is halved, the current is also halved, thus 1/2 the voltage times 1/2 the current equals 1/4 the power. I caught this immediately because I design and work with these systems on a daily basis.

Dan Lash
Expanets of IN

Response:

Obviously, the result of another long session of burning the midnight oil. Yes, you're absolutely right. Power is the product of both current and voltage (P = EI), so the correct answer is 25 watts, not 50 watts. Thanks for setting the record straight.

TJ Byers
Q & A Editor

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Continued from page 42

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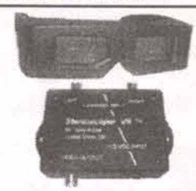

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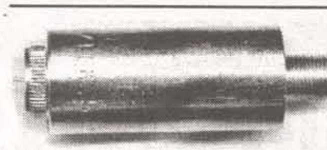

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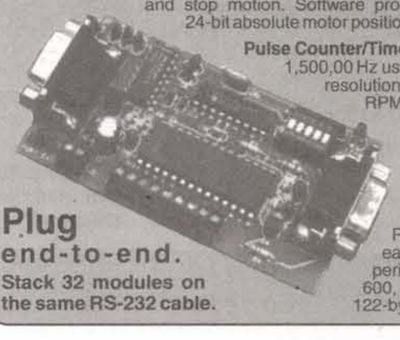

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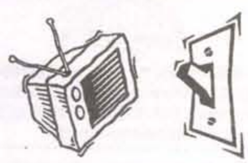

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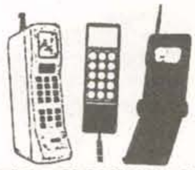

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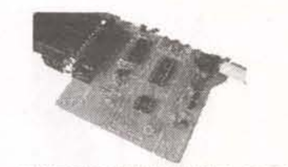

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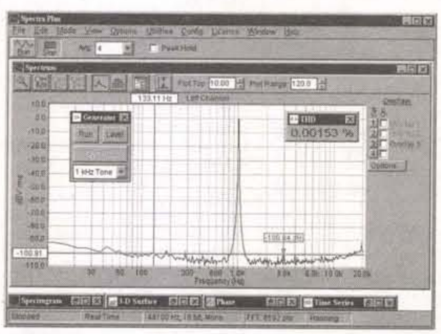

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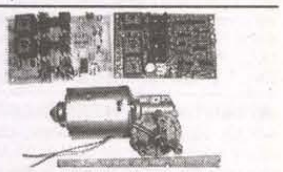

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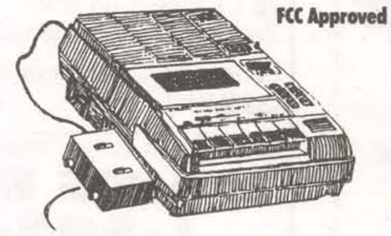

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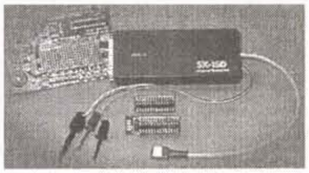

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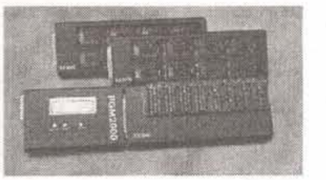

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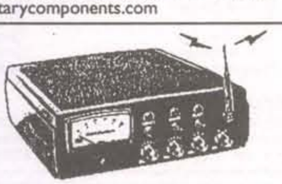

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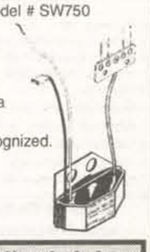

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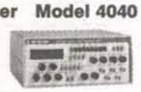

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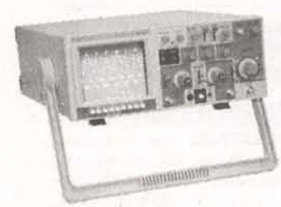

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AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

I can't believe it's spring already and I still don't have my robotics shop unpacked here at the new Robot Ranch. I mean, good grief, man, there's robots to be built, transistors to be fried, and neighbors to be mystified.

I do have my tool boxes and office stuff unpacked (that you are reading this column is witness to that), but all my test gear and development tools – oscilloscope, signal generator, breadboards, power supplies, device programmers, I2C monitor – are still in boxes. These boxes are underneath other boxes which, in turn, can't be unpacked until we get shelves up, but the shelves can't be put up because the power tools are also still packed, and, guess what, there's no room to unpack those tools without swimming in packing peanuts.

Gradually, Shoshana and I are finding space to put the domestic necessities and, as we do, the boxes on top of boxes slowly disappear. It's remarkably like an archeological dig, except the artifacts get higher tech the lower we excavate, and we do have an inventory of what's in the lower layers – we just can't get to them, yet.

Then, too, there are mysteries we haven't solved yet, such as where the heck my stapler is and exactly where Igor (my 386 PC) has got to. The stapler I can live without for a while longer, but Igor has me worried. Maybe Igor accidentally got sold at our moving sale, or maybe he's stuck in a lower layer in an un-inventoried box ... I just don't know. The romantic in me fancies that maybe Igor just slipped away in the night once I undid his chains. Whatever has become of him, it just won't be the same using Shoshana's laptop to perform his duties.

As if to counterbalance the disappearance of Igor and my stapler, I can't seem to turn around without tripping over some component or another of Spanky, my Linux system. Spanky (the name comes from the way I refer to working with Linux: Spanking the Penguin) is the main exception to the high-tech-on-the-bottom rule around here, though it does me no good because there's no room to set up another computer, not one with a 19-inch monitor. In fact, Spanky is actively impeding the unpacking process; the monitor is big enough, but the box it comes in is monstrous. Makes me entertain thoughts of selling all my worldly possessions and finding out if it really is possible to sail to Fiji and make everything you need with nothing but a Leatherman tool and the right attitude.

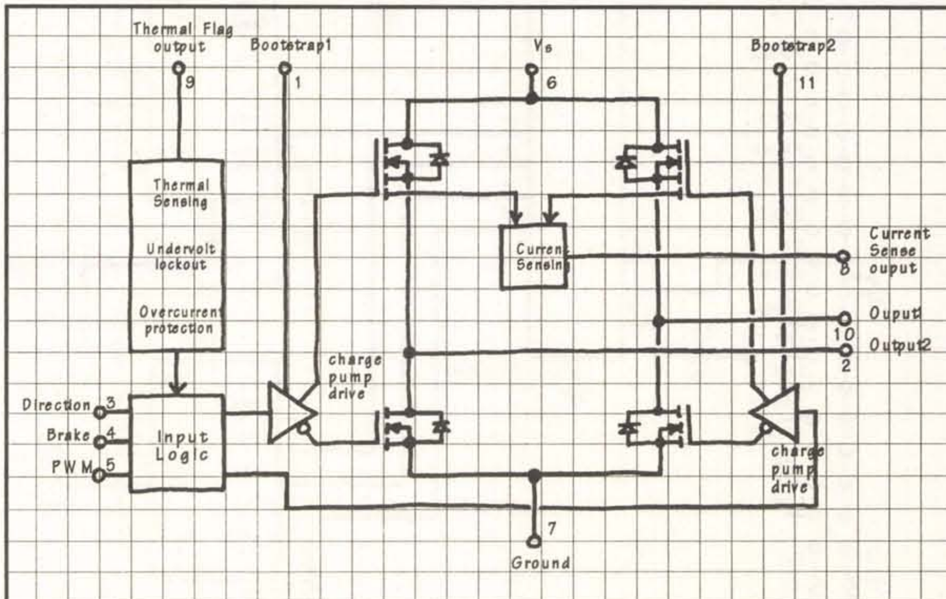

Figure 1: LMD18200 H-bridge chip

Left to My Own Devices

Shoshana brings me sharply back to reality, though, when she points out that we still need a few more years worth of Huggies diapers (try whittling some of those from a coconut husk some time).

I may still buy the Leatherman tool; I've been hoping for years to receive one as a Hannukah present, but for some reason all I ever get are things like socks and ties. The idea of a tool that can do practical-

TABLE 1

PWM	DIR	BRK	Active Output Drivers
H	H	L	Source1 Sink2
H	L	L	Sink1 Source2
L	X	L	Source1 Source2
H	H	H	Source1 Source2
H	L	H	Sink1 Sink2
L	X	H	NONE

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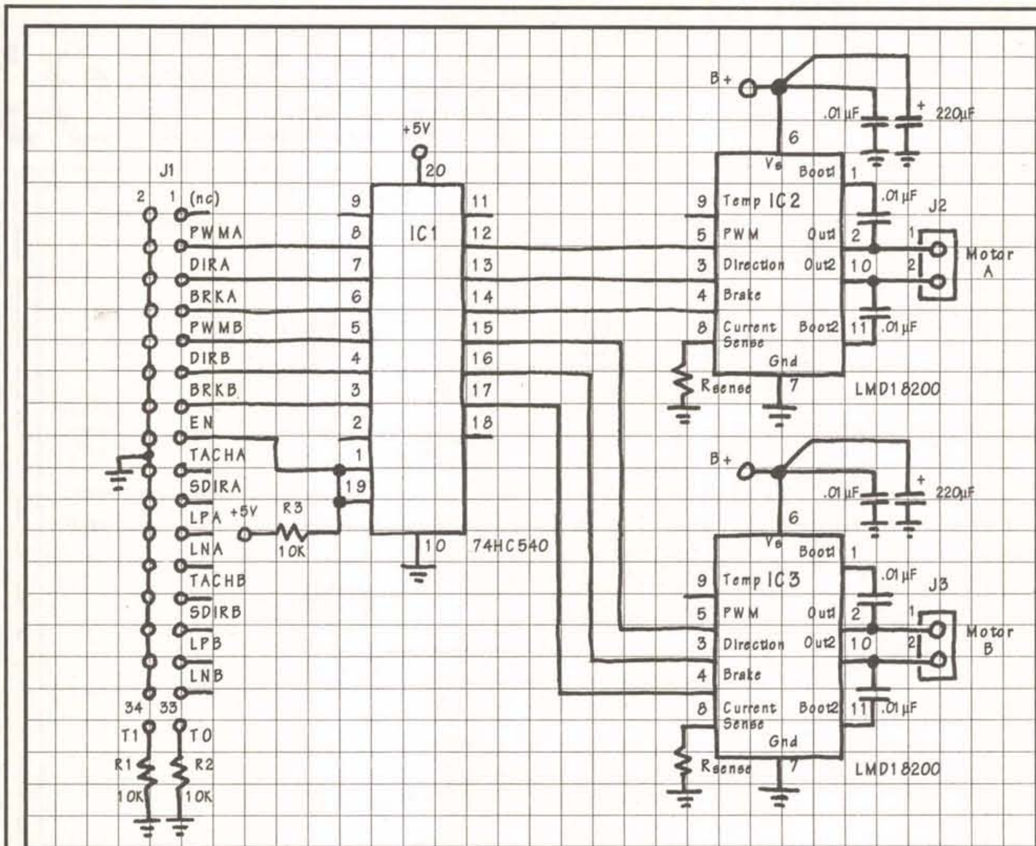

Figure 2: ROBBI Dual Motor Driver using LMD18200 H-bridges

ly everything intrigues me, and, to get back on the topic of robotics, I think it would be way cool to design a robot that could be built with nothing but a Leatherman tool and, say, scrap floppy drives and tuna cans ...

Ah, spring is indeed a time for daydreaming.

Fortunately, I have done more than daydream this month. I have in front of me some Robot Builder Interface (ROBBI) Dual Motor Driver boards I built several years ago. These boards nicely illustrate the device independence of the ROBBI interface specification I talked about last month.

One board uses four SPDT relays and a couple power MOSFETs to make two H-bridges, and the other two both use decidedly more high-tech IC H-bridges — the LMD18200 from National Semiconductor and the L6203 from SGS Thompson. As it turns out, these two chips have quite similar capabilities, and they are a good place to begin exploring the topic of integrated H-bridges.

The LMD18200

Looking at Figures 1 and 2, National's chip seems tailor-made for the ROBBI motor interface. Actually, it's the other way around. Back eight years ago in the Seattle Robotics Society, when we were going through the exercise of defining what signals belonged in the ROBBI spec, I had just got my hands on some samples of the then-new IR8200, International Rectifier's version of the LMD18200. I kept its elegant interface in mind as we defined the motor driver signal set.

See, most H-bridge chips merely provide separate control pins for each half of the H-bridge, in effect treating it as two independent half H-bridges or so-called "push-pull" drivers.

This can be advantageous when you want to control separate single-ended devices (i.e., devices that have one terminal tied either to ground or B+ and the other terminal tied to the push-pull driver output). Each half H-bridge then acts as an independent current source or sink.

When you are driving a motor, though, it just adds complexity, since you need to be able to manipulate both control pins in order to optimally control a motor in all four quadrants (four-quadrant control is just a fancy way of saying your H-bridge can accelerate or decelerate the motor in either direction).

Moreover, Sign & Magnitude (S&M) control requires different manipulations of those control pins than Locked Anti-Phase (LAP) control requires.

All of the solid-state H-bridge circuits I've presented so far in this series have used simple two-pin control, not because that's the best way to build an H-bridge, but because it makes understanding the H-bridge circuitry easier. The LMD18200, however, provides the extra interface circuitry that makes controlling a motor easy.

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Pumping Charge

The LMD18200 provides a great deal more, too, to make the robot-builder's life easier: it handles 6A peak current and 3A continuous and supply voltages up to 55V. Its switching elements have a low Rds ON resistance of about 0.3 ohms per switch — not as low as the power MOSFET H-bridges I've already presented, but respectable.

It uses an internal 300kHz charge pump to provide a constant high-side drive voltage, but it can also use external bootstrap capacitors. These are needed when you switch the bridge at frequencies higher than 1kHz because the on-chip charge pump can provide only enough current to give a high-side drive voltage rise time of 20 microseconds.

External bootstrap capacitors use the H-bridge switches themselves to generate a high-side voltage boost in exactly the same manner as the bootstrapped H-bridge I presented in my Jan. 2000 column.

To review, the bootstrap principle is, in essence, a charge pump where a large value capacitance provides enough energy to quickly charge the gate capacitance of the high-side switches, making much higher H-bridge switching frequencies possible.

The charge-pump action is accomplished by the power switching elements themselves so that, with 10 nF bootstrap capacitors connected from the outputs to the bootstrap pins of each high-side switch, rise times less than 100 ns are possible, allowing switching frequencies up to 500kHz. Tired of your PWM circuit whining? You won't have that worry with these babies.

The chip provides such niceties as internal fast recovery protection diodes (shown in Figure 1) and undervoltage lockout. Builders of robots powered by less than 12V won't like this nicety, but there it is. It also provides short circuit protection, a thermal warning output pin that trips at 145°C, and thermal shutdown at 170°C.

It also includes logic to produce a "deadband" delay between high-side and low-side switching transitions, thus eliminating shoot-through current — the current spike that would otherwise occur during the brief time when both upper and lower switches were conducting as one shut off and the other turned on.

One of the more intriguing features of the chip is its current sense output pin. The high-side switches dedicate a small number of their source gate cells to the current sense function. Rather than sense current by measuring the voltage across a precision low-resistance current shunt that carries the whole H-bridge current, these current sense cells siphon off a miniscule amount of current directly from the high-side switches.

This current is directly proportional to the current flowing through the high-side switches, with a ratio of about 377µA:1A. All it takes is a resistor from the current sense output to ground to turn the sense current into a voltage proportional to the motor current.

The LMD18200 comes in an 11-pin package that looks something like a double-wide TO220. The mounting tab is common with the ground pin, so you can heatsink to a grounded chassis with no problem. The chip goes for less than $20.00 through most distributors ($23.55 from Digi-Key). Here's a hint: If you ever need to find price and availability for a chip and who carries it, try this website: www.findchips.com.

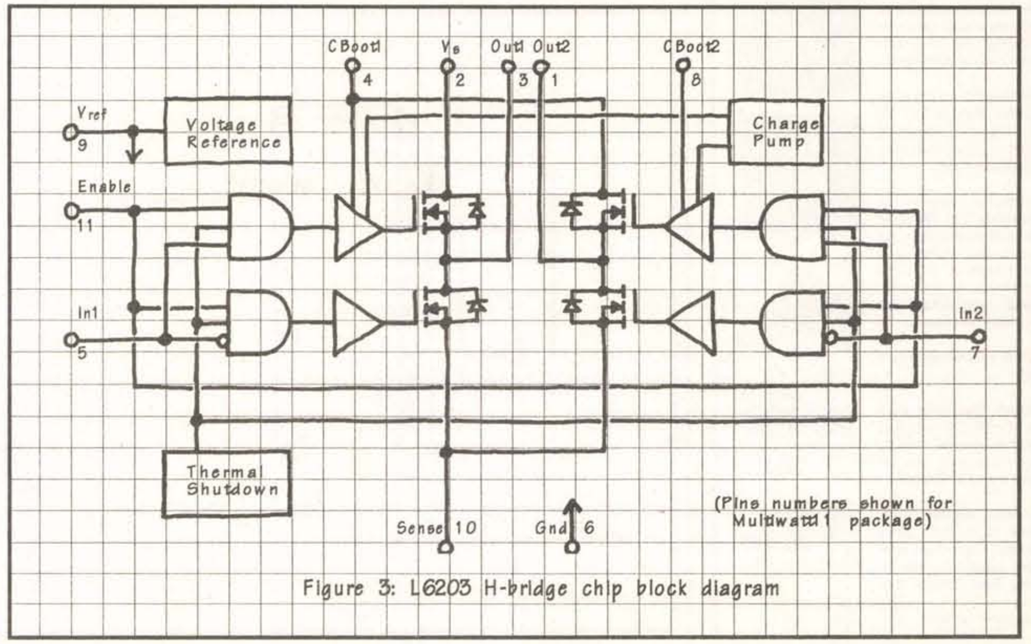

Figure 3: L6203 H-bridge chip block diagram

The L6203

Figures 3 and 4 show what SGS-Thomson's L6203 is all about. The similarities with the LMD18200 are striking. The L6203 can handle similar currents (5A peak, 4A cruise), has an Rds ON of 0.3 ohms, has thermal shutdown and shoot-through protection, and operates between 12V and 48V.

It also has an on-chip charge pump and pins for optional external bootstrap caps to improve high-side switching speed, and it comes in an 11-pin super-duper TO220 package (they call it the "Multiwatt11" package).

Its maximum operating frequency is 100kHz — 1/5 that possible with the LMD18200 — but this won't affect most motor drive

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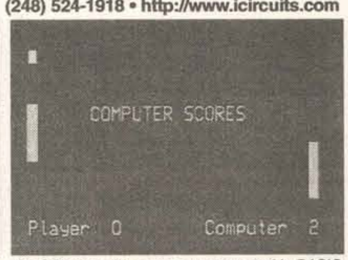

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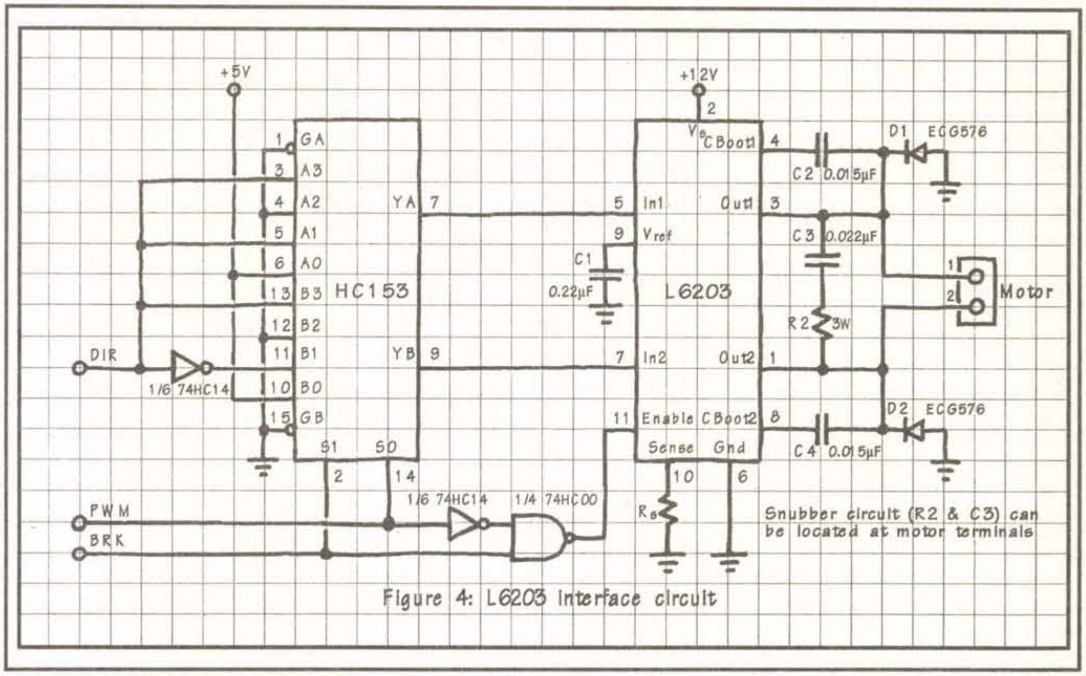

Figure 4: L6203 Interface circuit

designs. The larger differences are that it uses the two-wire control approach and that current sensing must be done the old fashioned way. It's also about half the cost of the LMD18200.

