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Nuts & Volts

The Preferred Magazine Of The Electronics Hobbyist/Industry

April 2002
Vol. 23 No.4

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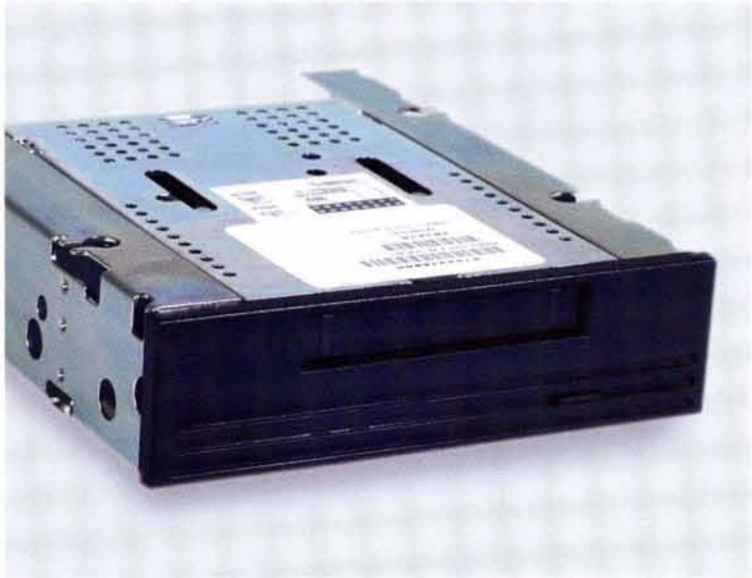

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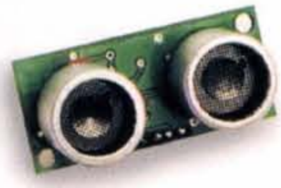

COLUMNS

DEPARTMENTS

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by Jeff Eckert

TechKnowledgy 2002

Advanced Technologies

Robots Assist in Search-and-Rescue Operations

For obvious reasons, most press coverage of the World Trade Center atrocity has focused on the human element. However, the events of September 11 also catalyzed what appears to be the first use of robots for rescue and reconnaissance operations in an urban disaster area. Within six hours of the event, the Center for Robot-Assisted Search and Rescue (CRASAR) had responded with a cache of robots, sending teams from Foster-Miller, Inc. **(www.foster-miller.com)**, iRobot Corp. **(www.irobot.com)**, the University of South Florida **(www.usf.edu)**, and the Space and Naval Warfare Systems Command (SPAWAR, **enterprise.spawar.navy.mil/spawarpublicsite/**).

"iRobot's Packbot performs reconnaissance of WTC surrounding structures." Courtesy of the Center for Robot-Assisted Search and Rescue.


"A small army of robots awaits deployment at Ground Zero." Courtesy of the Center for Robot-Assisted Search and Rescue.

The robots were dispatched to perform two functions: to search for survivors and to survey structures at "Ground Zero" to determine whether it was safe for humans to enter. Unfortunately, no survivors were found, but the robot team generated sensory information that was useful in the search and clean-up. This is widely viewed as simply the first step in the development and implementation of such devices.


"A robot's-eye view of human relief workers at Ground Zero, transmitted by a Talon robot provided by Foster-Miller."


"Eerie nighttime scene of the rubble at Tower Two location." Courtesy of the Center for Robot-Assisted Search and Rescue.

CRASAR is a nonprofit rise response and research organization that is seeking to exploit robots and other unmanned devices for humanitarian purposes worldwide. It operates under the auspices of the National Institute for Urban Search and Rescue. For more images and information about CRASAR, visit **www.csee.usf.edu/robotics/crasar/pics/reconrobots/**.

Mars Orbital Camera Returns More Images

Meanwhile, circling a far more placid planet, the Mars Global Surveyor recently began its second year of extended mission operations by providing some unexpected information. In 1999, the Mars Orbital Camera (MOC) detected an array of odd layers, scarps (cliffs caused by erosion), and "swiss cheese" holes in the south polar cap. Later images of the same areas revealed that the polar scarps had retreated approximately 3 m in less than one Mars year (687 Earth days). Early this year, scientists concluded that such rapid changes could have occurred only if the south polar cap is composed primarily of frozen carbon dioxide ("dry ice") rather than water ice. The two photos, illuminated from the upper left by sunlight, each cover an area 2 km wide by 6.9 km long. The arrows point at the same location, showing a drift in the topography. And because the polar cap is shrinking, it is now believed that the climate of Mars is undergoing a major change, perhaps coming out of an ice age. At the present rate of carbon dioxide release into the Mars atmosphere, there could be a fairly thick cover of "greenhouse gases" within a few hundred to a thousand years. This, in turn, could cause a global warming that thaws liquid water, encourages plant growth, and so on. At that point, it will be only a matter of months before the first McDonald's appears. For details, visit the Malin Space Science Systems web site **(www.msss.com/mars_images/moc/1yearExtend/)**. The MOC, incidentally, was built by Malin and the California Institute of Technology using spare hardware from the Mars Observer mission.


"Recently detected drifts in the Martian south polar regions have led scientists to the conclusion that the polar cap is made of frozen carbon dioxide. Photo courtesy of NASA/JPL/Malin Space Science Systems.

Computers and Networking

IBM Offers Cheaper Mainframes

In February, IBM **(www.ibm.com)** announced a new e-business oriented mainframe computer geared toward the more cost-conscious consumer. While most IBM mainframes cost $1 million plus, the new z800 server will dent you for only about $375,000.00. All z800 boxes are powered by a five-processor multichip module. The first processor unit (PU) is generally designated a general-purpose engine. PUs two through four can be defined as general-purpose, integrated facility for Linux, or coupling facility engines for use in a parallel Sysplex cluster. The final PU is used as a System Assist Processor to drive large amounts of data through the I/O subsystem. All models incorporated a total of 16 optional PCI Cryptographic Coprocessors and/or PCI Cryptographic Accelerators that support thousands of Secure Sockets Layer (SSL) transactions per second, thereby providing FIPS 140-1 level 4 security. All have 8 to 32 GB of main memory, a 64-bit architecture.

3-D Imaging on Your Computer

A new gadget from TDV Technologies **(www.tdv3d.com)** promises to bring three-dimensional viewing to your PC. The company's TDV 3D product — devised primarily for users of computer games — consists of a bundle of software and a pair of viewing glasses. The software converts 2-D applications into 3-D ones, and it is compatible with most industry standard 3-D graphics accelerators. Basically, TDV 3D works with your monitor by alternating each liquid crystal lens between opaque and transparent, and at the same time, flashing slightly different images on the monitor so that each eye sees a different version of the image. In this manner, the illusion of three dimensions is created.

If you aren't a game player, never fear. According to the company, the device can also be used for online shopping, education, fashion and lingerie shows, Sony IMAX movies, and, perhaps best of all, the latest *Sports Illustrated* swimsuit calendar. And it's all yours for only $99.95 online. But note: it cannot be used with flat-screen or laptop computer monitors.

Circuits and Devices

New Type of Consumable Memory Unveiled

In a conventional memory chip, the semiconductor fabrication process puts a single layer of devices on the active top portion of a substrate. Thus, when you want more devices on a chip, the chip spreads out horizontally. But a new process introduced by Matrix Semiconductor, Inc. **(www.matrixsemi.com)**, uses a modified 0.25 micron CMOS process to stack memory devices vertically, thereby creating up to 10 times the number of chips on the same size wafer. Matrix claims to be the first company to successfully develop a technology for producing such devices in high volumes, at low costs, and using standard materials and processes.

The first product, due out later this year, will be the Matrix 3-D Memory, a "write-once" 64-MB storage chip developed as a "consumable" product that can be used in much the same way as traditional camera film or audio tape. The market is envisioned to include digital cameras, digital audio players, portable games, cell phones, and so on. Although no specific information on price is available, it is expected that the devices will be much cheaper than today's flash memory. The company is backed by $80 million in venture capital, and investors are rumored to include Microsoft, Kodak, Sony, and others.

Industry and the Profession

Computer Crime Doesn't Pay (If You Get Caught)

Computer systems administrator Tim Lloyd was recently convicted of planting a software "time bomb" in a file server at Omega Engineering, his former employer. The bomb destroyed the company's production machinery software, which cost Omega more than $10 million in direct losses and $2 million in reprogramming. This led to layoffs of 80 employees. Lloyd will serve 41 months in a federal penitentiary and has been ordered to pay more than $2 million to Omega in restitution. The case has been hailed as a landmark, proving that the federal government is capable of tracking down and punishing computer criminals. However, it is estimated that only about two percent of all software attacks are ever reported to the authorities.

In an unrelated case, the co-leader of a software piracy group, known as DrinkOrDie, has pleaded guilty to federal conspiracy charges. John Sankus, Jr., faces up to five years in prison and a $250,000.00 fine for his crimes. DrinkOrDie was involved in illegal online distribution of pirated copies of computer games and videos and other software. Sankus apparently directed about 60 people who acquired the titles, stripped away security features, and generated counterfeit copies. DrinkOrDie then sold the illegal copies on a worldwide basis. It has been reported that the US Department of Justice's computer crime and intellectual property section is cooperating with the US Attorney's office in a long-term effort to prosecute hundreds of suspected software pirates.

Cornell Sues Hewlett-Packard

Cornell University officials recently announced that the university and the Cornell Research Foundation have filed suit in the US District Court, asserting that the Hewlett-Packard Company is infringing on a patent issued in 1989 that covers a computer instruction processing technique created by Professor Emeritus H.C. Torng of Cornell's School of Electrical and Computer Engineering. The invention (US patent No. 4,807,115) accelerates a computer's processing speed. The patented technique is applicable to computer processors with multiple functional units, and it permits multiple instructions to be issued per machine cycle, out of program order, thereby increasing processing efficiency and speed.

Cornell's suit alleges that Hewlett-Packard has been infringing on the patent since 1995. According to James J. Mingle, university counsel and secretary of the corporation, the patent infringement could lead to a request for damages in excess of $100 million, and the university intends to pursue the litigation vigorously. Mingle indicated that Cornell's numerous efforts to

address the infringement have been repeatedly rebuffed by Hewlett-Packard.

And AOL Subscribers Sue AOL

America Online **(AOL, www.aol.com)** is not exactly known for being a soft-sell kind of company. For example, they routinely offer trial memberships consisting of 1,000 hours of free access. Unfortunately, you have to use all 1,000 hours within a 45-day period, and there are only 1,080 hours in 45 days. This is great if you don't need more than 1.8 hours of sleep per night, would like to spend every minute of your life logged onto AOL, and have no bodily functions that require you to leave your terminal.

And whenever AOL subscribers log on, they are pummeled with pop-up windows that try to sell them a range of products. To avoid ordering these items, they must click on a "No Thanks" button. AOL has credit card and/or bank account information on all of subscribers, and it charges user accounts directly for items purchased.

Now, three Californians have filed suit in federal court in San Francisco alleging that, even though they declined the sales pitches, AOL nevertheless sent them merchandise that includes a desk planner ($10.00), a CD player ($171.00), and a "bed in a bag" ($74.00). Only three users are part of the suit as of this writing, but Barry Himmelstein, an attorney for the plaintiffs, says that more than 200 individuals have already contacted him and reported the same problem. Himmelstein is therefore seeking class-action status for the suit, which could become a serious problem for AOL if more than a few of its 33 million subscribers have experienced this problem. The suit is being handled by Lieff Cabraser Heimann & Bernstein, LLP. If you have received unordered merchandise from AOL or CompuServe, you might want to visit **www.lieffcabraser.com/aol_contact.htm**. The aggressive sales tactics are unlikely to stop, given that AOL Time Warner lost $1.8 billion in the fourth quarter of 2001, in spite of having revenues of $10.6 billion. The company also faces class-action suits from subscribers who were connected by AOL software via long distance lines and unexpectedly incurred monthly charges that in some cases exceeded $1,000.00. **NV**

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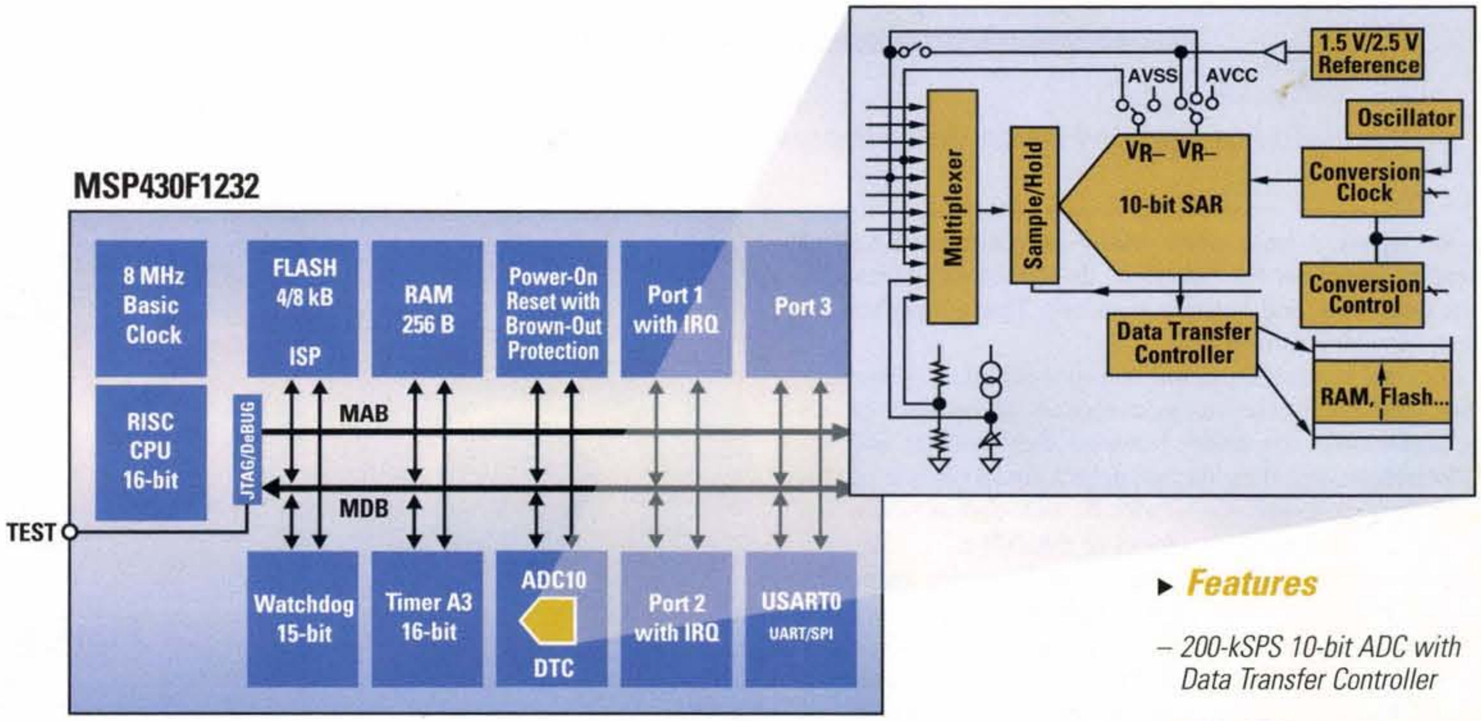

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TEXAS INSTRUMENTS

Devantech SRF04 Ultrasonic Range Finder

By Kerry Barlow

Devantech has designed a nice detector package in their SRF04 Ultrasonic Range Finder.

Over the years, I have used many different methods of obstacle detection for robotics. IR detectors, ultrasonic range detectors, and bumper switches. These detectors all have their place in robotics.

Bumper switches are an excellent and cheap method of protection for your robot, but they don't offer range detection. IR sensors based on the can type digital units are good, however they are not entirely useful for range detection, and they do not detect small narrow obstacles well. Solid walls are detected easily with IR, but narrow obstacles cannot be detected with them with any form of reliability.

The Sharp GP series detectors are very good for range detection within three feet, and they are very good for large object detection, but again they fail in detecting narrow objects. By narrow objects, I am referring to items such as chair legs, or small trees and fence posts.

The Devantech SRF04 Ultrasonic Range Finder overcomes all of the failings I have listed above and, in fact, can replace most other detection sensors on your robot. Acroname sells this ranger for $25.00. The SRF04 can be seen mounted on my Mars Rover. It is mounted at the front under the large solar panel. You can see the two transducers pointing forward. The optional housing that Acroname sells has not been used in this application. The rover is Stamp BS2 controlled. The SRF04 provides all the sensor input that is used for obstacle avoidance.

On indoor robots, I have always struggled with the problem of a robot driving into a chair leg. Bumper switches will, of course, solve this problem, however I wanted a means of not using any mechanical switches. On an outdoor robot, there would be problems with detection systems not doing their job and the robot would wander into a tree or signpost. Some methods of overcoming this pitfall are: overlapping sensors, multiple sensor readings, rotating sensor modules, different types of sensors on board, and the final back-up — a bumper switch.

Devantech has designed a nice detector package in their SRF04 Ultrasonic Range Finder. This ranger is a small printed circuit board 1.5" by .75" with two small round transducers mounted to the board. One transducer outputs a signal and the second transducer receives this signal, and calculates a distance measurement. The output is then sent to the microcontroller in the form of a digital word. Acroname sells the Devantech SRF04 Ultrasonic Range Finder among many other very nice robotics parts, including motors, gears, and sensors. Acroname also has many nice informative robotics articles and information. There is also a nice housing Acroname sells. Refer to Figure 5 for a picture. The housing will go around the SRF04 to finish off your project, and it can hold two different sensor units. The sensor pairs may be adjusted from 15-25 degrees apart. Please refer to the table of links for the Acroname website address.

The SRF04 has a range of 3cm to three meters and can detect a 3cm object at two meters. The basic operation and use of the SRF04 is very simple. The microprocessor must send an initialization command of 10 microseconds, followed by a receive or pulsin command. This pulsin command will store the SRF04 value in a word variable of your choosing and you may then do anything you wish with this value. The SRF04 may be left operating, and a thin broom handle can be passed in front of the sensor. The sensor will detect the broom handle100% of the time. Please refer to the table of specifications for more detailed information.

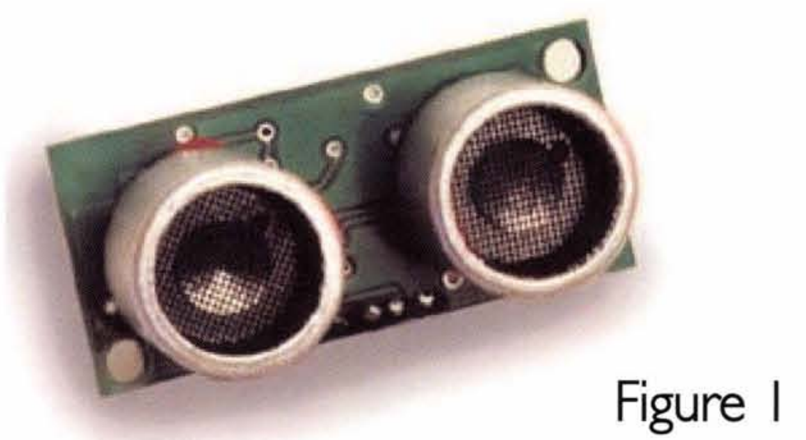


Figure 1

For those interested, the theory of operation is as follows. (Acroname's own description has been used.) The ranger works by transmitting a pulse of sound outside the range of human hearing. This pulse travels at the speed of sound away from the ranger in a

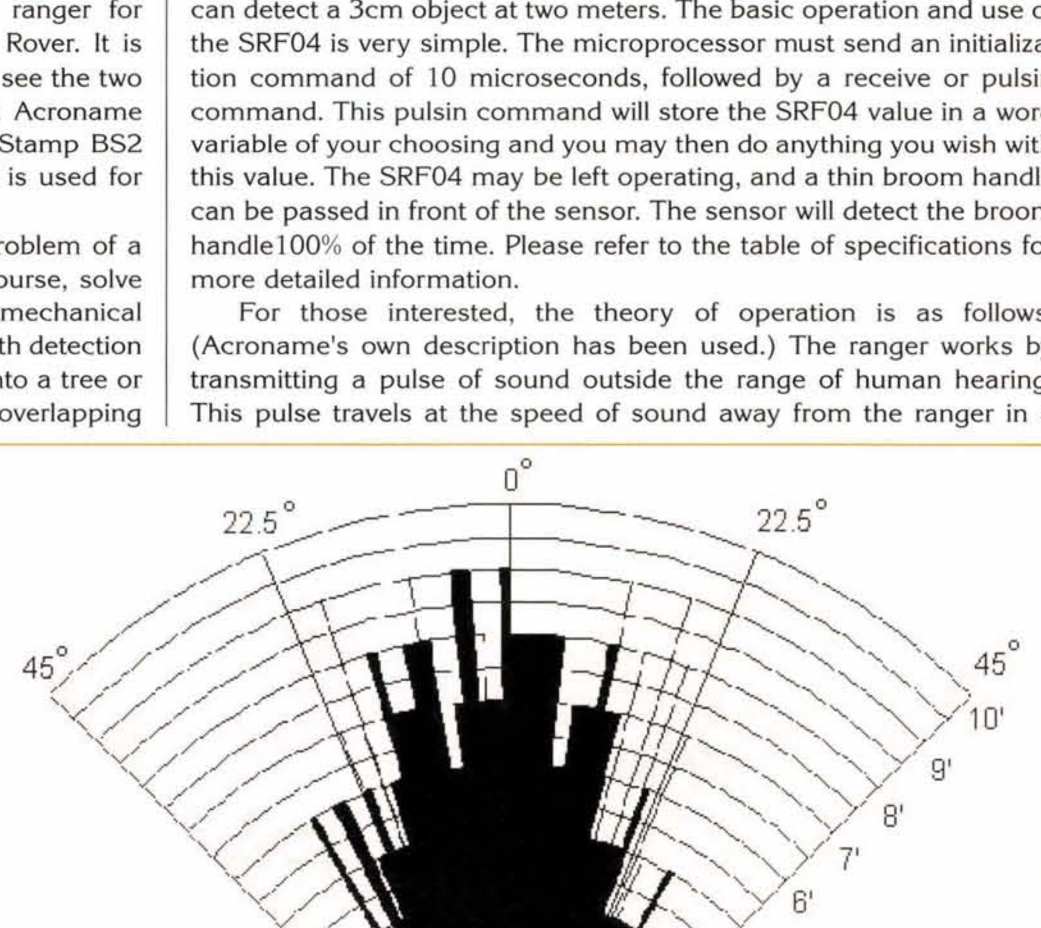


Figure 2

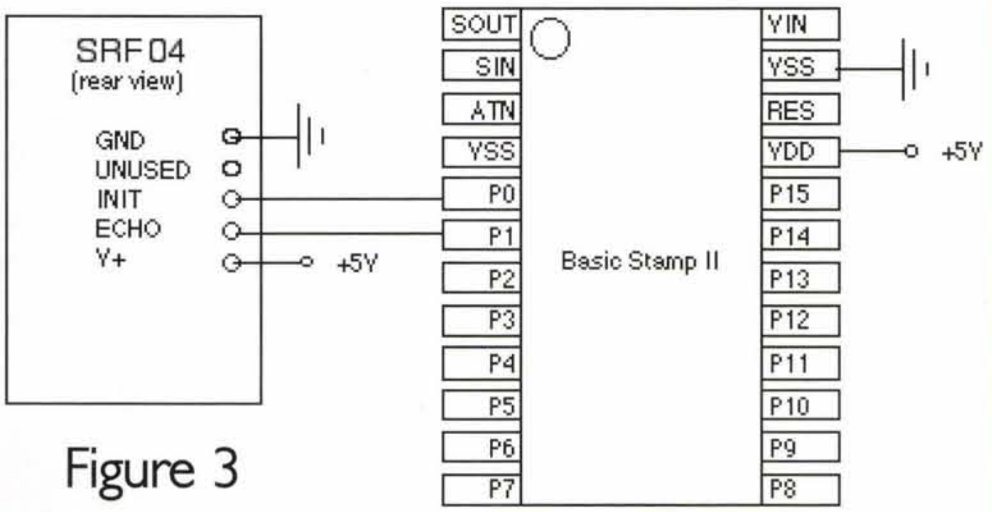


Figure 3

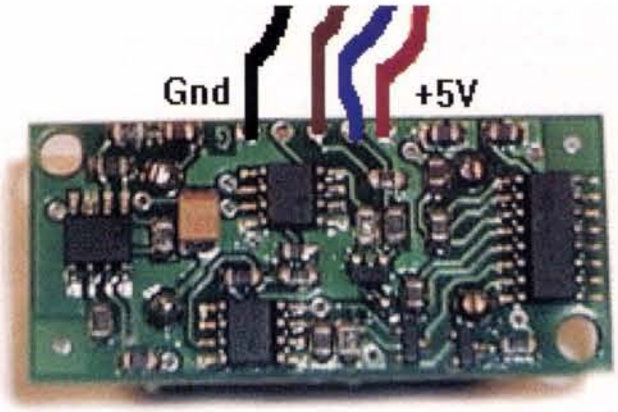


Figure 4

cone shape and the sound reflects back to the ranger from any object in the path of this sonic wave. The ranger pauses for a brief interval after the sound is transmitted, and then the ranger awaits the reflected sound in the form of an echo. The controller driving the ranger then requests a ping, the ranger creates the sound pulse, and waits for a return echo. If received, the ranger reports this echo to the controller and the controller can then compute the distance to the object based on the elapsed time.

Acroname has tested this sensor and found that it has a 30-degree cone of detection. In my real world use, I have found 30 degrees to be an adequate range of detection. I have used this sensor both indoors and outdoors. Please refer to Figure 2 for a beam pattern as tested by Acroname. The radial lines in the pattern are 6" increments. On one indoor robot, I do not even use the range sensing capability in my software. I simply want a detection of an object in front of the robot. This is okay too, as the SRF04 will detect the narrow objects nicely.

The SRF04 will work with any microprocessor. I have used the SRF04 with the Basic Stamp II and found no difficulties using it. Devantech specifications state that the sensor may draw up to 50 mA when in use. The voltage regulator on a Stamp is rated for 50 mA, so you will need an external power supply for operation. This is no problem, as robotics users will already have an external regulated power supply on board.

In testing, the SRF04 has been powered directly off the Stamp regulator, but it is not recommended for long term use. The SRF04 requires four connections for operation: +5V, ground, and the two signal wires. Please refer to Figure 3 for a wiring chart, connecting the SRF04 to a Basic Stamp. The SRF04 does not have any wires attached; you will be required to solder four wires to the SRF04 circuit board.

Wire holes are drilled in the board. No difficulty was encountered in actually soldering the wires to the board. Five holes are drilled in the SRF04, with one of the holes not being used. Acroname has a wiring chart in their printed manual, however a note about the diagram is in order. To use the wiring chart printed in the manual, you must know that the drawing is of the SRF04 with the two round transducer modules underneath the drawing in the manual. Place your sensor on a tabletop with the two round can shape transducers down and the five wire holes facing up. On the circuit board, there is a tiny G denoting the ground connection. Refer to Figure 4 for a wired SRF04. Please note that in Figure 4 +5V (red) is the right hand wire, Echo (blue) is the second wire, Init (brown) is the third wire, NC is the fourth hole, and ground (black) is the leftmost wire. I do not mean to belabor this point, but I myself lost some hair trying to figure out where the wires went from the printed manual.

The SRF04 will require two I/O lines from your microprocessor. The first sensor line is for initialization, and the second is for an echo/return line. For initial testing and design check-out, it is recommended to send the SRF04 sensor outputs directly to a debug window or a LCD display. Acroname has provided a very nice test program for the ranger that outputs the values to a debug window.

You will be able to get an idea of what the sensor is capable of this way because you can actually see its output. Listing 1 is a program provided by Acroname to send data to the debug screen. Acroname has recently released a new instruction manual that has different pro-

Table of Links

Acroname Sensors and Robotics parts: **http://www.acroname.com**

Devantech: **http://www.robot-electronics.co.uk/**

Devantech SRF04 Sensor from Acroname: R93-SRF04

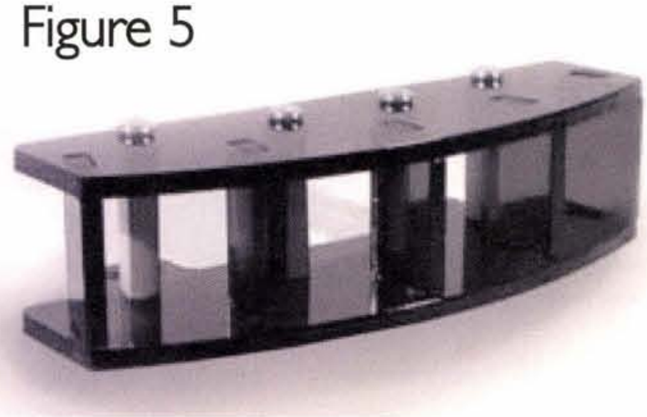
SRF04 housing: R103-SRF04-HOUSING

Authors Email Address: **Admin@MntnWeb.Com**

Table of Specifications

Beam Pattern	see graph
Voltage	5v
Current	30mA Typ. 50mA Max
Frequency	40KHz
Maximum Range	3 m
Minimum Range	3 cm
Sensitivity	Detect a 3cm diameter stick at > 2 m
Input Trigger	10uS Min. TTL level pulse
Echo Pulse	Positive TTL level signal, width proportional to range.
Weight	0.4 oz.
Size	1.75" w x 0.625" h x 0.5" d

Figure 5



gram code segments for the BASIC Stamps dated September 1st. This is to work around some of the timing problems associated with the Stamp controllers. Acroname also has a corrected program on their website for the Stamp timing issues, as well. Listing 1 shows two methods of controlling the Stamp, with the second section sr_sonar_2 being the program code which worked for my Stamp. I could not make the Stamp work on the first section's code example sr_sonar. Note: The execution time of the pulsin instruction will be slightly different for different Stamp pins. If you change the pin assignments, the pulsin command in the sr_sonar subroutine above may miss the rising edge of the ECHO input and return some readings of 0.

Using rctime instead of pulsin may fix this problem. Another trick is to introduce a small delay with a dummy command before measuring the echo time with the rctime command. This is illustrated in the alternate subroutine sr_sonar_2. You may need to experiment to determine the best code for your application. As stated earlier, the sr_sonar_2 code worked best on my Stamp II. I tried the SRF04 on various pins of my Stamp, and did not see any problems when using the sr_sonar_2 code.

A second method for testing is to send the sensor's output to your Stamp and then generate a tone output based on the range detection. Listing 2 is an example of the tone generation program.

For testing purposes, I connected a small portable Stamp, the

Continued on Page 71

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Reader Feedback

Dear Nuts & Volts

I read your article on the Blab Blaster with interest because I developed a similar project last year. Mr. Jim Cassedy was correct in his letter in your March issue where he stated that speech compression is used on commercials. My system used a PIC 16C73A/JW microprocessor with a LM386N amplifier and a small microphone. I used the microprocessor's A/D converter to take samples of the volume level over a several second interval and then calculate the average value of the recorded peaks. If the calculated value was too high, the processor sends the signal to decrease volume via an infrared LED that sends encoded volume up/down bursts for my particular TV set. I establish the correct level by pushing an up/down control on the unit that sends bursts of infrared to control the volume level. The PIC then "listens" for a period of time after the last button push and then maintains that volume level both up and down. The beauty of this system is that it is wireless and can be adjusted at any time from your viewing location. I also wrote an algorithm that could capture volume up and volume down code from any remote control and then duplicate it using the PIC.

Bruce Cambern
Madera, CA

Dear Nuts & Volts

I just got around to reading the January 2002 issue all the way through and I think the gremlins did it to you again in Stamp Applications. On Page 1, you were told to "vdd (+5) through a 10 KW resistor" and "insert a 1 KW resistor" and "through a 1 KW resistor." On Page 2 in two lines "the normal 1 KW resistance is divided (two 470 W resistors are close enough) and the 10 KW resistor will" and in Figure 3, you have P5 going to both DB4 and DB5 on the LCD.

I don't think the students and experimenters can get 10 KW or 1 KW or 470 W resistors. I haven't seen any of that size in a looooooooong time.

normdoty@bellsouth.net

Editor's Note:

Lost in the transmission ...
In last month's article by Murugavel Raju on using Texas Instrument's MSP430, there were a couple measurements that got changed inadvertently. The quantity "25µs" was changed to "25mS" in three different places: once under "Circuit Description" and twice in "Math_calc." Also, on page 37 of the same article, in the first and second to last paragraphs under the "Conclusion" section, two symbols needed to actually be micro amps. One read 300mA instead of 300MA and in the first sentence of the second paragraph, it should have read 2.1MA instead of 2.1mA. We apologize for any confusion this may have caused.

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HP 8642M Signal Generator, 0.1-2100 MHz, 1 Hz res., HPIB ... **$3750.00**
HP 8656B-001 Signal Generator, 0.1-990 MHz, 10 Hz res., HPIB, OCXO ... **$2750.00**
HP 8657A Signal Generator, 0.1-1040 MHz, 10 Hz res., AM, FM, HPIB ... **$3000.00**
HP 8660C/603A/633B Signal Generator, 1-2600 MHz, 1 or 2 Hz res., AM, FM ... **$3250.00**
HP 8660D/86603A-002 Signal Generator, 1-2600 MHz, 1 or 2 Hz res., phase modulation ... **$6000.00**
HP 8671A Signal Gen., 2.0-6.2 GHz, 1 kHz res., CW, FM, +8 dBm, HPIB ... **$2750.00**
HP 8671B Synthesized Signal Generator, 2-18 GHz ... **$4000.00**
HP 8672A Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +3 dBm ... **$4500.00**
HP 8672A-008 Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +8 dBm ... **$5000.00**
HP 8673C Signal Gen., 0.05-18.6 GHz, 1 kHz res., AM, FM, Pulse, HPIB ... **$14000.00**
HP 8673D-H15 Signal Gen., 0.05-26 GHz, 1 kHz res., AM, FM, HPIB ... **$15000.00**
HP 8673H-212 Signal Generator, 2.0-12.4 GHz, 1 kHz res., AM, FM, +8 dBm ... **$8500.00**
HP 8673M Signal Generator, 2-18 GHz, 1 kHz res., AM, FM, +8 dBm ... **$9500.00**
HP 8683B Signal Generator, 2.3-6.5 GHz, cavity tuned, AM/ WBFM/ Pulse ... **$2250.00**
HP 8683D Signal Generator, 2.3-13.0 GHz, cavity tuned, AM/ WBFM/ Pulse ... **$3750.00**
HP 8684B Signal Generator, 5.4-12.5 GHz, cavity tuned, AM/ WBFM/ Pulse ... **$2250.00**
MARCONI 2019 Signal Generator, 80 kHz-1040 MHz, 10 or 20 Hz res ... **$850.00**
WAVETEK 955 Signal Generator, 7.5-12.4 GHz, +7 dBm, AM, FM ... **$750.00**
WAVETEK 957 Signal Generator, 12-18 GHz, +7 dBm, AM, FM ... **$750.00**

SWEEP GENERATORS

HP 8350B/ 83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled ... **$3750.00**
HP 8350B/ 83525A Sweep Oscillator, 10 MHz-8.4 GHz, +13 dBm levelled ... **$5000.00**
HP 8350B/ 83540A-002 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step atten. ... **$3250.00**
HP 8350B/ 83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step atten. ... **$3750.00**
HP 8350B/ 83570A Sweep Oscillator, 18.0-26.5 GHz, +10 dBm levelled ... **$7000.00**
HP 8350B/83570A-H22 Sweep Oscillator, 17-24 GHz, +10 dBm levelled ... **$5000.00**
HP 8620C Sweep Oscillator Frame ... **$500.00**
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm, 70 dB step atten. ... **$1250.00**
HP 86222B-E69/8620C Sweep Osc. & frame, 0.01-2 GHz & 2-4 GHz bands ... **$1200.00**
HP 86240B RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled ... **$450.00**
HP 86241A RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled ... **$300.00**
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm unlevelled ... **$350.00**
HP 86251A RF Plug-in, 7.5-18.6 GHz, +10 dBm levelled ... **$500.00**
HP 86260A RF Plug-in, 12.4-18 GHz, +10 dBm unlevelled ... **$400.00**
HP 86260A-H04 RF Plug-in, 10-15 GHz, +10 dBm unlevelled ... **$400.00**
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled ... **$1500.00**
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled ... **$1750.00**
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB atten. ... **$750.00**
WAVETEK 2002B Sweep Generator, 1-2500 MHz, +13 dBm, GPIB ... **$1750.00**
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm, GPIB ... **$4500.00**
WILTRON 6669B-02,03 Sweep Gen., 0.01-26.5 GHz/ K conn.& 26-40 GHz/ WR28 ... **$7500.00**
WILTRON 6717B-20 Synthesizer/ Sweeper, 10 MHz-8.4 GHz, +13 dBm,GPIB ... **$6000.00**

POWER METERS

BOONTON 42B/ 41-4E Analog Power Meter, with 1 MHz-18 GHz sensor ... **$400.00**
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz ... **$900.00**
HP 436A-022/ 8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB ... **$1200.00**
HP 436A-022/ 8482A Power Meter, -30 to +20 dBm, 100 kHz-4.2 GHz, HPIB ... **$1200.00**
HP 436A-022/ 8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB ... **$1200.00**
HP 436A-022/ 8485A Power Meter, -30 to +20 dBm, 50 MHz-26.5 GHz, HPIB ... **$1500.00**
HP 436A-022/ 8485D Power Meter, -70 to -20 dBm, 50 MHz-26.5 GHz, HPIB ... **$1700.00**
HP 438A Dual Channel Power Meter ... **$3000.00**
HP 8477A Power Meter Calibtator, for HP 432 series ... **$400.00**
HP 8487D High Sensitivity Sensor, -70 to -20 dBm, 50 MHz-50 GHz, 2.4mm ... **$1850.00**
HP 8900D/84811A Peak Power Meter, 0.1-18 GHz, 0-20 dBm peak ... **$2500.00**
HP Q8486A Power Sensor, 33-50 GHz, -30 to +20 dBm, for 435/6/7/8 ... **$1500.00**
HP R8486A Power Sensor, 26.5-40 GHz, -30 to +20 dBm, for 435/6/7/8 ... **$1500.00**
HP R8486D Power Sensor, 26.5-40 GHz, -70 to -20 dBm, for 435/6/7/8 ... **$1750.00**

RF MILLIVOLTMETERS

BOONTON 92C RF Millivoltmeter, 3 mV-3 V f.s., 10 kHz-1.2 GHz ... **$500.00**
RACAL-DANA 9303 RF Millivoltmeter, -70 to +20 dBm, 10 kHz-2 GHz, GPIB ... **$750.00**

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz ... **$950.00**
BOONTON 82AD Modulation Meter, AM/ FM, 10-1200 MHz ... **$500.00**
C.P.I. VZC6961K1 TWT Amplifier, 35 dB gain, 4-8 GHz, 20 Watts ... **$3500.00**
ENI 525LA Amplifier, 50 dB gain, 1-500 MHz, 25 Watts ... **$3250.00**
HP 11713A Switch / Attenuator Driver, HPIB ... **$800.00**
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz ... **$1900.00**
HP 3730B/3738B Downconverter, 5.9-8.9 GHz & 8.7-11.7 GHz ... **$1200.00**
HP 415E SWR Meter ... **$200.00**
HP 8347A RF Amplifier, 25 dB gain, 100 kHz-3 GHz, +20 dBm, HPIB ... **$2750.00**
HP 8349A Amplifier, 15 dB gain, 2-20 GHz, +20 dBm output ... **$1650.00**
HP 8403A-002 Pulse Modulator, 0.8-2.4 GHz, 80 dB dynamic range ... **$450.00**
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5GHz ... **$500.00**
HP 8447A-001 Dual Amplifier, 20 dB, 0.1-400 MHz, +6 dBm Po, NF <7 dB ... **$650.00**
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output ... **$650.00**
HP 8447F-H64 Dual Amp., 0.01-50 MHz 28 dB & 0.1-1300 MHz 25 dB ... **$900.00**
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz, HPIB ... **$1350.00**
HP 8901B-001 Modulation Analyzer, 150 kHz-1300 MHz, HPIB ... **$1900.00**
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts ... **$2500.00**
MPD LAB-1-510-10 Amplifier, 48 dB gain, 500-1000 MHz, 10 Watts **$750.00**
RACAL 9009 Modulation Meter, 30-1500 MHz, AM, 1.5-100 kHz pk FM **$350.00**
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28 V ... **$200.00**
ROHDE&SCHWARZ ESH2 Test Receiver, 9 kHz-30 MHz ... **$3250.00**

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz ... **$300.00**
AMERICAN NUC. AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) *NEW* ... **$95.00**
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in & out ... **$450.00**
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz ... **$350.00**
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) ... **$75.00**
GENERAL RADIO 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz ... **$400.00**
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... **$450.00**
HP 11691D Directional Coupler, 22 dB, 2-18 GHz, N connectors ... **$450.00**
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... **$800.00**
HP 33327L-006 Prog. Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm ... **$1000.00**
HP 778D-011 Dual Dir. Coupler, 20 dB, 0.1-2.0 GHz, APC7 ... **$450.00**
HP 8498A-030 30 dB Attenuator, 25 Watts, DC-18 GHz ... **$500.00**
HP 87300C-020 Directional Coupler, 20 dB, 1.0-26.5 GHz, 3.5mm ... **$475.00**
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz ... **$350.00**
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... **$450.00**
HP K752A WR42 Directional Coupler, 3 dB, 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 ... **$250.00**
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... **$650.00**
HP R422A WR28 Crystal Detector, 26.5-40 GHz ... **$400.00**
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz ... **$450.00**
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 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz ... **$350.00**
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz ... **$750.00**
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz ... **$900.00**
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz ... **$1000.00**
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz ... **$1000.00**
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz ... **$250.00**
HUGHES 45752H-1000 WR22 Direct Reading Phase Shifter, 0-360, 33-50 GHz ... **$1400.00**
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz ... **$400.00**
HUGHES 47316H-1111 WR10 Tunable Detector, 75-110 GHz, pos. polarity ... **$600.00**
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32 GHz, +18 dBm ... **$2000.00**
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42 GHz, +18 dBm ... **$2750.00**
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f/f)/SMC ... **$200.00**
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC ... **$200.00**
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz ... **$450.00**
NARDA 3000-series Octave Band Directional Couplers, N connectors ... **$150.00**
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz ... **$500.00**
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz ... **$375.00**
NARDA 3090 Precision High Directivity Couplers ... **$225.00**
NARDA 368BNM Coaxial Hih Power Load, 500 Watts, 2-18 GHz, N(m) ... **$500.00**
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz ... **$900.00**
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz ... **$950.00**
NARDA 4000-series Octave Band Directional Couplers, SMA connectors ... **$75.00**
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) ... **$200.00**
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 ... **$500.00**
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz ... **$375.00**
NARDA 793FM Direct Reading Variable Attenuator, 0-20 dB,4-8GHz ... **$225.00**
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB,4-8GHz ... **$375.00**
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, neg. polarity, SMA m/f ... **$50.00**
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz ... **$250.00**
SONOMA SCI. 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz ... **$75.00**
TEKTRONIX 2701 Step Attenuator, 0-79 dB, DC-1 GHz ... **$150.00**
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz ... **$900.00**
TRG V551 WR15 Frequency Meter, 50-75 GHz ... **$600.00**
TRG W510 WR10 Direct Reading Attenuator, 0-50 dB, 75-110 GHz ... **$1000.00**
TRG W551 WR10 Frequency Meter, 75-110 GHz ... **$750.00**
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB ... **$200.00**
WEINSCHEL 150-110 Programmable Step Atten., DC-18 GHz, SMA ... **$450.00**
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) ... **$150.00**
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) ... **$150.00**

COMMUNICATIONS

HP 37204A-003 HPIB Extender, fiber-optic connection *unused* ... **$250.00**
HP 4934A-J02 TIMS; CCITT option; battery power ... **$1650.00**
HP 59401A HPIB Bus Analyzer ... **$375.00**
TAMPA MW. LAB BUC1W-02W-CST Ku band Upconverter, 1 Watt 14.0-14.5 GHz WR75 *NEW* ... **$150.00**
TEKTRONIX 1411R-opt.04 PAL Test Gen.,w/ SPG12,TSG11.TSP11,TSG13,15,16 ... **$1400.00**
TEKTRONIX 147A NTSC Test Signal Generator, with noise test signal ... **$800.00**

MISCELLANEOUS

EG&G/ P.A.R. 5302 / 5316 Lock-in Amplifier, 100 mHz-1 MHz, GPIB / RS232C ... **$2250.00**
FLUKE 2180A RTD Digital Thermometer ... **$500.00**
HP 59307A HPIB VHF Switch ... **$200.00**
P.A.R. 5206-95.98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB ... **$1250.00**
TEKTRONIX TM5003 TM5000-series 3-slot Programmable Power Module ... **$450.00**
TEKTRONIX TM5006 TM5000-series 6-slot Programmable Power Module ... **$500.00**
TEKTRONIX TM503 TM500-series 3-slot Power Module ... **$150.00**
TEKTRONIX TM504 TM500-series 4-slot Power Module ... **$175.00**
TEKTRONIX TM506 TM500-series 6-slot Power Module ... **$250.00**
TEKTRONIX TM515 TM500-series 5-slot Portable Power Module ... **$250.00**

Circle #48 on the Reader Service Card.

TECH FORUM

QUESTIONS

I would like to make or buy a serial to USB interface. I thought I remembered a project in *Nuts & Volts* some time ago in back issues, but don't recall the dates.

4021 **Edwin via Internet**

I support a network containing analog Public Switched Telephone Network (PSTN) dial modems that are used for dial out only.

For security reasons, I need to prevent the modems from answering calls received from the PSTN network. Due to the nature of the network and type of modem, the auto answer feature cannot be disabled. I need a circuit design or commercial equivalent that will pass the analog and -48DC on-hook/off-hook components, but block the 20Hz, 80Vac ringer component of the telephone signalling.

4022 **Mike Crawley Londonderry, Northern Ireland**

My wife and I work for two different airlines, both of which use proprietary terminal programs that work properly only under native DOS — not as a DOS window. Therefore, we spend about half of the time in a DOS environment and the other half in Windows 95 or 98.

In the earlier versions of DOS 6.x, the included Defrag program would allow the user to alphabetize the folders and files to easily find what you were looking for. From Windows 95 on, I haven't found the equivalent way of doing this in a native DOS environment, and a DIR command just brings up a jumble of files and folders that's tough to sort through.

How can I to do this without getting a third-party file manager? I've been told it can be done.

Also, when I minimize my Windows program, click on the DOS prompt to go to a DOS window... On my Win 95 machine, the Windows program stays minimized, the DOS C: prompt pops up, I do what I need to do in DOS, close the DOS program and type Exit, and I'm back to minimized Windows program again. If I try this on my Win 98 computer, the computer shuts down and reboots in DOS when I click on the DOS window, thereby dumping my minimized Windows program.

Is this a default settings problem on my Win 98 machine, or is there something fundamentally different between Win 95 and Win 98 in the way each handles DOS window requests?

4023 **Craig Bledsoe via Internet**

My wife owns a 1998 Honda CRV. She has lost one of the transmitters to lock and unlock the doors.

The dealer wants about $100.00 to replace it. Is there a cheaper replacement or can I make one myself?

4024 **Eric Funchess via Internet**

I am setting up a diskless workstation. I need a boot PROM for a NIC for a diskless node, but can't find info on this topic or where to get the PROM. Is it possible to "roll my own" boot PROM?

The application is a bare-bones system that I now bring up from a floppy. The disk has a self-decompressing minimal Linux system on it. I can eliminate the floppy if I boot from the network. But, if I can find a chip to act as a boot PROM with enough memory on it (EEPROM would be great) to also store the Linux system, I can eliminate the floppy, and the system could boot without a server.

Maybe there are boot applications that would not necessarily involve the NIC, and that would be fine, but I need the network to communicate with the running system anyway.

4025 **Kurt Stevens via Internet**

I was wondering if it would be worthwhile to try to interface a NEC Silentwriter Model 640 laser printer to a PC?

It has an eight-pin connector (LocalTalk) and the instruction manual describes the function of the pins. I can only locate MAC software for this printer. Is this an attempt at futility?

4026 **Michael Taylor via Internet**

What type of DC motor and controller could be used to obtain a smooth non-cogging slow rotation down to 3 RPM — direct drive?

Is there anyone (on the side, reasonably priced) who might do custom work involving a linear lathe and motor control?

I'm trying to reproduce a simple overhead record mastering

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!

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

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 email or we can not send payment.
- Your name, city, and state, will be printed in the magazine, unless you notify us otherwise. If you want your email address printed also, indicate to that effect.
- 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

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, Phone Number, and email. Only your name, city, and state will be published with the question, but we may need to contact you.

lathe and I do have one to help us.

4027 **Kim**
via Internet

I have recently purchased a semi-remote 20 acre parcel overlooking a lake, that I frequent about twice a month.

Being a former goldmine, it has a cabin and several buildings on it, but no electricity or phone line. The closest phone terminal is about one-two miles away. My problem is securing the property.

My plans are to attain dialtone and, through an alarm hooked to an autodialer, keep the premises secure. Line extension from the phone company will run into thousands of dollars.

Is there a way to use RF (i.e., mobile radio, ham, gmrs, frs) to interface to a telephone to give my property dialtone? I know there are repeaters in the 400+ MHz range, but, they are outside my budget. Any suggestions?

Power is not a problem. I have solar panels, batteries, inverters, etc. I am also into electronics.

4028 **Sean Miller**
via Internet

I have a Teac AG-D8900 AV digital home theater receiver.

Everything works great, except I inadvertently programmed one AM station into memory scan four times and an FM station in three times.

When I use the remote scan, it stops four times on AM and three times on the FM band, what a pain.

I need to erase the extra stations from memory and leave the area blank like it was originally.

Teac never acknowledged my letters.

How do I erase a programmed channel from memory scan, other than adding another frequency in its place?

4029 **Anonymous**

I am looking to build a simple VGA-to-TV composite video converter. I need it to work in DOS only and be able to convert plain (25 lines) monochrome text only. I am aware of commercial units for $100.00+.

40210 **Haim Sandel**
via Internet

ANSWERS

[3023 - MAR. 2002]

I've admired radio clocks for a while. I plan to make a PIC clock next. Is there a chip I can integrate in for self-setting time?

There does not appear to be a one-chip solution to receiving the time signal you refer to. This URL: **www.solutions-cubed .com/Stamp/july99.pdf** will take you to a six-page PDF file that is a paper describing a BASIC Stamp2 project similar to the one you envision.

The paper includes a schematic that is described as having been published in the July '99 issue of *Nuts & Volts.*

The schematic includes receiver and decoder modules from a company called ULTRALINK. The paper's author is from ULTRALINK. This URL **www.ulio.com** is the ULTRALINK home page. There is no pricing information there, but there is an email link that would let you ask.

Another site with a lot of information about projects like yours is **www.cl.cam.ac.uk/˜mgk25 /lf-clocks.html**. The trick to finding all this information and more is to search for the common name of the signal source you are interested in. For example, for receivers that work in the US, a search for "WWVB receiver" will have you hip deep in links. For receivers that work in the U.K. a search for "Rugby MSF Receiver Modules" will yield an overwhelming number of pages. One interesting one is **www.maplin.co .uk/**. This site offers a module of the sort your interested in for receiving a U.K. time signal.

Tom Tillander
Bay Village, OH

[3024 - MAR. 2002]

Does someone have a good schematic and parts list of a PC-based stepper motor controller that a beginner could build for a three-axis controller? Or a kit?

It looks like Robert Nansel wrote an article addressing your question in the same issue your question was printed in! Look at the Amateur Robotics column on page 59 of the Mar. '02 issue for a schematic of a three-axis controller. Apparently they're also being sold.

I built a very simple single stepper controller about six years ago. It was merely a bunch of transistors with their bases connected through a 4.7k resistor to the data bits of my parallel port. I programmed it using QBASIC using a simple loop sending four (?) bytes, corresponding to the pins which needed to be activated, to the port then repeating.

The motors were very weak. I'm unsure if this was due to my circuit, my programming, or the

[2026 - FEB. 2002]

I have a US Army Signal Corp., radio receiver and transmitter set that needs batteries, to get the set in operation. The P/N for the batteries are B-A-38-"B" and B-A-37-"B" battery.

I need information on how I can get the Army manual (TM-11-235), and batteries.

#1 The radio you are referring to is probably the BC-611 "handy talkie." It would operate from 3.5-6 MHz AM with an output of around 35 milliwatts.

The 611 used a 1.5 volt BA-37 filament battery, and a 103.5 volt BA-38 for the plates on the tubes. According to military nomenclature, the BC-611 is the radio itself. The SCR-536 is the complete unit including batteries.

You can find a schematic at: **http://hereford.ampr.org/millist/sch/bc-611.gif**

If you want to get a copy of TM11-235, check out Military info.com: **www.military-info.com/ mphoto/new1j01.htm**

You will also find neat info on the 611 at: **www.pacificsites.com/˜brooke/BC611.shtml**

Phil Shewmaker
Louisville, KY

#2 You can get the manual and much more at **www.military-media.com/master.html**. The CD contents are at: **www.military-media. com/radio.html**.

Instead of the original batteries, which will be expensive, I suggest a commonly available battery and DC-to-DC converter.

Russell Kincaid
Milford, NH

[2022 - FEB. 2002]

I want to build an electronic (LCD) weight scale. I would like to measure pressure caused by certain stresses anywhere from 1lb to 1000lbs. I was thinking piezo electric material for the voltage transducer and then amplified.