The two-wire control causes the most headaches when it comes to interfacing to the ROBBI signals. Figure 4 shows a low-tech, but quite usable design using simple HC glue logic.

You could replace everything to the right of IC1 in figure two with two copies of the circuit in figure four to get a full ROBBI Dual Motor Driver (that schematic is left as an exercise for someone less sleep-deprived than me).

The HC logic implements the truth table shown in Table 1, which allows an L6203 to behave the same as an LMD18200 with full S&M and LAP modes.

The heart of the design is a dual 4-to-1 logic multiplexer. Multiplexer logic design is as easy as writing down a truth table. In this circuit, two logic inputs – PWM and BRK – drive the multiplexer select lines S0 and S1.

The logic level at the outputs then corresponds with the logic level present at the multiplexer input selected. Notice that some of the MUX inputs are permanently tied either high or low; the outputs are functions of PWM and BRK alone, corresponding to the "X" (don't-care) states of DIR.

For instance, when both PWM and BRK are low, you want to turn ON the high-side switches of both halves of the bridge, regardless of the state of DIR, so the A0 and the B0 MUX inputs are tied high. When PWM is low and BRK is high, on the other hand, you want all switches –high-side and low-side – to be turned OFF, again regardless of the state of DIR. Tying B2 and A2 to ground accomplishes this.

The rest of the multiplexer logic uses either true or inverted versions of the DIR input to determine the states of the outputs. Inspecting the truth table reveals that the A1, A3, and B3 inputs all must use the non-inverted DIR signal because the required logic outputs YA and YB are the same level as DIR for those combinations of PWM and BRK. The B1 input, however, must use DIR inverted because YA and YB need to be the opposite logic level as DIR for that state.

The rest of the logic, the second invertor and the NAND, takes care of the last line in the truth table. When PWM is low and BRK is high, all of the H-bridge switches must be turned OFF, and a low level on the L6203's Enable pin does the trick.

If the above explanations about multiplexer logic have left your head spinning, take a look at Don Lancaster's *TTL Cookbook* or *CMOS Cookbook*; in these classic books, he gives the complete rundown on multiplexer logic design with lots of examples to help you reach the "Ah-hah!" stage.

And, for those of you who really do want to implement this interface as individual gates – maybe to program them into a PLD, say – here are the corresponding logic equations in C notation:

```
In1 = (!PWM && !BRK) ||
   (PWM && !BRK && DIR) ||
   (PWM && BRK && DIR)
In2 = (!PWM && !BRK) ||
   (PWM && !BRK && !DIR) ||
   (PWM && BRK && DIR)
Enable = !(!PWM && BRK)
```

(I've made no attempt to tease out the common terms and minimize these equations; this is also left to the reader as an exercise.)

Build Your Own Robot!

Few books on Amateur Robotics have been as avidly anticipated as Karl Lunt's book, *Build Your Own Robot!* (paperback, published by A. K. Peters, 2000, ISBN 1-56881-102-0). I know I was looking forward to it, and I may well have been the first person in the country to receive a copy of it: a hefty sheaf of laser-printed galley sheets. For those of you who have only recently begun reading *Nuts & Volts*, Karl preceded me with his own column, "Amateur Robotics," before I began writing the Amateur Robotics Notebook column. Amateur Robotics ran 70 issues straight from October '92 to

Please note that my contact information is now different. If you have suggestions, questions, or comments about amateur robotics topics, you can now reach me at:

Robert Nansel
Box 228
Ambridge, PA 15003

The E-Mail address is the same:
E-Mail: bnansel@nauticom.net

May '98. When I slipped into Karl's shoes (metaphorically speaking) in June '98, I knew I'd have a long way to go before I could claim 70 straight columns in a row, and an even longer way to go before I could say I'd come close to filling those shoes.

Now he's gone off and put together a book, a collection of his favorite *Nuts & Volts* columns – a big book, 574 pages – and I despair of ever even catching up to him, forget about the shoes.

I subscribed to *Nuts & Volts* during most of Karl's tenure specifically to read his column even though we saw each other at least once a month at Seattle Robotics Society meetings.

In those years, we talked endlessly about robots over the phone or at dinners at each other's homes, or on the beach during the SRS annual G.E.A.R. campouts.

I subscribed because, even with all this obsessive communication, I still couldn't otherwise keep up with everything Karl was up to in robotics. Reading his column helped me and many, many others get consistently good information, new ideas, and new projects.

When I first met Karl in 1990, the position of Joe Gearhead in the world of Amateur Robotics was pretty grim: amateur robotics was just starting to recover from the debacles of the 1980s, but even so, there was no BOTBoard, no TinyForth, and no SBasic.

Interactive C was barely a gleam in Randy Sargent's eye, and Flynn and Jones' *Mobile Robotics: From Inspiration to Implementation* had not even been written. A lot has changed in 10 years.

Leafing through this book, I'm struck by how much influence Karl has had. The ubiquitous BOTBoard, for instance, came about in part because Marvin Green was trying to find ways to beat Karl in the Line Following contest.

There were several years there where Karl's 'bots would beat Marvin's by margins of just a fraction of a second. I remember escorting Marvin to a local hobby shop one Sunday morning an hour before one of these competitions so he could put larger wheels on his 'bot to gain a little more speed.

Anyway, Karl has arranged the best of his columns into related categories (Getting Started, Software, Electronics, Mechanics, Robotics Projects, Adventures in Hacking, Way Cool Robots, and Sidelights), adding background and historical where-are-they-now blurbs at the beginning of each. He's finished it off with three superb appendices: Contacts, Hobby Servo Mods, and Web Pages.

There are some slight negatives. Karl warns that some of the material in his book is dated, and it's true. In particular, certain surplus deals and toys he hacked over the years are no longer readily available.

Then, too, there is a certain Seattle-centrism that's hard to overcome (I know, I never could overcome it when I lived in Seattle). But his enthusiasm and expertise are infectious, and the way he approaches any project, new or old, is worth the $34.00 price.

Next Time

Next time, I'll take a break from H-bridges and motors (mostly) and talk instead about the results of this year's Trinity Home Robot Fire Fighting Contest.

Going to Hartford for this, the largest Amateur Robotics competition in America, always gets me jazzed up. Also, I've got a whole new robot design in progress, the beginnings of which you'll see, too. **NV**

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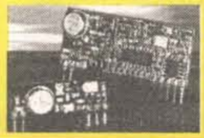

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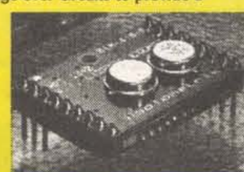

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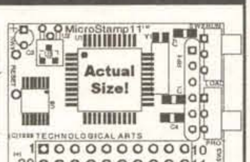

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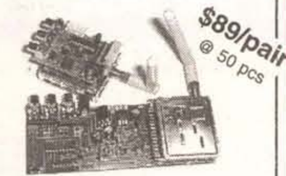

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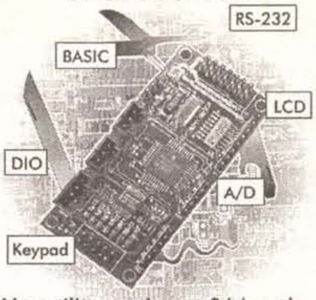

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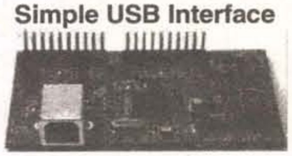

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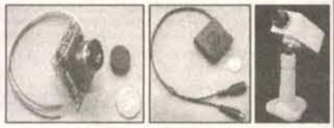

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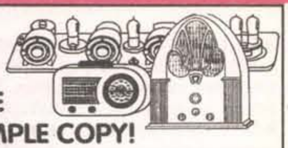

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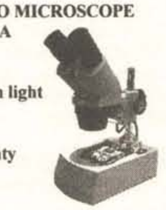

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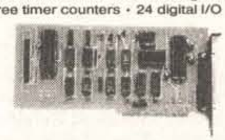

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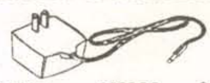

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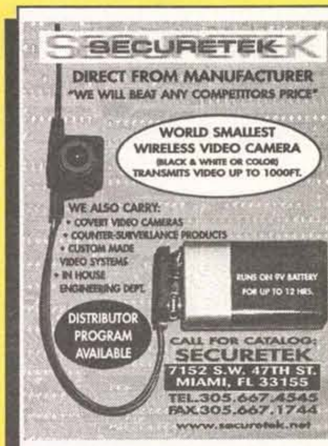

reader FeedBack

Continued from page 7

OTHER SOURCES OF KELVIN-VARLEY VOLTAGE DIVIDERS

A differential voltmeter nulls the voltage to be measured against an equal amplitude internal reference. This was a way to get multi-digit measurement resolution in the days before digital voltmeters (DVMs) became common. To achieve a null, the internal reference voltage must be adjustable in steps equal to the measurement resolution. This adjustment is done with a Kelvin-Varley divider.

Since DVMs are now so common and inexpensive, differential voltmeters are no longer in much demand so they can often be bought rather inexpensively. For example, I recently got a Fluke model 891A for $40.00. It contains a lovely four-digit Kelvin-Varley divider. The divider assembly is easy to remove for stand-alone use. The photo in Figure 1 shows the divider assembly as it looks when removed from the model 891A. The rotary switches and pot are easily removed from their aluminum mounting bracket. The resistors are all precision wire wound units mounted on the circuit board that is hidden by the removable shield.

This meter was designed to measure voltages up to 1,000 volts so the divider has a 1 megohm input resistance — see Figure 2. This isn't a problem except good shielding is necessary. I suggest retaining the shield shown in the photograph and also putting the divider assembly into an aluminum enclosure. A SESCOM model MC-14A* looks like a good choice. It measures 8.5 inches wide by 10 inches deep by 3.5 inches high. I've included a suggested circuit as Figure 3. The SESCOM enclosure is deep enough to put the opamp power supply behind the divider assembly with a shield plate between them.

Since the input resistance is high, the output resistance is also high so I suggest an output voltage follower using a low-noise chopper stabilized opamp. This could be built on a small circuit board mounted very near the output binding posts. Another suggestion is to replace the single-turn 10K pot (R37) with a 10-turn pot. This adds another digit to the resolution, but does require recalibration by adjusting R36 (in Figure 2).

Of course, you may not find a Fluke 891A, but ALL differential voltmeters contain a divider which is bound to be useful. Look around and see what you can find. It's helpful (but not essential) to get an Instruction Manual. A good source is Manuals Plus, 130 N. Cutler Dr., N. Salt Lake, UT 84054. 801-936-7000. www.manualsplus.com.

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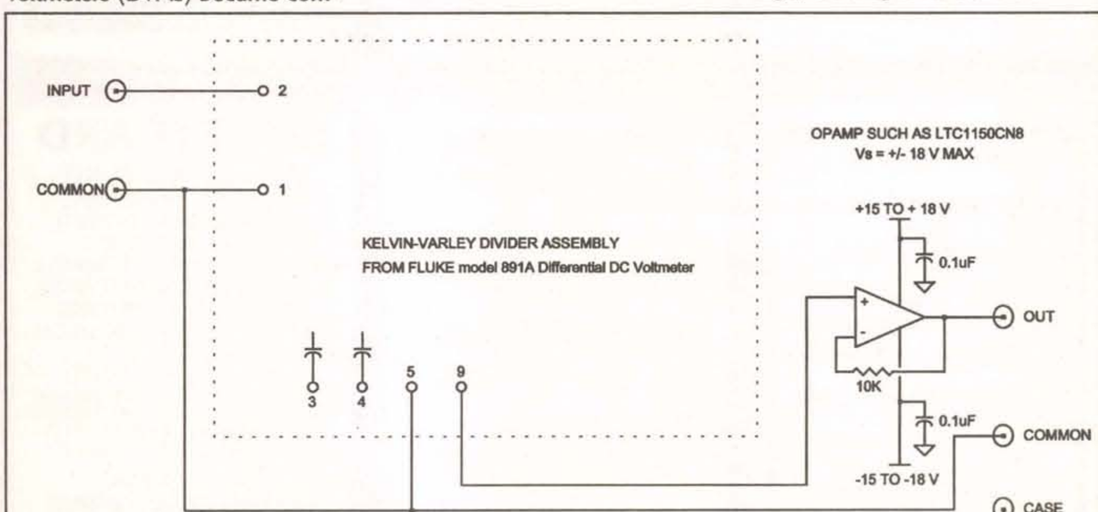


Fig. 3 – An example of using the Kelvin-Varley Divider Assembly

Dear Nuts & Volts:

On the earthquake prediction device article, here is an interesting note. According to my search of the Internet both, Japan and Russia are working on it.

In the Readers Digest book "How in the World" on page 204 it says that there are four possible indicators that may be methods of predicting earthquakes.

"And the fourth is any change in the electrical and magnetic behavior of rocks in the moments when they come close to their breaking point before an earthquake."

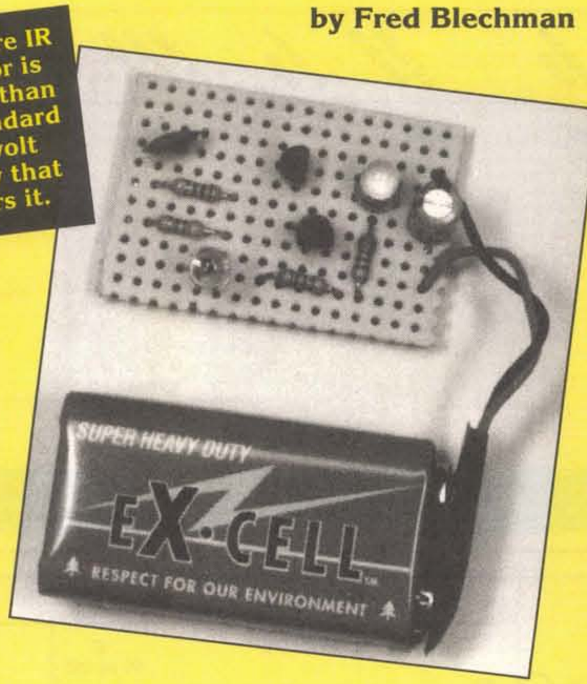
It goes on to say that that and other methods worked in 1974 to predict a magnitude 5 earthquake in Hollister, CA an entire day in advance! This is evidence that my invention will work!

Bob Davis

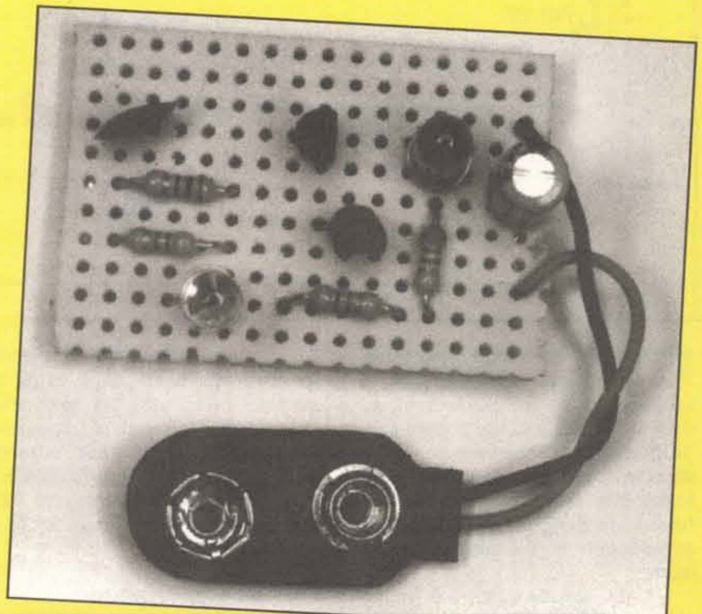
Build An Infrared Detector

by Fred Blechman

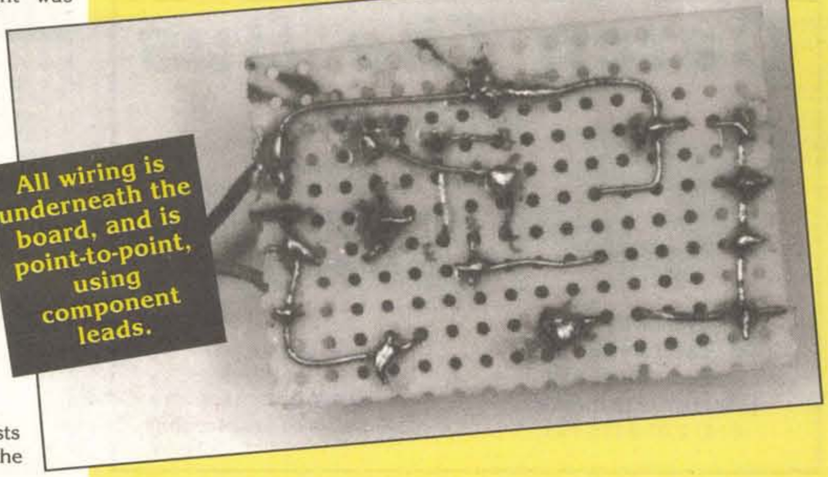
Build this simple circuit to test infrared remote controls. It uses only 10 common electronic parts you can get at any RadioShack store or order on-line. No printed circuit board is required and a common nine-volt battery will last "forever."



The entire IR Detector is smaller than the standard nine-volt battery that powers it.



Only 10 electronic parts, a small piece of perforated board, and a battery snap connector are used to build the IR Detector.



All wiring is underneath the board, and is point-to-point, using component leads.

They are everywhere!

You'll find them in living rooms, family rooms, breakfast rooms, dining rooms, and bedrooms. They may even be found in some bathrooms! What? Infrared (IR) remote controls.

IR remote controls are used to perform various functions for television sets, cable boxes, video cassette recorders, hi-fi audio sets, lights, ceiling fans, and a growing number of other electronic devices.

Increasingly, pressing various buttons on these remote controls are the ONLY way to perform some functions on these devices. Manufacturers, in order to save the cost and installation of switches and potentiometers, simply program a chip in the device to respond to infrared commands. For example, try to find a CONTRAST or BRIGHTNESS control on your modern TV set. Or clock controls on a VCR. These, and many other settings, have been relegated to the IR remote control designed for the specific device.

For the most common functions — ON/OFF, Channel, Volume, Play, Record, Fast Forward, Rewind, and others — a "universal" remote control can operate several different devices.

But what do you do when the control doesn't seem to work? Is there a battery problem? Is a button making contact when pressed? Is the control defective? Since you cannot see the infrared beam produced by these controls, how can you tell if it is working properly?

This dilemma is solved with the "IR Detector" which you can build from only 10 common parts.

Older Remote Control Methods

Probably the first use for remote control in the home came with changing television channels. At first there were mechanical methods, using a cable connected to the TV tuner. You physically pushed a button or turned a knob to change channels. Various means were devised to turn off the sound ("commercial killers"), some as simple as a flashlight beam shining on a photocell in the speaker circuit. However, daylight and sunlight could also trigger the sound off.

Pretty soon ultrasound — sound waves above human hearing — were used. This drove some animals wild, and was subject to interference from other sound sources.

But some years ago, infrared signals came into use. To prevent interference with other light sources, the infrared light was pulsed at around 38,000 cycles per second (KHz), with different pulse codes for each function. Therefore, infrared receivers could be "tuned" to about 38 KHz and decode the specific pulse train for each function. Infrared emitters and detectors coupled with programmed integrated circuits made all this practical.