#1 The National Semiconductor website has an application note (#AN301) that has a circuit for a weighing system using a strain gauge.

The strain gauge is a resistive bridge which is unbalanced by strain. You glue it to a bendable beam which indicates the weight by the amount of bending. You can view the app note at: **www.national.com/an/AN/AN-301.pdf**. Another weighing system is at: **www.national.com/an/AN/AN-295.pdf**.

Russell Kincaid
Milford, NH

#2 I have dealt with exactly this problem!

The best "quick-start" reference is definitely OMEGA's free manual/catalog The Pressure and Force Handbook (at **OMEGA.COM**). It's a great source for learning the basics about instrumentation.

The allowable load range is rather large, so you may find it more economical to break it into two ranges. For the 0 to 40 pound range, you may want to use their LCL-040 ($69.00).

You DO NOT want to use piezoelectric sensors! They only measure changes in load. If you were to step on a piezo, it would only emit a signal as you were stepping on it (applying the load), but nothing afterwards (simply resting the load on it).

Thomas Ng
San Jose, CA

#3 The easiest way to accomplish this is through a strain gauge measurement in a bridge arrangement. Use a metal piece with eyelets and a suitable cross section (you need to stay in the linear region of the material, but get the stresses up to get a useable signal) and glue strain gauges perpendicular to each other on this piece with the recommended adhesive. Hook the four connections up to bridge excitation and signal conditioning (Linear Technology and Signetics have a few application notes on this, check their websites).

The output is typically 0-10 volts and can be connected to a digital panelmeter.

You can get ready-made loadcells for industrial applications, but they are pricey and have 0 or 4-20 mA outputs or use other digital interfaces.

Walter J. Heissenberger
Hancock, NH

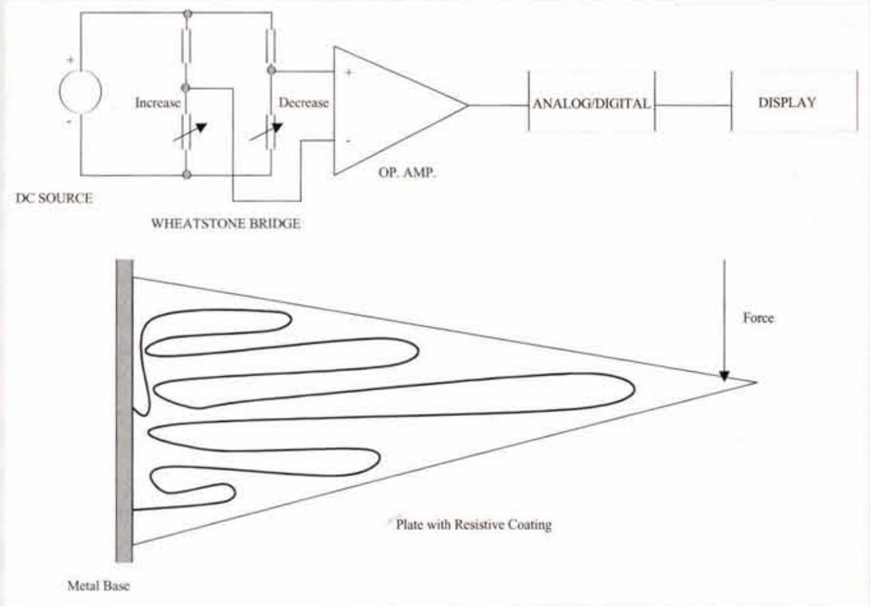
#4 The weight scale you just took apart is using a resistive sensor and a Wheatstone bridge to measure how much the plate is bending because of the weight.

The small plate is covered on both sides with a resistive material. Once the weight is bending the plate, one resistor is elongated and one is shortened. This causes the resistance to change and the bridge looses the equilibrium. The resulted voltage is usually applied to a O.A. and then to a A/D to be converted and displayed. The IC from the control board is quite complex and if you try to reproduce the function with normal ICs, it's not so simple, so it will be a good idea to reuse that IC.

A mechanical fixture adapted to the new weight range is a good and simple solution.

See figure below.

Radu Constantinescu
Falls Church, VA



motors themselves.

If you're interested in this overly-simple approach feel free to email me.

Eric Hungerford
Seattle, WA
finatronics@yahoo.com

[12015 - DEC. 2001]

I purchased a kit from Parallax, to program the Scenix SX28AC/DP microcontroller.

I want to use the b pins as wake-up inputs and I can't figure out how.

Could someone submit a program that would react to a push button on b1 by turning on an LED at a1, or a push button at b2 by turning on an LED at a2, and going to sleep after either case, only to wake up and react again to either of those buttons being pushed?

The source file, sxMIWU.src (Available at **www.nutsvolts.com**), shows how to use the sleep and wakeup interrupts on the Scenix SX28 chip. By changing the constant in the line "MOV !rb,#%11110100 ; port B[7:4,2] to normal..." you can select which of the four switches wake up the processor.

The documentation indicates that an interrupt at location 0 is executed, but my testing indicates that it performs a reset when a button is pressed. The code has been modified accordingly. The SXkey debugger is particularly weak in monitoring interrupt routines, but free running seemed to produce similar results!

Barry
Camas, WA

Continued on page 56

Circle #38 on the Reader Service Card.

Handheld Radio with Built-in GPS

By Gordon West

The long overdue handheld two-way radios with built-in GPS and maps are here ...

It was long overdue – a handheld two-way radio with built-in Global Positioning System and maps. Ham radio manufacturer Kenwood Corporation has proved that the utility of portable GPS automatic sending-of-position is a valuable tool over the airwaves. Thousands of hams have the Kenwood D7 amateur radio handheld, coupled with a little jumper cable to almost any type of GPS receiver that would output the NMEA datastream. Amateur radio operators will then tie in this signaling technology to the Automatic Packet Reporting System (APRS), allowing other operators around the world to see the position of the equipment as long as there is a host download station nearby that takes the packets and puts them onto a website. The system works great!

But the Kenwood D7 portable ham radio handheld with the accompanying Global Positioning System receiver was a bit bulky in light of micro-GPS capabilities. After all, GPS receivers may now be constructed within the innards of a wristwatch, so why not take this micro-GPS technology and build it into a simple two-way radio portable transceiver?

A couple of years ago, Garmin USA previewed a prototype cellular phone with a built-in GPS. This product never really got off the ground, and unfortunately, it was several years well ahead of its time. NOW, under FCC order for enhanced 911 service, many new portable cellular phones now incorporate GPS capabilities so emergency dispatchers may easily see the GPS position displayed on their dispatch center screen. While the E911 program with GPS positioning is still in its infancy, the capabilities of a single two-way radio with position-finding capabilities is thought to be a big breakthrough. But why won't a manufacturer give us a simple little handheld that could be used for license-free communications and also automatically transmit location information to another handheld with the same built-in GPS circuitry? Out hiking, Mom calls the kids and asks, "How far ahead are you on the trail?" Back comes the answer, and Mom looks down at the display and sees that she better pick up the pace because the kids are almost a mile ahead.

FIRST EVER CONSUMER GPS HANDHELD

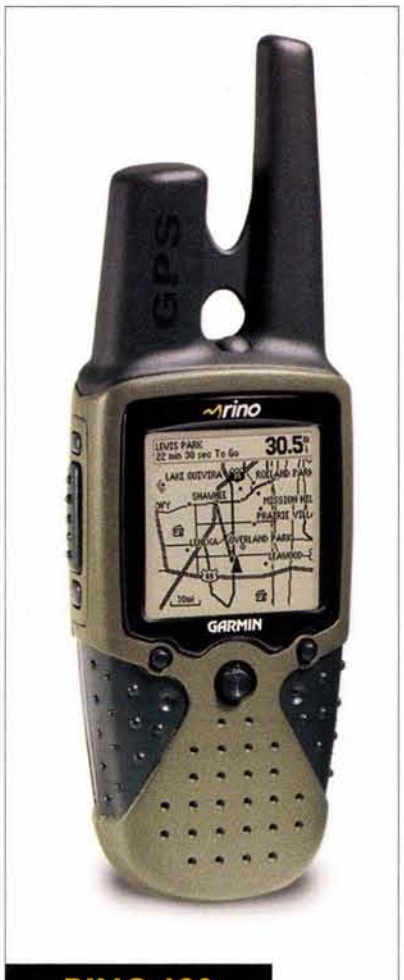
Garmin USA – a leader in marine electronics and GPS technology – announced the first-ever consumer electronics GPS positioning UHF handheld, surprisingly signaling both voice and data over the common Family Radio Service 14 channels, as well as capabilities on their step-up model for longer range General Mobile Radio Service (GMRS) repeater and simplex operation. What was truly amazing about this all-in-one transceiver was its affordable price (under $170.00 each) and capabilities to not only send voice and data on the common FRS channels, plus voice on GMRS, and also stay working even after submersion in case the canoe turns turtle.

"Federal Communications Commission rules would need to be amended to authorize Family Radio Service (FRS) units to transmit an additional emission type, and to revise the permissible communications rule that applies to FRS units," comments Dan Bartel, Director of Recreational & Consumer Electronic Sales at Garmin. In its petition, Garmin proposed to allow FRS units to transmit GPS location information using emission type F2D in a digital data burst of not more than one second.

After they sent in their proposal to the FCC, there were several months for users and other radio companies to either agree with their petition or to try to block their path for a rule waiver. From what I understand, there was very little opposition, and Garmin was ultimately given the green light by the FCC to begin marketing this new concept in communications.

"We believe the record in this proceeding warrants proposing amendment ... of our rules because we (the FCC) believe that the proposed amendments will benefit FRS users," comments the FCC in their discussion of the petition in a released statement on December 20, 2001.

"Specifying only one emission type in Section 95.631(d) may have unintentionally limited some manufacturer's capability to develop FRS units that could be even more useful to the public ... we agree with Garmin that limiting



RINO 120

RINO 110

FRS units to transmitting a digital data emission for no more than one second out of a 10-second period and requiring that a digital data transmission be initiated manually by the FRS user appear to be, in combination, a reasonable method of minimizing interference between data communications and voice communications on FRS channels," adds the FCC.

The new Garmin FRS/GPS radio is nicknamed "Rino," partly because the twin antennas look a little bit like the head of a Rhinoceros, and a not necessarily so easily understood acronym on how this new radio works. I would have called it something like "COMM NAV" or simply "Radio Locator." But nonetheless, both the Rino 110 and Rino 120 support 22 communication channels, where you may select CTCSS, as well as add voice scrambling for your operation on FRS and GMRS frequencies. Keep in mind that GMRS operation requires a license. FRS does not. The Garmin radios feature 12-channel GPS with Wide Area Augmentation System (WAAS) differential correcting reception. Instead of getting down to the radius of a 30-foot circle, most Garmin WAAS-enabled receivers get you down to about a six-foot circle!

The less expensive Rino 110 has a graphic plotter screen for mapping of user waypoints and points of interest. The more expensive Rino 120 includes 8 MB of internal memory and the addition of a built-in base map of North and South America. Map detail includes cities, highways, thoroughfares, and secondary roads within metro areas. With the 8 MB downloaded, you can get all the way down to topographic, bathymetric, and street level detail via Map Source™ data from Garmin who does their own sea and land cartography in house. The Rino 120, priced at around $250.00 each, adds more mapping capabilities including running Garmin exceptionally clear and clean marine charts. This means the step-up model may be used for both boating, as well as on the roads.

HOW DOES IT WORK?

So, the way it works is you are communicating with another similar Rino unit from Garmin, and the other stations asks you where you are located. You look around and all you see are trees and hills. Manually activate the GPS data send function, and presto, the other station will now see how far away you are, magnetic bearing to you, and could even pull up your position on their own local map. And if you want to know where THEY are, ask them to send you THEIR position — and within just a couple of seconds, your little Family Radio Service does the number crunching and you see their distance and magnetic bearing on YOUR screen. And according to Pete Brumbaugh — the Garmin media man and in-the-know about all of Garmin products — the final version of the Rino 110 and 120 will probably get into the hands of frequent radio users with capabilities to play with configurable maps from Garmin to make the equipment exactly the way that everyone wants it to be on the airwaves, and for location position gathering. Pete says that the waiting time for a sample unit is over a few months, and they are having way too much fun themselves playing with all the bells and whistles that this equipment may offer.

Certainly, safety is a big issue in what this new GPS-based transceiver could do in an emergency. If the kids, out on the trail, trip over a rock and slide down a hill, you would ask them to send their location, and presto, you would be able to get to their location down to the radius of that six-foot circle. "Rino stands for Radios Integrated with Navigation for the Outdoors," comments Brumbaugh. "Step-up model 120 may offer a plethora of accessories including a VOX headset, vibration alert, voice scrambler, call ring function, and all of the capabilities to upload Garmin cartography," adds Brumbaugh, proudly showing off the new Rino and its unique capability to send and receive other Rino positions.

But keep in mind that the way GPS works is through the process of trilateration to more than four satellites within view. Inside a shopping mall, there will be no satellites in view. So don't expect that the GPS function will work anywhere other than with a clear shot at the sky. Sure, in another 10 years, I expect to see GPS signal extenders inside shopping malls, as well as inside big factories to control robotics, but for now, the other station needs to be in view of the satellites in order to derive their GPS position fix.

WHAT'S NEXT?

Garmin also indicates that it may soon put together a program with Timex — the watch people — and this will add one more wristwatch GPS system out there tuning into the 1575 MHz satellite airwaves. The new Garmin FRS/GMRS handhelds have plenty to offer, including safety. The technology is certainly here to incorporate the Garmin GPS receiver inside any one of their many models of two-way radios. Garmin went to great efforts to convince the FCC to look over their petition on a better use for those 14 FRS channels in addition to voice, and for the next couple of years, Garmin will prove that this technology is indeed practical, affordable, and my guess, lifesaving. Look for the new Garmin radio/GPS handheld transceivers to hit the market around summertime, and let's see where they go with this new communication and radio GPS location technology. Pete Brumbaugh at Garmin welcomes your comments and questions — email pete.brumbaugh@garmin.com or phone 913-397-8200. I'm on the review list, and I'll let you know the outcome soon! **NV**

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:

LVDTs explained ... you might be surprised. Lots of counter circuits for lotsa applications. Cheap data logger and a simple time delay relay. Finally, is there really such a thing as an electronic fuse? You decide.

Linear Displacement Devices

Q. I have a cyclindrical device that's one-half inch in diameter by four inches long, with a spring-loaded plunger at one end and five wires (red, green, black, white, and yellow) at the other end. I am guessing it is an LVDT (Linear Variable Differential Transformer), but I don't have a clue as to how it works. Is it AC or DC, and what is the voltage output?

Peter Stratigos
via Internet

A. An LVDT, which belongs to the group of linear displacement devices, is made of three coils, placed side-by-side, wound on a common form or bobbin. The center coil — the primary or exciter coil — is excited with a sinewave voltage normally in the region of 1kHz to 30kHz at 0.5 to 10 volts. The other two coils — the secondaries — are wound such that when a ferric core is in the central linear position, an equal voltage is induced into each coil. (Figure 1)

The secondaries are connected in opposition so that, with the core in the central position, the outputs of the two secondaries cancel each other out. As the core moves back and forth, the induced voltage in the secondary windings decreases and increases. In order to know in which half of the secondary coil the core is located, the phase of the output, as well as the magnitude, has to be measured. This is done by comparing the secondary phase with the excitation phase.

National Semiconductor makes an LVDT signal conditioner — the NE5521 — for use with a linear and rotary variable differential transformer (RVDT). An RVDT is identical to an LVDT, except that the core motion is rotary. A typical NE5521 application uses just five external parts and an optional low-pass filter, as shown in figure 2.

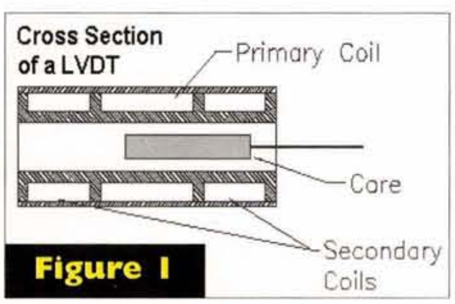


Figure 1

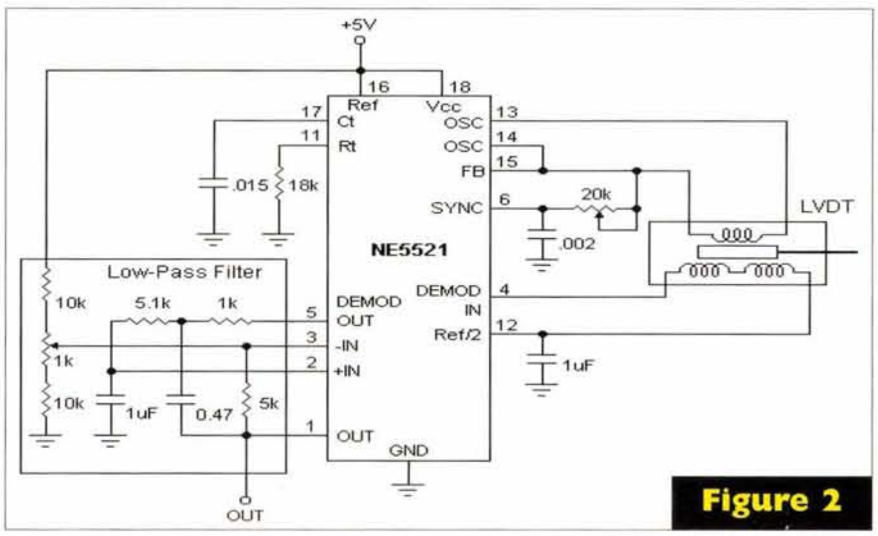


Figure 2

Digital Delay

Q. Our son, Tim, is a graduate research assistant at the Univ. of Wisconsin (Madison), where he is involved in Medical Ultrasound research. His problem involves an ultrasound scanner that produces an output somewhat like video. The frame rate is 10 Hz to 40 Hz, and the scan rate is 100 to 300 lines per frame. The outputs are analog for the "video" and TTL level for the frame and scan line pulses. The team wants to view a single line of each frame on an external oscilloscope, which they can do using a delayed sweep for the top lines of the frame. However, to view the bottom lines at 10 Hz per second requires a delay of 100 mS and the scope has a maximum delay of 1 mS.

Tim suggests two approaches. The first would be to use a variable digital delay, with upper delay of 50 mS to 100 mS, feeding the frame pulse to the scope's external trigger. The second is a line counter which counts line pulses beginning with each frame pulse and triggers the scope at the desired line.

William Stiles
via Internet

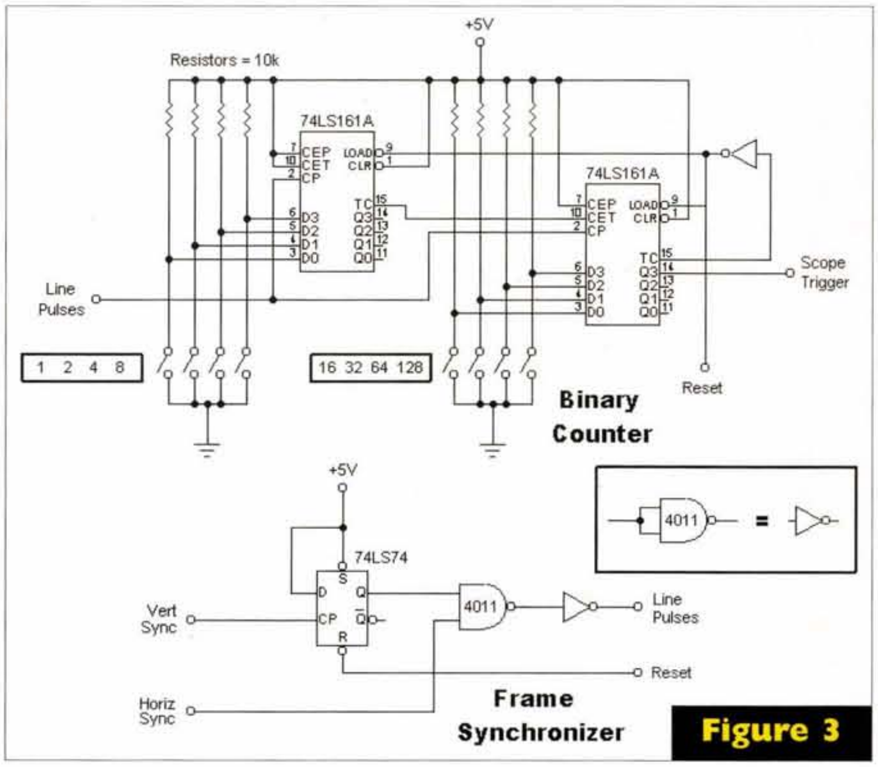


Figure 3

A. Here is a programmable line counter (Figure 3) that will serve as a stable oscilloscope trigger delay. The first counter counts up to 16 and the second counts up to 256, offering a full range of numbers between 0 and 256. The switches set the delay time by grounding selected inputs to equal the line number you wish to single-out for viewing. Notice that the switches are coded in binary format, so if you want to trigger a delay for 80 lines, you enter the values of 16 + 64. After the programmed count is reached, the TC (carry out) output of the second stage reloads the "delay" switch settings and starts the count again.

Of course, for this counter to

work, the roll-over count must equal the number of scan lines in the frame. Without knowing which line the scope is synchronized onto, the counter will wander between scan lines. A way to correct this problem is to use the vertical retrace blanking pulse to synchronize the counter to the frame. The lower circuit, Frame Synchronizer, should provide that function — with some reservations. First, you have to have access to both the horizontal and vertical sync pulses. If they are combined, as would be the case with composite sync or sync on green, you need to run the signal through a sync separator. Second, the Frame Synchronizer assumes negative blanking pulses for the horizontal and vertical retrace. If not, you will need to add inverter gates as needed to correct the polarity.

There is another approach that doesn't require separate horizontal and vertical sync pulses, but does require a separate counter to reset the Binary Counter. This can be done using the existing outputs, or via a parallel binary counter. Unfortunately, it doesn't sync on the beginning of the frame, just the same line over and over, which requires some math intervention and additional hardware chips. An advantage to this approach is that it provides a manually-adjustable trigger line that moves up or down, which may be advantageous. Let me know if you need further help.

Data Logging On The Cheap

Q. I have a vacation cabin in a rural area where the electricity is sometimes out for minutes, hours, or even days at a time. Since this cabin is unoccupied most of the time (it might be a month or so between visits), I would like to have some sort of simple device that would allow me to see when, and for how long, the power was off. I am thinking of some sort of recording timer — either mechanical or electronic — that I could view on arrival to determine just how long the freezer, etc., was inoperable. Any ideas?

John Seibels
Columbia, SC

A. The easiest and cheapest answer is to use a totalizer that adds up the minutes the power is off. Such a circuit can be made using a relay — RadioShack counter (910-4910) — and a clock pulse, as shown in the schematic below (Figure 4). When the power is on, the relay is engaged and power to the pulse generator is disconnected. When the AC power fails, the relay applies voltage to the pulse generator. I've taken the liberty of making the circuit very simple by assuming 64 seconds per min is an acceptible error. That amounts to 1.5 hours per day. Otherwise the design would require a lot more circuitry, and according to your schedule, the error is no big deal.

The problem, of course, is that a totalizer doesn't tell you when the power failed or for how long per event. For that you need a data logger, which doesn't come cheap. Then it hit me! There are plenty of data loggers on the surplus market that can be had for as little as $10.00. I'm talking about temperature chart recorders of the paper disk variety (not paper strip recorders) — the kind used to monitor walk-in freezers and warehouses. They come in wind-up, battery power, and AC (with battery back-up) versions, and can record data for days or weeks. To record your power on/off periods, simply place the temperature sensor close to an incandescent night light and start the platter spinning. When the power fails, the lamp goes out, and the sensor will record the drop in temperature.

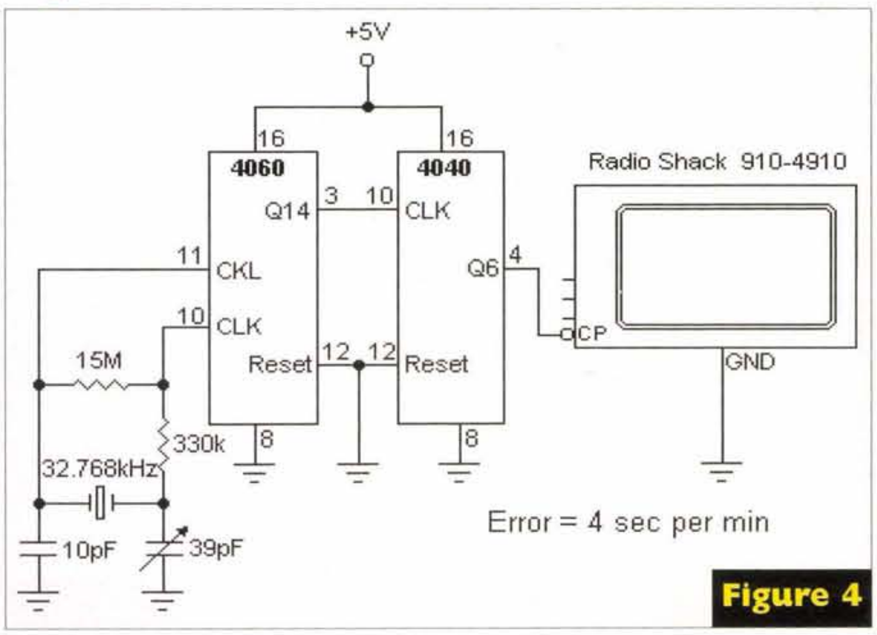


Figure 4

PC Boot Delay

Q. I have modified a connector to one of my PC's power leads that makes a branch line carrying 12 VDC that I use to operate an external relay which switches on the 120 VAC power for the monitor, printer, scanner, and other computer devices. The relay arrangement works fine, but I would like to have a delay of 5 to 10 seconds to let the hard drive get up and running before the external peripheral devices start up. Please provide me with a diagram for a circuit that I can package in a small "project box," which will detect the presence of the 12 volts from the computer and then wait 5 to 10 seconds before engaging the relay.

R. Brelsford
South Carolina

A. Here's a small circuit that'll do your bidding. (Figure 5) It's a single transistor switch that can't turn on until the voltage across the 100uF capacitor reaches about nine volts. If you wish to adjust the delay, the time it takes before the relay pulls in is approximately t = RC.

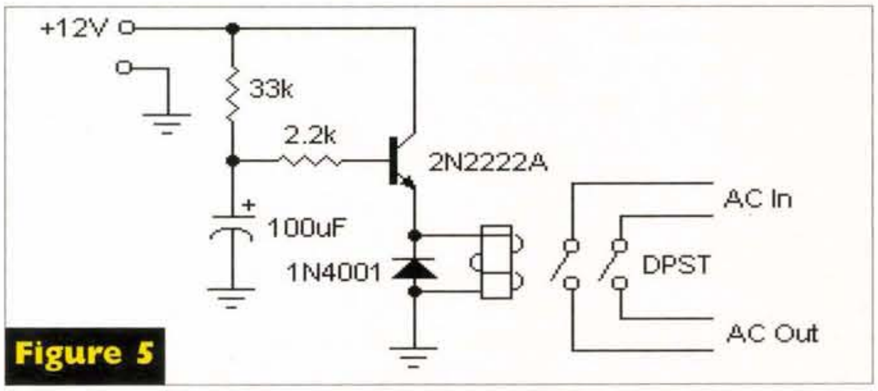


Figure 5

Ahoy, All Volts Aboard!

Q. My question concerns the voltage requirements for marine radar, chartplotters, sounders, and similar devices. The voltage input for some of these instruments ranges from 11 to 40 volts, while others specify 12/24 volts. Why the difference in the input voltages? Do they assume that large boats with big diesel engines have 24-volt systems, while those under 35 feet have 12-volt systems? Is 30 or 40 volts better than 12 volts? I want to install a sounder/fishfinder, but I'm so confused by all these voltage differences.

Rickey Boggiatto, Sr
via Internet

A. The marine industry has three voltage standards commonly found on small boats: 12, 24, and 32 volts. And yes, the voltage tends to increase with the size of the boat and the horsepower of the engine. Marine elec-

Cool Web Sites!

Crimeboss — History of crime comics of the 1940s and 1950s. Includes a large cover gallery.
http://www.crimeboss.com/

The Blue Highway — The history of the blues is more than a musical chronology.
http://thebluehighway.com/

Red Hot Jazz Archive — History of Jazz before 1930.
www.redhotjazz.com/

Historical Atlas of the 20th Century — Keeping the Turn of the Century in perspective
http://users.erols.com/mwhite28/20centry.htm

Figure 6

Figure 8

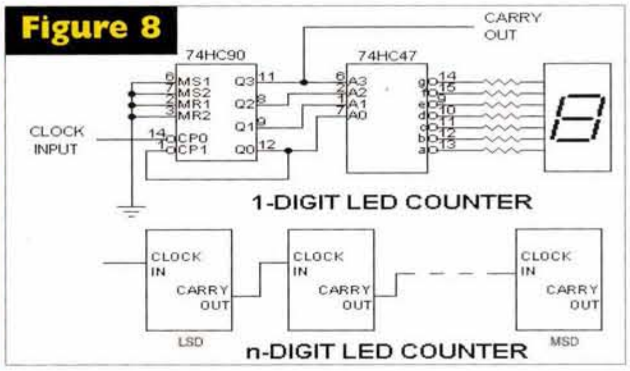
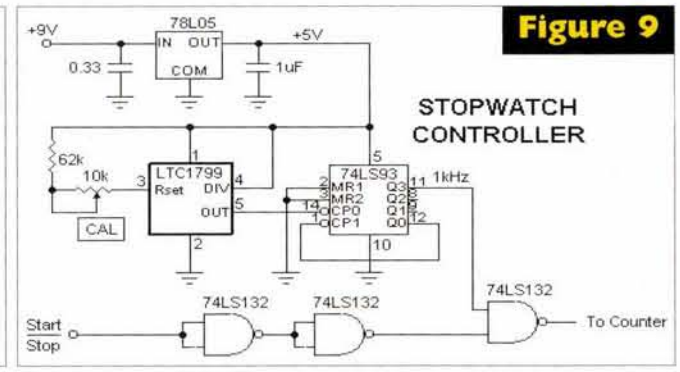


Figure 9



tronics that advertise 11- to 40-volt input have a circuit that automatically converts the input voltage to the working voltage used inside the unit. Systems that say 12/24-volt operation often have a selector switch on the unit that selects the proper input voltage. Regardless of the input voltage, the voltage inside the instrument is independent of the input voltage, so there's no advantage to using 32 volts over 12 volts — except for the way the unit is installed. The lower the voltage, the higher the current requirements and the larger gauge wire is needed to overcome voltage loss in the wiring. For example, if the unit is rated two amps at 12 volts, it will only draw one amp at 24 volts.

Make Way, Coming Through!

Q. I need to increase the voltage that powers a vehicle back-up alarm in order to make it louder. The alarm is rated 12 to 72 VDC, and is presently driven by my 12-volt (car battery) back-up tail lights.

Peter Stratigos
via Internet

A. Unless it's a really cheap unit, which yours isn't, increasing the input voltage won't increase the loudness of the alarm. You see, the sound level is regulated by law at 107-109 dB measured at a distance of one meter (97 dB at four feet). As the voltage increases, the alarm automatically adjusts to the new voltage, thus maintaining a constant sound level.

An interesting item that I ran across in an auto parts store the other day is the Back-Up Alert Beeper (Figure 6) which combines a halogen lamp with a back-up alarm. Simply remove your existing back-up lamp and replace it with this device. Now each time you shift into reverse, the halogen lamp lights and the beeper beeps at a non-disruptive 87dB.

Precision Stopwatch

Q. I am looking for a stopwatch circuit for a Drag Racing simulation game. I need a circuit with a display that can count up and has an accuracy of 1/1000 second (00.000).

Wayne Duvall
via Internet

A. At first I thought this would be an easy question. Simply locate an inexpensive stopwatch kit and steer you that direction. As it turns out, they don't exist. So I'm doing the next best thing, adding a stopwatch function to a counter.

The type of counter isn't important. Any instrument with an input frequency of 1 kHz or better will work. Okay, this is supposed to be a DIY magazine, so I went back to a counter design that has become a staple of the industry — and is abundantly available in kit form for about $20.00 to $30.00. Here is a short list of suppliers (Listing 1) and a schematic. (Figure 7)

These kits increment the timer in multiples of three digits, so I've included an older design (which I believe is no longer in kit form) using the 74LS90/74HC90 that allows you to add the digits one by one. (Figure 8) The unlabeled resistors can vary between 100 and 470 ohms, depending on the LED brightness.

Now we come to the crux of the matter — the stopwatch controller (Figure 9). For this, a stable 1-kHz oscillator is needed. After considering several options, I opted to go with the recently-introduced LTC1799 precision oscillator chip from Linear Technology (available from **Digi-Key: 800-344-4539; www.digikey.com**). and occupies very little PC board space. The oscillator frequency is programmed by a single, external resistor and has an accuracy of 1.5% or better without the need for external trimming components. My design includes a 15-turn trimmer resistor to achieve accuracy of better than 0.1%. The 16.000-kHz frequency is divided by a 74LS93/74HC93 ripple counter to produce a stable 1-kHz clock pulse.

This 1-kHz clock is gated through a NAND gate to display the elapsed time of your dragster. The Start|Stop input is buffered by two 74LS132/74HC132 Schmitt NAND gates to sharpen the rise-time and prevent false triggers by establishing a hysteresis zone. As shown, the stopwatch controller will start the timer when a positive voltage is applied to the input and stop the timer when the input is grounded. If your logic is the reverse (low on, high off), remove one of the 74LS132 inverter gates.

Pop Goes The Fuse!

Q. I am trying to make an electronic fuse using transistors that work like a mechanical fuse. I've tried various designs over the years and have never been able to make them work properly. Could you please provide me with a circuit?

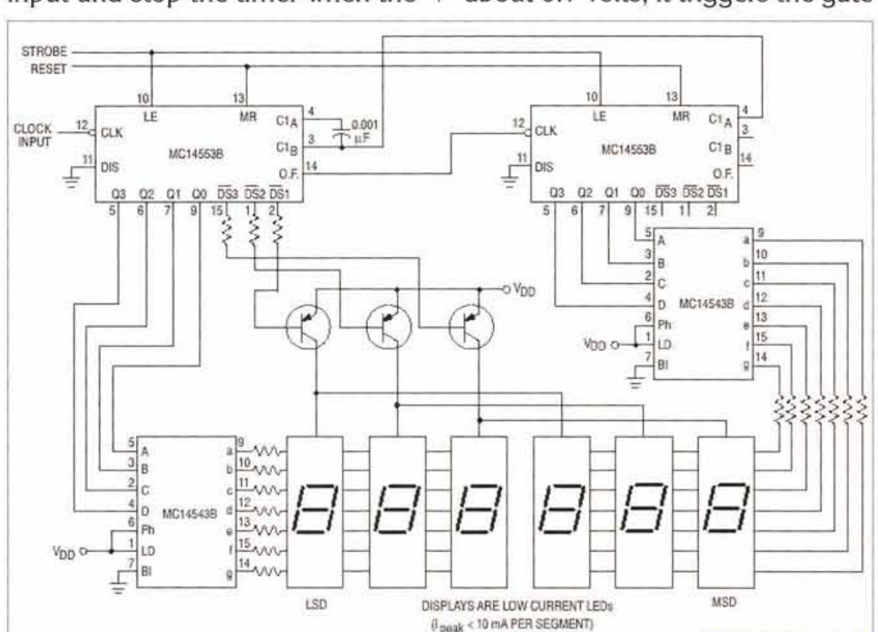
Cletus Bell
Louisville KY

A. I have a feeling that the designs you have been looking at are really current limiters, and not electronic fuses. To behave like a fuse, the load has to be disconnected from the power source. My first design — Figure 10, ELECTRONIC FUSE — uses an SCR as the disconnecting element.

When power is first applied to the circuit, the TIP120 pass transistor conducts via base current supplied by the 470-ohm resistor. This, in turn, causes a voltage to develop across R1 that's proportional to the current flow. When the voltage across R1 exceeds about 0.7 volts, it triggers the gate

Listing 1

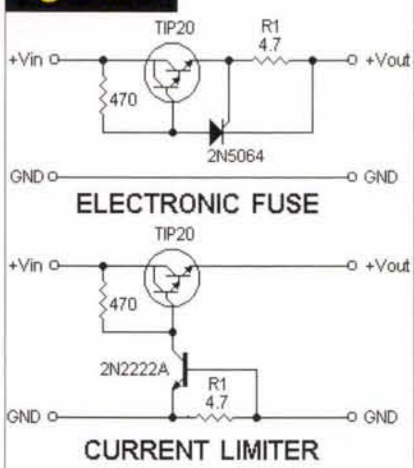
www.web-tronics.com/kit1thredigl.html
www.qkits.com/serv/qkits/diy/pages/QK1.asp
www.wiltronics.com.au/listproducts.asp?prod_id=172&cid=23
www.quasarelectronics.com/counters_timers_meters.htm
www.ozitronics.com/kitlist.html
www.electronics123.com/amazon/catalogue/c3-3-4.htm



6-DIGIT LED COUNTER

Figure 7

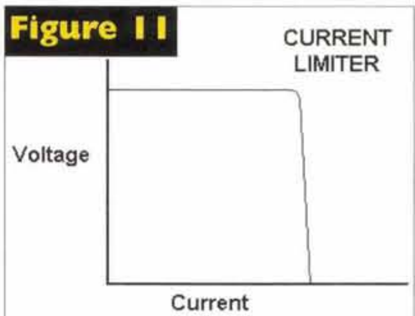
Figure 10



R1 ≈ 0.7/Trip Current

Current	R1
5A	0.14
3A	0.23
1A	0.70
500mA	1.40
150mA	4.67

Figure 11



of the 2N5064 SCR, which shorts the base of the pass transistor to its emitter, which turns the transistor off. Now it's the nature of an SCR to keep on conducting even after the trigger source is removed. Consequently, the fuse remains "open" until the short is removed or the power is turned off (the SCR will continue to short out the pass transistor until the current drops below 5 mA).

However, having to manually reset a blown fuse isn't always desirable or practical. That's why a lot of "electronic fuse" circuits are actually current limiters. This device works by sensing the current through the load, and putting a limit on the current allowed. If we were to draw a graph of this action, it would look like a shear cliff, (Figure 11) where the output voltage drops sharply as the load resistance decreases.

This is done with a 2N2222A NPN transistor which has the current-sensing resistor (R1) connected between its base and emitter. When the voltage across R1 exceeds 0.7 volts, the transistor begins to conduct, which effectively shunts the pass transistor's (TIP 120) base current to ground and holds the output current at that level no matter how much current the load may demand. At higher currents, you will want to heatsink the TIP120 because it will be operating in its linear region.

Why the two designs? As mentioned before, the electronic fuse is a one-time shot that has to be manually reset like a circuit breaker. The second is self resetting after the short or overload is removed. But there's something else. Notice that the upper circuit senses the current from the high side of the line, whereas the current limiter takes its cue from the lower line. When you sense the lower line, it inserts a resistance from the load to ground (hence, a voltage drop), which isn't always desirable. You choose.

LCD Math

Q. I want to drive an LCD display from a computer with a VGA output using a VGA/NTSC converter. The display has a NTSC input and a resolution of 1152H x 234V. Would this work for displaying PC text and graphics, even though the VGA output is 640H x 480V?

David Kamulski
Oxford, MI

A. Yes, it will display your PC graphics and text, but maybe not the way you are expecting. There are two factors involved here, the most critical being the difference in the number of vertical lines. The VGA has a resolution of 480 vertical lines, of which only half can be seen on the display. The result is degraded text and graphics quality. The second factor is the screen aspect ratio, the ratio between the vertical and horizontal dimensions of the image. For the VGA format, that ratio is 1:1.3; your screen has an aspect ratio of 1:5, which means the horizontal resolution of your VGA image will be reduced from 640 to about 320 after the NTSC converter corrects for the aspect ratio. Still want to use your new-found treasure?

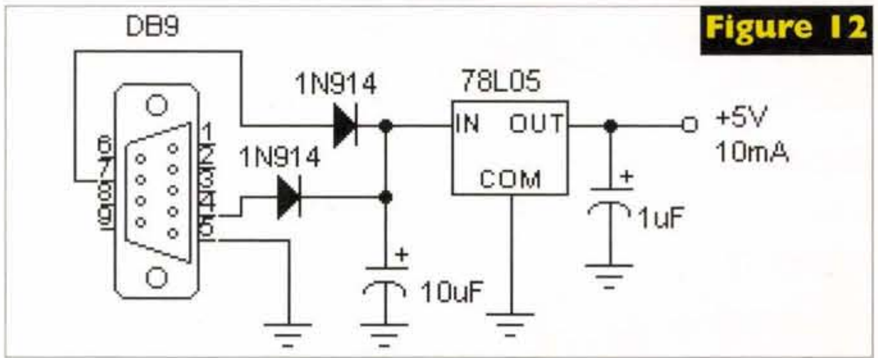
Serial Port Power, Revisited

Q. In the Dec. 2001 issue, you advised Jack Simpson as to how he could power his PIC circuit by stealing power from the serial port. I am making an isolation circuit for my parallel port using 6N137 optocouplers, and would like to power the gates that feed back into the status and control portions of the parallel port with power from the serial port. Do you think that the serial port will supply me the current I require?

Brian Rippie
via Internet

A. Well, that all depends because the maximum current you can "steal" from the serial port is about 10mA. According to the 6N137 datasheet, the guaranteed trigger point is 5mA, which means you only have enough current to power two devices. However, a closer look at the datasheet reveals that 2.5mA will work in all but the most extreme conditions, which is sufficient to drive four 6N137 gates. However, the parallel interface has five inputs, so you may have to find a way to work with just four input lines to pull this off. Or, if you have access to a lot of 6N137 chips, you can sort through them and pick out those which have the lowest current requirements. For those readers who missed the circuit Mr. Rippie is talking about, here it is again. (Figure 12) **NV**

Figure 12



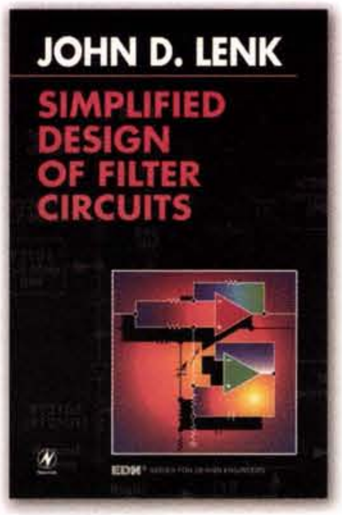
Keep your electronics library up-to-date with these latest reads —

New Books

Simplified Design of Filter Circuits

by John D. Lenk

$24.99

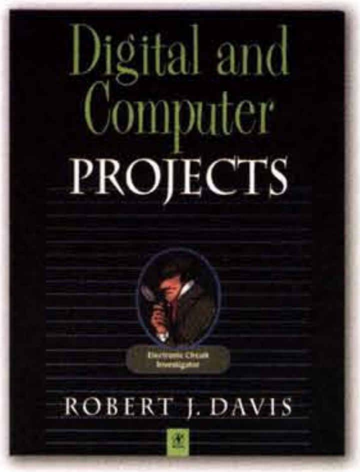


Simplified Design of Filter Circuits, the eighth book in this popular series, is a step-by-step guide to designing filters using off-the-shelf ICs. The book starts with the basic operating principles of filters and common applications, then moves on to describe how to design circuits by using and modifying chips available on the market today. Lenk's emphasis is on practical, simplified approaches to solving design problems.

Digital and Computer Projects

by Robert Davis

$24.99

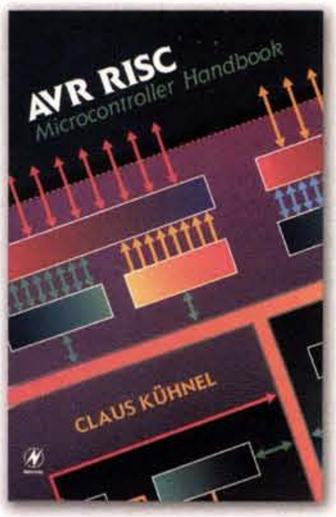


Compiled from the author's research for articles published in *Nuts & Volts* magazine, this book is filled with digital electronics projects and projects that involve computer peripherals. It is divided into digital projects, from Epson copiers and adapters to quiz machines; printer port projects, from a digital storage oscilloscope to an audio mixer; and monitor projects, from VGA adapters to conversion of monitors to 31 KC operation.

AVR RISC Microcontroller Handbook

by Claus Kuhnel

$39.99

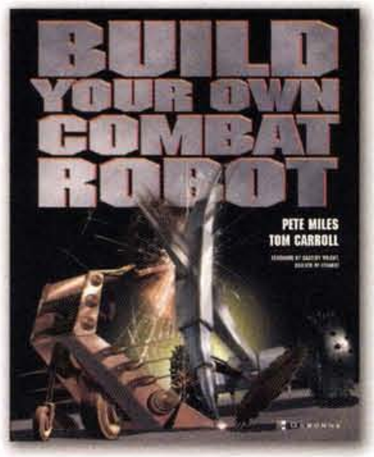


The *AVR RISC Microcontroller Handbook* is a comprehensive guide to designing with Atmel's new controller family, which is designed to offer high speed and low power consumption at a lower cost. The main text is divided into three sections: hardware, which covers all internal peripherals; software, which covers programming and the instruction set; and tools, which explains using Atmel's Assembler and Simulator (available on the Web) as well as IAR's C compiler.

Build Your Own Combat Robot

by Pete Miles and Tom Carroll

$24.99

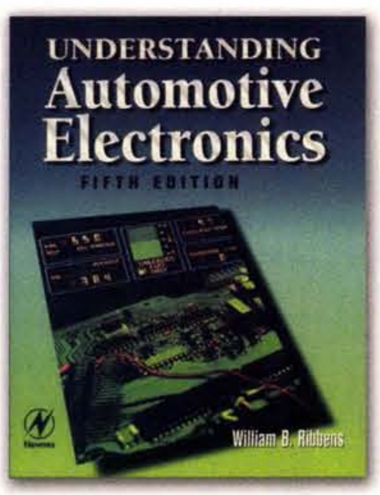


Build a powerful and invincible robot — for full-blown competition or just for fun — using this authoritative robot resource. This team of experts gives you an inside look at the innovative new world of robotic combat, explaining the origins of the sport as well as all the elements that go into constructing a fighting robot. Learn technical basics from motors and wiring to locomotion, and read builders' true stories from the front lines of robot competition. Whether you're mechanically minded or not, you'll find this book both entertaining and informative.

Understanding Automotive Electronics Fifth Edition

by William B. Ribbens

$34.99

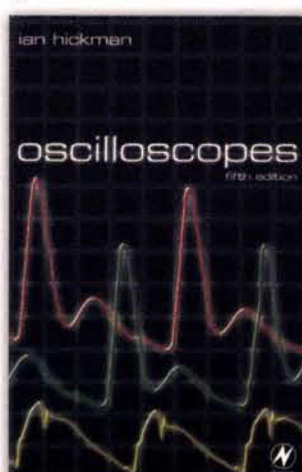


This edition of *Understanding Automotive Electronics* covers the most recent technological advances in operation and troubleshooting of electronic systems and components. This is a practical text, suitable for the automotive technician, student or enthusiast. It includes low-emission standards, on-board diagnostics and communications, digital instrumentation, and digital engine control.

Oscilloscopes Fifth Edition

by Ian Hickman

$39.99



Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models are available. But which is the right one for a particular application? Which features are essential and which not so important? Ian Hickman has the answers.

This handy guide to oscilloscopes is essential reading for anyone who has to use a 'scope for their work or hobby: electronics designers, technicians, anyone in industry involved in test and measurement, electronics enthusiasts... Ian Hickman's review of all the latest types of 'scope currently available will prove especially useful for anyone planning to buy - or even build - an oscilloscope.

These new titles can be ordered from the *Nuts & Volts* Bookstore.
Call **1-800-783-4624** or visit our web site at **www.nutsvolts.com**

SERIOUSLY SIZED SERVOMOTOR SLIDE, provides 21" of precise travel. But Wait...There's More!

These heavy duty, motorized linear slides, do their sliding on 3/4" diam. Thompson steel rail. The X axis is motivated by a substantial 3.4" diam. EG&G servomotor type: ME3515-191B with an EG&G 1000 count encoder driving a flex coupled 1/2" pulley which belt drives 2.2" diam. transfer pulley which direct drives the 1.5" final drive pulley which moves the 0.6" wide toothed belt which moves the carriage. The X axis carriage contains a motorized rotary unit with the same type EG&G servomotor driving a 5.5" diam. 1/4" thick aluminum platter mounted at about a 20 degrees angle to the base. Rotation is via an anti backlash gearing system directly driven by the motor. Supporting all these goodies is a welded, 3" wide steel channel frame. The system overall size is: 45"L x 14.25"W x 8.75"H. These units must ship via truck. Very limited quantity. These are used in good condition.

XSLIDE-ROTARY....... $229 ea. or 2 for $399

INCREMENTAL OPTICAL ENCODER, LUCAS/LEDEX TYPE: S-10208A-1386. Provides 1386 counts per rev! That's 5544 counts per rev in quadrature!

5VDC powered. TTL compatible outputs of: A A, B B and M M, 1/4"diam. x 1/2"L, ball bearing shaft. Size: 2.3"diam x 1.9"deep Removed from equipment. A super value.

LUCAS-ENC1368...........$39ea.

A SECOND SERIOUSLY SIZED SERVOMOTOR SLIDE, By ANORAD, Provides 23.5" of Precise Travel. But Wait...There's a Z AXIS BONUS!

These SUPER HEAVY DUTY, motorized linear slides, do their sliding on crossed roller bearings. The X axis is motivated by a 2.25" diam. EG&G servomotor type: MT-2130-012BE or similar with

encoder driving a flex coupled 0.75" diam. ball screw drive. The huge carriage is: 28" L x 5.5" Wx 1.1" Thick. The X axis is a massive precision machined (Mehanite) casting. Mounted to the carriage is a substantial Z axis unit sporting dual THK, YH2218, 0.6"H x 0.5"W rails or similar. Riding the rails are four recirculating ball carriages attached to a 1/4" thick aluminum plate. (Two carriages on each side) Running down the center is a 1/2" diam. ball screw driven by a size 23 stepper motor. This motor provides the drive for the 10.5" travel, Z axis. These units were originally designed to be used in a "gantry" configuration. ie. suspended over the workpiece with the workpiece moving in the Y axis. Overall size is 48"L x 17"W x 20"H. This is the perfect setup for heavy duty cutting or engraving. Slides of this quality don't come around very often. Don't miss out. We have a very limited quantity. These units must ship via truck. These are used in good condition removed from optical equipment. **ANORAD SLIDE.. $349 ea. or 2 for $649**

WOW! OPTICAL EXPERIMENTERS DELIGHT, DUAL PHOTO DIODE DETECTORS and FIBER OPTICS to boot!!...

These unique assemblies are removed by us from a precision optical systems. The goodies provided go something like this: Two silicon photodiodes from Hammamatsu. One type 2386-18K, 1.2 mm² active area, 5pA dark current in a TO-18 pkg. and one type 2387-66R, 33mm² active area, with high linearity and 50pA dark current in a flat glass/ceramic package. Both with usable sensitivity from 320nm to 1100nm and a peak sens. @ 960nm. These beautiful detectors are each mated with a Burr Brown OPA111BM, low noise high performance amplifier. The amps alone are currently over $8ea in 1000 qty. High quality 10,000Mohm resistors are on board as well. Power is via ± 15VDC through 14" long ribbon I/O cable. The entire PCB is enclosed in a removable shielded enclosure. There is a 1.3"L x 0.4"H opening in front of the large area detector. Also provided is a 7" removable fiber optic cable which provides the input to the small area detector. Originally the system provided large area signals through a color filter wheel an main lamp feedback through the F.O. cable. A super little unit. Overall size: 5.2"L x 2.8"W x 2" H We provide the manufacturers data sheets for the detectors and the amplifiers as well as the power connection info. The rest is up to you. This is a beauty. These are removed by us from new optical equipment. **DUAL DETECTOR.... $19 ea. or 4 for $49**

NEW, VICOR, DC/DC CONVERTER. Type: V48C3V3C75A002 The latest design

provides 3.3V@ 75Watts form 48VDC @ 97W input. Mini size: 2.3"L x 1.4"W x 0.55"H. These are brand new and very pricey. At full output, adequate cooling is required.

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WE ARE LOOKING for UNIQUE ELECTRO-OPTICAL, MOTION CONTROL DEVICES and RELATED. PLEASE FAX US YOUR LIST of AVAILABLE MATERIAL.

CARL ZEISS, S-PLANAR LENS,

GCA type 37, 1.4/75, M1:5nA=0.30,

A fantastic lens with a current replacement cost of $20K. Extremely flat field and extemely high quality. Removed from wafer-lithography system, excellent condition. **ZEISS-PLANAR................$495**

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BRAND NEW, FIRST QUALITY. GMTFT68.......$169ea.
Regulated 12 VDC/110VAC power supply.......$8.95ea.