Infrared Energy

Infrared energy consists of light rays that are below the

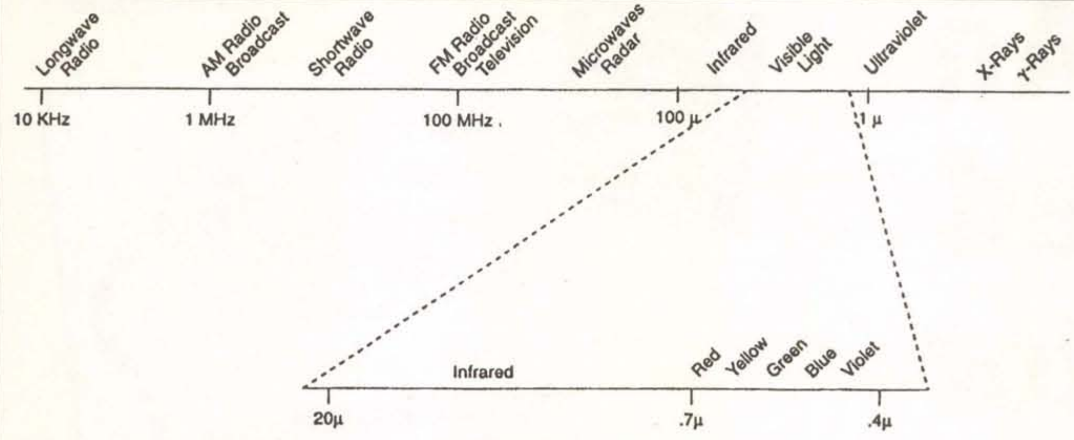


Figure 1 — Frequency spectrum from longwave radio to gamma rays, with expanded view of infrared to ultraviolet.

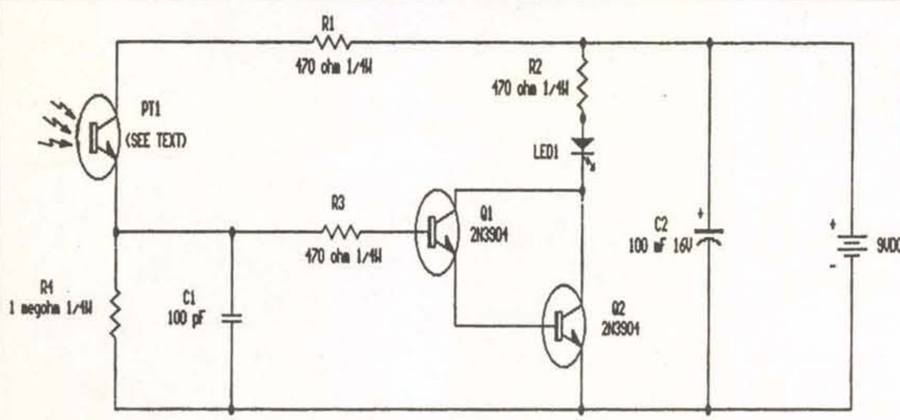


Figure 2 — IR Detector Schematic.

red end of the visible spectrum. The wavelength of these rays is longer than that of visible light, so they are invisible to the human eye. Infrared rays, however, can be detected by means of special photodetector semiconductors that have been designed to be sensitive to radiation in the infrared spectrum.

Light wavelengths are much shorter than typical broadcast and microwaves, and longer than x-rays. The higher the frequency, the shorter the wavelength.

Figure 1 shows the frequency spectrum from longwave radio to gamma rays, with an expanded view of the infrared to ultraviolet wavelengths. Note that infrared wavelengths are approximately from 0.7 micrometers to 20 micrometers. (A micrometer is a millionth of a meter.)

Circuit Description

The schematic of the IR Detector is shown in Figure 2. Powered by a simple, standard nine-volt battery, essentially no current flows through this circuit unless PT1, an infrared phototransistor, "sees" light. Since visible light also contains invisible infrared light, daylight and even artificial light will cause some current to flow in the circuit.

Basically, the circuit consists of the phototransistor, when responding to light, biasing a pair of transistors in a Darlington amplifier circuit so that current can flow through the light-emitting diode, making it glow.

PT1 has no base lead, since infrared light is intended to provide base bias. When there is no infrared light, little or no current flows from the collector to the emitter (the arrowhead symbol) of PT1. This means there is no bias voltage to the base of transistor Q1, so it does not conduct, also depriving transistor Q2 of bias, so Q2 does not conduct. Therefore, essentially no current flows through resistor R2 or light-emitting diode LED1. The circuit is dormant.

However, as soon as any light — especially infrared light — is allowed to fall on the transparent shell of PT1, the current from collector to emitter increases; the brighter the light, the greater the current. Resistor R1 limits the current through PT1, as well as providing a voltage-divider with resistor R4.

As current flows through PT1, a positive voltage is created at the intersection of resistors R3, R4, and capacitor C1. This voltage biases Q1 into conduction, which allows Q2 to conduct, thus providing a path for current to flow through current-limiting resistor R2 and LED1, which then glows.

Since the infrared signals this detector is expected to receive are operating in a pulse mode with a basic signal frequency of about 38 KHz, capacitor C1 acts to filter out the signal and pulses, and electrolytic capacitor C2 stabilizes the power.

Construction

Before you can build the IR Detector you need to get the parts, some of which are so common you probably already have them. Nothing is critical in the layout or components of this circuit except for the infrared phototransistor, PT1.

Q1 and Q2 may be just about any NPN general-purpose silicon transistor, such as the 2N2222. The resistors, capacitors, and LED can be slightly different sizes or values. You might even find other phototransistors would work in this cir-

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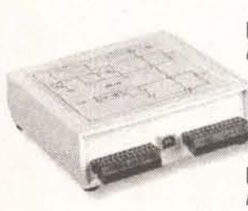

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cuit, but I've found that RadioShack carries an acceptable unit, as well as all the other parts, as identified in the Parts List.

This simple circuit can be built on a perforated board, using point-to-point wiring. If a perforated board with holes spaced 0.1-inch apart is used, Figure 3 (enlarged view for readability) shows the perforated board holes and the parts layout I used for the IR Detector. Although the computer drawing program has distorted the shape of some of the components, the locations are accurate. Figure 3A shows the actual size.

Figure 4 (enlarged view for readability) shows the parts on the top of the board and the wiring paths UNDERNEATH the board. This wiring is accomplished by bending the component leads under the board and connecting them as shown. The only place it is necessary to jump one wire over another is, as shown, between the emitter of Q1 and the base of Q2.

Use care in soldering and orienting the parts properly. If you use the 2N3904 or 2N2222 transistors, when looking at the flat face of the transistor with the leads at the bottom, the leads are emitter, base, and collector (EBC) from left to right.

Note, however, that many types of general-purpose transistors will work in this circuit, and some have pinouts that are CBE. As a matter of fact, the unit shown in the photos — for you eagle-eyed readers — has such transistors, and they face in the OPPOSITE direction than the 2N3904 or 2N2222 would face. See Figure 3 for the correct orientation.

As for the phototransistor, the collector, which connects to R1, is the lead closest to the flat side of the clear plastic dome. The LED cathode, which connects to the collectors of both Q1 and Q2, is closest to the flat spot on the clear plastic dome. Most electrolytic capacitors identify the negative lead. The disc capacitor and resistors have no polarity.

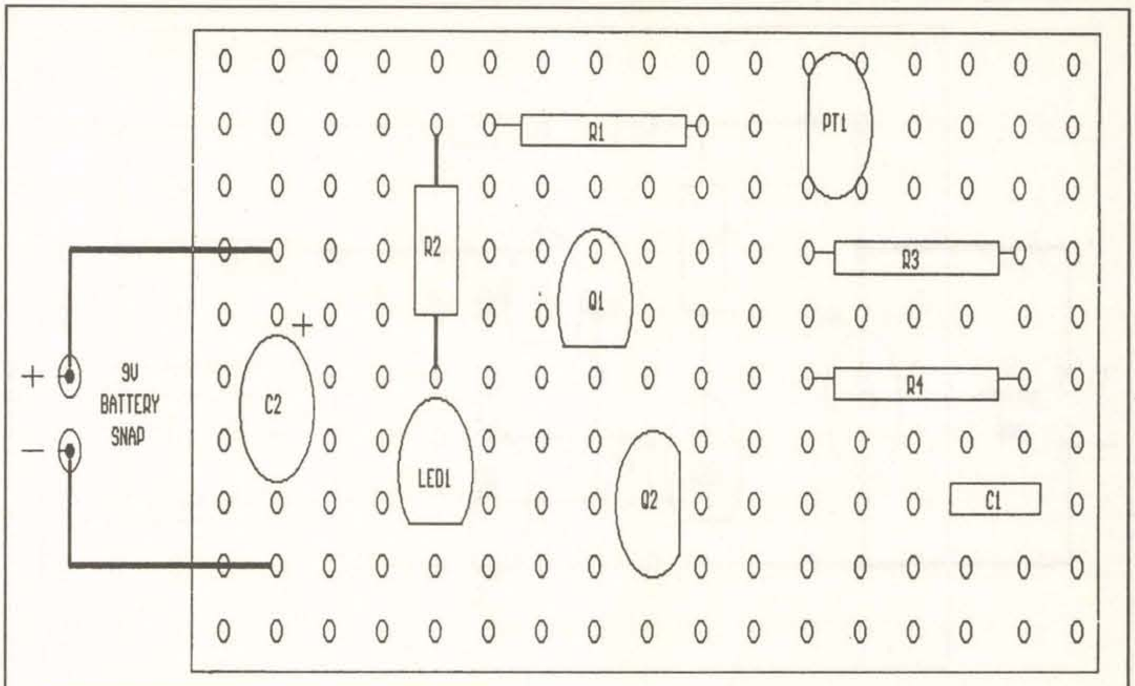

Figure 3 — Enlarged view of parts layout on 0.1-inch spaced perforated board.

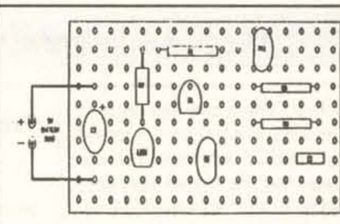

Figure 3A — Actual size parts layout.

Testing

Testing the unit is simple. All you really need is an infrared remote control and a nine-volt battery. It is not necessary to use an alkaline battery — zinc-carbon will do nicely. But only leave the battery connected when you will be using the IR Detector, since there is current flowing when any light (which usually contains some infrared) falls on the phototransistor.

It is necessary to test the unit in very dim light. This unit is VERY sensitive, and the LED will glow with any appreciable ambient light once the battery is connected. You can place a black tubular "hood" (such as can be made from a large soda straw wrapped with black tape to make it opaque) over the phototransistor to block light from the sides of the Detector. Or, you could mount the entire unit in a black box with just a small hole for access to the phototransistor.

With the battery connected, and the IR Detector in dim light, LED1 should not be glowing — or glowing dimly. Now, from six inches to a foot away, point the active end of the IR remote control directly at the photodetector, press ANY button, and LED1 should either flash once, or glow with a pulsing light. Some remote buttons only put out a single short burst, others continue to pulse.

Test all the buttons on the remote to see if the Detector picks up their signal. Some buttons, especially on older units, have developed high contact resistance internally, and some buttons may have to be pushed hard to make enough contact to emit a signal.

Also be aware that the selection of the device on universal

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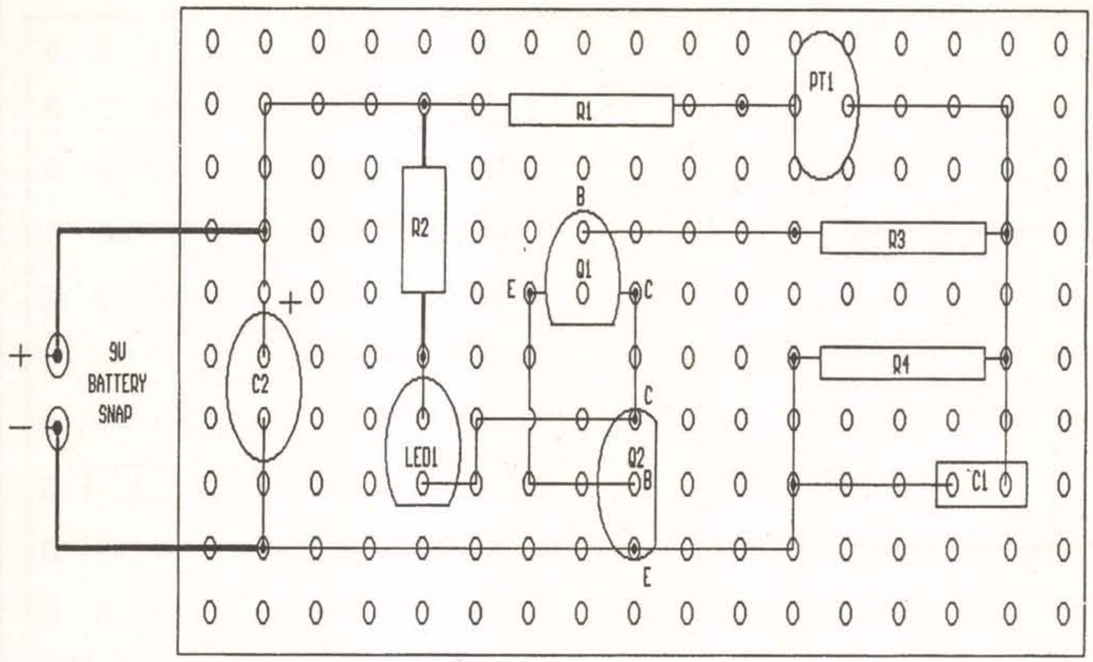

Figure 4 — Enlarged view showing wiring on the board underside.

Parts List
RadioShack (RS) or equivalent parts

R1, R2, R3 - 470-ohm 1/4-watt resistors (RS #271-1317)
R4 - 1-megohm 1/4 watt resistor (RS #271-1356)
C1 - 100pF 50V disc capacitor (RS #272-123)
C2 - 100mF 16V electrolytic capacitor (RS #RSU 11935210)
PT1 - Infrared NPN silicon phototransistor (RS #276-145) See text.
Q1, Q2 - 2N3904 NPN silicon transistor (RS #RSU 11328564) See text
LED1 - Red light-emitting diode (RS #276-041)
Perforated board - 0.1-inch spaced holes (RS #276-149)
Nine-volt battery - Alkaline (RS #23-875). Carbon-zinc okay.
Nine-volt battery snap connector - RS #270-325

remotes may affect the strength of the emitted infrared signal. I found selecting CABLE on one remote greatly reduced the signal strength, and I had to hold the remote closer to the Detector to light LED1.

Troubleshooting

What do you do if nothing happens during testing? Well, first you check the Detector battery and its polarity, then the orientation of all parts and the wiring between them.

Using a digital voltmeter with the battery connected to the snap, and the IR Detector in relative darkness, you should read about nine volts at the collector of PT1, at the positive side of C1, and at the intersection of R1 and R2. There should be little or no voltage at the base of Q1. The voltage at the cathode of LED1 should be about 7.5 volts.

When an infrared signal is aimed at the phototransistor, the voltage at the base of Q1 should jump to over one volt, and LED1 should light. If LED1 does not light, be sure it was not installed backwards.

Using an ohmmeter and Figure 4, check continuity between components to verify path and soldering.

Using

Use the IR Detector to verify the operation of any IR remote control that does not seem to be working. It may need batteries, or one or more of the keys may not be making contact when pressed.

When testing a UNIVERSAL remote — one that controls more than one type of device — be aware that it must be producing the proper codes to operate your specific equipment.

Even if the IR Detector indicates that the remote is producing infrared signals, the signals might not be the right pulse code for the particular device you are trying to control. In that case, you'll need to refer to the remote's instructions to set the proper codes for each device. **NV**

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Dealing With AC Power Line EMI

> Radio reception is many things to many people, but all forms of radio activity boil down to one thing: the signal-to-noise ratio (SNR) game. There is always some basic noise level caused by a combination of natural and man-made sources.

Figure 1 shows the fundamental situation in all radio reception problems. There is always some basic noise level caused by a combination of natural and man-made sources.

As society becomes more and more electrical, the man-made component becomes huge. But the actual amplitude of the noise signal is not nearly as important as the SNR, i.e., the relative strengths of the desired signal and the noise.

You will find that listening to weak signals on some frequencies, especially in the AM band or the "tropical" MW/SW bands, is made difficult or impossible by hash from the AC power lines.

Figure 1 shows four situations. There is a basic RMS noise level, which is labeled 0 dB. Four signals are present (A, B, C, and D). Signal A is clearly below the average noise level, so will not be heard. Some very skilled operators might be able to hear signal B because it sticks up just above the 0 dB noise level, but for most people it will remain a "... was that a signal or my imagination?" situation.

When the signal gets a little higher, say 3 dB above the noise floor, it becomes readable with a bit of discomfort and annoyance. For most situations, "comfortable" listening requires an SNR of 10 dB, i.e., a signal that is considerably above the 0 dB noise floor.

Keep in mind that the absolute amplitudes of the noise and signals are not as important as the signal-to-noise ratio. Of course, as you start digging for weaker and weaker signals, the amplitude of the noise signal must be suppressed in order to get a usable SNR.

AC Power Line Noise

Perhaps the most common form of man-made noise afflicting radio and television reception is from the AC power lines. When I first moved into my present home, my HF shortwave receivers were all but useless because of the high "hash" level of noise present.

The problem turned out to be a collection of "dimmer" switches that replaced the ordinary light switches. Those devices use a duty-cycle SCR circuit to lower the power level of incandescent lights, and the truncated waveform they produce is rich in harmonics (well into the HF bands!).

I replaced all six dimmers with conventional switches, and the noise level dropped enough decibels to be really impressive.

Over the years, I have found a large number of non-radio sources of interference to AM broadcast band (BCB), FM BCB, high fidelity audio, and television equipment in addition to shortwave and scanner receivers.

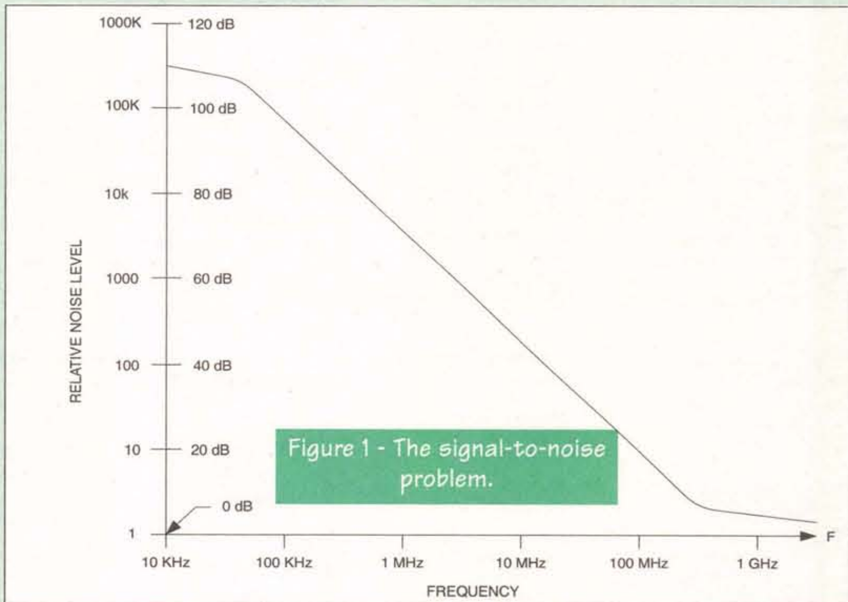

Figure 1 - The signal-to-noise problem.

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Included are: electric motors, a microwave oven, loose tie-wires on AC mains transformers (on the pole outside the home), and electrical space heaters.

Many different forms of appliances were indicted, including (oddly enough) a dishwasher that has an SCR controller inside to turn it on and off, a garbage disposal unit under the complainant's sink, a garage door opener, and the most raucous door bell-chime I've ever heard.

Two forms of noise seem to be present. First, the harmonics of the 60 Hz power line waveform are present throughout the spectrum. If the power line produced a pure sinewave, then this would not occur. But the power line waveform is distorted, so has harmonics. Because the power levels are so high, the significant harmonics form a "comb" spectrum every 60 Hz high into the radio frequency spectrum. Second, any item that sparks (e.g., electric motors) will produce static signals much like lightning does.