NEW, GM960R TIME LAPSE VIDEO RECORDER

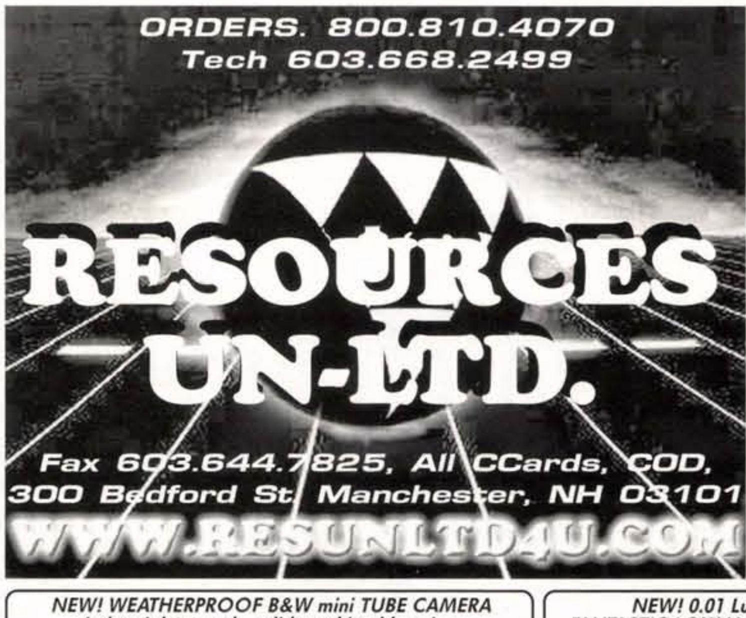
Finally a brand new, 4 head, T/L recorder with all the features at a price you can afford. Features: • Up to 960 hours on a standard T-120 VHS tape.• 12 different modes for record and playback • Audio recording in the 12H and 24H mode. • 30Day memory backup • Easy mode setting.• On- screen menus • Auto-Repeat recording mode • Serial or One-shot recording • Time, Date, speed, and Alarm indicators on screen. These deluxe units are front loading and are 14"W x 3.5"H x 12.2"D, 110VAC powered.

SPECIAL, GM960R-VCR ......$379ea.

A VIDEO MICROSCOPE in the PALM of your HAND! NEW, MAGCAM, VIDEO INSPECTOR, OFFERS HIGH POWER and LOW COST. Two optical magnifications at the flick of a lever. Choose either 40X or 140X.

A high quality, digital, color CCD camera, with dual optical magnification settings and built in object illumination via two ultra bright, white LED's. Entire system is fully integrated into a rugged and ergonomically designed, hand held unit only 2.7"W x 3"H x and 1.8"D Video output is standard NTSC via a RCA jack. 12VDC powered. CCD provides 380 lines of resolution and 0.8lux sensitivity . Complete with power supply and 3 foot RCA cable. A fantastic and useful device for inspection, diagnostics and observation of small objects. Perfect for SMT inspection.

SPECIAL, GM- MAGCAM....$199ea.



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Features include: Interactive infrared illuminator with 10 high power, wide angle LEDs @ 880nm . See objects 60 feet away during total darkness. A super quality 5 element, glass lens, specially coated with a 100 layer optical coating. For perfect focus with white light and a crisp image under infrared. Normally impossible due to the different focal point for IR and visible light. Solid state infrared optical switch provides day time IR cut filter for excellent color. At night infrared filter will turn off to allow infrared to pass. Also, night time IR LEDs will gradually turn on with proper amount of illumination. You can also see color images such as lights and signs at night. Fog free cover glass. Specs: 0.5 lux color sensitivity. 60dB S/N ratio typical. 12" I/O cable with BNC video and DC barrel jack. 120 dB smear rejection ratio. Adjustable mount and C power adapter included. **GM450K-IR.........$199ea.**

NEW, LINEAR BALL SLIDES from DCI, Three models available: The large is 6"L x 2.6"W x 1"H with 4" of travel. The medium is 5"L x 2.6"W x 1"H with 3" of travel. The small is 1.75"W x 1.75"L x 0.75"H with 1" of travel with a removable spring return for use against a micrometer or similar. Features common to all include: Solid machined aluminum with anodized construction, hardened steel ways. Slides are usable in any position and can carry heavy loads. Over 100lbs for the large and medium and 25lbs for the small. Straight line accuracy of 0.00008"/inch of travel. All are new. Limited quantity.

DCI-LONG............$69ea.
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NEW! WEATHERPROOF B&W mini TUBE CAMERA Industrial strength, solid machined housing.

Sleek black anodized, BRASS, housing is O-Ring sealed & WATERPROOF. Adjustabe mount included. Specs: 1/3" CCD, 400 Lines resolution, 0.05 Lux sensitivity, AGC, Auto Shutter. Operates on 12VDC @200mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25" diam. X 2" long. With 60 ft. cable. Great for outdoor use too.

NEW, GM300K-N........$99

NEW! 0.01 Lux, COLOR NIGHT VISION CAMERA! FANTASTIC LOW LIGHT PERFORMANCE. Exclusive ON SCREEN, menu driven setup of all camera parameters. NEW, STATE of the ART, GMV-35KOSD,

Perfect for covert, military & scientific applications that must be color. Unbelievable 0.01Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration & advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 lens shown below. Specs: Shutter speed auto or manual, 1/60 to 1/120,000, 60dB S/N ratio!, 154dB Smear rejection!, AGC gain 0 dB to 18 dB. Digital gain 0dB to 12dB. Digital zoom continuous from up to 2X in 0.1X steps. Masking mode allows hiding 4 programmable zones for privacy protection. Camera on screen name. Choose you own name for the camera and display it on monitor for easy identification.) White balance modes: Auto tracking, one push or selection from 3200k, 4800k, 5600k, 7800k, and "double white balance" independent white balance circuit for both bright and dark zone, maintains correct white balance even with combined indoor and outdoor lighting. Programmable 48 zone back light compensation mode for difficult lighting situation. Negative mode for negative film reading. Mirror image and up/down selection for rear view and camera mounted upside down. Seven Gain/Shutter modes are user selectable. Normal, X2, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 30, 15, 8, 4, 3, 2, and 1 per second. Alum. housing, dual 1/4x20 mtg. Specs: 1/3" CCD, 811(H) X 508(V), with 412K pixels, 470 Lines, 12VDC ±1V@250mA, Std. video out on BNC. Std S-Video out on 4Pin connector. Size: 2"H x 2"W x 4.5" long. Regulated power adapter included. C-mount lens not included. **GMV-35KOSD............$399ea.**
High performance lens, 4mm, f1.3...$49ea.

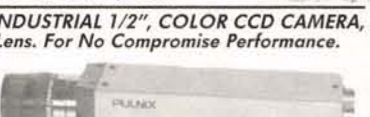
NEW, 470 LINE, DSP COLOR Micro CAM The HIGHEST PERFORMANCE available. MICRO SIZED PACKAGE too!

Yes 470 lines with a 60db S/N ratio to back it up! That's 16X better than a typical 46dB standard camera! The GM-4500, CCD camera with its' DSP technology provides high speed white balance with no color rolling. Auto shutter speed of 1/60 to 1/120,000 second. Truly state of the art. Sleek cast aluminum housing protects the 18mm x 26mm pc board inside.Mounting bracket & 18" cable with BNC video and DC pwr. jack for, no sweat hook up. requires only 12VDC@ 65mA. Optional mirror function available. Why fool around with an open P.C. board? This camera has it all. • 1/4" CCD • 1 Lux • AGC • Auto Shutter • 270k pixels • Std. 3.7 mm, 68° FOV lens • Focus:10mm to infinity • 3<ounce! • Size (mm): 33W x 29H x 30D **GM-4500-STD, SPECIAL...$99ea.**

NEW, lower cost, High quality, MINI BOARD CAM,

1/3" CCD, 420 Lines Res., 0.3 Lux sens., AGC, Pwr. from 9 to 12VDC @100mA, 266k PIXELS, 3.7mm, 92° FOV lens,A real glass lens. Auto shutter from 1/60 to 1/100,000 sec. Focus from 10mm to infinity. Std. NTSC video out. 1/2 ounce! SENSITIVE to IR. Size: 1.25"sq. x 1"d. Connections via a 3" pigtail with PC board connector. **GM-1000B-STD........$45ea.**

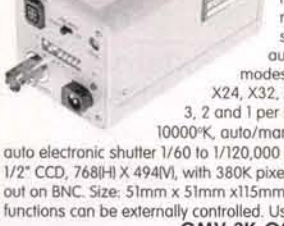
PULNIX, TMC7 INDUSTRIAL 1/2", COLOR CCD CAMERA, with Pentax Lens. For No Compromise Performance.



Specs: 1/2" CCD, 460 Lines resolution, 768H x 494V Pixels, 2 Lux sens. @f1.4, Auto/Man AGC, Auto/Man Shutter: 1/60 to 1/10,000 remotely controllable via 6 pin connector (not incl.) Auto/Man white balance, Manual gain and hue controls are external.Complimentary color filter. 12VDC @320mA, Pwr supply incl. Pentax, 16mm f1.4 lens, A real glass lens. Included. Std. NTSC video out on BNC. Y/C (S-Video) output available on 12 pin connector supplied. Superior construction. Compact size only: 1.6"W x 1.25"H x 5.5" long. Perfect for use in process monitoring, medical, surveillance and microscopy. Used, excellent condition, Regular price $600. Limited quantity.

PULNIX, TMC-7............$149ea. or 2 for $249

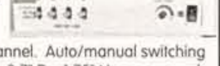
NEW! 0.005 Lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE. State of the Art Video, Exclusive ON SCREEN, menu driven setup of all camera parameters!



For covert, military & scientific applications that must be color, this is it. Unbelievable 0.005Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 auto iris lens shown below. Seven Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 15, 8, 4, 3, 2 and 1 per second. Auto/Man. white balance 3200° to 10000°K, auto/man BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768(H) X 494(V), with 380K pixels, 470 Lines, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions can be externally controlled. Use standard c-mount lens not included.

GMV-3K-OSD..........$449ea.
High performance auto iris lens, 12mm, f1.2...$199ea.

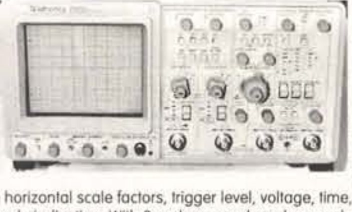
NEW! 4 or 8 CHANNEL, VIDEO AUTO SWITCHERS



Connect four or eight std. video signals and they will be sequentially output to the dual rear panel BNC outputs. Front panel user adjustable, variable dwell 1 to 15 sec per channel. Auto/manual switching with channel bypass. Compact only 8.6"W x 3.7" D x 1.75" H, ac powered. Video loop through.**GM-34, 4 Chan...$65, GM38, 8 Chan...$75**

SPECIAL PRICE, 350MHz, TEKTRONIX 2467, MICRO CHANNEL PLATE CRT! with 4 Channels, 500ps per div. in normal room light.

Displays intermittent variations as they happen. Captures the slowest one shot events with 4ns per division a 100 fold increase in the visual writing rate over conventional CRT. Features: 1 ns rise time, 500ps/Div time base, 2mV/Div. vertical sensitivity at 350MHz, 20ps time interval resolution, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vertical & horizontal scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. With 2 probes, pouch and manual. EX. cond. 90 day warranty.



New..$12K Now SALE, TEK 2467........$1995.

Circle #49 on the Reader Service Card.

News Bytes

LEDs. Camera. Action! On-line Product Training Videos Bridge the Gap between Cyberspace and the "Hands On"

LEDtronics® now has informational videos featuring LED lighting solutions available for on-line viewing at their website: **www.ledtronics.com**.

These succinct videos bridge the gap between cyberspace and the "hands on" by delivering show-and-tell to the desktop. LED products are shown up close enabling the viewer to see the attention to detail that is inherent in all LEDtronics products.

Each movie features installation and application demonstrations.

Additionally, the videos serve to educate the audience on the primary advantages (e.g., 100,000-hour diode life, amazing energy-efficiencies, solid-state design) of using LEDs over incandescent light.

This site allows you to choose from several player formats and connection speeds to optimize viewing on your computer set-up.

The Internal Revenue Service and Internet Programming & Consulting, Inc., Agree to Promote the Electronic and Online Filing Of Business Tax Returns at www.tax software.com

Internet Programming & Consulting, Inc. (IPC) have signed an agreement with the Internal Revenue Service to promote the electronic and online filing of business tax returns at http://www.taxsoftware.com/.

The agreement supports the IRS' mission to increase the overall volume of electronically-filed business tax returns. This will be the first year that an estimated five million businesses will be able to file Form 1041, U.S. Income Tax Return for Estates and Trusts and Form 1065, US Partnership Return of Income via the Internet.

Company spokesperson Edward Segal said Taxsoftware.com is believed to be the first and only service that allows businesses to prepare, print, and submit these two forms via the Internet.

Under the terms of the agreement, IPC and the IRS will include reciprocal links to each other's Web sites.

Form 1041 is expected to be available for e-filing after the IRS tests it within the next two weeks. Businesses will be able to e-file Form 1120S, US Income Tax Return for an S Corporation, beginning in 2004, when the IRS debuts the Form 1120/1120S e-file program.

The fees to file forms electronically via http://www.taxsoftware.com/ are as follows:

* $25.00 for each 1065 or 1041 return, including up to 100 K-1's. Companies with additional K-1's will be charged an extra $10.00 plus 25 cents per extra K-1.

* Forms 1098, 1099-Series, 5498, and W2-G are free for those who have already filed their 1065 or 1041 returns at http://www.taxsoftware.com.

* Non return-filers will be charged $10.00 for up to 100 forms. Additional Forms 1098, 1099, 5498 and W2-G will be charged an extra $10.00 plus 25 cents per filing of each extra form.

These prices are valid through April 11, 2002. The price will be doubled for tax year 2001 income tax returns that are electronically filed after April 11, 2002.

Filing Deadlines

According to the IRS, the schedule for the e-filing of forms for tax year 2001 is as follows:

Form Series IRS Copy Recipient Copy Form 1065 and all Partnership returns April 15,

News Bytes

2002 April 15, 2002

Forms 1098, 1099, and W-2G April 1, 2002 January 31, 2002

Forms 5498 and 5498-MSA May 31, 2002 May 31, 2002

Form 1041 April 15, 2002 April 15, 2002

For more information, go to http://www.inprocon.com/.

TRW's Revolutionary Adaptive Cruise Control Launches with VW Group

TRW Automotive's revolutionary radar-enabled Adaptive Cruise Control (ACC) system on a Volkswagen Group platform is now available to the public. TRW has been selected to deliver ACC on four luxury and mid-range platforms from the Volkswagen Group.

TRW's ACC system is the first on the market to feature MMIC long-range radar sensing technology which tracks information up to 150 meters ahead in all weather and road conditions. The breakthrough radar is the result of an 80 million euro ($69.5 million USD) investment project from Autocruise, a joint venture between TRW and the French defence and aerospace company, Thales.

The information from the radar is analyzed by electronics contained in the unit. The system identifies the vehicle nearest to the driver in their lane and tracks it. If that vehicle is travelling slower than the selected cruise speed, the ACC system sends a signal to the engine and braking system to decelerate until there is an appropriate following distance.

The system maintains this following distance while the vehicle travels below the selected cruise speed. When the road ahead clears, or the driver overtakes, the ACC system sends a signal to the engine management system to accelerate the vehicle to the driver's selected speed.

The company's ACC system uses fully MMIC (Monolithic Microwave Integrated Circuit) based radar sensing technology to detect other vehicles on the road ahead. The core of the radar sensing is a high frequency (77Ghz) TRM (Transmit Receive Module) incorporating the MMIC chips, developed initially for defense and telecommunications use.

Vehicle-specific characteristics, such as acceleration and deceleration rates, are determined by software and can, therefore, allow for feature differentiation across various vehicle platforms based on common hardware.

The radar-enabled ACC system is a step on TRW's technology roadmap for Driver Assistance Systems. These systems ultimately lead to integrated vehicle control systems, comprising active safety features such as vehicle stability control, electric steering systems, and active roll control systems linked with vision, infrared and radar sensing systems. These "smart" sensing technologies will also allow advanced passive safety features such as active retracting seatbelts and intelligent airbag systems. TRW news is available on the Internet at www.trw.com .

The World's First Midrange Blue Book Launches Online

Website Will Revolutionize the Way the Pre-Owned 20 Billion Dollar Midrange Computer Marketplace Buys and Sells Hardware

The Midrange Blue Book, Inc., website, http://thembb.com/, is designed to level the playing field of the pre-owned midrange computer marketplace.

The mission of The Midrange Blue Book is to provide an unbiased arena for end users and dealers to obtain the most current market pricing on manufacturers' hardware like, IBM, Cisco, Sun Micro, HP, and many others.

The Midrange Blue Book does for the midrange computer industry what Kelly Blue Book has done for the used car industry. The site currently covers the market prices on over 50,000 pieces of midrange equipment, ranging from the smallest tape drive to a complete system.

The Midrange Blue Book has employed a team of researchers, who, in conjunction with some of the countries top midrange dealers, work vigorously to ensure that the pricing is always accurate.

TheMBB.com allows users to set profiles of the hardware they own or wish to buy. They can then request to receive monthly e-mail alerts of what the current market value is and to be notified when that equipment's market price changes.

The Midrange Blue Book is available in the form of a Retail and a Wholesale Subscription. The cost of a subscription is $399.00 per year and $125.00 per quarter.

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Tempe 85281

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Tullamarine 3043
www.dontronics.com

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Anaheim 92801

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Emeryville 94608

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Fremont 9453

5611 Blackstone
Fresno 93710

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Laguna Hills 9265

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Long Beach 90803

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San Francisco 94133

871 Blossom Hill Rd.
San Jose 95123
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San Diego 92105

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Emma Marion Ltd.
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Vancouver, BC V5K 1Z5
Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

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4211 Waialae Ave.
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2701 Westland Ct. #B
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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.

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

All listing information should be sent to:

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

APR-JUL

APRIL 2002

APRIL 6

AR - FORT SMITH - Hamfest. Fort Smith Area ARC, 501-996-6511. Email: kc5jby@arrl.net Web: www.fsaarc.org

IN - COLUMBUS - Hamfest. Bartholomew County 4H Fairgrounds, Community Bldg., St. Rd. 11, SW. Columbus ARC, 812-342-4670. Email: carc_in@yahoo.com

KY - ELIZABETHTOWN - Hamfest. Lincoln Trail ARC, 270-351-4721. Email: n4tfk@qsl.net

APRIL 6-7

MD - TIMONIUM - Greater Baltimore Hamboree. Baltimore ARC, 410-426-3378. Email: w3ft@juno.com Web: http://gbhc.org

WA - YAKIMA - State Convention. Yakima ARC, 509-249-0897. Email: n7kno@arrl.net Web: http://eagle.ykm.com/~w7aq/hamfest.html

APRIL 13

MN - ST. PAUL - Hamfest. Robbinsdale ARC, 763-537-1722. Email: k0ltc@visi.com Web: http://www.visi.com/~k0ltc

NJ - WEST ORANGE - Hamfest. West Orange High School, 600 Pleasant Valley Way. Roseland Radio Club, 973-994-0637. Web: www.qsl.net/k2gq

NY - NEWARK - Hamfest. Drumlin ARC, 315-597-2192. Email: wa2sok@rochester.rr.com Web: www.drumlinsarc.com

OH - GARFIELD HEIGHTS - Hamfest. 216-663-3258. Email: ln4js@visn.net

TX - BELTON - Hamfest. Bell County Expo Center. Temple ARC, Email: hamexpo@tarc.org Web: www.tarc.org

APRIL 14

CT - SOUTHINGTON - Hamfest. Southington ARA, 860-628-9346. Email: KA1ILH@chetbacon.com www.chetbacon.com/sara.htm

NC - RALEIGH - State Convention. Jim Graham Bldg., NCS Fairgrounds. Raleigh ARS, 919-872-6555. Email: k4hf@arrl.net Web: www.rars.org/hamfest

WI - STOUGHTON - Hamfest. Mandt Community South 4th St. Madison Area Repeater Assn., 608-245-8890. Email: n9vwh@arrl.net Web: http://www.qsl.net/mara

APRIL 20

FL - CORAL GABLES - Hamfest. Physics Parking Lot. Flamingo/University of Miami ARC, 305-264-4465. Email: wa4tej@beethoven.com

FL - TAMPA - Hamfest. TARC, email: k4law@arrl.net Web: www.hamclub.org

ME - SOUTH PORTLAND - Hamfest. Greater Portland Electronics Flea Market, Portland Amateur Wireless Assn., 207-799-1116. Email: k1gax@arrl.net Web: www.digilogic.com/pawabra/pawa/pawa.htm

NC - MORGANTON - Hamfest. Catawba Valley Hamfest Committee, 828-205-8335. Email: kc4qpr@vistatech.net http://cvhamfest.linuxham.org

VA - CHESAPEAKE - Hamfest. Chesapeake AR Service, 757-583-1703. Email: ruthis23505@yahoo.com Web: www.qsl.net/cars

APRIL 20-21

CA - PALO CEDRO - EMCOMM Convention. Sacramento Valley Section ARES, 530-396-2256. Email: k6bz@arrl.org Web: www.qsl.net/k6soj/

APRIL 21

MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., Email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html

PA - WASHINGTON - Hamfest. WACOM, 724-228-0546. Email: jbur@mlynk.com

APRIL 26-27

AR - LITTLE ROCK - Hamfest. Little Rock Expo Center, Exit 126, I30. Web: www.aristotle.net/~hamfest

TN - OAK RIDGE - Conference. Garden Plaza Hotel. Southeastern VHF Society, 865-481-2468. Web: www.svhfs.org

APRIL 27

CA - SONOMA - Hamfest. Sonoma Valley Veteran's Memorial Bldg., 126 First St. W. Valley of the Moon ARC, 707-996-4494

FL - GAINESVILLE - Alachua County Fairgrounds, 3400 NE 39th Ave., SR222. GARS, 352-378-0512. Email: k4hfj@arrl.net Web: www.gars.net/hamfest

MO - KANSAS CITY - Hambash. Ararat Shrine, 5100 Ararat Dr. Ararat Amateur Radio

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Web: ncshows.com

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

Shrine Club, 816-941-3392. Email: sdowdy@kc.rr.com

OR - EUGENE - Hamfest. Up The Crick Radio Club, Email: mikea@efn.org Web: www.w7utc.net

PA - YORK - Hamfest. York County School of Tech, 2179 S. Queen St. York Hamfest Foundation, 301-620-0270. Email: banderso@eni.net

SC - WINDSOR - Hamfest. Salkehatchie ARS, 803-245-4673. Email: af4qz@arrl.net Web: www.qsl.net/kf4cvo

APRIL 28

DE - NEW CASTLE - Convention. Nur Temple, Rt. 13 N. Penn-Del ARC, 302-793-1080. Email: hfrantz@snip.net Web: www.high-techservices.com/penndel

IL - ARTHUR - Hamfest. Moultrie/Douglas County Fairgrounds. Moultrie ARK, 217-543-2178 days or 217-873-5287 eves. Email: rzancha@one-eleven.net

OH - ATHENS - Hamfest. Athens Community Recreation Center. ACARA, email: ka7jxg@callsign.net Web: www.fhradio.org

OH - CANFIELD - Hamfest. Mahoning County Career and Technical Center, 7300 N. Palmyra Rd. Twenty Over Nine ARC, 330-793-7072. Email: n8lne@arrl.net

MAY 2002

MAY 3-4

MO - LEBANON - State Convention. Lebanon ARC, 417-532-4642. Email: bwheeler@advertisnet.com

NH - HOPKINTON - Hamfest. Hosstraders, email: k1rqg@aol.com

MAY 4

AZ - SIERRA VISTA - Hamfest. Cochise ARA, 520-336-5216. Email: mcnab@c2i2.com Web: www.qsl.net/k7rdg

KY - LOUISA - Hamfest. Big Sandy ARC, 606-638-9049. Email: wa4swf@arrl.net Web: http://www.bsarc.org

NY - OWEGO - Hamfest. Binghamton ARA, 607-748-5232. Email: n2bc@arrl.net

SC - SPARTANBURG - Hamfest. Blue Ridge ARS, 864-833-2204. Email: w4rgw@arrl.net Web: www.brars.org

WI - CEDARBURG - Hamfest. Ozaukee RC, 262-377-6792. Web: http://www.qsl.net/orc

MAY 4-5

AL - BIRMINGHAM - Hamfest. Birmingham ARC, 205-681-5019. Email: ke4yzk@bellsouth.net Web: http://www.w4cue.com

NJ - EDISON - Trenton Computer Festival. Raritan Center, Rt. 514 NJ Tpke., Exit 10. KGP Productions, 1-800-631-0062. Email: kgp@mail.com Web: www.tcfshow.com/

TX - ABILENE - Hamfest. Abilene Civic Center. Key City ARC, 915-672-8889. Email: ka4upa@arrl.net

MAY 5

IL - SANDWICH - Hamfest. Sandwich Fairgrounds. KARC, 815-895-3310. Email: bob@w9icu.com Web: http://www.qsl.net/wa9cjn

PA - WRIGHTSTOWN (BUCKS COUNTY) - Hamfest. Warminster ARC, 215-822-0749.

Email: k3zma@aol.com Web: http://www.k3dn.org

MAY 11

NV - RENO - Hamfest. Reno Area Metro Simplex, 775-673-6401. Email: glen@kk7ih.net Web: www.nvrams.org

PA - FREDERICKSBURG - Hamfest. AARG, 717-534-2945. Email: info@aa3rg.net Web: www.aa3rg.org

WA - STANWOOD - Hamfest. Stanwood-Camano ARC, 360-629-2921. Email: huppert@whidbey.net

MAY 17-18-19

OH - DAYTON - Hamvention. Hara Arena. Dayton ARA, general information call 937-276-6930, email: info@hamvention.org Web: www.hamvention.org/

MAY 19

MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html

MAY 26

MD - WEST FRIENDSHIP - Hamfest. Howard Co. Fairgrounds. MFMA, 410-923-3829

OH - HILLIARD - Hamfest. Franklin County Fairgrounds. 614-267-7779. Email: clind2@juno.com

MAY 31, JUNE 1-2

NY - ROCHESTER (HENRIETTA) - Convention. Rochester ARA, 716-424-7184. Email: harold@rochesterhamfest.org Web: www.rochesterhamfest.org

OR - SEASIDE - Convention. Seaside Convention Center. SEA-PAC, 503-297-1175. Web: www.seapac.org

JUNE 2002

JUNE 1

IL - SPRINGFIELD - Hamfest. Sangamon Valley RC, 217-628-3697. Email: egaffney@family-net.net

GA - MARIETTA - Hamfest. Jim Miller Park. Atlanta RC, 770-995-6446, johnka4vqh@aol.com Web: www.saf.com/arc/atlfest.htm

MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. Independent Repeater Assn., Inc., 616-698-6627 after 4pm EST. Web: www.w8hvg.org

JUNE 2

IL - PRINCETON - Hamfest. Starved Rock RC, 815-433-2117. Email: bk9vzh_gov@yahoo.com

PA - PITTSBURGH (BUTLER) - Hamfest. Breezeshooters ARC, 412-221-3806. Email: n3ue@arrl.net Web: http://www.breezeshooters.net

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, 703-335-9139. Email: n4yic@arrl.net Web: http://www.qsl.net/olevahams

JUNE 7-8

MS - PASCAGOULA - Hamfest. Jackson County Fairgrounds Civic Center. Jackson County ARC, 228-826-5095. Email: nn5af@arr.net Web: www.angelfire.com/ms3/jcarc

Continued on page 57

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

by Jon Williams

Stamp Applications

Sonic Sight-Seeing With Sound

Several months back, Bill Boyer, a DPRG club member — an experienced BASIC Stamp user — demonstrated the Devantech SRF04 ultrasonic range finder. Bill did some really neat things with it. His robot is able to scan an area and locate a target as narrow as a broom stick. I've used IR object detection for avoidance, but it's not really suitable for object location. I had to try the SRF04.

By now, many of you know that I live in Dallas and really love the city. For a wanna-be geek, it's a great place to live in with so many technology companies located here. Where this helps a regular guy like me is when geeks [and I mean that in the best way] gather. My favorite local gathering of geeks is the Dallas Personal Robotics Group.

The DPRG is one of the bigger robotics clubs in the country. We have members from very young to very ... uh, "mature" (that's you, Ralph) — male and female. The diversity of the DPRG's membership is a real strength, and no matter what a person's experience level, the DPRG has something to offer.

One of my favorite aspects of club meetings is "show and tell." Members are allowed to show off their handiwork, whether it be hardware, software, a mix of both, or just some bolt-out-of-the-blue idea. Everything is enthusiastically welcomed by the club.

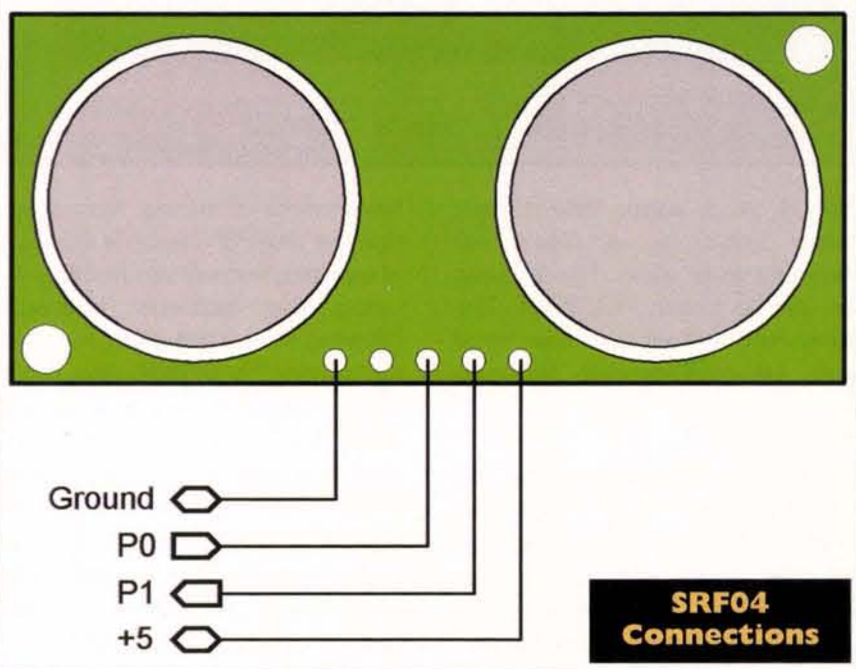
Several months back, club member Bill Boyer — an experienced BASIC Stamp user — demonstrated the Devantech SRF04 ultrasonic range finder. Bill did some really neat things with it. His robot is able to scan an area and locate a target as narrow as a broom stick. I've used IR object detection for avoidance, but it's not really suitable for object location. I had to try the SRF04.

Well, it took a while, but I finally called Acroname (see sources) and ordered a sensor. It arrived a few days later, complete with documentation that included a demo program for the BS2. We'll expand on that program here.

Blind Like A Bat

I find it interesting that we refer to bats as blind. I grew up in the desert of southern California and used to play a game with the local bats: dodge this rock. When the bats would come out in the early evening, I would casually toss a small stone into their flight path. With amazing dexterity and precision, the bats would avoid the rock and continue on their quest for insects. Clearly, bats aren't blind; even if their eyes don't work particularly well. (Note: No bats were ever harmed in the course of my little game.)

The SRF04 "sees" the same way a bat does — by emitting a short burst of sound and "listening" for the echo. Under control of the Stamp (or other micro), the SRF04 emits an ultrasonic (40 kHz) sound pulse. This pulse travels through the air at about 0.9 feet per second (the speed of sound), hits something, and then bounces back. By measuring the time between the transmission of the pulse and the echo return, the distance to the object can be determined.

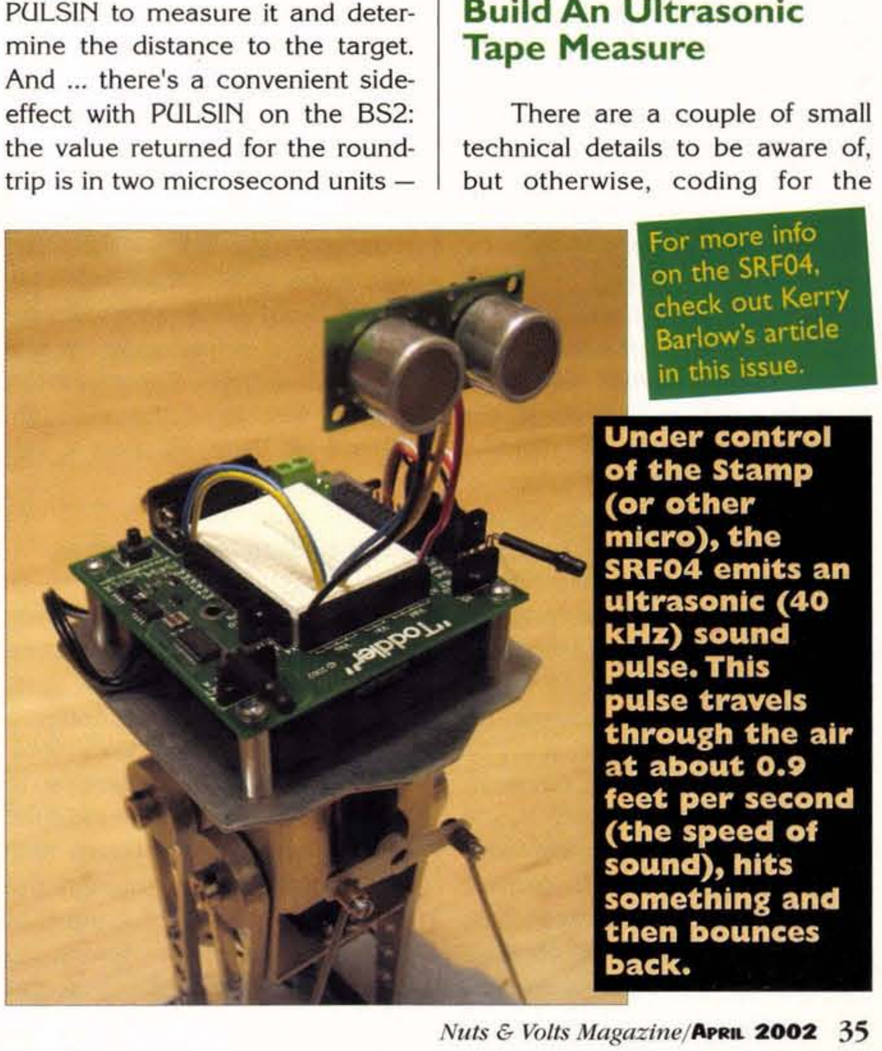


SRF04 Connections

The SRF04 outputs a high-going pulse that corresponds to the time required for the echo to return. We can, of course, use PULSIN to measure it and determine the distance to the target. And ... there's a convenient side-effect with PULSIN on the BS2: the value returned for the round-trip is in two microsecond units — the same as a one-way trip (sensor to target) in one microsecond units.

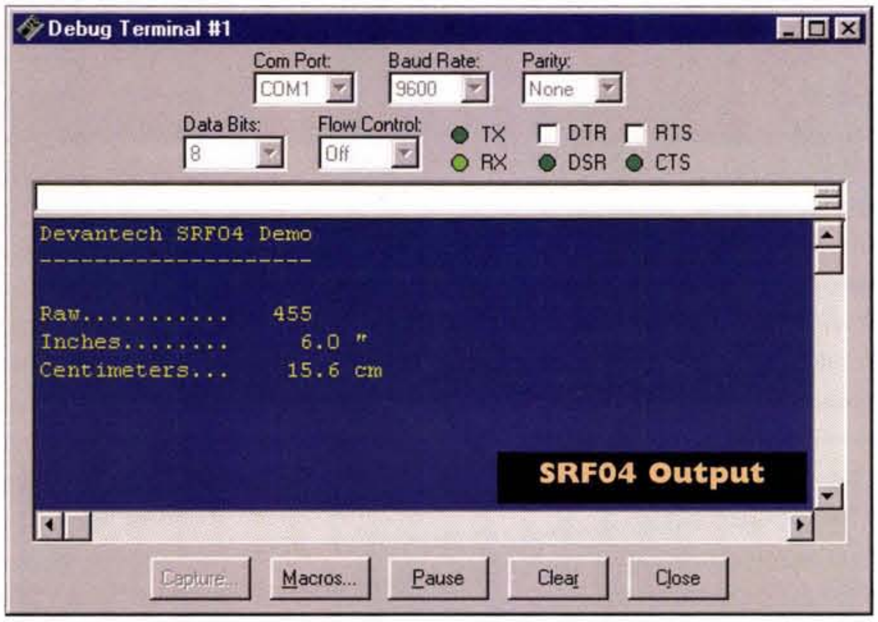
Build An Ultrasonic Tape Measure

There are a couple of small technical details to be aware of, but otherwise, coding for the



For more info on the SRF04, check out Kerry Barlow's article in this issue.

Under control of the Stamp (or other micro), the SRF04 emits an ultrasonic (40 kHz) sound pulse. This pulse travels through the air at about 0.9 feet per second (the speed of sound), hits something and then bounces back.



SRF04 Output

SRF04 is a snap. The trigger pulse must be at least 10 microseconds wide. That's easy; we can do it with PULSOUT. The other requirement is that we must wait 10 milliseconds between measurements. No problem there, either.

The heart of this program is a subroutine called Get_Sonar. This routine started with the code sample that came with the sensor. What I found, however, was that the reading seemed to bounce around a bit. I felt like a little filtering (averaging several readings together) would smooth things out and make the output more useful.

The value returned by the routine will be stored in rawDist, so the code starts by clearing it. Then, within a loop, the code takes five readings from the sensor and averages them together. This may look a bit odd because most us think about adding numbers and then dividing to get an average. We do the dividing first and then add the result into the return value because we could have an overflow if we do all the addition first. Yes, the dividing first technique can lead to rounding errors, but only if the values were very small. I have not seen this when using the sensor. Since one inch (the minimum range of the sensor) is about 74 microseconds, dividing by five (loop value) each time through causes no problem.

With the raw measurement complete, we can display it and convert it to units that make more sense to us humans. To convert the raw measurement to inches, we need to divide by 73.746. If we change this to 7.3746, then we'll have tenths of inches. Remember that we can't divide by a fractional number, but we can multiply by using the star-star operator. Dividing by 7.3746 is the same as multiplying by 0.1356 (the reciprocal). To get the star-star parameter, we multiply 0.1356 by 65,536 to get 8886 (Note: Using 8886 with star-star is actually equally to multiplying by 0.13558 — pretty darned close). The same technique is used to convert the raw value to centimeters.

To keep the display neat, I used a simplified version of Tracy Allen's right justification technique. Since the units are in tenths, the value is divided by 10 before sending to RJ_Print. On return, the decimal place is printed, then the tenths digit by using the DEC1 modifier. How's that for an easy program?

Now that I've got my SRF04 working, I'll start on the "search" routine. Maybe Bill will help me with some code ... If all goes well, my BOE-Bot will be able to locate and retrieve empty soda cans in some future DPRG Roborama. I'm a long way from that, though. When I get there, I'll share it with you.

More Robot Goodies

Our friends at Quadravox have been busy and they've come up with a couple of cool new modules that are useful for robotics.

The first is the QV316M4-TTS. This module is identical to the QV306M4 sound module, except that is does speech synthesis (male voice) through the entry of allophones. For those of you have been scratching to locate an SP0256-AL2 — forget about it. Go get a QV316M4. It has much better quality than the SP0256-AL2, an onboard amplifier, and an easy-to-use serial interface. It will buffer up to 40 allophones so that your micro isn't tied up while the unit is "talking." As I indicated a moment ago, if you're using a QV306M4 to do [pre-recorded] speech, you can pop a QV316M4 into its place and have an unlimited vocabulary.

The second new product is called the QV356M4 — the BOE-Bot Speech Board. This product was designed to mount right onto the Parallax BOE-Bot chassis. The QV356M4 combines the elements of the QV306 sound module and the QV430 programmer into one PCB; then it adds a whole host of new features.

In addition to its pre-recorded robot vocabulary, the QV356M4 can record a user message under control of the Stamp. The message is similarly played back. You can even change the sound of the prerecorded speech by changing the sampling and playback frequency. The feature that I particularly like is the ability to mix sounds generated by the Stamp (FREQOUT, DTMFOUT) through the QV356M4 amplifier. This means there's no need to record simple beeps that can be generated in code by the Stamp.

Both units are available from Parallax. Check the web site for additional details, documentation, and demo source code.

Oops...

It came to my attention that another contributor to *Nuts & Volts* suggested (in the February issue) that the BASIC Stamp is not capable of decoding and analyzing Sony IR signals. I got several calls and e-mail notes from confused readers regarding this statement.

Since I work for Parallax and have more Stamp experience than the other author, please allow me to set the record straight: the BS2sx and BS2p are great at Sony IR decoding — all 12 bits of the consumer protocol. And in case you missed it, be sure to check out my article called "Control from the Couch" that was published in this column in August 2001. The article includes IR signal analysis and complete 12-bit decoding using the BS2sx or BS2p.

Even the "elder statesman" (the stock BS2) is capable of basic IR decoding and can handle simple remote commands like channel up and down, volume control, and power on and off. We've entertained thousands of school children and trade show visitors the last couple of years with BS2-powered, IR-controlled BOE-Bots and other Parallax demos. We love IR control! Come visit us at a trade show or educational course and you'll see just how much.

Thanks for allowing me to clarify. Until next time, Happy Stamping. **NV**

Resources:

Jon Williams
jonwms@aol.com

Parallax
599 Menlo Drive, Suite 100
Rocklin, CA 95756
(888) 512-1024
www.parallaxinc.com

Acroname
www.acroname.com

Devantech
www.robot-electronics.co.uk

Dallas Personal Robotics Group
www.dprg.org

```
'
' ===========================================================================
'
'   File...... SONIC SIGHT.BS2
'   Purpose... Devantech SRF04 Ultrasonic Range Finder
'   Author.... Jon Williams
'   E-mail.... jonwms@aol.com
'   Started...
'   Updated... 06 MAR 2002
'
'   {$STAMP BS2}
'
'
' ===========================================================================


' ---------------------------------------------------------------------------
' Program Description
' ---------------------------------------------------------------------------
'
' This program uses the Devantech SRF04 to measure the distance between the
' unit and a target.  Display is raw value, inches and centimeters.
'
' Conversion formulas:
'
' inches = echo_time / 73.746           (use 7.3746 for tenths)
' centimeters = echo_time / 29.033      (use 2.9033 for tenths)


' ---------------------------------------------------------------------------
' Revision History
' ---------------------------------------------------------------------------


' ---------------------------------------------------------------------------
' I/O Definitions
' ---------------------------------------------------------------------------

Trigger         CON     0
Echo            CON     1


' ---------------------------------------------------------------------------
' Constants
' ---------------------------------------------------------------------------

MoveTo          CON     2                   ' cursor position control


' ---------------------------------------------------------------------------
' Variables
' ---------------------------------------------------------------------------

pWidth          VAR     Word                ' pulse width from sensor
rawDist         VAR     Word                ' filtered measurment
distance        VAR     Word                ' converted value
blips           VAR     Nib                 ' loop counter for measurement

temp            VAR     Word                ' value for RJ_print
digits          VAR     Nib                 ' used by RJ_Print


' ---------------------------------------------------------------------------
' EEPROM Data
' ---------------------------------------------------------------------------


' ---------------------------------------------------------------------------
' Initialization
' ---------------------------------------------------------------------------

Init:
  PAUSE 250
  DEBUG CLS
  DEBUG "Devantech SRF04 Demo", CR
  DEBUG "--------------------", CR, CR
  DEBUG "Raw........... ", CR
  DEBUG "Inches........         ", 34, CR
  DEBUG "Centimeters...         cm", CR


' ---------------------------------------------------------------------------
' Program Code
' ---------------------------------------------------------------------------

Main:
  GOSUB Get_Sonar                           ' take sonar reading
  DEBUG MoveTo, 15, 3
  temp = rawDist
  GOSUB RJ_Print                            ' display raw value

  DEBUG MoveTo, 15, 4
  distance = rawDist ** 8886                ' divide by 7.3746
  temp = distance / 10
  GOSUB RJ_Print                            ' display inches
  DEBUG ".", DEC1 distance

  DEBUG MoveTo, 15, 5
  distance = rawDist ** 22572               ' divide by 2.9033
  temp = distance / 10
  GOSUB RJ_Print                            ' display centimeters
  DEBUG ".", DEC1 distance

  PAUSE 200                                 ' delay between readings
  GOTO Main

  END


' ---------------------------------------------------------------------------
' Subroutines
' ---------------------------------------------------------------------------

Get_Sonar:
  rawDist = 0
  FOR blips = 1 TO 5
    PULSOUT Trigger, 5                      ' 10 uS trigger pulse
    PULSIN Echo, 1, pWidth                  ' measure distance to target
    rawDist = rawDist + (pWidth / 5)        ' simple digital filter
    PAUSE 10                                ' minimum period between pulses
  NEXT
  RETURN


RJ_Print:                                   ' right justify
  digits = 5
  LOOKDOWN temp, <[0,10,100,1000,65535], digits
  DEBUG REP " "\(5 - digits), DEC temp
  RETURN
```

Bluetooth: a wireless technology that is ready for you. Are you ready for it? by Louis E. Frenzel

Open Communication

If you are a hopeless wireless junkie like me, you have probably already heard of Bluetooth. But maybe you haven't had the time to find out more about it. Or, if you are not hooked on wireless, you may not know much about it at all. In any case, here is an overview of this hot new wireless technology that will affect you in some way in the near future.

What Is It?

Bluetooth is a low-power microwave radio system designed for cable replacement and other short-range communications applications. Bluetooth is implemented in one or two integrated circuits, so it is small enough and cheap enough to use almost anywhere wireless capability makes sense and, in some cases, in places where it doesn't make sense. And besides making wireless two-way voice or data exchanges fast and easy, Bluetooth is designed to automatically inter-network with other Bluetooth-enabled devices. Bluetooth is a neat high-tech radio technology you will be seeing more of this year and beyond.

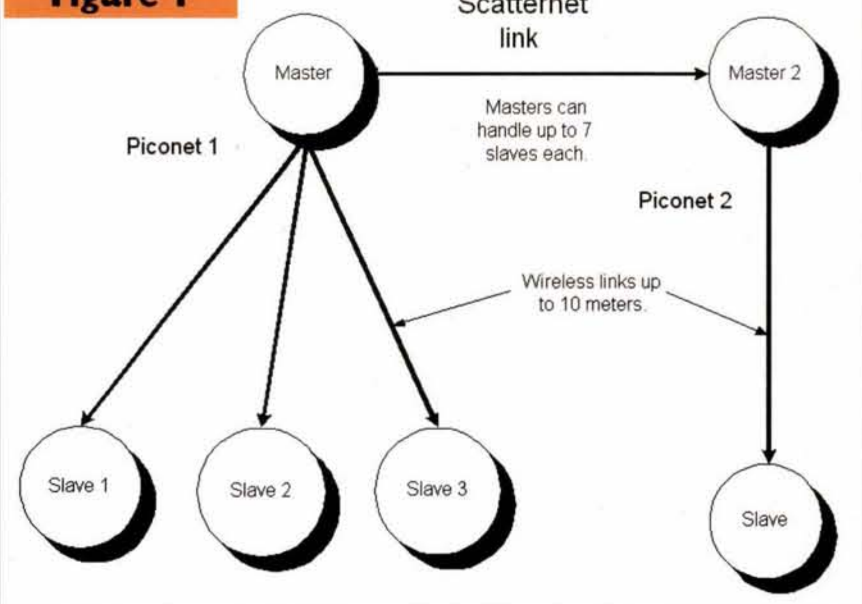
A Cable Replacement Radio. You Must Be Kidding!

Several years ago, I was involved with the design of a wireless link for sensors in an industrial application. The goal was to replace long runs of twisted pair cables from RTD temperature sensors back to the PID temperature controllers. My first reaction was "surely you jest." In my left-brain dominant engineer's mind, I reasoned that even a long piece of twisted pair has got to be cheaper than a two-way radio link.

As it turns out, twisted pair is a heck of a lot more expensive than you think, especially in a hostile industrial setting where each wire has to be installed in a metal conduit by a $75/hour union electrician. You can run up an unbelievable tab if you have to install many long (100 to 1,000 feet) runs of cable. As I proved to myself, you can actually put a simple digital radio on each sensor far cheaper than all that high-ticket cable and conduit and still have big bucks left over. I am not kidding. I can see why more engineers and electronic experimenters don't use a wireless approach. It just doesn't seem logical or possible that a wireless connection could be cheaper or easier than stringing a bunch of wires. Yet it often is, and that is even more true now that dirt-cheap (almost) Bluetooth and other wireless chips are here.

When I did this design, I actually had to invent the radios, as well as the modem and protocols. But you don't have to today. Bluetooth is a complete digital radio with all of the RF and baseband digital protocols already spelled out. In fact, Bluetooth is a formal standard as established by the Bluetooth Special Interest Group (SIG). This standard is supported by over 2,000 semiconductor and electronic equipment manufacturers. It is also covered under the IEEE's 802.15 wireless personal area networking (WPNA) standards.

Figure 1



Bluetooth was actually created as a wireless cable replacement by cell phone giant Ericsson. They were seeking a replacement for the annoying cable connecting a hands-free headset to a cell phone. With a wireless arrangement, you can actually use your headset anywhere within about 10 meters (30 feet) of your cell phone. Other cable replacements are on their way, along with dozens of other heretofore non-wireless applications now that affordable Bluetooth chip sets are available.

Tech Specs

Bluetooth radios use the license-free 2.4 GHz industrial-scientific-medical (ISM) microwave band defined under the FCC's Part 15. All data, including voice, is transmitted in digital format using frequency hopping spread spectrum (FHSS). See sidebar for more details. The modulation is Gaussian FSK, a form of FSK in which the digital data pulses are shaped by a Gaussian filter prior to modulation to help narrow their bandwidth in the radio channel. The hop rate is a fast 1,600 hops/second (625 mS interval) over 79 different frequencies from 2.402 to 2.480 GHz spaced every 1 MHz. The data rate is 1 Mbps but some of that is devoted to the protocol overhead making the peak one-way payload data rate a maximum of 723.2 kbps or 433.9 kbps symmetric two-way. Data to be transmitted is put into packets that are transmitted during each 625 mS hop period. A packet may be made up of up to five time slots. The data may be voice or any other type of information that can be put into serial digital data format.

There are three classes of

Figure 2

Bluetooth transmitters at different power levels. Class 3 uses 0 dBm (1 mW) of power for a maximum range of about 10 meters. [Note: Remember that dBm is the power in dB referenced to one milliwatt or dB = 10log (power/1 mW)]. The Class 2 transmitters use 4 dBm or 2.5 mW for a slightly extended range, while Class 1 specifies 20 dBm (100 mW) for a range up to 100 meters. That's pretty much the outer limits for most Bluetooth wireless applications, especially if it involves indoor obstacles.

While Bluetooth can be used for almost any simple one-way or two-way communications, what really makes it special is its ability to form a network with up to seven other nearby Bluetooth-enabled devices. Such networks are referred to as ad hoc or personal area networks (PANs). They allow multiple users of laptops, PDAs, or whatever to interconnect automatically and wirelessly, and exchange messages or data. The big question, what do you do with all that automatic networking capability?

How Bluetooth Works

A Bluetooth transceiver is constantly sending out a signal seeking a nearby networking partner. Should one exist within the range of the hardware, it will respond and the two units will automatically set up a communications link referred to as a piconet. One unit becomes the master and the other becomes the slave. The master unit controls the transmit and receive events. In fact, the master can actually hook up with up to seven slaves concurrently. See Figure 1. All of these units share the same bandwidth, but by using time division multiplexing, all can transmit and receive to exchange information with one another. A good example of this might be multiple laptop computers used by individuals in a meeting to pass electronic business cards, transfer files, or just chat. If two different piconets are established near one another, these two may also link up to form a scatternet. The key thing to point out here is all this networking is done automatically without user initiation or intervention. The guidelines of this inter-networking are built into the protocol.

And don't worry about security. With any wireless technology, intercept security can be a concern. Besides being secure just because of the pseudo-random hop sequence, Bluetooth has a built-in 128-bit encryption algorithm that pretty much ensures 100% privacy of communications.

Bluetooth Hardware

The first Bluetooth products were chip sets made up of a complete radio transceiver chip and a baseband chip. The only missing parts are the antenna, those components needed for filtering and impedance matching to the antenna, a quartz crystal to set the operating frequency, and those components that develop or use the data. The baseband chip implements the digital protocol and manages all of the data formatting, transmission, and reception. Today, most of the newer Bluetooth ICs are a single chip containing both the transceiver and the baseband circuits. These silicon ICs are made of 0.25 or 0.18 mm (micron) CMOS. Class 2 and 3 Bluetooth transmitters have their final power amps on chip, but if Class 1 100 mW operation is desired, a separate external power amplifier is required. These are usually made of bipolar silicon-germanimu (SiGe) or gallium arsenide (GaAs) FETs. You can also buy complete Bluetooth modules with all parts on a small PC board ready to go.

Bluetooth Applications

The first and by far most

SPREAD SPECTRUM PRIMER

Spread spectrum is a unique radio technology that spreads the radio signal out over a very wide bandwidth rather than confine it to a narrow channel as is the case in most wireless applications. See Figure A. Spread spectrum is not really new as it was discovered and patented by Hedy Lamar (the attractive movie star of old) during World War II. (I am not making this up.) Its primary use was secure military radios. Spread spectrum's primary benefit is security. Its signals are very difficult to intercept and decode, and they are virtually jam proof. Because of its secret nature and it technical complexity, spread spectrum was not really widely used until the 1980s when more information became available, the FCC allowed its use in commercial bands, and new integrated circuits made it easier to adopt. Today, spread spectrum is widely used in many wireless applications such as cordless telephones and in cell phones where it is known as CDMA (code division multiple access). It is also used in wireless data acquisition and wireless local area networks (LANs). Military and other satellites have also used it for years. And, of course, it is the basis of Bluetooth.