Dealing With AC Power Line EMI

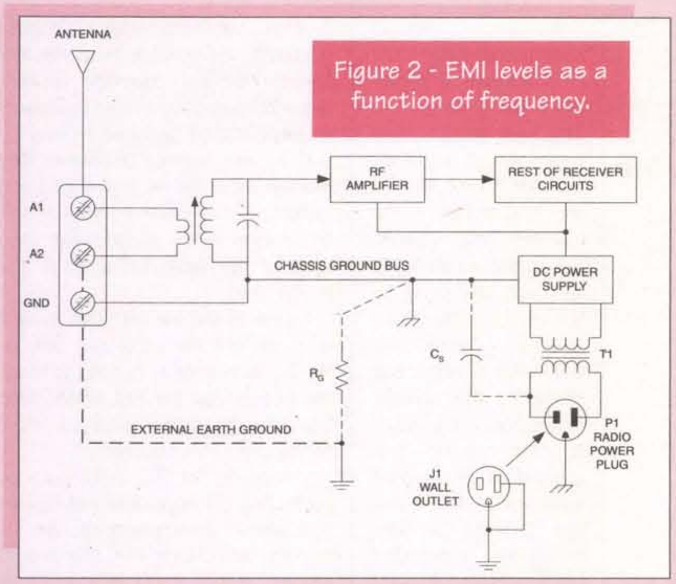

Figure 2 - EMI levels as a function of frequency.

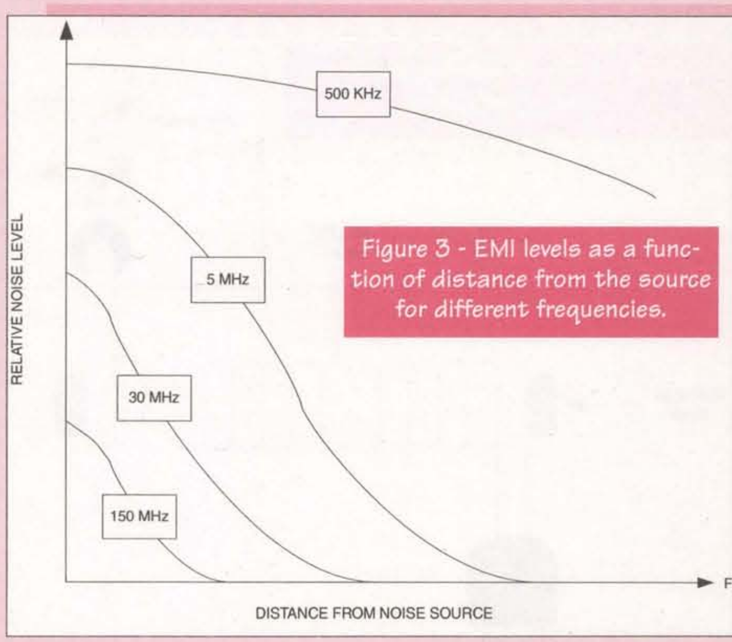

Figure 3 - EMI levels as a function of distance from the source for different frequencies.

Figures 2 and 3 characterize this noise emission in two different ways. Figure 2 shows the relative level in arbitrary units versus frequency. Typical intensity levels might run from a fraction of a microvolt per meter (µV/m) to nearly 500,000 µV/m, depending on the source (which is why Figure 2 is in "arbitrary voltage units").

Note in Figure 2 that the distribution of signal intensity is uneven throughout the spectrum. The levels will be extremely high in the VLF portion of the spectrum, and fall off almost evenly up into the UHF spectrum. If you tune into the AM BCB or medium wave bands (up to about 7 MHz or so), then you will note a high hash level. It is more intense on the lower frequencies, but annoying well into the shortwave bands.

Figure 3 characterizes the 60 Hz power line EMI problem as a function of distance from the noise source. Again, because the actual values of the distance and signal strength vary with your particular situation, relative units are used in Figure 3. Note that the 500 KHz (bottom of AM BCB) strength does not fall off nearly as fast as the higher frequency components.

This fact leads us to a strategy for finding the source. Start at the lowest frequency, and tune to higher frequencies until the noise just begins to disappear. You want it audible, but barely so. Walk, drive, or turn your antenna in first one direction and then the other to see in which direction an increase is noted. Go in that direction until the signal is again strong.

At that point, pick another higher frequency at which the noise is just barely audible and repeat the process. This process is repeated at successively higher frequencies until you are very, very close to the source. At that time, start looking for likely culprits.

Once the source is located, it can be dealt with by one or more methods. If it is the power line (loose connections raise hob with reception!), then contact the power company and ask them to fix it ... demand it if they balk. If it turns out to be an appliance, then either the appliance needs repair or some sort of filtering is needed.

Unless it is your appliance, I recommend having a professional technician actually do the work. If you do the necessary work on your neighbor's appliance, then you will be "married to it" if anything at all goes wrong even in the distant future (some people will use any excuse to get someone else to pick up their tab).

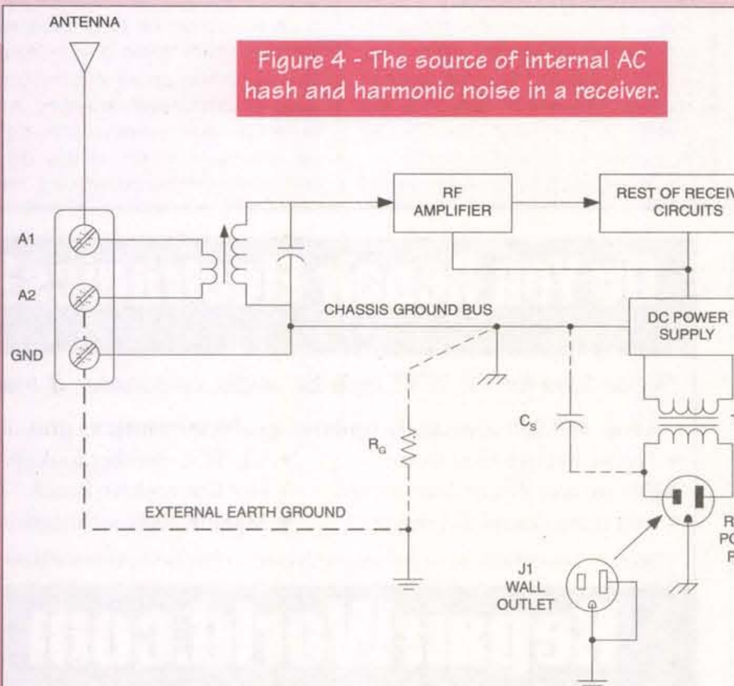

Figure 4 - The source of internal AC hash and harmonic noise in a receiver.

Things To Do At Your Receiver

You may or may not be able to do something about the noise source (which is always the best solution!), but there are some things that you can do about the problem at your receiver. Let's take a look at some of those problems.

First, let's look at one of the sources of the problem. Let's assume

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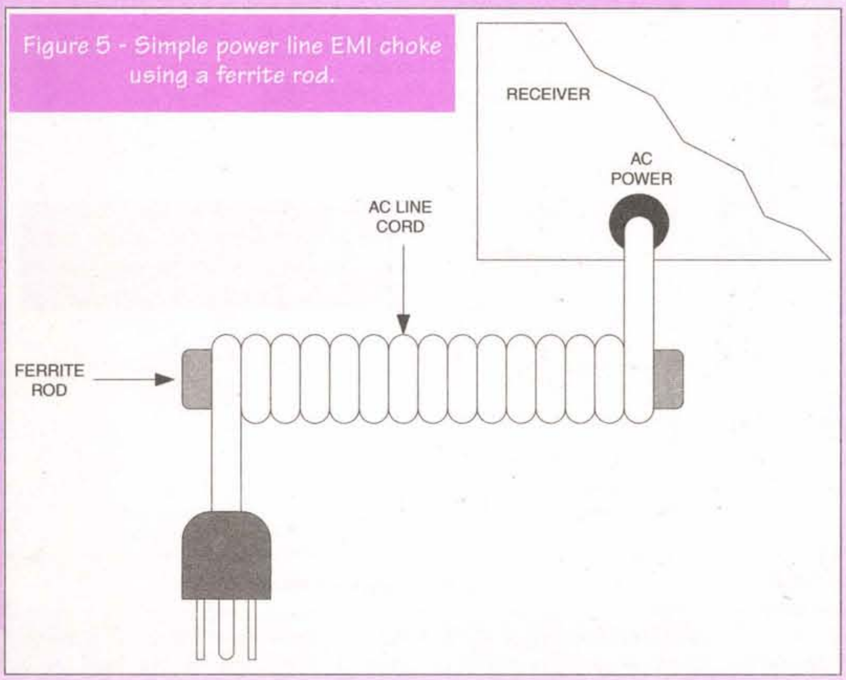
Dealing With AC Power Line EMI

Figure 5 - Simple power line EMI choke using a ferrite rod.



a generic shortwave or scanner receiver with a three terminal antenna connector (Figure 4).

The antenna terminals include A1 and A2, which lead to the antenna input circuitry, and GND which is the chassis ground (and zero-signal common). There is normally a coupling path between the AC power wiring and the chassis of the receiver.

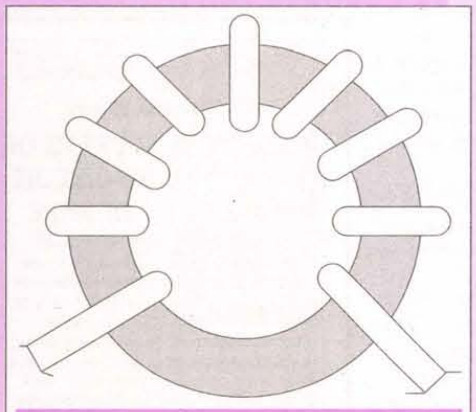


Figure 6 - EMI choke using toroid core.

The capacitance between the AC power wiring and the chassis forms a path, represented by capacitor CS in Figure 4. This means that noise-laden AC is passed onto the receiver chassis, where it can be coupled into the RF amplifier and the rest of the circuit due to common ground impedances (RG).

Assume first that the external antenna is attached to A1, and that both A2 and GND are not connected. In this circumstance, the ground loop voltage developed across RG is seen as a valid signal by the receiver. The radio chassis is eventually grounded to earth, but through the power connectors (P1 and J1), to the power line ground at the service entrance to the building. Because of wire resistance, connector blade resistance, and the fact that your service entrance ground might be poor for RF, the value of RG can get quite high.

The solution: add an external ground connection to the receiver the way the instruction manual told you to do – strap A2 to GND, and then through a heavy conductor to a proper ground rod buried in the earth. That may eliminate a large part of the power line hash without further work.

AC Power Cord Chokes

Now let's assume that the receiver is properly grounded, but that a high noise level still exists. It may be that the RF components are riding into the receiver via the power lines, and then radiated into the sensitive circuitry. The way to deal with this problem is to eliminate them before they enter the receiver cabinet.

It is often hard to diagnose this problem, but if the receiver is battery powered, the problem is easier. My favorite general coverage receiver has a DC connector on the rear panel to allow it to be operated from a 12-volt battery source. Disconnect the receiver from the AC power line and operate it from the battery. If the noise level drops appreciably, then suspect the entrance path is the power cord.

One of the easiest ways to deal with the problem is to use only as much power cord as needed to reach the outlet. Coil the rest of the cord into a six-inch diameter loop as close to the chassis as possible.

A species of "RF choke" can be built using the approaches of Figures 5, 6, and 7. The simplest approach is to wrap the receiver's AC power cord around a ferrite rod (Figure 5) as close as possible to the power entrance on the rear panel of the receiver.

Any of several ferrite rods can be used, but the Amidon Associates R61-050-750 is appropriate. Wrap as many turns as will fit onto the 7.5-inch rod, and then secure them with tape (they have a tendency to come unwrapped). There should be enough cord left to plug into the outlet, but even if you have to use an extension cord, wrap as many turns as will fit onto the rod.

A superior approach to the same idea is to use a toroid core as shown in Figure 6. Use one of the larger toroid cores (the kind used for making kilowatt and up BALUN transformers) so that the relatively thick coaxial cable can be accommodated. Wrap as many turns of the power cord as possible onto the toroid core. Note one thing well, however, with the power plug connected this might be impossible to do. If you don't want to modify the power cord, then

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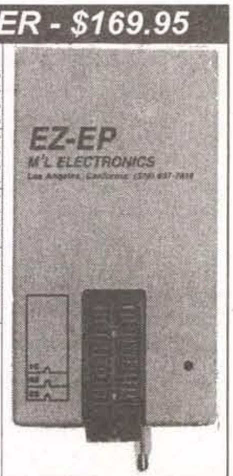

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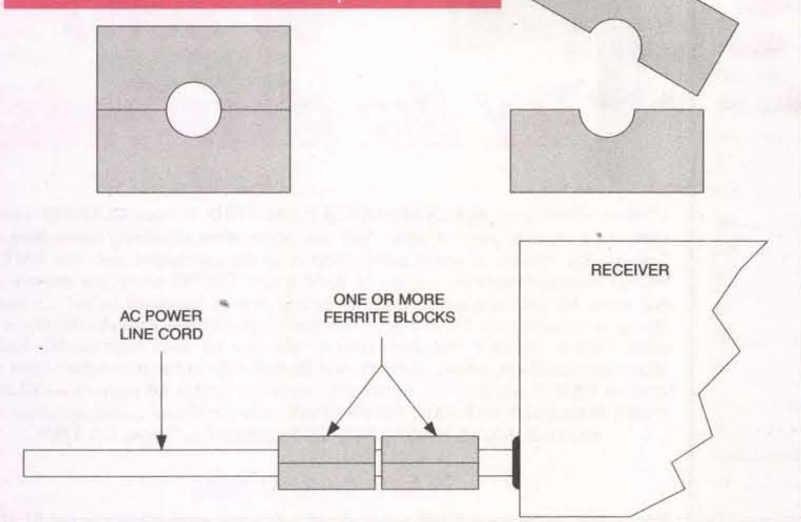
Dealing With AC Power Line EMI

Figure 7 - EMI choke fashioned by clamping ferrite blocks onto the AC power cord.



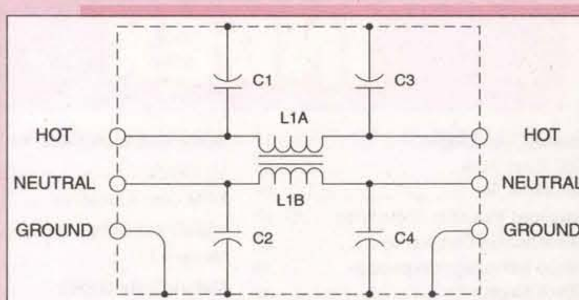


Figure 8 - AC power line EMI L-C low-pass filter (see warning in text).

you might want to either use the ferrite rod approach, or a ferrite block as shown in Figure 7.

Two views of a ferrite split block are shown in Figure 7A. These blocks come in two halves, each of which is notched such that when put together they form a hole. The application of these blocks is shown in Figure 7B. The blocks are clamped onto the receiver's AC power cord as close as possible to the rear panel of the receiver. Once the blocks are clamped together, they can be secured with tape. In some cases, only a single split block is needed but, in severe cases, two or more split blocks may be added in series. These blocks act like RF chokes, so will snub the higher frequency components while not affecting the 60 Hz AC power.

Ferrite split blocks are available in a number of sizes and shapes to accommodate a number of different forms of cord. Some are flat to allow clamping onto computer ribbon cable, in case a digital device such as a computer is the noise culprit.

AC Power Line Filters

Another way to deal with the problem of EMI carried into the receiver on the AC power line is shown in Figure 8. The idea here is to use a low-pass filter in series with the AC power line so that the RF components are snubbed out, leaving the 60 Hz to pass unimpeded.

Several filter designs are popular. Some of them use separate pi-section filters in both the hot and neutral lines, while the other uses a pair of coupled coils in a common mode arrangement such as Figure 8.

This design uses a ferrite rod such as the Amidon Associates R61-050-750 to form L1A and L1B. The turns are wrapped onto the cord with a size of AC power wire appropriate to the size. For the maximum power levels, use #12 AWG solid wire intended for AC power wiring applications. The turns for L1A and L1B are wound in the bifilar manner (Figure 9).

The capacitors used in the filter of Figures 8 and 9 should be rated for 125 volt AC service. Ordinary 600 volt or 1,000 volt capacitors are not suitable because they are not rated for constant application of 125 volts AC power line voltage. A typical rating for C1 through C4 is 0.0047 μF to 0.05 μF (0.01 μF typical) at a voltage rating of 125 volts AC, and 1,400 volts DC (tested to at least 2,800 volts DC). Electronic parts catalogs are a good guide to suitable types of capacitor.

SAFETY NOTE: Working with AC power lines is dangerous. Accidental contact with the line can kill you. Improper wiring or a bad selection of components, or improper construction methods can create both electric shock and fire hazards. It is highly recommended by the author, editor, and publisher that you select a commercially made, UL approved AC line RF filter made for this purpose rather than homebrew your own. If your receiver uses the same kind of square AC power receptacle that IS found on computers, then you can find a replacement for the chassis receptacle that has an EMI filter built in.

Special Case

About five years ago, I had a problem at my house that created AC power line hash in great quantities, and also affected my AC power service. For several years, I listened to an evening shortwave broadcast in the 5-6 MHz band, and on Saturday night to WSM in Nashville (650 KHz AM) ... good country music is where you find it (There! I'm out of the closet ... a Carr's a hillbilly music fan!).

The hash started one summer, and continued into the fall, ruining many evenings of listening. It had an average signal strength of S7 to S8 on my Drake R-8 receiver S-meter. I suspected that the problem was on the power pole, but the local power company could not find any problem.

That winter, a strange thing started happening with the lights in my home. Whenever any heavy current drain (refrigerator, freezer, furnace) would turn on, the lights would nearly double in brightness. Notice anything odd? Lights should dim, not get brighter, when a heavy load is turned on.

This time, the power company did find a problem. The technician came to the Carr house about 10 o'clock one evening, when the effect was nearly constant, and found that the neutral line connection to my AC power line service was loose.

The fellow raised his "cherry picker" basket up to the power pole, at the point where my service tap was located, and used the largest crimping tool I've ever seen to repair the connection. The lights went back to normal, which was a blessing.

But the next evening, I noticed that the S-8 noise level was down somewhere near decimal dust ... the hash was gone. I suspect that the loose connection was causing the hash all along. Indeed, the power company could have fixed the service problem earlier if they had taken the EMI problem seriously. The hash was merely a prodomal symptom of the service problem!

Conclusion

AC power line harmonics and spark hash can create havoc with radio reception. But with the methods discussed in this article, you will be able to overcome many of these problems. **NV**

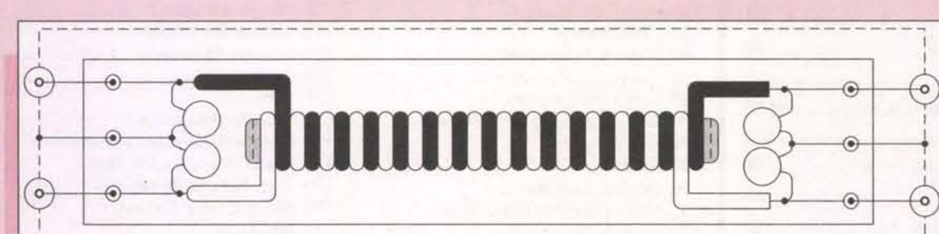


Figure 9 - Construction of the power line EMI filter.

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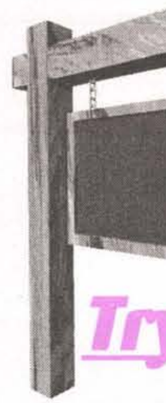

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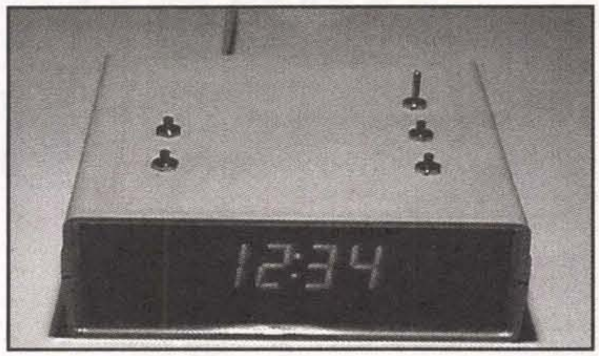

Alarm clocks have become so common and cheap that it's hard to find a construction project for a complete alarm clock. This article is just that, a complete alarm clock, from the power supply to the case. While it's probably no cheaper than one from K-Mart, unlike most construction projects, at least when it's built, your spouse won't need to ask, "What is it?"

Hardware

The alarm clock has all the basic features found in most commercial digital alarm clocks. The block diagram shown in Figure 1 breaks the alarm clock into four parts: power supply, alarm, microcontroller, and display. There are actually two circuit boards that make up the alarm clock: the DB1 display board and the CK2 circuit board which includes the power supply, alarm, and microcontroller.