Figure A

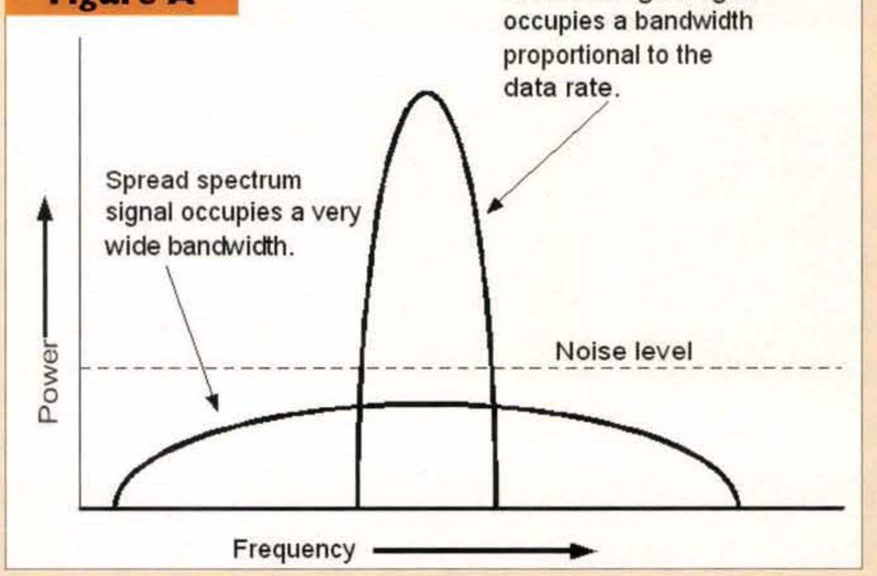
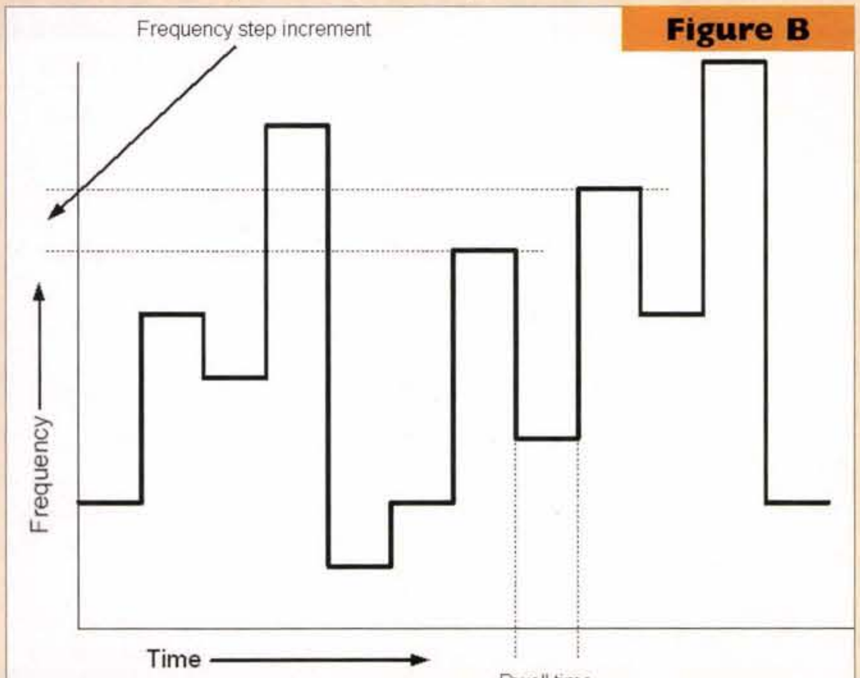


Figure B



There are two basic flavors of SS: frequency hopping and direct sequence. In frequency hopping spread spectrum (FHSS), the actual frequency of operation is changed in a pseudo-random manner at a high rate of speed. This is known as the hop rate. See Figure B. The frequency remains the same for a specific short dwell period during which time data is transmitted. The result of this is that the signal energy is spread over a very wide band of frequencies.

In direct sequence spread spectrum (DSSS), the digital data to be transmitted is sent to an exclusive OR gate along with a higher frequency pseudocoded "chipping" signal. The modulation is BPSK, or some variation thereof. The result is a scrambled signal whose spectrum is very broad.

Because this technique spreads the signal over such a broad bandwidth, its average power is very low, typically below the noise level of the channel. As a result, a spread spectrum signal does not interfere with any other signal in the same band. In fact, you can actually overlay many other spread spectrum signals in the same bandwidth without them interfering with one another. For this reason, spread spectrum is also a type of multiplexing allowing many signals to share the same space. A bunch of spread spectrum signals all transmitting simultaneously just looks like a bunch of background noise to a narrow band receiver.

Besides its security and jam-resistance, SS is also more tolerant of multipath fading so common to radio communications in the UHF and microwave ranges. That makes it useful not only indoors, but also in high density urban areas for reliable communications.

Figure 3

prevalent Bluetooth product is the wireless headset. Virtually all of the big cell phone manufacturers (Nokia, Motorola, Ericsson, etc.) have several models. Another new product is the wireless printer connection. These interface devices connect to a printer parallel port or a USB port and use a Bluetooth transceiver to talk wirelessly to a nearby Bluetooth-enabled printer like Hewlett Packard's Deskjet 995c. An example is 3Com's neat 3CREB96 Bluetooth USB Adapter shown in Figure 2.

The blue-tipped antenna moves back and forth and rotates so you can position it for optimum reception. No cable is required. This is really handy as it lets you be more flexible in placing the printer with respect to the PC. And the link-up is automatic.

Bluetooth also lets you make wireless connections between laptops, PCs, and PDAs like Palm Pilots. Multiple laptops can talk to one another or a nearby PC. Or a Palm Pilot can hot-sync to a PC or a laptop. Figure 3 shows 3Com's PC card that plugs into a laptop. It uses a unique XJACK antenna that folds up and clicks back into the card when you are finished using it. An even more serious networking application is wirelessly connecting a laptop to a nearby PC LAN. Bluetooth may also be a contender in the rapidly growing home networking field.

Some manufacturers predict that a key application for Bluetooth will be Internet connectivity by a cell phone. The cell phone industry has been working on the next generation — third generation or 3G — phones which have the potential to access the Internet. But with the slow data rates, very small cell phone screens, and no keyboard, it does not seem likely.

A good alternative is to use your laptop to talk wirelessly via a Bluetooth link built into your cell phone. The cell phone connects you to your ISP while Bluetooth makes the connection from laptop to cell phone.

Some other uses include wireless connections for camcorders, digital cameras, and security systems. Connections between other consumer audio and video products such as stereos, headphones, and MP3 players are another possibility. Wireless industrial telemetry and a multitude of automotive applications are also expected.

Using Bluetooth

Yes, Bluetooth chip sets and some Bluetooth-enabled products like the wireless headset and printer connections are available today. Many others are on the way. And you may even be able to play around with some of the chip sets yourself to create wireless projects. Yet, Bluetooth in not the cheapest or easiest wireless hardware to use. You don't have to be a RF engineer to create a Bluetooth device since the chip sets leave little for you to do other than mount them, connect power and an antenna, and go. The hard part is interfacing your application to the baseband circuits. This is more of a software and programming project that requires knowing and interacting with the Bluetooth software stack. Development boards and software make this easier, but they are expensive.

As Bluetooth becomes more widely used, prices will continue to drop and development will become easier. Until then, there are many other simpler wireless options that I will talk about here in future columns.

Let me know what other communications and networking topics you would like to hear about in this space. Email me at lfrenze@attglobal.net. **NV**

Web Sites for More Information

Here is a selection of information sources about Bluetooth in case you want to learn more.

www.bluetooth.org
Official Bluetooth SIG site.

www.csr.com
Cambridge Silicon Radio, one of the first Bluetooth chip suppliers and the leading chip supplier today (Over 2 million sold!).

www.ericsson.com
Ericsson's site. Bluetooth founder. Go to the Bluetooth section for a short tutorial.

http://grouper.ieee.org/groups/802/15/pub/Tutorials.html
IEEE's web site concerned with wireless personal area networks (WPANs) and related standards. Some tutorials there.

www.3com.com
One of the Bluetooth sponsor and pioneer companies.

www.mot.com/bluetooth/index.html
Motorola's Bluetooth site.

www.semiconductors.philips.com/technologies/bluetooth/
Philips' good site.

www.sss-mag.com
Great site for complete information on any spread spectrum technology.

http://www.webexpert.net/vasilios/telecom/telecom.htm
Good general site for info on telecommunications subjects like spread spectrum, wireless, etc.

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Learning RVK-Basic Part 4

By Bob Vun Kannon

RVK-Basic is a free Basic compiler for the Atmel AVR line of microcontrollers. You can download a copy of this compiler from the Nuts & Volts web site. With this compiler, you can write and compile very fast, efficient programs for most of the AVR microcontrollers.

In this article, we will explore the use of the A/D converter and the UART. I will be assuming that the reader has already worked his way through the first three articles. If you missed them, contact *Nuts & Volts* for back issues.

Analog-to-Digital Conversion

The analog-to-digital (A/D) converter contained in some of the AVR devices is a very useful gadget. It will convert an analog voltage into a digital number for you on command.

The A/D converter is a 10-bit converter. Its result is a 10-bit number, so it won't fit in a byte variable. So, now we need to use an integer (two-byte) variable. In RVK-Basic, this is done by using a variable name which ends in a percent sign, like var%.

Integer variables in RVK-Basic are unsigned. They have a possible range of values from 0 through 65535 (&H0 through &HFFFF). They can be used in IF statements and equations just like byte variables, as we did in previous articles. The main difference between integers and byte variables is that the integers are stored in static RAM in the chip. This means that it takes two clock cycles to bring the variable into the processor from RAM and two more clock cycles to write the result back out to RAM. Thus, integer computations proceed more slowly than byte operations.

In order to perform an A/D conversion and put the result into an integer variable we use the A2D statement. The basic syntax is A2D variable, mux, option. The AVR chips generally have more than one channel that can be read by the A/D converter. So you could potentially have as many analog inputs to the chip as it has channels. The "mux" in the A2D syntax is a number, which corresponds to the particular channel to be converted. These channels are numbered from 0 up to as many as 7 for the 8535 processor.

There is an extensive list of options in RVK-Basic for the A2D command. Please read the RB.TXT file supplied with the compiler for documentation on all the options. In this example, we will be using the IDLE option. This is a neat feature which allows for very accurate, noise-free conversions. When IDLE is specified, the processor shuts down while the conversion is being performed and then wakes back up when the conversion is finished. That way, there is no digital noise from the processor interfering with the conversion.

So let's write a program to perform A/D conversions for us and display the result.

To display the result, we will put the answer out on the B port to the LEDs on the development board. The only problem this causes is that there are only eight LEDs and there are 10 bits in the integer. An easy way to solve this is to throw away the two least significant bits. We can do this with the SHIFT statement.

The idea of shifting is best seen looking at a number in binary. If we have a number like 18, in binary that is

    00010010

Now shifting it right one bit will give

    00001001

Shift it right one more time and you will get

    00000100

See how that works?

So if we shift our 10-bit number to the right two times, we will have an eight-bit number in the lower byte of the integer. For example, 0000001100110011 would become 0000000011001100. This can be performed by writing:

```
SHIFT var%,2,RIGHT
```

The final piece of the process is to get the bottom byte of the integer into a byte variable (so we can write that byte out to Port B). This is done in RVK-Basic by setting a byte equal to an integer. So the entire program will now become the following.

```
DEVICE 2333
MHZ    4

DIRPORT B,OUT

DO
        A2D x%,0,IDLE
        SHIFT x%,2,RIGHT
        temp = x%
        OUTPORT B,temp
LOOP
```

To run this program, hook a potentiometer (10K will work nicely) up to the power and ground pins of the analog header of the development board and hook the wiper of the pot to Channel 0 of that port. When you run the program, you will see the digital number shown on the LEDs change as you turn the pot. When dealing with data from the real world, it is often very useful to be able to filter the data to remove noise. For this purpose, there is a FILTER statement in RVK-Basic.

I'm going to modify the program we just wrote to filter the data coming in from the pot. In this next program the input will only be read every tenth of a second. I will filter the data by a factor of 2^4 (two to the fourth power) which will give us a 1.6 second filter. Run the following program and make a quick change to the pot. You will see the result change rather slowly and gradually creep into its final value. This is the software equivalent of using a resistor and capacitor to make a low-pass filter. You will want to try changing the "4" in the FILTER statement to a "3" and watching the results speed up by a factor of 2.

```
DEVICE 2333
MHZ    4

DIRPORT B,OUT

DO
        A2D y%,0,IDLE
        FILTER x%,y%,4
        SHIFT x%,2,RIGHT
        temp = x%
        OUTPORT B,temp
        PAUSE 100
LOOP
```

If you intend to run this program on an STK500 board, I recommend changing the "B" in the DIRPORT and OUTPORT statements to "D" and connecting the jumper from the LEDs to port D. I am told that the upper bit on the LEDs may not function properly if driven from port B on the STK500 board.

The Universal Asynchronous Receiver-Transmitter

One of the more useful things you can do with an AVR microcontroller is to connect it to a PC. Information can flow in both directions. The first thing we will do is to transmit the data from our pot (hope you haven't disconnected it yet) to your PC. I'm assuming you have a real PC that has an RS-232 port on it and not one of these newfangled USB ports.

The AVR development boards have a nine-pin connector for RS-232 communications. So all you will need to do is connect a serial cable from the nine-pin connector of the development board to the nine-pin connector on the back of your computer. Follow me as I write a little more code.

There are two statements in RVK-Basic for running the UART. XMIT controls transmissions out of the UART and RECV controls reception from the UART. First, we will just transmit the data from the POT out of the UART in the following program. The first XMIT statement initializes the UART to the baudrate we want. The second XMIT statement actually transmits the data. Please refer to the detailed description of the XMIT and RECV statements in the file RB.TXT.

```
DEVICE 2333
    MHZ    4

    DIRPORT B,OUT
    XMIT INIT 9600

    DO
            A2D y%,0,IDLE
            FILTER x%,y%,4
            SHIFT x%,2,RIGHT
            temp = x%
            OUTPORT B,temp
            XMIT OUT temp
            PAUSE 100
    LOOP
```

Now, if you were to look at the TXD output pin of the chip with a scope, you would see a stream of ones and zeros going out in bursts every tenth of a second. It would be much more instructive to actually see this data showing up on the screen of your PC.

The following program can be run on your PC under QBASIC, or compiled by Quickbasic or Power Basic and then run. So long as it is running, anything coming in over the serial port (COM1) will show up as a number on the screen. The program ends whenever you hit a key. This should run on any IBM compatible PC with a COM port. If it uses Windows, you may need to go to the command prompt to run the program.

```
OPEN "COM1: 9600,N,8,1,RS,CD0,CS0,DS0" FOR RANDOM AS #1

    DO
        IF eof(1)=0 THEN
            a$ = INPUT$(1,1)
            PRINT ASC( a$);
        END IF
        IF INKEY$<>"" THEN EXIT DO
    LOOP
    PRINT
    PRINT
    END
```

To get this up and running, type EDIT from the command prompt and enter the program as you see it here. Save it under some convenient file name like TEST.BAS. Then you should be able to run it by the command "QBASIC TEST." I hope that you get this all up and running with no trouble and that it opens up new avenues for you in how to use an embedded microcontroller. Now, let's get our data flowing in both directions. The following program in RVK-Basic will read a byte from the PC and then add one to it and send it back to the PC. So data will flow only when the PC sends something.

```
DEVICE 2313
MHZ    4
XMIT INIT 9600
RECV INIT 9600
RECV INTERRUPT ON
rflag = 0

DO
        IF rflag | 0 THEN
                INCR rbyte
                XMIT OUT rbyte
                rflag = 0
        END IF
LOOP

'================================
'   INTERRUPT HANDLER FOR        =
'   RECV FROM THE UART           =
'================================
 INTERRUPT RECV
    PUSHFLAGS
    PUSHREG
    rflag = 1
    RECV IN rbyte, errflag~
    POPREG
    POPFLAGS
 END INTERRUPT
```

There are several new ideas in this program that deserve comment. The RECV INTERRUPT ON statement enables interrupts from the receiver side of the UART. Whenever a byte comes into the UART, an interrupt is generated. This means that no matter what the program is doing, it will jump to the interrupt handler for that interrupt. In the case of the RECV, it will jump to the statement INTERRUPT RECV.

The two PUSH statements save the current state of the processor data and flags onto the system stack. At the end of the interrupt routine, the two POP statements retrieve the processor data and flags from the stack so that it can return to the main program in the same state as when the interrupt occurred. These statements should be placed in every interrupt handler that you write. The real work of the interrupt handler is in the two statements in the middle. It sets the variable rflag, which informs the main program that a byte has been received. The RECV IN statement loads the data from the UART into the variable rbyte and also loads a byte of error flags (which we ignore) into "errflag~." This is a new type of variable to the student at this point. By placing a tilde on the end of the name, I have specified that the variable is a byte variable stored in RAM (not in a register). Remember that you only get to use 28 register variables in a program and all others must go into RAM. So this shows you how to do that.

Back in the main program, we simply watch for the rflag to become set. Whenever this happens, we increment the rbyte (that's what INCR does) and transmit it out to the PC. So, if the PC sends us an "A," we will echo back a "B." You can try this out with the following program on your PC.

```
OPEN "COM1:
9600,N,8,1,RS,CD0,CS0,DS0"
FOR RANDOM AS #1

PRINT "HIT ESC TO END
THIS PROGRAM."
        PRINT
        DO
      A$ = INKEY$
      IF A$<>"" THEN
         IF ASC(A$) = 27
THEN EXIT DO
         PRINT #1,A$;
      END IF

         IF EOF(1) = 0 THEN
            a$ = INPUT$(1,1)
            PRINT ASC( a$);
         END IF
      LOOP
      PRINT
      PRINT
      END
```

When you have this PC program running together with the AVR program, you will have established two-way communications between your PC and the development board.

In the next article, we will take up program structure. **NV**

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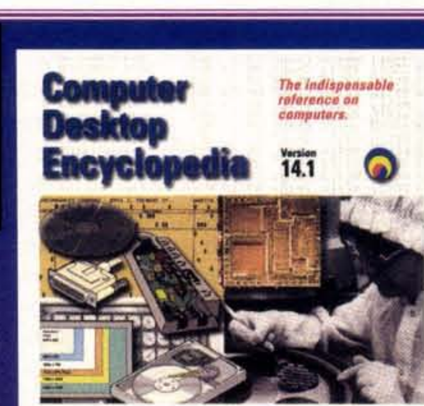

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The Blinkery Blinkeroo Flashing Light

By George Philips, Rachel Philips, and Thomas Philips

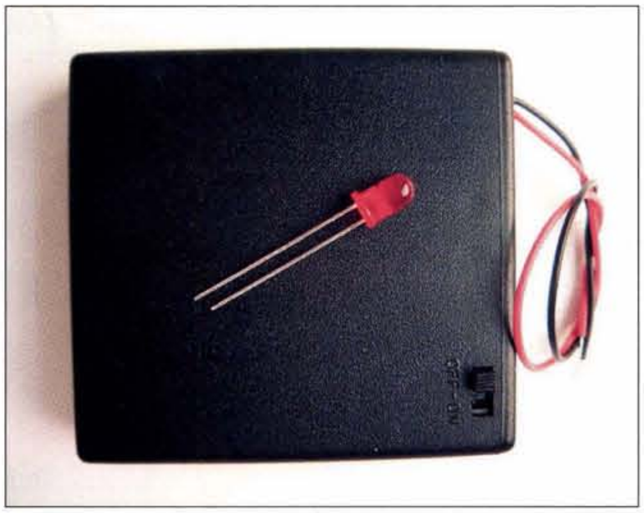
This is a perfect beginner's gadget for someone who has never built an electronic project before. It's intended to be built by kids with adult supervision, since it requires soldering.

The Blinkery Blinkeroo is a small battery powered flashing light that can be built in half an hour by someone who has never built an electronic project. It costs less than $3.00 and has only two components: a battery case with a built-in switch and a flashing light-emitting-diode (LED). Furthermore, it requires only two soldered joints to attach the LED to the battery. Its simplicity and ease of assembly makes it a perfect introduction to electronics for the budding hobbyist or young Scout. Two of the authors (George and Rachel, age 15 and 9) built Blinkery Blinkeroos for themselves and their friends with ease.

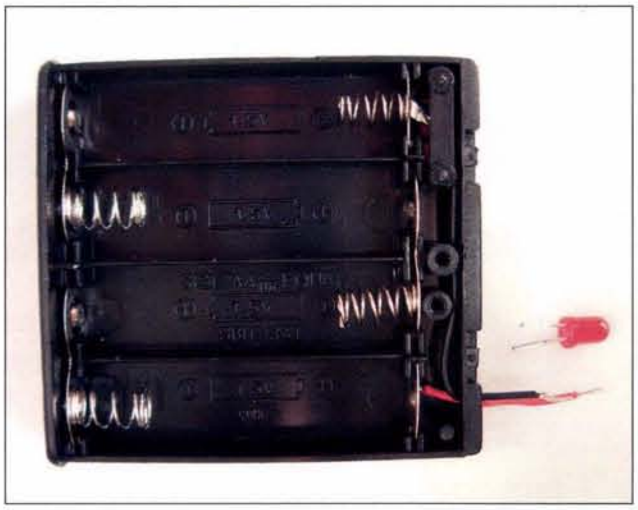
The battery case and flashing LED are best bought from Digi-Key Corporation (1-800-344-4539 or www.digikey.com). Obtain a four AA cell battery case (item number SBH-341AS-ND) and a flashing LED in the color of your choice (Bright Red: 67-1499-ND, Dark Red: 67-1497-ND, Red: 67-1498-ND, Green: 67-1496-ND or Yellow: 67-1495-ND). A similar battery case and green LED can be obtained at RadioShack (items 270-409 and 276-305 respectively), but the Digi-Key battery case is easier to use.

Remove the cover of the battery case by sliding it forward and you will see two wires – one red and the other blue – connected to the positive and negative terminals of the batteries respectively via a switch. The wires exit the battery case through a hole near the positive battery terminal. Cut the leads half an inch away from the case and use a wire stripper to remove one third of an inch of insulation from each wire. Pull both leads back through the hole with a pair of tweezers.

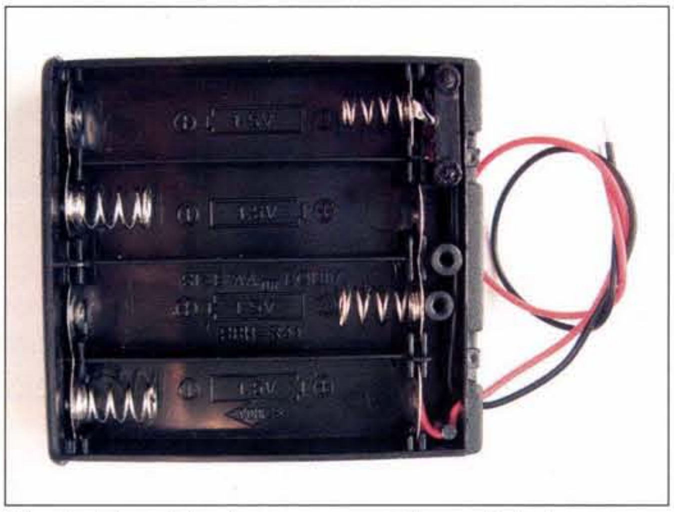
Next, using needle-nosed pliers, bend the leads on the LED so that they are parallel to its rear surface. Start the bend 1/8" away from the rear surface to allow for the thickness of the battery case. The longer lead is the anode, and must be connected to the red (or positive) wire. The shorter lead is the cathode, and must be connected to the black (or negative) wire.



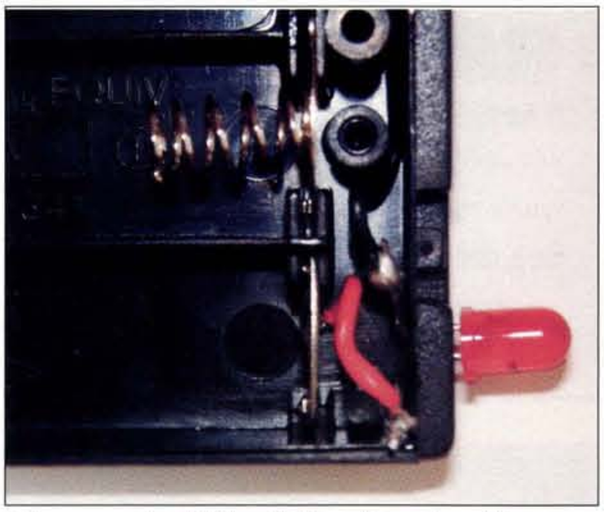
The entire component list — one LED and one battery case with switch.



Ready for assembly. The battery case and LED with their leads trimmed.

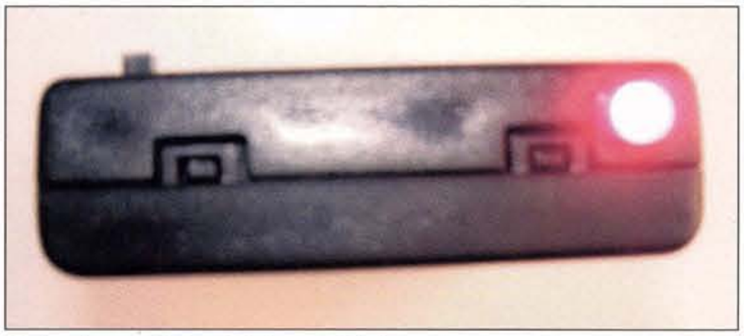


The inside of the battery case. The switch is at top right.



Close-up detail. The LED soldered and in place.

Almost ready for action! The Blinkery Blinkeroo with its batteries installed.



Side view of the Blinkery Blinkeroo.

Trim both leads to a length of half an inch, but ensure that the anode remains longer than the cathode to facilitate correct identification. An incorrectly wired LED will not flash, and may even be damaged or destroyed. Slip both leads of the LED through the hole in the battery case and, under adult supervision — solder the red wire to the anode and the black wire to the cathode as follows:

1. Connect the LED to the wires. Twist the red wire and the anode lead together and the black wire and the cathode lead together. Ensure that the two junctions do not touch each other.

2. Apply a hot soldering iron to the first junction for about 10 seconds. Ensure that the soldering iron does not touch the plastic battery case. Inexpensive soldering irons can be purchased from Digi-Key (Item WP25-ND) or RadioShack (Item 64-2184).