Display Board

Display Controller

The DB1 is based on the MC14489, U1 in Figure 2. Motorola calls this chip a "Multi-Character LED Display/Lamp Driver." It's quite a versatile device, capable of driving a five-digit common-cathode display plus decimals, 25 discrete LEDs, or just about any combination in between. In the DB1 circuit, it drives four seven-segment digits plus colon while the fifth digit is used to drive four annunciator LEDs. It does this by multiplexing segments "a" through "h" among the five digits, or five banks as they are called on the IC's data sheet. The MC14489's internal oscillator guarantees a minimum refresh rate of 700 Hz, more than fast enough to insure a flicker-free display. Other than the LED display, the only external component required is a single resistor (R1) to set the maximum segment drive current. Drive currents can go as high as 30 mA per segment, but thermal considerations become critical at high drive currents. The DB1 is designed for a peak segment drive current of approximately 12 mA.

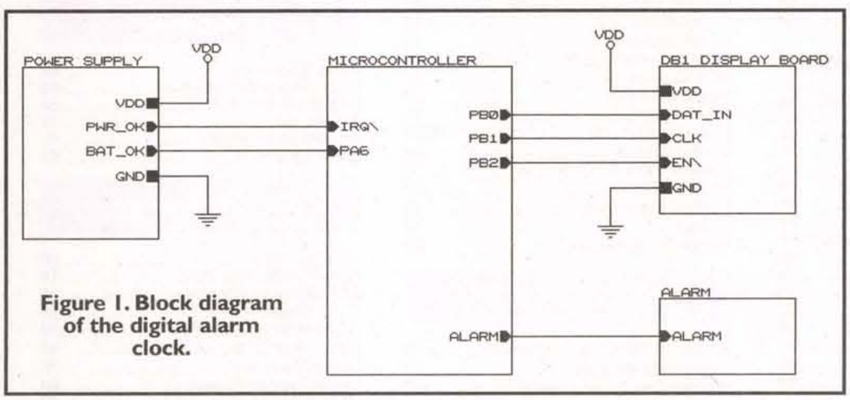

Figure 1. Block diagram of the digital alarm clock.

The MC14489 has an eight-bit configuration register and a 24-bit data register. The configuration register controls blanking and how each digit's data is decoded.

Communication with the MC14489 is via a synchronous serial interface. For details on the serial interface or programming the MC14489, consult the part's data sheet which can be downloaded from the Motorola web site, http://www.mot-sps.com/.

LED Display

The actual display is a CC56-21EWA multiplexed LED module. This is a high efficiency red, four digit, common cathode, seven-segment display with 0.56" high digits.

The four discrete LEDs on the DB1 are annunciators. Their functions are shown in Figure 3. The upper-left LED is lit whenever the alarm is enabled. This will tell you at a glance whether you have the alarm turned on.

Main Circuit Board

Power Supply Circuitry

Now we return to the main circuit board, the CK2. Figure 4 shows the power supply. The alarm clock can be powered by a 9VDC wall transformer or a 9V backup battery. D1 and D2 isolate the 9VDC wall transformer and backup battery from each other. All the alarm clock circuitry runs on +5V, which is provided by U1, a 78S40 universal switching regulator subsystem. This high-efficiency step-down regulator keeps heat build-up at a minimum and extends the battery life when main power is off.

The regulator is designed to deliver +5V at up to 100mA of current. For normal operating conditions, the alarm clock draws between 30 and 50 mA, depending on the number of active segments in the display. When running off the battery in low power mode, the current drain drops to 5 mA. For an excellent tutorial on designing with the 78S40, see Motorola application note AN920.

Two comparators from the LM339 (U2) quad-comparator comprise the voltage monitoring portion of the power supply circuitry. U2A monitors the battery voltage and U2B monitors the 9VDC input at J2. Both comparators use a resistive divider to drop the monitored voltage close to the 1.2V reference from the 78S40. The total resistance of the divider for the battery (R4+R7) is high so the current drain on the battery is low.

In fact, as long as external voltage is applied at J2, reverse leakage current through D2 keeps the net drain on the battery near zero. Because the battery voltage drops slowly, hysteresis is required to prevent erratic switching. The output of U2A (BAT_OK) switches from high to low

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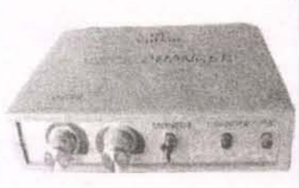

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as the battery voltage falls below 6.5V, and back high as battery voltage rises above 7.4V. Hysteresis is also required on U2B because most DC wall transformers have large filter capacitors that cause the 9VDC to decay slowly when the main AC supply fails. The output of U2B (PWR_OK) switches from high to low as the voltage at J2 falls below 8.2V, and back high as the voltage rises above 8.6V.

Microcontroller

The MC68HC705J1A microcontroller, or J1A for short, is shown as U3 in Figure 5. The J1A has 1240 bytes of one-time-programmable (OTP) EPROM, 64 bytes of RAM, a 15-stage multifunction timer with prescaler, and 14 bidirectional I/O lines. For complete data on the MC68HC705J1A, see the technical data manual available from Motorola. The crystal frequency is 4.1943MHz which is 2^22. The J1A operates at half the crystal frequency or 2.097152MHz. Since the operating frequency is an exact binary number, the multifunction timer can produce real-time interrupts at integer Hertz rates. The alarm clock software sets the multifunction timer for 16 real-time interrupts per second.

The J1A's I/O lines are divided among two ports, port-A has eight lines (PA0-PA7) and port-B has six (PB0-PB5). On the CK2, PA0-PA5 are all used as inputs with pullup resistors. PA6 is an input for the BAT_OK signal. PA7 is an output and controls the alarm. PB0-PB2 are outputs to the display board.

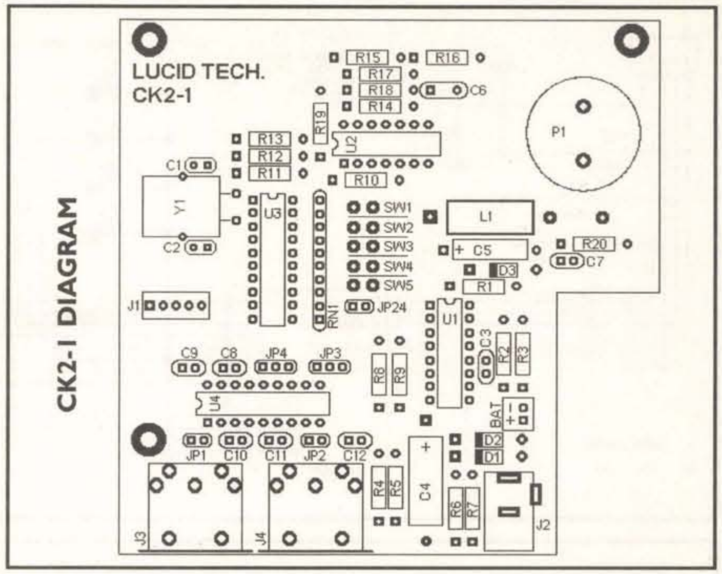
Controls

PA5 connects to a jumper used to select a 12- or 24-hour display format. Grounding PA5 (closing jumper JP24) will give you the 24-hour display. The function is controlled by a jumper, because most people have a definite preference, but a switch can be connected if you want to switch between display modes. If you hardwire the 24-hour display, the AM/PM indicators on the display board will never come on, so you need not even install them.

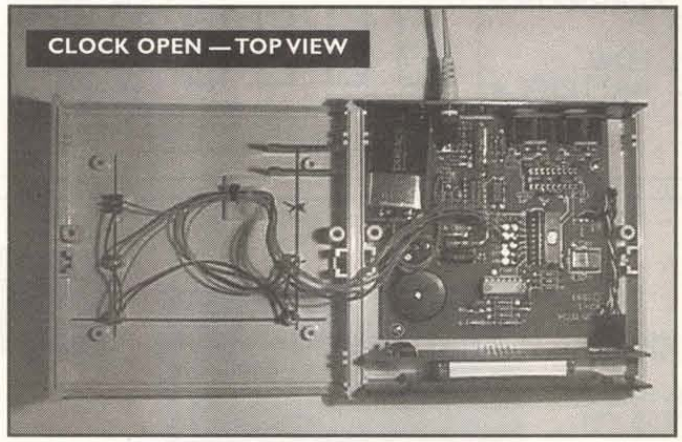
PA0-PA4 connect to user operated switches. Each switch connects to a pair of pads on the CK2 circuit board. The five pairs are marked SW1-SW5. The TIME_SET, ALARM_SET, HOURS_SET, and MINUTES_SET switches are all normally-open push buttons. The TIME_SET button allows you to set the time of day. Pressing it together with the HOURS_SET button will increment the hours digit until one of the buttons is released. Similarly, the TIME_SET and MINUTES_SET buttons will increment the minutes digit. When you press and hold the ALARM_SET button, the display will show the alarm time. While the alarm time is displayed, it can be changed with the HOURS_SET and MINUTES_SET buttons.

The ALARM_ENABLE switch can be an SPST toggle, or an SPST toggle in parallel with a normally-open push button. The ALARM_ENABLE switch connects to PA4 via SW5. When the switch is open, PA4 is high and the alarm enabled LED will be lit. At the first second when the time of day equals the alarm time, the J1A will turn on the alarm circuit if PA4 is high.

To turn off the alarm, PA4 only needs to be grounded for 1/16 of a second. A momentary push button works fine to turn the alarm off, but as soon as you release the button, the alarm is enabled for the next day. On the other hand, if the ALARM_ENABLE switch is a toggle, the alarm will turn off as soon as the switch is toggled closed, but you have to remember to toggle it back open to re-enable the alarm. However, the toggle will allow you to turn the alarm off for the weekend whereas the push button will not.



CK2-1 DIAGRAM


CLOCK OPEN — TOP VIEW

Alarm Circuitry

The alarm circuitry is shown in Figure 6. Comparator U2C is configured as a gated oscillator. The gate signal (ALARM) is the PA7 I/O line from the J1A. When PA7 is high, the output of U2C is a 1300 Hz squarewave. When PA7 is low, the output of U2C is low. R18 and C6 set the oscillator's frequency according to the equation F =1/(1.388*R18*C6) where R18 >= 10*R19. U2D functions as an inverting speaker driver. When U2C is low, U2D is high and both terminals of the

DB1 PARTS LIST

Qty.	Ref#	Part
Resistors		
1	R1	3.3K, 0.25W, 1% (orange-orange-black-brown)
3	R2-R4	10K, 0.25W, 5% (brown-black-orange-gold)
Capacitors		
1	C1	0.1uFd
Semiconductors		
4	D1-D4	Red T-1 LED
1	DISP	CC56-21EWA, four-digit multiplexed display module
1	U1	MC14489P
Other components		
1	DB1	Circuit board

CK2 PARTS LIST

Qty.	Ref#	Part
Resistors		
1	R1	1.0 ohm, 0.25W, 5% (brown-black-gold-gold)
1	R2	30K, 0.25W, 5% (orange-black-orange-gold)
1	R3	10K, 0.25W, 5% (brown-black-orange-gold)
1	R4	2.2M, 0.25W, 5% (red-red-green-gold)
1	R5	6.8K, 0.25W, 5% (blue-gray-red-gold)
2	R6,R20	1.2K, 0.25W, 5% (brown-red-red-gold)
1	R7	470K, 0.25W, 5% (yellow-violet-yellow-gold)
7	R8, R11-R16	330K, 0.25W, 5% (orange-orange-yellow-gold)
1	R9	1K, 0.25W, 5% (brown-black-red-gold)
1	R10	10M, 0.25W, 5% (brown-black-blue-gold)
1	R17	150K, 0.25W, 5% (brown-green-yellow-gold)
1	R18	560K, 0.25W, 5% (green-blue-yellow-gold)
1	R19	15K, 0.25W, 5% (brown-green-orange-gold)
1	R20	1.2K, 0.25W, 5% (brown-red-red-gold)
1	R21	33K, 0.25W, 5% (orange-orange-orange-gold)
1	RN1	10-pin, 10K, pin-1 common
Capacitors		
2	C1,C2	20pFd,25V
1	C3	680pFd, 10%
1	C4	47uFd, 35V axial electrolytic
1	C5	22uFd, 25V axial electrolytic
1	C6	0.001uFd
3	C7,C8, C13	0.1uFd
Semiconductors		
3	D1,D2, D3	1N5818, 30V Schottky rectifier
1	U1	78S40, switching regulator
1	U2	LM339, quad comparator
1	U3	MC68HC705J1A, microcontroller
Other components		
1	Y1	4.1943MHz crystal, HC-49
1	L1	100uH coil
1	J2	DC power jack, 2.1mm center pin
1	P1	Piezoelectric speaker, AT-20K or equal
1	JP24	Two pin header
1	BAT	Battery connector (red +, black -)
1	U1	16-pin low profile socket
1	U2	14-pin low profile socket
1	U3	20-pin low profile socket
1	CK2	Circuit board

The following are available from:

Lucid Technologies
12907 Crookston Lane, Unit 22
Rockville, MD 20851
http:/www.cs.net/lucid/

1) The big kit for $39.00. Everything needed to build the alarm clock described in the article except the case, switches, and wall transformer.
2) The small kit for $31.00. This includes only the circuit boards, integrated circuits, four-digit LED display module, discrete LEDs, red Plexiglass window, and one capacitor.
3) ICs and display-only kit for $20.00. This is the kit for you if you don't intend to use the case or circuit boards shown in the article. It includes only the following parts:

78S40 universal switching regulator
LM339 quad comparator
MC68HC705J1A programmed microcontroller
MC14489 multi-character LED display driver
CC56-21EWA four-digit LED display

NOTE: Schematics, source code, assembly instructions and users manual are supplied on disk. Include $3.20 for shipping in the US and Canada, $6.00 elsewhere. Maryland residents include 5% sales tax.

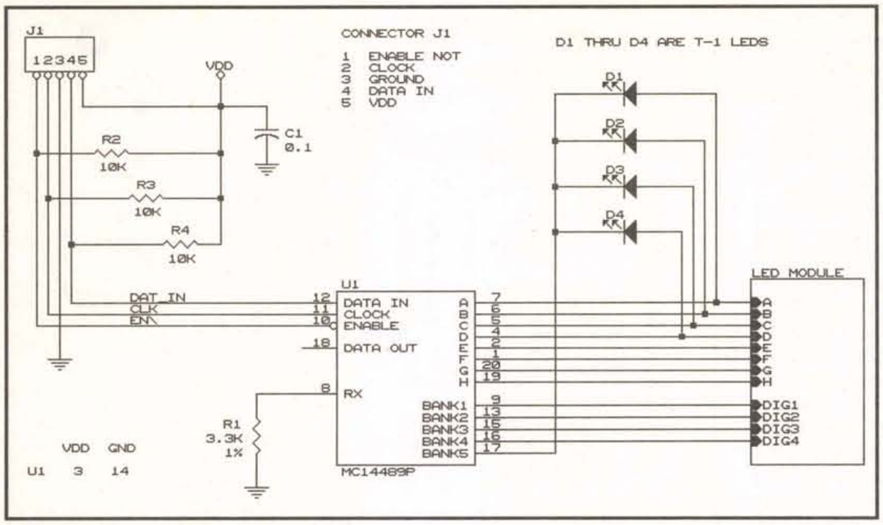


Figure 2. Schematic of the DB1 display circuit board.

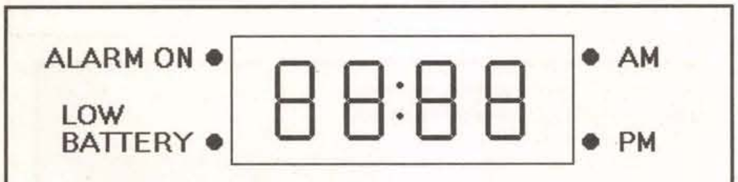
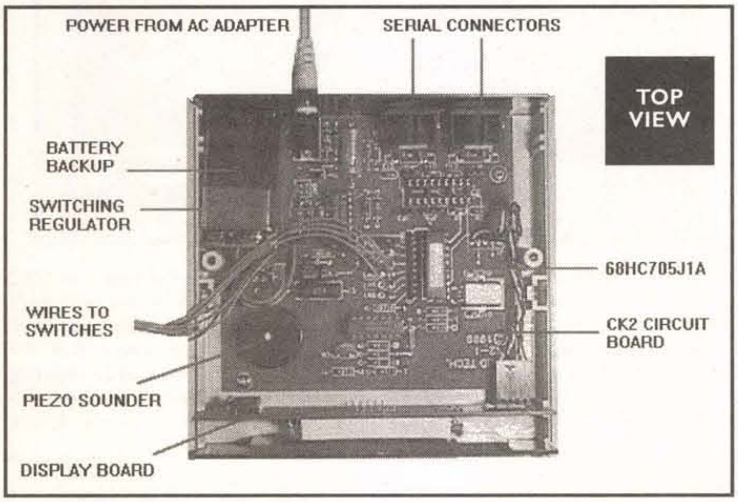


Figure 3. Function of annunciator LEDs.



piezoelectric speaker are at the same potential so there is no audio output. When U2C oscillates, U2D applies a 5V squarewave to the piezoelectric speaker.

In addition to the circuitry mentioned above, the CK2 also includes an RS-232 serial communications link. Since this feature is not used with the digital alarm clock, the components associated with it are not installed on the CK2.

Software

There isn't enough space to print the entire assembly language source code in this article. However, it is available on the *Nuts & Volts* website. The source code is well-commented and highly modular, so it should be easy to understand.

The code begins with several blocks of comments. These explain the memory map, functioning of all the ports, and the display interface. Mixed in with the comments are a large number of equate (EQU) statements. Equates associate understandable names with the numeric values used to reference various registers and memory locations. These equates make the difference between readable code and undecipherable hieroglyphics. The next section of code is the RAM definition area.

This section doesn't actually generate any code, but it does assign variable names to addresses in RAM. The subroutines come next in the program. One of the subroutines converts binary values to BCD, another converts 24-hour time to a 12-hour format, and another serializes the data before sending it to the display board. Internally, all times are kept in a 24-hour format, so the alarm will go off only once a day, even if you select the 12-hour display format.

Setting the time

Two other subroutines are responsible for setting the time of day and alarm time. Both of these subroutines call a delay subroutine that monitors how long you hold the "set" push buttons depressed. For example, if you press the TIME_SET and MINUTES_SET push buttons, the minutes will increase by one immediately.

If you keep both buttons depressed, the next increment will occur after 0.8 seconds; the interval between increments will then get smaller and smaller until it reaches a rate of five per second. This way, you can rapidly change a value by holding both buttons. Note that when the TIME_SET button is released, the seconds counter is cleared so that timekeeping resumes from the start of the displayed minute.

Program flow

At power-up, control is transferred to the address stored in the reset vector. In this case, it is the label "RESET." This portion of code configures all the J1A I/O lines, and sets the multifunction timer for 16 real-time interrupts per second. All variables are initialized and the memory holding the current time is set to 0000, midnight in the 24-hour format. It then starts flashing the display on for one second, then off for one second until the TIME_SET button is depressed. Once the correct time is set, the program enters the main loop.

The main program loop (at the label LOOP) begins by putting the J1A in the WAIT-mode. The J1A must be brought out of WAIT-mode by an interrupt. When a real-time interrupt occurs, execution jumps to the real-time interrupt service routine, TICK. In the TICK routine, the memory locations holding the current time are incremented by 1/16 of a second. Execution then returns to the instruction following the WAIT instruction. After a real-time interrupt tick, the program checks the status of PWR_OK.

Assuming PWR_OK is true, the program branches to the normal power mode at label ML100. The program checks the TIME_SET and ALARM_SET switches and calls the appropriate subroutines as required. The program clears the alarm condition flag if the ALARM_ENABLE input (PA4) is false.

Next, the program checks to see if it is the first tick of a new second. If it is, the display is updated. If it is the start of a new second and ALARM_ENABLE is true, the program compares the alarm time to the time of day.

If the times are equal, the alarm condition flag is set. While the alarm condition flag is true, the program will pulse the alarm on for one second, then off for one second for up to 30 minutes. Note that, in normal operation, switches are monitored every 1/16 of a second and the display is updated once a second. Finally, execution branches back to the LOOP label.

If PWR_OK is false, and has been for 32 consecutive real-time interrupt ticks, the program branches to low power (battery backup) mode at label LP100. When first entering low power operation, the alarm clock will turn off all LED displays to conserve battery power. After the first real-time interrupt tick of every second, the program compares the alarm time to the time of day.

If the times are equal and ALARM_ENABLE is true, the alarm condition flag is set. While the alarm condition flag is true, the alarm will sound continuously for up to 59 seconds or until the ALARM_ENABLE input goes false.

Note that there is no visible indication of operation in low power mode and none of the SET switches will work. But as long as the battery lasts, the alarm will sound at the alarm time set before main power failed. This could keep you from missing work if a thunderstorm knocks the power out during the night. Finally, execution branches back to the LOOP label.

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BP-83 pack 7.2v 600mAh $23.95
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For KENWOOD TH-77, 75, 55, 46, 45, 26, 25:
PB-6x (NiMH, w/chg plug!) 7.2v 1200mAh $34.95

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Interrupts

Following the main program loop, we come to the interrupt service routines. The first is TICK, the real-time interrupt service routine. TICK uses indexed addressing to access two tables: the time-of-day table (label TODAY) in RAM, and the rollover table (label RLOVR) in EPROM. Each time the real-time interrupt causes TICK to run, the TICKS variable is incremented. If TICKS is >= its rollover value, it is cleared and the next higher variable in the time-of-day table is incremented. This process continues until there is no rollover or the entire time-of-day table is cleared, which happens every midnight. Finally, TICK clears the real-time interrupt flag, which enables the next real-time interrupt.

The second interrupt service routine is HICK, the external interrupt (IRQ) service routine. This routine consists of a single return from interrupt (RTI) instruction. The IRQ pin is tied to the PWR_OK signal monitoring the external 9V power supply. Thus, a falling edge on PWR_OK can trigger an IRQ interrupt. The IRQ input is monitored in the normal course of the program, so at first glance, it would seem that an interrupt service routine is not needed. Normally, one could simply disable the IRQ interrupt, but, to help keep power consumption low, the alarm clock program uses the WAIT instruction. WAIT automatically enables the IRQ interrupt so a minimal interrupt service routine must be provided.

Special registers

A special byte in EPROM — at address 07F1 — is called the mask option register (MOR). It controls several J1A hardware options. For the alarm clock, the MOR is programmed for: a 2M resistor across the oscillator pins, EPROM access allowed, no port-A interrupts, IRQ edge triggered, and watchdog timer disabled.

The J1A has four 16-bit interrupt vectors. Each vector contains the address for an interrupt service routine. When an interrupt occurs, the appropriate vector is fetched and execution branches to that address. The vectors are: 07F8/9 = Timer interrupt. This is the real-time-interrupt. The vector points to TICK. 07FA/B = External interrupt. This is the IRQ pin. The vector points to HICK. 07FC/D = Software interrupt. This is not used. The vector points to RESET. 07FE/F = Reset. The vector points to RESET.

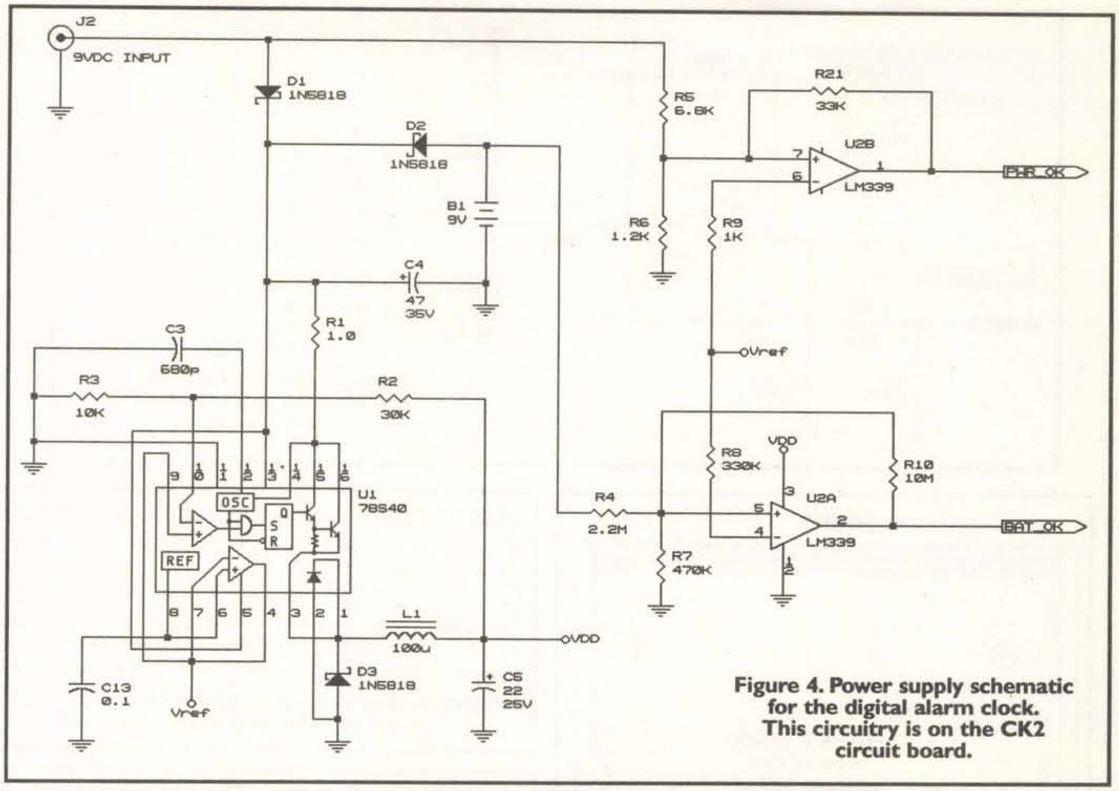


Figure 4. Power supply schematic for the digital alarm clock. This circuitry is on the CK2 circuit board.

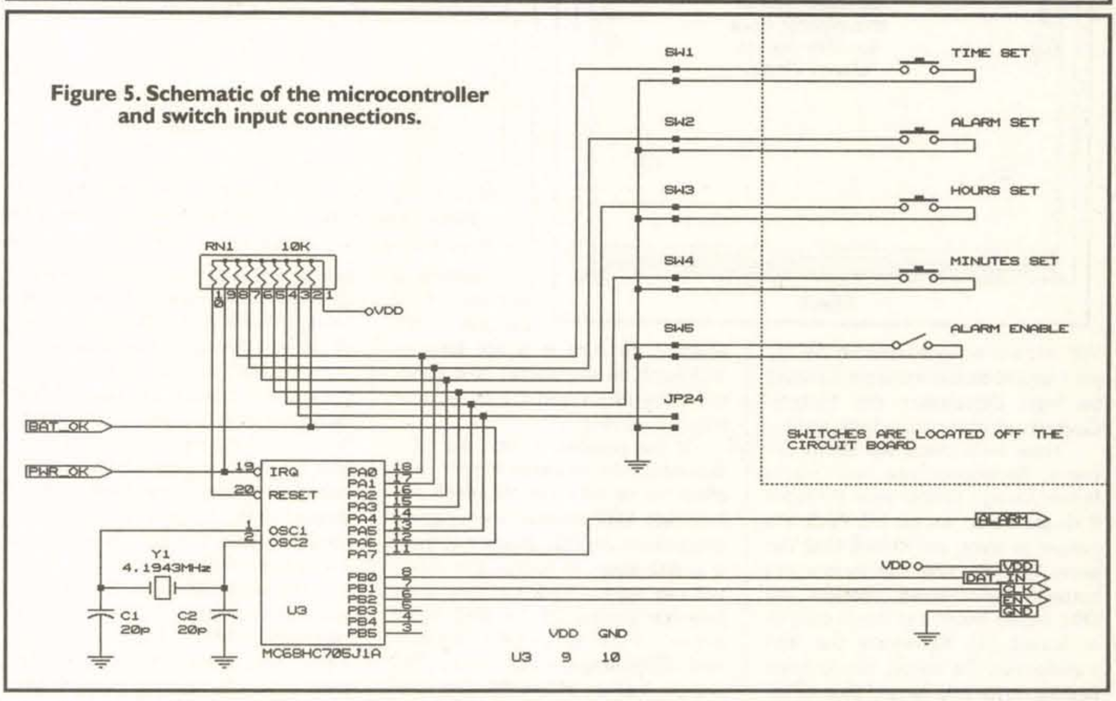


Figure 5. Schematic of the microcontroller and switch input connections.

Circuit Construction

The DB1 and CK2 circuit boards were designed to fit in a plastic case sold at RadioShack stores; you can, of course, put the clock in any case you like. If you don't purchase the circuit boards, you can put all the circuitry on one board instead of two. You can include a transformer and full-wave bridge in the clock case so you don't need a wall transformer. You can use a different LED display, but if you do, consult the MC14489 spec about setting the maximum segment drive current for your display.

For now, though, we'll assume you are building the alarm clock using the DB1, CK2, and RadioShack case. Detailed assembly instructions are included with the circuit boards. The only unusual thing about assembling the boards is that the DB1 has components on both sides. The LED module and discrete LEDs are on the front side, while all the other components are on the back or inside.

Circuit Board Checkout

Once the boards are assembled, you will need a multimeter or oscilloscope to check out the circuitry. You'll also need the wall transformer at this time. You can use any wall transformer with a 9VDC output — 100 mA or more — and a coaxial power plug with 5.5mm O.D. and 2.1mm I.D.

Place the CK2 circuit board on an insulating surface. *DO NOT install the ICs in their sockets or attach a battery yet.* Attach the negative lead of your voltmeter to ground, such as the negative side of C4 or C5. Plug in the wall transformer and connect it to J2 on the CK2. The supply voltage should measure at least 9VDC at pins 5 and 13 of socket U1. Disconnect the wall transformer at J2, then insert the 78S40 in socket U1. Reconnect the wall transformer, then measure the voltage on the positive side of C5 (Vdd). The voltage should be between 4.8 and 5.1 volts.

Disconnect the wall transformer again, then insert the LM339 in socket U2. Reconnect the wall transformer, then measure the voltage at pin 4 of the 78S40. The voltage should be between 1.1 and 1.3 volts. This is the reference voltage (Vref) for the comparators. Next, we'll check the power monitoring comparators. With the wall transformer connected, measure the voltage at pin 1 of U2; it should be high. Measure the voltage at pin 2 of U2; it should be low. Now connect a fresh battery (Vbat >= 8V) to the CK2 battery connector. U2 pins 1 and 2 should both be high. Disconnect the wall transformer at J2 while leaving the battery connected. Confirm that

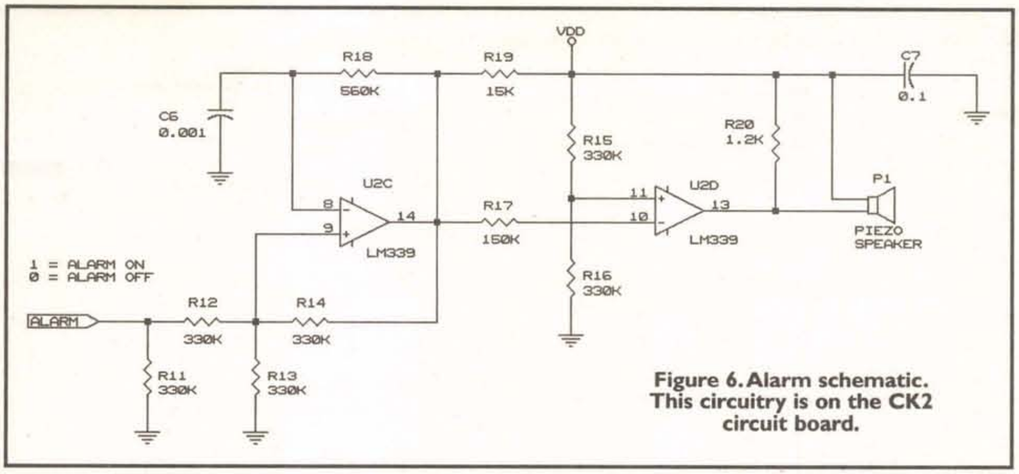


Figure 6. Alarm schematic. This circuitry is on the CK2 circuit board.

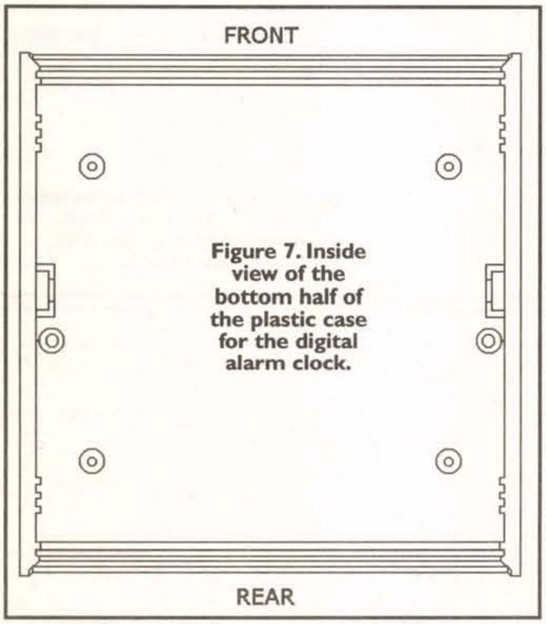


Figure 7. Inside view of the bottom half of the plastic case for the digital alarm clock.

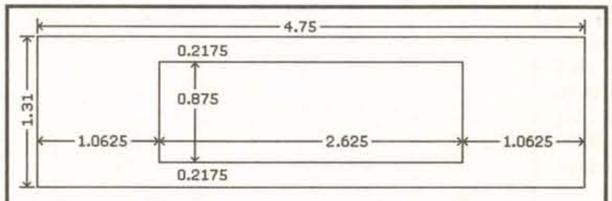


Figure 8. Display window cutout for the plastic front panel of the digital alarm clock case.

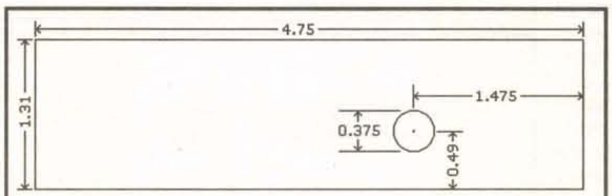


Figure 9. Location of hole for the power cable in the plastic rear panel of the digital alarm clock case.

Vdd remains at approximately 5V. U2 pin 1 should be low while pin 2 should be high. Disconnect the battery. Correct any errors and check again.

Now we'll check the alarm circuitry. Reconnect the wall transformer. Using a jumper wire, short pin 9 to pin 11 on socket U3. With this jumper in place, you should hear the alarm. With the wall transformer and battery disconnected, connect the DB1 display board and insert the J1A in socket U3. Reconnect the wall transformer. The display should begin flashing on for one second then off for one second. If this is not the case, the problem is either the J1A or the display board.

To see whether the J1A is functioning correctly, we'll look at the control lines going to the display. Observe pin 6 of the J1A with an oscilloscope or logic probe. This is the display select line which should pulse low, for about 360 microseconds, once a second. Next, look at pin 7 of the J1A. This is the synchronous data clock, which should exhibit a series of high pulses once a second. Finally, check pin 8 — the serial data to the display board. The serial data should exhibit a series of pulses once a second. If these three pins are functioning normally, we can be confident the J1A is good, and any problem is with the DB1. If the J1A is the problem, be sure it is not installed backwards in the socket, and check the value of C1 and C2 to be sure they are correct.

If the problem is with the DB1, disconnect the wall transformer. First, check to be sure the MC14489 and four-digit LED module are oriented properly on the DB1. If either of these is upside-down, of course, the display will not work. Check for zero ohms between ground on the CK2 board and pin 14 of the MC14489. Check for zero ohms between Vdd on the CK2 and pin 3 of the MC14489. Check for zero ohms between pin 6 of the J1A and pin 10 of the MC14489. Check for zero ohms between pin 7 of the J1A and pin 11 of the MC14489. Finally, check for zero ohms between pin 8 of the J1A and pin 12 of the MC14489. Correct any errors and check again.

This completes the electrical checkout of the circuit boards. Final checkout can only be done after the clock is completely assembled and all the switches are connected.

Putting It All Together

Prepare the case

Now we turn our attention to the case (RadioShack 270-0214) and getting it ready to install the circuit boards. Begin by identifying the bottom half of the case. The two screw holes, for holding the case together, go all the way through the bottom half.

The posts that these screws pass through are toward the rear of the case, as shown in Figure 7. There are four short posts for mounting a circuit board inside the case. The CK2 uses only three of these. The fourth post — located under the battery — must be removed so the battery will lie flat on the bottom of the case.

The next step is to add the red window to the front panel. Make a rectangular cutout 2-5/8 (2.625) by 7/8 (0.875) inches centered in the front panel; see Figure 8. Smooth the edges of the cutout and remove any plastic burrs. Place the front panel textured side down on a work surface. Position the red Plexiglass window (included with the circuit boards) on top of the panel, centered on the cutout. Place a drop of Super-Glue at the left and right edges of the window. This will bond the red Plexiglass window to the inside of the front panel. Don't touch the front panel until the glue has dried.

A hole must be drilled in the rear panel for the power plug that connects to J2. Figure 9 shows the position of the hole's center. Check your wall transformer's power plug to see how big a hole you must drill. Now we can start working on the top half of the case. First, we'll drill the holes for the switches. There is no specific location for switches — you can put them wherever is best for you — but pay attention to two things. First, identify the front and rear of the top half. If you drill the holes in the wrong place, you can't just turn it around, the case only fits together one way! Second, watch the vertical clearance between the bottom of your switches and parts on the CK2 circuit board. I used submini momentary push buttons (RadioShack 275-1571) and a micro toggle switch (RadioShack 275-624). Temporarily place the CK2 and a battery in the bottom half of the case so you can measure clearances. After marking the switch locations on the top, drill the required mounting holes and securely mount the switches in the top half of the case.

Wire the switches

The switches must now be wired to the CK2 circuit board. Remove the J1A from its socket and store it in a safe place while soldering to the CK2. Figure 5 shows which switch goes to which SW connection on the CK2. One side of each switch is grounded and this ground can be daisy-chained around the switches, reducing the total number of wires going to the CK2. Allow enough slack in the wires so that the case can be opened and the battery replaced after the CK2 is attached to the bottom half of the case.

Finishing up

To keep the battery in place when the clock is moved, some sort of support is required. The simplest way to do this is to glue a piece of foam rubber to the inside top half of the case, just above the battery.

Attach the CK2 circuit board to the bottom half of the case using the three self-tapping screws that came with the CK2 circuit board. Insert the front panel into the most forward slot such that the red Plexiglass window is on the inside. Insert the DB1 circuit board into the slot behind the front panel. Insert the rear panel into the rear slot so that the hole lines up with connector J2. Put the J1A back in its socket. Plug in the wall transformer and connect it to the alarm clock via the hole in the rear panel. The display should now be flashing.

Try setting the time-of-day and alarm-time. Check that the alarm enabled LED follows the ALARM_ENABLE switch. If switches don't perform the anticipated function, you may have wired them to the wrong SW pad on the CK2.

Attach a 9V battery to the battery connector and place the battery in the case. Place the top on the case being sure not to pinch any wires in the seam. Use the long self-tapping screws that came with the case to securely close the case. Your alarm clock is now finished. Replace the battery whenever the low battery LED comes on. **NV** by Gordon West

MORE ON 121.5 MHz

In the April issue of *Nuts & Volts*, we described the importance of the emergency locator beacon service at 121.5 MHz and the relatively new 406.025 MHz datastream. When the 406.025 MHz signal also carries GPS coordinates, rescue personnel can get activated and on-scene much faster than conventional COSPAS-SARSAT Doppler shift positioning solely on 121.5 MHz.

But once rescuers arrive at the 406.025 MHz GPS-derived position, they won't necessarily be right on top of the activated emergency beacon. You may be assured that the GPS system is accurate within the radius of a 300-foot circle, but the uploaded 406.025 MHz GPS datastream may be rounded off. This occurs in order to minimize the frequency of updates of the position data.

The 406 MHz encoded position signal is encoded initially to be as close as possible to the actual position. The initial offset encoded is selected so that it may be summed with the course position to produce a finer position that is as close as possible to the actual position. Subsequent position updates (if applicable) are then encoded by retaining the course position and changing only the offset, provided that the required value is within the range of the offset. If the position update cannot be encoded by changing the offset alone, there is a reset according to procedure for the initial position encoding.

Another problem might creep in where the position is in hours, minutes, and fractions of a minute, yet navigation to the EPIRB GPS-derived position is in hours, minutes, and seconds. The difference between fractions of a minute calculations and seconds within a minute calculations may affect how close rescue agencies are able to arrive on-scene to the indicated 406.025 MHz GPS-derived EPIRB position.

And what really happens out there with search and rescue agencies clearly illustrates the need for local homing in on the ever-present, half-watt, 121.5 MHz "localizer" signal. It is *this* signal that also transmits along with the now-and-then 406 MHz signal that allows rescuers to zero in on the activated ELT or EPIRB.

"We use the 406 MHz GPS position to get us in close, and then direction-find right down to the activated EPIRB on 121.5 MHz," comments William Alber, a reserve aero squadron sheriff. "Some of the equipment I own personally allows me to walk right up to an activated beacon, even though it might be totally hidden from the air," adds Alber.

Aboard the Coast Guard search and rescue boats and aircraft, direction finding to the 121.5 MHz signal employs an ADCOCK array antenna system which electronically spins the incoming signal heterodyned with an internal signal to calculate phase relationships among the multi-element antenna. These phase relationships are computed within the ADF to a visual readout of the signal source. As they fly in a direct path to the signal source, the ADF reads the bearing dead ahead. When they fly over the signal source, the ADF immediately shows the bearing behind the aircraft, and the signal strength begins to fall off, indicating the position has indeed been flown over.

But ADF systems are mighty expensive for rescue squad personnel who may only receive funding from donations. And this is where the ACR VECTA handheld direction-finder really pays off.

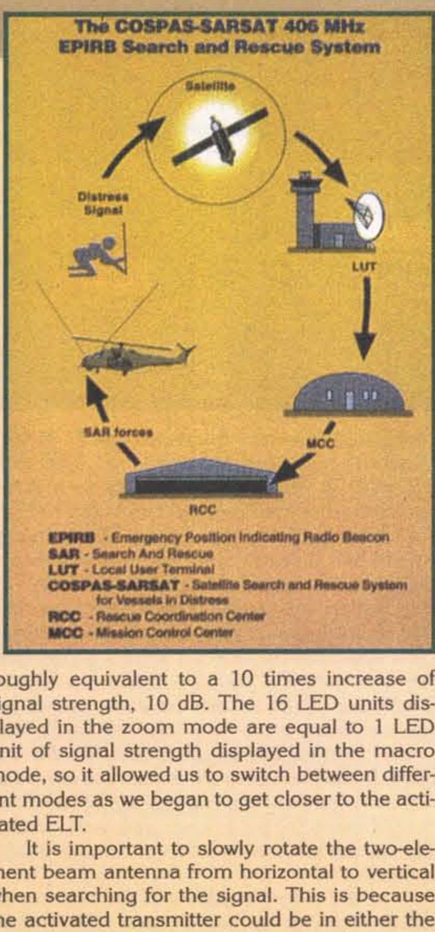
The ACR VECTA is a small, two-element beam antenna with an integral boom superheterodyne receiver tuned to 121.5 MHz in Channel 1, and test frequency 121.775 MHz in Channel 2. The receiver outputs to a built-in weatherproof speaker, and the bright red LED signal strength indicator shows 255 step resolution of full scale in the zoom mode, and 16 steps of resolution on a full-scale mode. The LED signal meter will scroll in an upward fashion indicating an increase in signal strength as you approach the beacon and rotate the directional antenna in the direction of the beacon. During our trials on both the water, as well as in dense foliage, the LED bar becomes quite active showing our operators visually that they were getting closer to the rescue position as the LEDs began to climb up the signal meter. We would swing the beam back and forth, and easily see the general direction of the transmitting beacon.

In the macro mode, with the macro scale LED illuminated, the bottom light-emitting diode represents a value of zero, or no incoming signal. The next LED represents a value of 16, the third LED a value of 32, and so on. Each LED step represents a value jump of 16 units until you reach the top LED that has a value of 240 units in macro mode.

In the zoom mode, the bottom LED represents a value of 1, the second a value of 2, and so on. Each LED represents a value jump of 1 unit giving the top LED a value of 16, which is

ELT DEMO IN THE MALIBU HILLS ...

(Above) Red Cross radio volunteers attend a briefing before an ELT transmitter hunt. (Right) Author West turning on the ACR test beacon during a search and rescue drill.



roughly equivalent to a 10 times increase of signal strength, 10 dB. The 16 LED units displayed in the zoom mode are equal to 1 LED unit of signal strength displayed in the macro mode, so it allowed us to switch between different modes as we began to get closer to the activated ELT.

It is important to slowly rotate the two-element beam antenna from horizontal to vertical when searching for the signal. This is because the activated transmitter could be in either the vertical or the horizontal plane, and you will receive best signal strength when the two planes are aligned.

When in the immediate vicinity of the beacon, signal reflections may cause you to receive numerous false direction indications. We wanted to reduce the sensitivity of the VECTA, so we closed the antennas and then wrapped our hands around the VECTA to detune the antennas. We next held the unit close to our body, using the body as a shield by holding the base of the VECTA next to our belt line. By doing a couple of body twirls, we were finally able to figure out the general direction of the incoming signal in the direction of our belt buckle. The buckle actually has nothing to do with DFing, but the signal is dramatically less when coming in and needing to pass through our body back side.

Amateur radio operators who take part in VHF "fox hunting" are expert in tracking down hidden low-power transmitters, and anyone wishing to increase their fox hunting skills should buy the well-illustrated book by Joe Moell K0OV, at most ham radio dealers.

ACR is so committed to emergency locator beacon tracking, they offer a complete training package with the VECTA handheld portable direction-finder, along with a low-power test beacon operating on FCC-authorized EPIRB/ELT training frequency 121.775 MHz. The test beacon is an O-ring-sealed, battery-operated unit with an external antenna. It is submersible and carries a flotation collar for on-the-water training exercises. Although the unit only transmits 75 milliwatts, this is plenty of power at 121.775 MHz for open field or open water testing with the handheld VECTA direction finder.

Emergency groups working near an airport may also use the ACR emergency transmitter direction finder on the supplied external antenna as an initial alert device to an activated ELT that sometimes may occur with a hard landing. Many older aeronautical ELTs have no audible alert that the equipment is activated. The emergency group, or airport manager, or the airport Unicom station would have the VECTA running on AC power connected to the omnidirectional antenna. There is no mistaking the sound of an activated ELT. The emergency group would then respond by taking the VECTA off of the omnidirectional antenna and power supply, going outside and unfolding the directional antennas, and beginning the initial search of the airport grounds to identify the source of the emergency signal.

If this can be done within a few minutes after activation, it very well could save a local Civil Air Patrol or United States Coast Guard unit from beginning an all-out search when notified by a mission control station that satellites are picking up an activated EPIRB somewhere in their area (as we described last month in *Nuts & Volts*).

"It is much easier to track down an activated EPIRB on the water than it is an activated ELT at an airport," claims Bill Alber. "On the water, there are little reflections of the signal, and the ACR handheld direction finder can easily spot the transmitting beacon. But at an airport, the VHF signals are easily reflected and scattered by metal hangars, and this is where the ACR equipment really pays off with its capability of attenuating the incoming signal," adds Alber. He points out that on-the-water signals can sometimes be traced in as little as 20 minutes, but down at the airport, it might take up to 40 minutes.

"Even though there is tremendous emphasis on boaters choosing a new 406 MHz EPIRB, this does not mean that 121.5 MHz is going away," comments Paul Hardin of ACR.

"121.5 MHz is still the frequency of choice for radio direction finding, or homing purposes – the 406 MHz side of the EPIRB is only on the air for less than a half a second duration at 50-second broadcast intervals – it is much easier to home in on 121.5 MHz, almost ignoring the 406 MHz signal when in close during direction-finding procedures," adds Hardin.

But when the 406 MHz signal is activated, along with the unique ACR interfaced GPS position datastream, rescue efforts start immediately, and ultimately end up with local rescue units homing in on the activated EPIRB with the 121.5 MHz local signal. If you have any type of VHF equipment that can listen in on 121.5 MHz, give it a try and see if you can pick up the sounds of an activated ELT or EPIRB. **NV**

The Computer Controlled World: RS-232 Network Control Methods and Applications

Video for Windows (Part 2)

by Ryan Sheldon, National Control Devices • (417) 646-5644 • www.controlanything.com

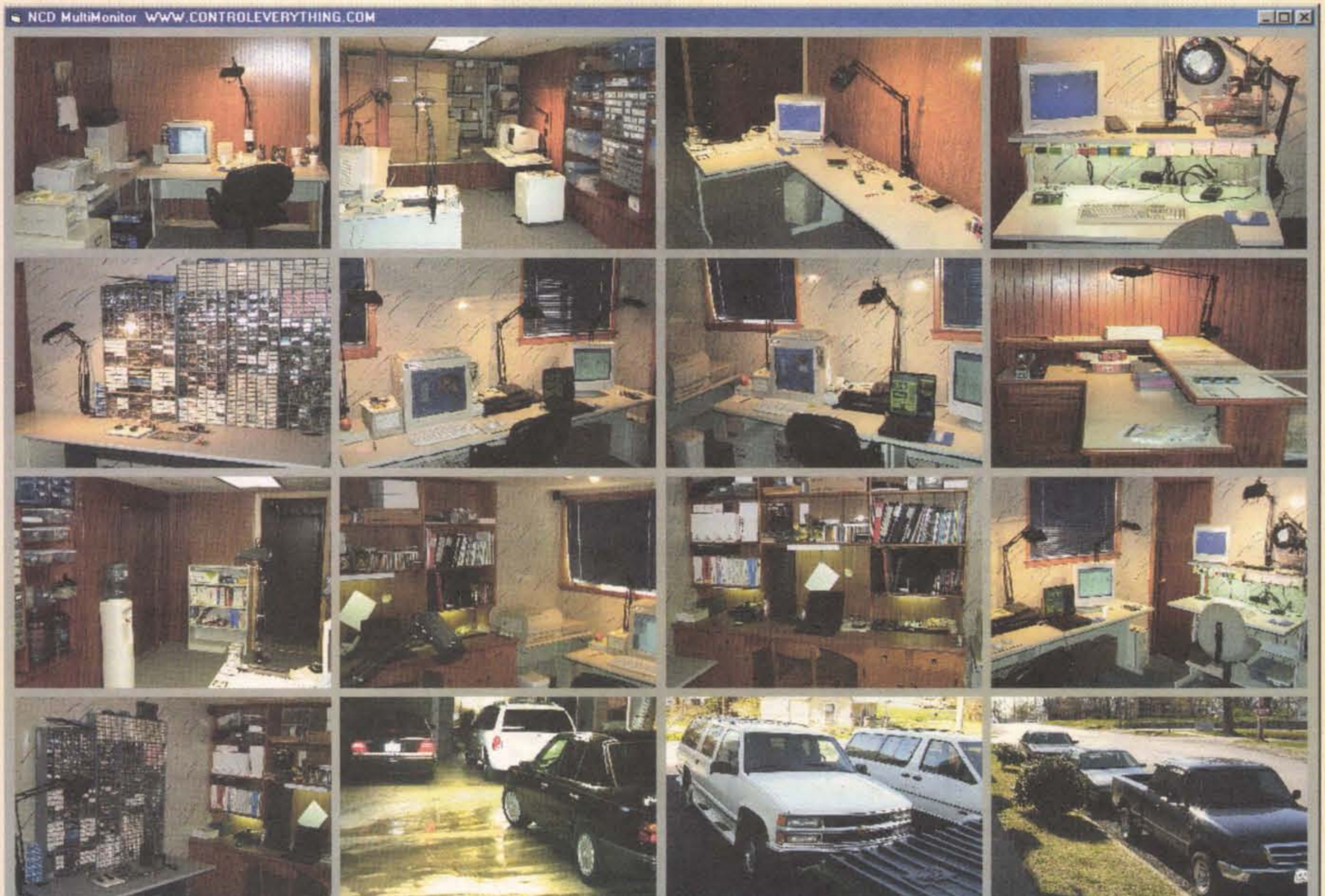
Watch 16 video cameras in a Windows 98 window and control the position of each camera.

Last year, I showed you how to watch 16 different video cameras in a Windows 95 window. This article serves as an update to the original article published in May '99. This article shows how the same job can be accomplished using a low-cost video control module. We also add the ability to control the position of each camera using our new SCAM chip. And, for the first time, the video window can be adjusted to fit any size monitor.

To complete this project, you will need a few low-cost items. The capabilities of the system are simply a function of how much money you want to spend. Chances are, you already have some of these items. If not, Table 1 shows a simple list of items and sources I recommend.

Figure 1 shows the video window for all 16 cameras. The program tells the ASEL video switcher to go to camera 1, grab a frame, and display it in the video window. It then switches to camera 2, grabs a frame, and displays it next to the first image. It cycles through all 16 cameras, grabbing images, and updating the respective video window.

FIGURE 1



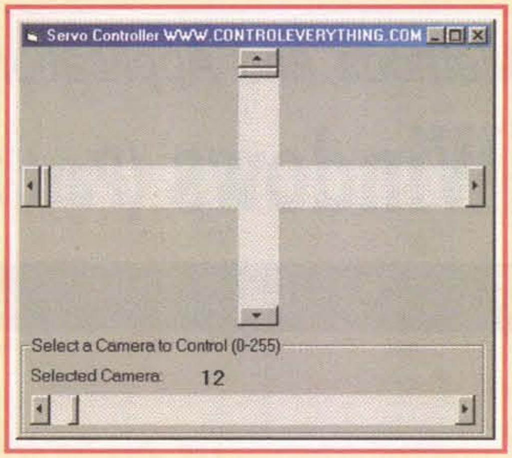


FIGURE 2

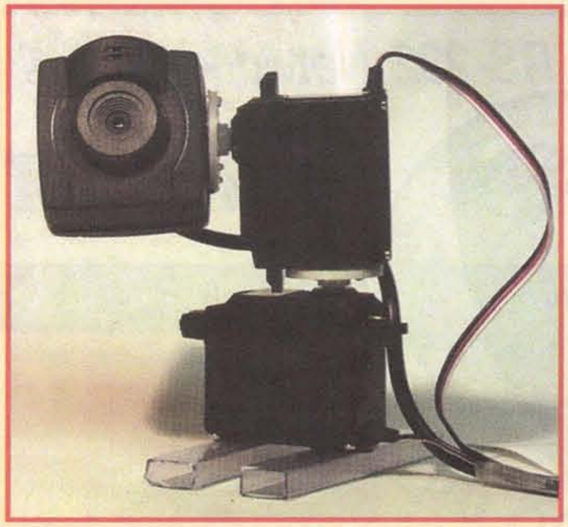


FIGURE 3A

FIGURE 3B

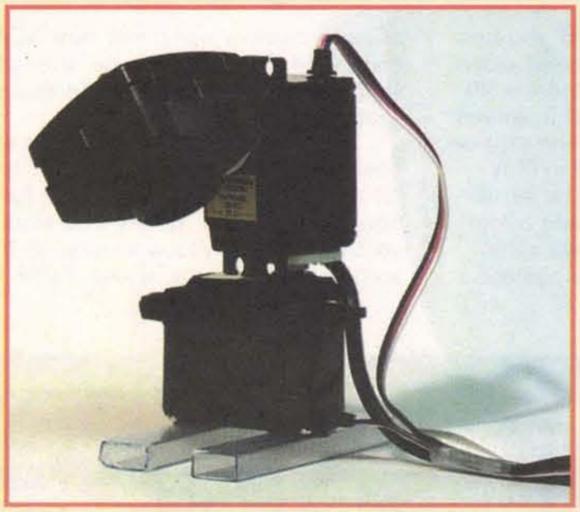


FIGURE 3C

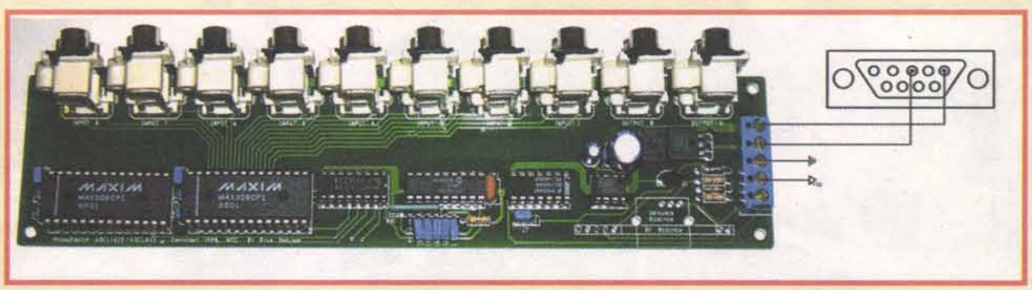


FIGURE 4

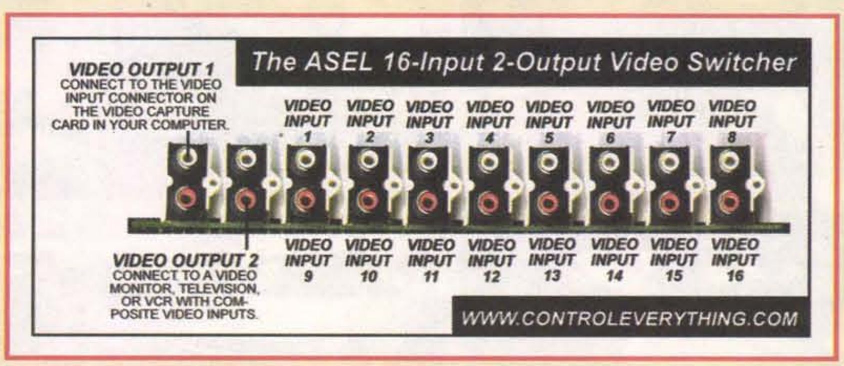


FIGURE 5

Performance

This program is capable of updating each video window every 2.14 seconds using a STB TV Tuner card on a Pentium II 400 system. If you have a faster computer, and an AGP All in Wonder Pro (with integrated TV Tuner), you will probably get faster frame rates.

Figure 2 shows sliders that can be used to position the video cameras. Use the slider on the bottom to select a camera to control, then use the horizontal and vertical sliders to move the camera.

Figures 3A, B, and C show how a small Panasonic CCD camera can be mounted to a couple of servos for pan and tilt. Use hot glue to attach the servos together. Make sure the servos are centered prior to gluing. The camera shown in this article is available from www.digikey.com, part number P9506-ND. The servos shown are System 2000 Standard Servo TS-51 from www.towerhobbies.com. These were purchased a few years ago and don't seem to be available. I believe the TS53J servo will work as a replacement, but have not tried it.

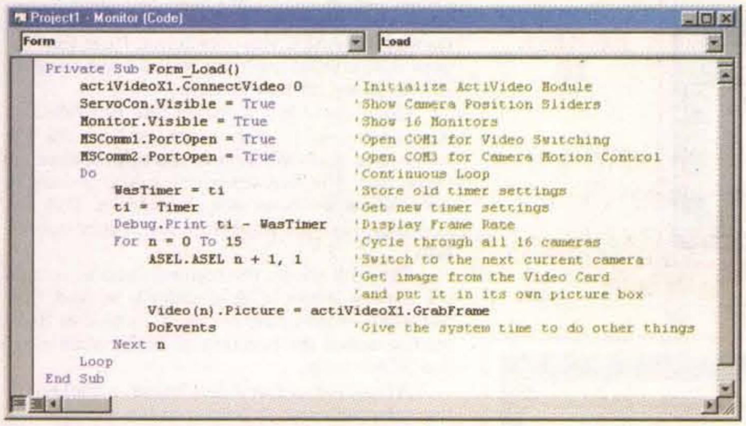
Hardware Installation

Figure 4 shows the ASEL video switcher connected to the solder side of a DB-9 female connector. Connect the DB-9 female to COM1 on your computer. A 12-volt DC power supply is required to power the video switcher board. Power can be tapped from the yellow and black wires used to power the hard drive inside your computer.

Figure 5 shows the video connections on the ASEL video switcher. Connect a camera to each of the video inputs. Connect Video Output 1 to the video input of your video capture card. Connect Video Output 2 to an external monitor.

Figure 6 shows a simple diagram for connecting your computer to several SCAM chips for camera positioning. The DB-9 female should be connected to COM3 on your computer. If COM3 is not available, it will be necessary to change the COM port in the software.

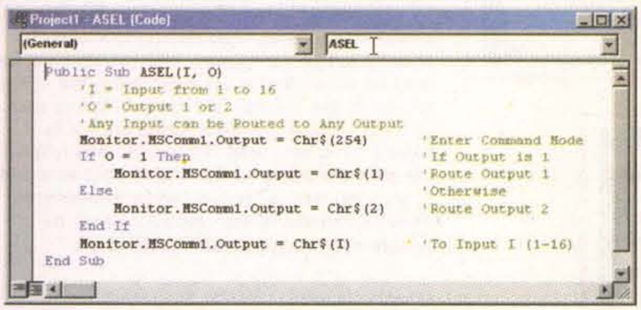
It is possible to connect the ASEL video switcher with version 2.0 firmware on



```
Project1 - Monitor (Code)
Form                                    Load

Private Sub Form_Load()
    actiVideoX1.ConnectVideo 0            'Initialize ActiVideo Module
    ServoCon.Visible = True               'Show Camera Position Sliders
    Monitor.Visible = True                'Show 16 Monitors
    MSComm1.PortOpen = True               'Open COM1 for Video Switching
    MSComm2.PortOpen = True               'Open COM3 for Camera Motion Control
    Do                                    'Continuous Loop
        WasTimer = ti                     'Store old timer settings
        ti = Timer                        'Get new timer settings
        Debug.Print ti - WasTimer         'Display Frame Rate
        For n = 0 To 15                   'Cycle through all 16 cameras
            ASEL.ASEL n + 1, 1            'Switch to the next current camera
                                          'Get image from the Video Card
                                          'and put it in its own picture box
            Video(n).Picture = actiVideoX1.GrabFrame
            DoEvents                      'Give the system time to do other things
        Next n
    Loop
End Sub
```

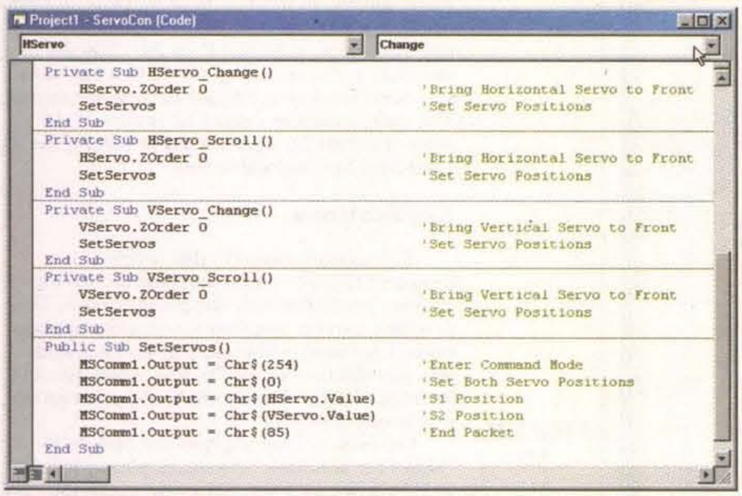
FIGURE 7



```
Project1 - ASEL (Code)
(General)                               ASEL

Public Sub ASEL(I, O)
    'I = Input from 1 to 16
    'O = Output 1 or 2
    'Any Input can be Routed to Any Output
    Monitor.MSComm1.Output = Chr$(254)        'Enter Command Mode
    If O = 1 Then                             'If Output is 1
        Monitor.MSComm1.Output = Chr$(1)      'Route Output 1
    Else                                      'Otherwise
        Monitor.MSComm1.Output = Chr$(2)      'Route Output 2
    End If
    Monitor.MSComm1.Output = Chr$(I)          'To Input I (1-16)
End Sub
```

FIGURE 8



```
Project1 - ServoCon (Code)
HServo                                  Change

Private Sub HServo_Change()
    HServo.ZOrder 0                             'Bring Horizontal Servo to Front
    SetServos                                   'Set Servo Positions
End Sub
Private Sub HServo_Scroll()
    HServo.ZOrder 0                             'Bring Horizontal Servo to Front
    SetServos                                   'Set Servo Positions
End Sub
Private Sub VServo_Change()
    VServo.ZOrder 0                             'Bring Vertical Servo to Front
    SetServos                                   'Set Servo Positions
End Sub
Private Sub VServo_Scroll()
    VServo.ZOrder 0                             'Bring Vertical Servo to Front
    SetServos                                   'Set Servo Positions
End Sub
Public Sub SetServos()
    MSComm1.Output = Chr$(254)                  'Enter Command Mode
    MSComm1.Output = Chr$(0)                    'Set Both Servo Positions
    MSComm1.Output = Chr$(HServo.Value)         'S1 Position
    MSComm1.Output = Chr$(VServo.Value)         'S2 Position
    MSComm1.Output = Chr$(85)                   'End Packet
End Sub
```

FIGURE 9

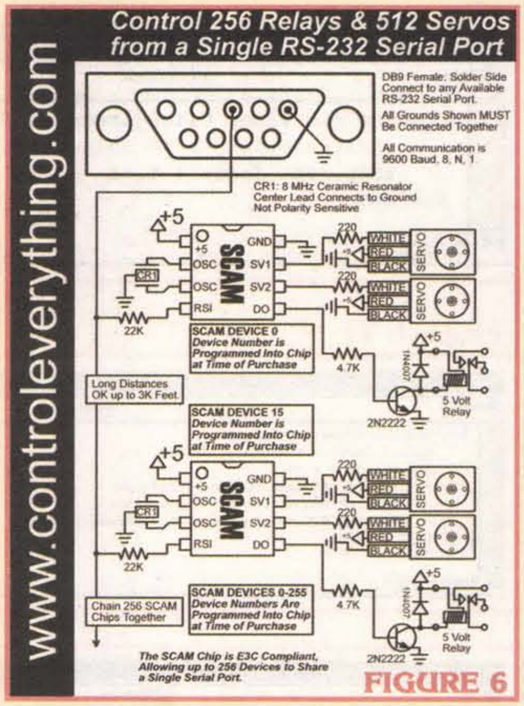


FIGURE 6

the same serial port as the SCAM chips. We chose not to do this in this application because of the high bandwidth requirements of this application. It is much better to devote COM1 to video switching and COM3 to motion control.

Software Installation

Step 1
Begin by installing Visual Basic 6 Professional or Enterprise on your computer.

Step 2
Go to www.controleverything.com, select ASEL 16x2 RS-232 Controlled Video Switcher from the main page. From this page, select "Watch 16 Video Cameras in a Windows 98 Window." Now select "Download ActiVideo Control Module."

Step 3
Select "Download MultiMonitor Source Code" and unzip the contents into its own folder on the desktop.

Step 4
Install and register the ActiVideo control module with the manufacturer.

Step 5
Double click "MultiMonitor.vbp" to load the program in Visual Basic 6. Run the program. If you get any errors, they are probably related to the COM port. Remember, this program expects COM1 and COM3 to be available.

Using the Visual Basic Software

When the program is run, you will see 16 boxes, each with a video frame from each of the 16 cameras. Click on one of the video boxes to select a video source that will be displayed at full speed on the external monitor connected to Video Output 2 on the ASEL video switcher.

Next, use the sliders on the Servo Controller window to position a camera. You can control which camera is positioned by adjusting the slider on the bottom of this window.

Programming Details

When the program is run, the code shown in Figure 7 begins to execute. The program starts by connecting the ActiVideo control module to your video capture card. It then displays the MultiMonitor video window and opens COM1 and COM3. You can change which COM ports are in use by changing the "Properties" window for the MSComm1 and MSComm2 control modules. These modules are shown as telephone icons in the lower right corner of the program (when it is not running). These telephone icons represent COM1 (left) and COM3 (right).

Once the COM ports are open, the program goes into a continuous loop. The first three lines inside the loop are used to display the rate at which frames update. The number given in the immediate window represents the elapsed time between frame grabs.

The program then counts from 0 to 15, representing each of 16 video sources. The ASEL video switcher is routed to the first camera using the

Project1 - Monitor (Code)

Video | Click

```
Private Sub Video_Click(Index As Integer)
    'Switch Output 2 to Selected Monitor
    ASEL.ASEL Index + 1, 2
End Sub
```

FIGURE 10

FIGURE 11

Project1 - ServoCon (Code)

HScroll2 | Change

```
Private Sub HScroll2_Change()
    Label2.Caption = HScroll2.Value                  'Update Interface Caption
    For Repeat = 1 To 4                              'Do 4 Times, Ensures Reception
        Monitor.MSComm2.Output = Chr$(254)           'Enter Command Mode
        Monitor.MSComm2.Output = Chr$(252)           'Command to Select a Device
        Monitor.MSComm2.Output = Chr$(HScroll2.Value) 'Set Device Number to Control
    Next Repeat
End Sub
```

Project1 - Monitor (Code)

Form | Resize

```
Private Sub Form_Resize()
    'Set Limits
    If Monitor.Width < 3000 Then Monitor.Width = 3000
    If Monitor.Height < 2500 Then Monitor.Height = 2500
    'Set Padding Size
    Pad = 120
    'Set Width and Height based on Overall Width and Height
    VWide = ((Monitor.Width - (Pad * 5)) / 4) - (Pad / 4)
    VHigh = ((Monitor.Height - (Pad * 5)) / 4) - (Pad / 1.2)
    'Set Horizontal Positions
    Video(0).Left = Pad
    Video(4).Left = Pad
    Video(8).Left = Pad
    Video(12).Left = Pad
    Video(1).Left = Pad + Pad + VWide
    Video(5).Left = Pad + Pad + VWide
    Video(9).Left = Pad + Pad + VWide
    Video(13).Left = Pad + Pad + VWide
    Video(2).Left = Pad + Pad + VWide + Pad + VWide
    Video(6).Left = Pad + Pad + VWide + Pad + VWide
    Video(10).Left = Pad + Pad + VWide + Pad + VWide
    Video(14).Left = Pad + Pad + VWide + Pad + VWide
    Video(3).Left = Pad + Pad + VWide + Pad + VWide + Pad + VWide
    Video(7).Left = Pad + Pad + VWide + Pad + VWide + Pad + VWide
    Video(11).Left = Pad + Pad + VWide + Pad + VWide + Pad + VWide
    Video(15).Left = Pad + Pad + VWide + Pad + VWide + Pad + VWide
    'Set Vertical Positions
    Video(0).Top = Pad
    Video(1).Top = Pad
    Video(2).Top = Pad
    Video(3).Top = Pad
    Video(4).Top = Pad + Pad + VHigh
    Video(5).Top = Pad + Pad + VHigh
    Video(6).Top = Pad + Pad + VHigh
    Video(7).Top = Pad + Pad + VHigh
    Video(8).Top = Pad + Pad + VHigh + Pad + VHigh
    Video(9).Top = Pad + Pad + VHigh + Pad + VHigh
    Video(10).Top = Pad + Pad + VHigh + Pad + VHigh
    Video(11).Top = Pad + Pad + VHigh + Pad + VHigh
    Video(12).Top = Pad + Pad + VHigh + Pad + VHigh + Pad + VHigh
    Video(13).Top = Pad + Pad + VHigh + Pad + VHigh + Pad + VHigh
    Video(14).Top = Pad + Pad + VHigh + Pad + VHigh + Pad + VHigh
    Video(15).Top = Pad + Pad + VHigh + Pad + VHigh + Pad + VHigh
    'Set Width and Height of All Videos
    For n = 0 To 15
        Video(n).Width = VWide
        Video(n).Height = VHigh
    Next n

End Sub
```

FIGURE 12

System Requirements	Cost	Sources
Visual Basic 6 Professional	varies	www.ebay.com
ActiVideo Control Module	$100.00 Registration	www.controleverything.com
SCAM Servo Camera Controller Chips	$10.00/each	www.controleverything.com
ASEL Video Switcher	$149.00	www.controleverything.com
All in Wonder Pro with TV Tuner	$100.00 (approx.)	www.buy.com
CCD Cameras P9506-ND	$125.00/each	www.digikey.com
Tower Hobbies LXJB61 TS53J Servo	$9.99/each	www.towerhobbies.com
Television with Composite Video Input	varies	

TABLE 1

ASEL routine shown in Figure 8. Figure 8 shows the actual RS-232 commands used to control the ASEL video switcher. Note that your ASEL video switcher MUST have version 2.0 firmware for this to work.

Once the video is routed, the ActiVideo module is used to grab an image from the TV tuner card and display it in the appropriate video box. The DoEvents command is used to allow Windows to service other tasks. This command is very important for proper operation.

Figure 9 shows the routine used to control the servos. When a servo slider is moved, the SetServos subroutine is called. Note that this routine sends the position of BOTH sliders to the SCAM chip.

When one of the video boxes is clicked, the selected video is routed to the monitor connected to Video Output 2 of the ASEL video switcher. The routine that manages the "click" and "switch" operation is shown in Figure 10.

The SCAM chips support the E3C command set, allowing 256 different devices to share a single serial port. The SCAM chip that is to be controlled is selected using the slider shown at the bottom of Figure 2. When this slider is moved, the subroutine shown in Figure 11 is executed. This routine is responsible for controlling which SCAM chip responds to your horizontal/vertical slider movement. These commands are sent four times to ensure the receipt by all SCAM chips.

Scaling the Video Window

One of the big changes for the new program is the ability to dynamically scale the video window to fit the size of monitor you are using. For the first time, it is possible to use any size monitor, from 14" to 24". Thanks to the routine shown in Figure 12, you can resize the video window to fit your particular monitor. The code shown in Figure 12 resizes all 16 video windows by dynamically adjusting the horizontal and vertical scales.

Applications

The project shown in this article was designed to give you an introduction to the endless possibilities of computer control. This program can be modified for security applications, time lapse photography, and has endless possibilities for distributing video over the internet. Using a few simple tools, you can do just about anything.

I hope you have enjoyed my update to "Video for Windows." As usual, please feel free to E-Mail or call if you have any questions. **NV**

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ncdryan@aol.com
www.controlanything.com

New Product News

NIGHTVISION VIDEO CAMERAS

Applications such as drug interdiction and border security require the ability to operate in total darkness without the luxary of external infrared illuminators.

This new nightvision video camera is built around an enhanced generation-one intensifier tube.

The unit offers available ambient light operation, as well as total darkness technology via a built-in IR illuminator.

Lens is 90mm with a 14-degree field of view, with 3X magnification.

Weight is only 1.5 pounds and a convenient tripod socket is located under the unit's center of gravity, and the unit is rugged and water resistant.

The image intensifier operates on an internal three-volt battery which provides 12 hours of continuous operations.

The video camera operates on12-volts DC.

The intensifier tube has automatic brightness control and light overload protection.

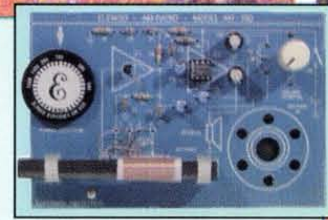
The video camera features auto exposure control and standard RCA video connectors for use with any standard VCR, monitor, or transmitter. Widely used for monitoring of illegal toxic waste dumping, drug interdiction, vandalism, and more.

Available for only $1,299.95 from Supercircuits.

For addtional information, contact:

SUPERCIRCUITS
1 SUPERCIRCUITS PLAZA, DEPT. NV
LEANDER, TX 78641
512-260-0333 FAX: 512-260-0444
WEB: www.supercircuits.com

AM-780 AM RADIO KIT



Elenco Electronics announces the AM-780 AM Radio Kit. The AM-780 is a tuned radio frequency receiver of the standard amplitude modulation (AM) frequencies (550 KHz 1660 KHz) that you asemble.

The AM-780's manual has easy-to-follow, step-by-step assembly instructions. The instructions include many drawings to clearly illustrate the assembly. All components are clearly identified.

The radio measures 5.3" x 3.5" and requires a nine-volt battery.

The AM-780 is designed to be a learning experience in electronics. It teaches proper soldering techniques using easy-to-understand pictures. It has a theory of operation section and block diagrams explaining how it works, along with schematics and other technical information. There is also an explanation of the resistor color code and a glossary.

The AM-780 is available at a list price of only $13.25.

For more information, contact:

ELENCO ELECTRONICS, INC.
150 W. CARPENTER AVE., DEPT. NV
WHEELING, IL 60090
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The RCC7K is available at a list price of only $33.25.

For more information, contact:

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MULTIMEDIA SPEAKERS

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TLR-6960 TIME LAPSE RECORDERS

Matco releases TLR-6960 Time Lapse Recorders. They are manufactured by JVC and distributed by Matco, Inc.

The TLR-6960 Time Lapse Recorders are the ideal solution for a variety of applications including consumer, industry, and business security systems.

The TLR-6960 Time Lapse Recorder has four heads and provides high-quality, clear pictures.

Some features of the TLR-6960 Time Lapse Recorders are: recording ranges from 6-960 hours; built-in time and date generator with alarm inputs; easy time setting and tape recording; it integrates a battery backup up to three months that provides a special feature of automatic resumption of system operation after power failure; in addition, it has very easy on-screen programming.

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For more information, contact:

MATCO, INC.
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1-800-719-9605
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DC Volts: up to 1000V
AC Volts: up to 750V
AMPS: up to 20 Amps (AC & DC)
Resistance: up to 30M ohm
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Transistor hfe Test: Display shows approximate hfe value based on test condition of 10uA base current and Vce of approx. 3V.
Temperature Test: Measures from 0° to 1832° F (probe supplied!)
Diode Test: Tests if diodes are shorted or open

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Accuracy

Vdc:	±1.0% reading +5 ditis
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Adc:	±1.2% reading +5 digits
Aac:	±1.5% reading +5 digits
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#3201

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***Other Models are Available.** See www.web-tronics.com under "hard drive and accessories" for more details and pictures.*

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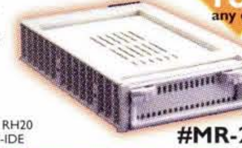

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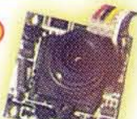

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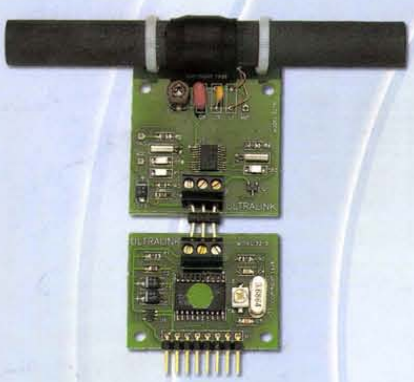
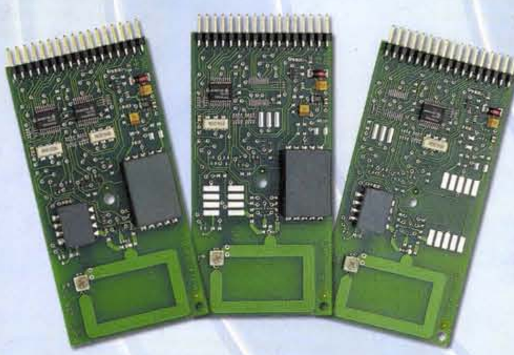


Sometimes a wire just won't do. These handy devices provide wireless solutions for data logging, control, and timekeeping. To demonstrate the operation of all of these products together, call our BASIC Stamp using a terminal emulation program at (916) 624-0160, with 2400 bps 8 N 1 settings. Press the "T" key to display the current time and temperature as transmitted via RF from our rooftop location in Rocklin, California. Details of this project are shown at www.parallaxinc.com.

Atomic Time Clock WWVB Receiver (#27971 - $79.00)

Ultralink's WWVB receiver/decoder provides an accurate real time clock based on the National Institute of Standards and Technology radio station WWVB in Fort Collins, Colorado. Receiver and antenna may be separated for maximum signal reception. Operates in the 48 contiguous states and parts of Canada.



433 MHz Transmitter (#27986 - $59.00)
433 MHz Receiver (#27987 - $89.00)
433 MHz Transceiver (#27988) $119.00)

These RF modules provide wireless single and bi-directional serial communication up 250 between BASIC Stamps using simple SERIN and SEROUT commands. Each module has a built-in antenna, encoder, decoder, and RD data processors for sending serial strings or simple on/off controls.

Mode	Requires
Single-direction communication	(a) Transmitter and Receiver; (b) Transmitter and Transceiver; or (c) Transceiver and Receiver
Bi-directional communication	(a) Two Transceivers.

Cermetek Modem AppKit (#27947 - $89.00)
Cermetek Modem (#603-00011 - $69.00)

Okay, this modem isn't wireless, but sometimes only a wire will do! This AppKit consists of a Cermetek modem, components, and PBASIC source code required to let your BASIC Stamp dial a PC running a terminal program and transmit serial data. Includes a DS1620 Digital Thermometer as an example of monitoring remote temperature. Bi-directional communication between two BASIC Stamps requires two modems.

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