3. Press solder wire against the hot junction (not against the soldering iron) to melt it. Use just enough solder to cover the junction.

4. Remove the solder and the soldering iron and do not move the leads as they cool.

5. Repeat these steps for the second junction.

Resist the temptation to solder the LED to the wires before passing its leads through the hole in the case. The soldered joints are too large to fit comfortably through the hole.

Two vitally important words of caution are in order.

1. IT IS IMPERATIVE THAT THE WIRES BE SOLDERED CAREFULLY UNDER ADULT SUPERVISION — A SOLDERING IRON CAN REACH A TEMPERATURE OF 700° F OR MORE, AND CAN CAUSE SERIOUS AND LIFE-THREATENING BURNS IF IMPROPERLY USED.

2. WEAR SUITABLE PROTECTIVE CLOTHING, INCLUDING GLOVES TO PROTECT YOUR HANDS AND GOGGLES TO PROTECT YOUR EYES, WHILE SOLDERING.

After the soldered connections have cooled, bend them away from each other so that they cannot touch and short the battery, and stick the rear surface of the LED to the battery case using a small dab of fast setting adhesive such as SuperGlue. Finally, put in four AA cells and slide the case shut. Your Blinkery Blinkeroo is ready to go! To operate it, slide the power switch to the On position, and allow the Blinkery Blinkeroo to welcome you to the wonderful world of electronics with its rhythmic blinking!! **NV**

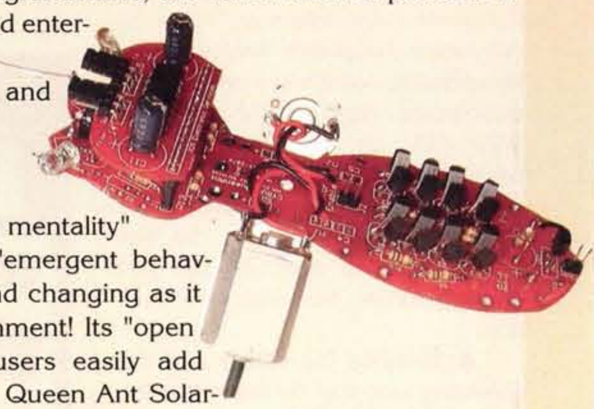
Blinkery Builders
Rachel and George

New Product News

Newest Insectoid Robot Kit Rules the Electronic Colony!

Mondo-tronics' Robot Store introduces the newest and largest member of the popular CYBUG family of robot kits — the CYBUG Queen Ant.

Bigger, expandable and evolvable, and with options for becoming solar-powered and even programmable, the Queen Ant kit provides a fun-to-build, educational, and entertaining experience for intermediate robot builders, and even beginners with some soldering experience.



The Queen Ant's "hive mentality" lets it exhibit fascinating "emergent behaviors" — actually learning and changing as it explores its robotic environment! Its "open architecture" design lets users easily add solar panels (with optional Queen Ant SolarWings add-on kit), or plug in a fully programmable BASIC Stamp microcomputer (available separately) that permits the creation and downloading of new behaviors from a PC. The robot's curvaceous bright red circuit board emphasizes its ominous arthropod look and immediately shows who rules the hive!

CYBUGs model living organisms, with behaviors and instincts designed into their circuitry. CYBUG robots have the ability to seek out their own "food sources" to keep themselves alive. Just as a honeybee seeks flowers for nectar, the CYBUG seeks out the brightest light source to find a meal of fresh electricity to recharge its batteries!

Fifteen-year-old Mondo-tronics, Inc., features a fascinating array of interactive robot kits, books, parts, tools, and more. The latest Robot Store Catalog can be downloaded as a .PDF file from the RobotStore.com web site.

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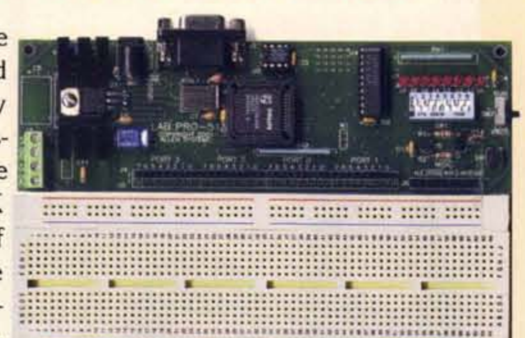

The LAB PRO-51 is a single board computer based upon the popular 8051 family of microcontrollers. The processor used on the board is the P89C51RB2BA, which has 16K bytes of Flash and 512 bytes of RAM. A major advantage of the 89C51, however, is its mechanism for in-system programming. On-chip Flash can be programmed by connecting the board to a PC serial port. This approach is referred to as "in-system" since the 89C51 remains installed on the LAB PRO-51 during programming.

A major design feature of the LAB PRO-51 is its prototyping area. The prototype area contains a large number of solder pads (.060 pad with .036 hole) placed on a .1 inch grid. User circuitry can be built and tested in this area. Board connectors are available to connect to the 89C51.

An optional solderless breadboard can also be purchased and

Continued on page 81

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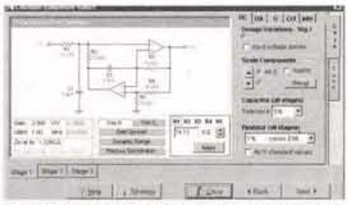

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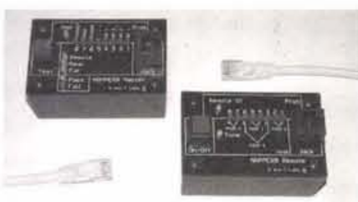

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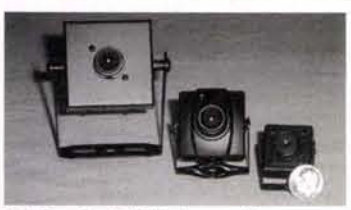

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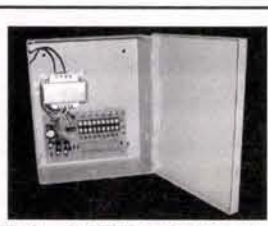

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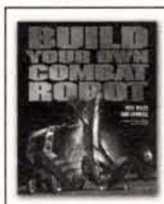

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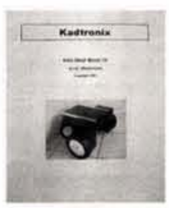

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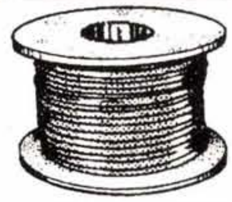

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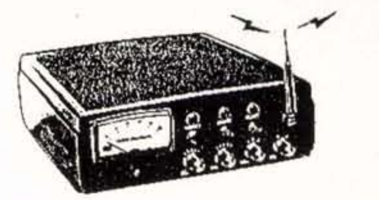

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Continued from page 18

[2025 - FEB. 2002]

I have a Commodore MPS-803 friction feed printer. I heard that the printer can be converted to a traction feed type. How do I do this?

The Commodore MPS-803 can be converted from a friction-feed to a tractor-feed with the use of a retro assembly called a TU-803, that was offered by Commodore.

The unit attached to the printer by removing two small rectangular pieces (about 1/2" wide and 1" long) just above the carriage bar.

The unit had two extensions on the underside that inserted into the slots, snapping onto the shaft inside. Pushing back, it snapped down and the gear meshed with the gear on the side of the paper advance wheel.

To find one may not be easy, since Commodore is no more, but they are out there. Try your area hamfests, talking to the vendors and dealers of old equipment and most of all, with the amateur operators themselves. You would be surprised how many have some Commodore equipment stashed in garages, closets, and store rooms gathering dust. If not, they may know where. Some may even give it to you if you go get it. But you have to ask around.

When you find one, check it over, they are mostly plastic and don't take too well to rough handling.

Verl Wooters
Centralia, IL

[1029 - JAN. 2002]

I have some old ceramic resonators or crystals, I'm not sure. How can I find their frequency?

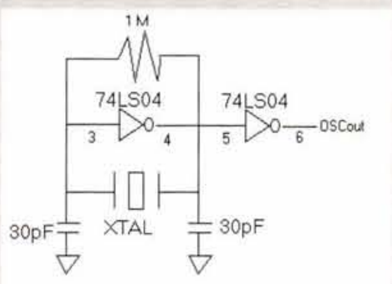
#1 Two steps are needed to determine the frequency of a crystal:

1. Cause the crystal to oscillate at it's resonant frequency.

2. Measure the frequency of oscillation.

There are several ways of performing each of these steps, based on the equipment that you have at hand and, to a lesser extent, on the frequency range of the crystal. You may need more than one technique to separate a wide range like 32KHz and 100MHz!

Step one is done by placing the crystal between XTALin and XTALout of a chip that oscillates, such as a Scenix processor (rated 0-50MHz), or by building a stand-alone oscillator circuit.

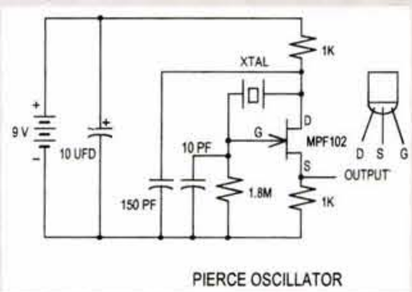


Measuring the frequency can be done directly with a frequency counter, or indirectly with a scope or computer program. The oscilloscope will measure the time from rising edge to rising edge. The frequency can then be calculated by freq=1/time. For example, 1/20ns=50MHz, 1/1uSec=1MHz.

The program method can use a processor running from the unknown crystal and waiting a known number of instruction cycles before toggling an I/O pin, or can run with a faster crystal and count how many cycles are executed between sucessive toggles of an I/O pin. The latter is very effective for measuring crystals of 10MHz or slower.

Larry Barry
via Internet

#2 One of the easiest ways to determine the frequency of a crystal is to place it into a Pierce oscillator circuit and check the output waveform at the source of



the FET with a scope or frequency counter, as shown in the diagram.

For some frequencies, the Pierce oscillator circuit might need trimming of the two capacitors, 10 pF and 150 pF.

A Pierce crystal oscillator has no tuning elements, and will oscillate over a wide range of frequencies. The crystal will oscillate at its fundamental frequency. Once the fundamental frequency is known, the crystal can be placed in a conventional oscillator circuit such as a Hartley or Colpitts with a resonant tank circuit tuned to the third of fifth harmonic. This will permit operation of the crystal at higher frequencies.

schematic scanned graphics pierce.bmp

Anthony Caristi
Waldwick, NJ

#3 Figure 1 is a Colpitts circuit I built years ago (and still use). A milliammeter at TP will indicate crystal activity.

Figure 2 is a Pierce circuit that I have not built, but should work over the range of 455 KHz to 10.7 MHz.

For both circuits, the value of B+ is not critical, 5-15 volts will work. Any two-leaded crystal or resonator will work, but overtone crystals will oscillate at the fundamental frequency. I think a three-leaded resonator (filter) will oscillate in these circuits, but have not tried it. The 900 numbers are RadioShack.com part numbers.

Russell Kincaid
Milford, NH

Figure 1

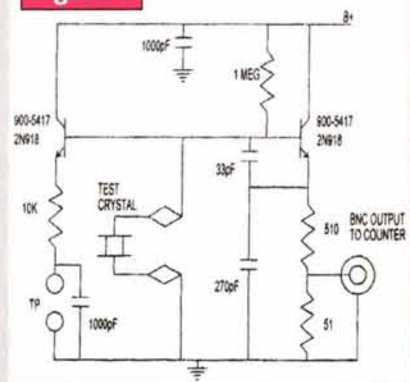
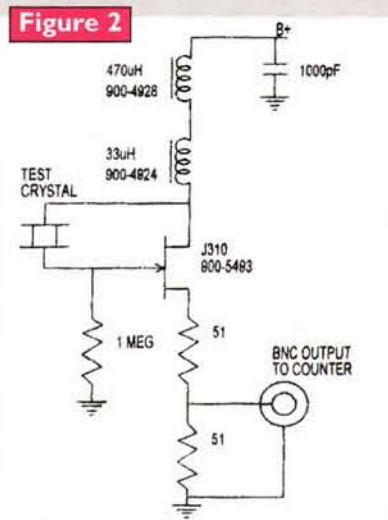


Figure 2



Continued from page 34

JUNE 8

MO - MACON - Hamfest. Macon County, Nemo, Schuyler, & Tri-County ARCs, 660-385-3629. Email: n0pr@arrl.net Web: www.qsl.net/n0pr/hamfest.html
PA - BLOOMSBURG - Convention. Columbia Montour ARC, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.qsl.net/cm-arc
TN - KNOXVILLE - Hamfest. Cokesbury Center, 9915 Kingston Pike. Knoxville RAC, 865-670-1503. Email: d.bower@ieee.org Web: www.w4bbb.org

JUNE 9

IL - EFFINGHAM - Hamfest. National Trail ARC, 217-342-3054 (M-F 9am-5pm).
IL - GRANITE - Hamfest. Southwestern IL College Campus, IL Rt. 203. The Egyptian RC, 618-655-1232, email: w9pat@arrl.net. 618-667-4592, email: kb9ail@arrl.net. 618-656-0905, email: k2kfw@arrl.net Web: www.w9aiu.org
IL - WHEATON - Hamfest. Six Meter Club of Chicago, 708-442-4961. Email: wa9fih@arrl.net http://cyberconnect.com/orion/hamfest.htm
KY - INDEPENDENCE - Hamfest. Northern Kentucky ARC, 513-797-7252. Email: n8jmv@arrl.net

JUNE 14-15

NE - SOUTH SIOUX CITY - Convention. 3900 Club, 712-252-4107 (10am-5:30pm). Email: tands@pionet.net Web: http://www.3900club.com

JUNE 15

NJ - DUNELLEN - Hamfest. Columbia Park. Raritan Valley RC, Inc., 732-469-9009, email: wb2njh@aol.com, or 732-968-7789
OH - MILFORD - Hamfest. Milford ARC, 513-753-5066. Email: kb8snh@cs.com

JUNE 16

MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html

JUNE 28-29-30

CA - FERNDALE - Convention. Humboldt ARC, Redwood ARC, Farwest Repeater Assn., & Southern Humboldt ARC, 707-442-3866. Email: conven@humboldt-arc.org Web: www.humboldt-arc.org

JULY 2002

JULY 4

PA - HARRISBURG (BRESSLER) - Hamfest. Harrisburg RAC, 717-938-8249. Email: k3pd@arrl.net Web: http://hrac.tripod.com/July4.htm

JULY 7

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, 815-933-1323. Email: karsfest@yahoo.com Web: www.w9az.com
PA - WILKES-BARRE - Hamfest. Murgas ARC, 570-824-7579. Email: n3wpg@juno.com Web: www.qsl.net/k3ytl

JULY 12-13-14

UT - BRYCE - Convention. Utah Hamfest Committee, 801-547-9218. Email: jimkatpa@aol.com Web: www.utahhamfest.org

JULY 13

GA - GAINESVILLE - Hamfest. Lanierland ARC, 770-967-6364. Email: w4tl@arrl.net Web: www.lanierlandarc.org/hamfest.htm
TN - CLEVELAND - Hamfest. Cleveland ARC, 423-472-1660. Email: bgault@wingnet.net

JULY 14

PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, 610-667-1650. Email: sflink@juno.com Web: www.marc-radio.org/hamfest.html
PA - PITTSBURGH (NORTH HILLS) - Hamfest. North Hills ARC, 412-486-1681. Email: aa3ta@bellatlantic.net Web: www.nharc.pgh.pa.us

JULY 19-20

OK - OKLAHOMA CITY - Oklahoma State Fair Park, Oklahoma Bldg., intersection I-40 & I-44. Central Oklahoma Radio Amateurs, Inc., www.geocities.com/heartland/7332

JULY 20

NY - ALEXANDER - Hamfest. Genesee Radio Amateurs, 716-343-2844. Email: wa2abq@localnet.com

JULY 21

IL - SUGAR GROVE - Hamfest. Fox River Radio League, 815-786-2860. Email: w9ceo@arrl.net Web: www.frrl.org/
MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html

Circle #36 on the Reader Service Card.

Circle #37 on the Reader Service Card.

Events Calendar

MO - WASHINGTON - Hamfest. Zero Beaters ARC, 636-629-7368 (days) Email: n0mfd@arrl.net

JULY 26-27

FL - MILTON - Hamfest. Milton ARC, 850-994-7335. Email: wa4tfr@worldnet.att.net Web: http://home.att.net/~k4ozl/marc.htm

JULY 26-27-28

AZ - FLAGSTAFF - Convention. Amateur Radio Council of AZ, 602-881-2722. Web: www.arca-az.org/arca

JULY 27

NC - WAYNESVILLE - Hamfest. Western Carolina ARS, 828-236-0181. Email: wa4ola@arrl.net http://wcars.org/hamfest/index.htm

NY - FRANKFORT - Hamfest. Utica ARC, 315-797-6614. Email: ktrnd@borg.com

OH - CINCINNATI - Hamfest. OH-KY-IN ARS, 859-657-6161. Email: wd8jaw@arrl.net Web: http://www.ohkyin.org

JULY 28

MD - TIMONIUM - Hamfest. BRATS, 410-828-1605. Email: bbennett@ketron.com Web: www.bratsatv.org

AUGUST 2002

AUGUST 2-3-4

OR - PORTLAND - Convention. Willamette Valley DX Club, 360-256-7437. Email: k7ar@arrl.net Web: www.wvdxc.org

AUGUST 3

NY - ITHACA - Hamfest. Tompkins County ARC, 607-257-6066. Email: jdreid@lightlink.com Web: www2.compcenter.com/~tcarc/

OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, 614-846-7790. Email: kb8kpj@cs.com

AUGUST 3-4

KY - LEXINGTON - Convention. National Guard Armory. Bluegrass ARS, Inc., 859-253-1178. Email: jrbarnes@iglou.com

DUSTMEISTER

Hunting the Elusive Dust Bunny — Part 2

By Robert Lang and Thomas Ober

In DUSTMEISTER Part 1, the hardware necessary to build an automated dust collector controller for a woodworking shop or for controlling any large electric motor was presented. In Part 2, building of a tool sensor from scratch and the programming and testing of the DUSTMEISTER will be covered.

The inconvenience of manual dust collector controls may lead the woodworker into not using the dust collector and thereby not getting the improved safety or air quality benefits. On the other hand, continuously running a dust collector leads to a distracting, noisy shop and the wasting of electricity and air conditioning. With the DUSTMEISTER, the shop-wide vacuum/dust collector system turns on whenever a woodworking tool is turned on and shuts off after the tool is turned off.

PROGRAMMING THE DUSTMEISTER

The PIC16F877 microprocessor is the brain that gives the DUSTMEISTER its intelligence. The microprocessor must be programmed before the vacuum controller will perform its function. Unlike your home computer, the PIC16F877 microprocessor does not forget its program when power is turned off.

Initially the software did not use interrupts, but this led to an unacceptable delay time from the time a tool was turned on or off before the DUSTMEISTER realized it. Since it was necessary to use interrupts, the programming was done in PICMICRO assembly language. The MICROCHIP MPLAB Integrated Development Environment which includes the assembly language is available for free at Source 1.

The assembled and linked code is available as DUSTMSTR.HEX at Source 2. After downloading the program, the program must be loaded into the PIC16F877. A simple circuit from Source 3 is shown in Figure 1 and can be connected to the PC's parallel port for programming the PIC. Several articles on the PIC programming process are found in Source 4. If you do not want to go to the trouble of programming the PIC16F877 chip yourself, preprogrammed chips are available from

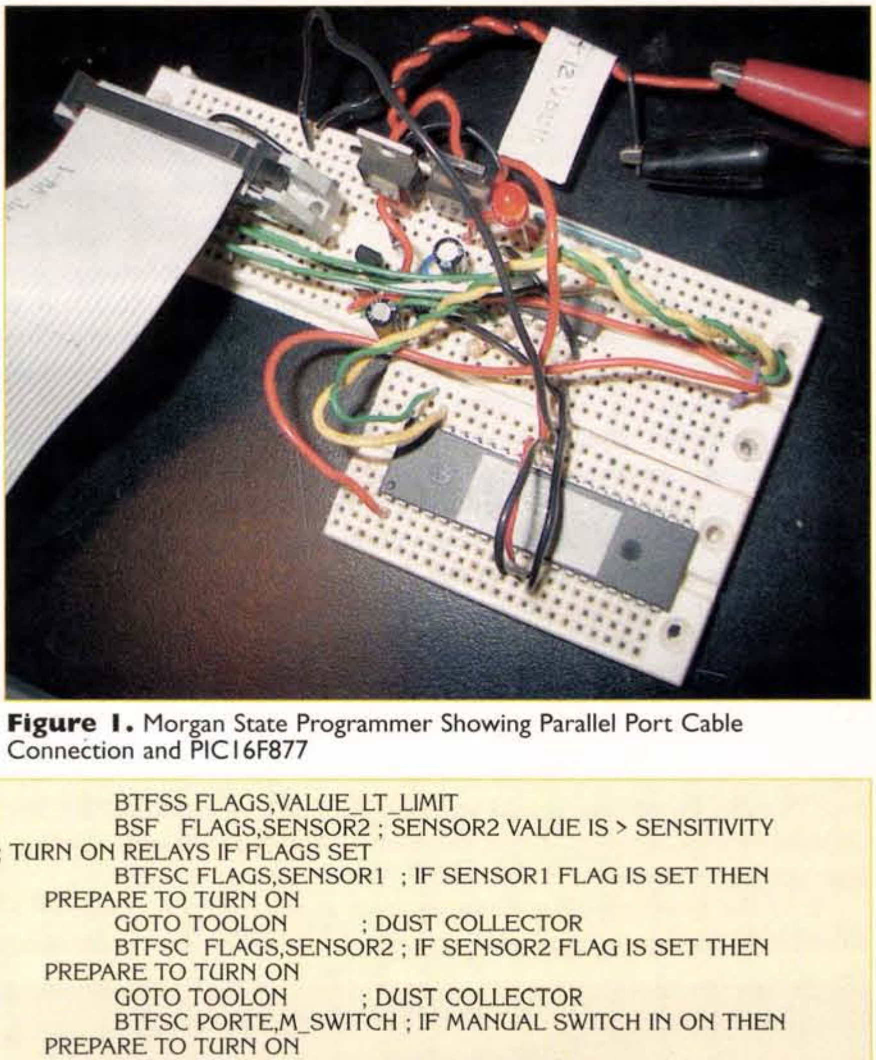


Figure 1. Morgan State Programmer Showing Parallel Port Cable Connection and PIC16F877

Figure 2. DUSTMEISTER Interrupt Source Code

```
;***********************************************
;**********INTERRUPT SERVICE ROUTINE **********
;***********************************************
; SAVE IMPORTANT REGISTER DATA
INTERRUPT  MOVWF    TEMP_W   ; SAVE W CONTENTS
    SWAPF  STATUS,W  ; SAVE STATUS WITH SWAPF TO
                ;PREVENT CHANGING STATUS REGISTER
    MOVWF  TEMP_S   ; SAVE STATUS (SWAPPED)
    MOVF   FSR,W    ; STATUS REGISTER IS SAVED SO NO NEED
     TO USE SWAPF
    MOVWF  TEMP_FSR  ; SAVE FSR INDEX REGISTER
    BANK0 ; MAKE SURE WE'RE USING BANK0

; IS THIS A REAL TIME CLOCK INTERRUPT?
    BTFSC  INTCON,T0IF  ; IS THIS A TIMER0 INTERRUPT?
    GOTO RTC_INTERRUPT
    GOTO POP  ; OTHERWISE EXIT INTERRUPT ROUTINE
; IS IT A RTC INTERRUPT
RTC_INTERRUPT   DECFSZ INTERRUPT_COUNTER,F
        GOTO POP
        MOVLW 15 ; ONLY PROCESS EVERY FIFTEENTH INTERRUPT
        MOVWF INTERRUPT_COUNTER
        CALL INIT_AD  ; INITIALIZE DATA AND SAMPLE CHANNEL
    0 = SENSOR1_V
        CALL CONVERT_ANALOG ; GET OTHER 2 CHANNELS =
    SENSOR2_V, SENSITIVITY_V
; RESET ALL TOOL ON FLAGS TO OFF
SETOFF1       BCF FLAGS,SENSOR1
        BCF FLAGS,SENSOR2
        COMPARE_NUMBERS SENSOR1_V, SENSITIVITY_V ; CHECK
    SENSOR1 AGAINST LIMIT
        BTFSS FLAGS,VALUE_LT_LIMIT
        BSF   FLAGS,SENSOR1 ; SENSOR1 VALUE IS > SENSITIVITY
        COMPARE_NUMBERS SENSOR2_V, SENSITIVITY_V ; CHECK
    SENSOR2 AGAINST LIMIT
        BTFSS FLAGS,VALUE_LT_LIMIT
        BSF   FLAGS,SENSOR2 ; SENSOR2 VALUE IS > SENSITIVITY
; TURN ON RELAYS IF FLAGS SET
        BTFSC FLAGS,SENSOR1  ; IF SENSOR1 FLAG IS SET THEN
    PREPARE TO TURN ON
        GOTO TOOLON          ; DUST COLLECTOR
        BTFSC  FLAGS,SENSOR2 ; IF SENSOR2 FLAG IS SET THEN
    PREPARE TO TURN ON
        GOTO TOOLON          ; DUST COLLECTOR
        BTFSC PORTE,M_SWITCH ; IF MANUAL SWITCH IN ON THEN
    PREPARE TO TURN ON
        GOTO TOOLON          ; DUST COLLECTOR
        BTFSC SYSTEM,VACUUM_STATE ; IF NO TOOLS OR MANUAL
    SWITCH ARE ON AND
        CALL TURN_OFF  ;  DUST COLLECTOR IS ON, THEN PREPARE
    TO TURN OFF
        GOTO POP
TOOLON        BTFSS SYSTEM, VACUUM_STATE ; IF DUST COLLECTOR IS
    OFF AND
                    ;TOOLS/SWITCH ARE ON
        CALL TURN_ON       ; THEN PROCEED TO TURN ON DUST
    COLLECTOR
                    ; RETURN REGISTERS
POP         CALL SET_TIMER    ; RESET TIMER0
        BCF INTCON,T0IF ; CLEAR TIMER0 INTERRUPT FLAG
        MOVF    TEMP_FSR, W  ; MOVE SAVED FSR REGISTER TO W
        MOVWF   FSR          ; RESTORE FSR REGISTER
        SWAPF   TEMP_S, W    ; SWAP STORED STATUS REGISTER TO W
        MOVWF   STATUS       ; RESTORE STATUS REGISTER
        SWAPF   TEMP_W, F ;USE SWAPF INSTEAD OF MOVF SO Z BIT
    STATUS
        SWAPF   TEMP_W, W   ; WILL NOT BE CORRUPTED.
        RETFIE
; END OF INTERRUPT SERVICE ROUTINE
```

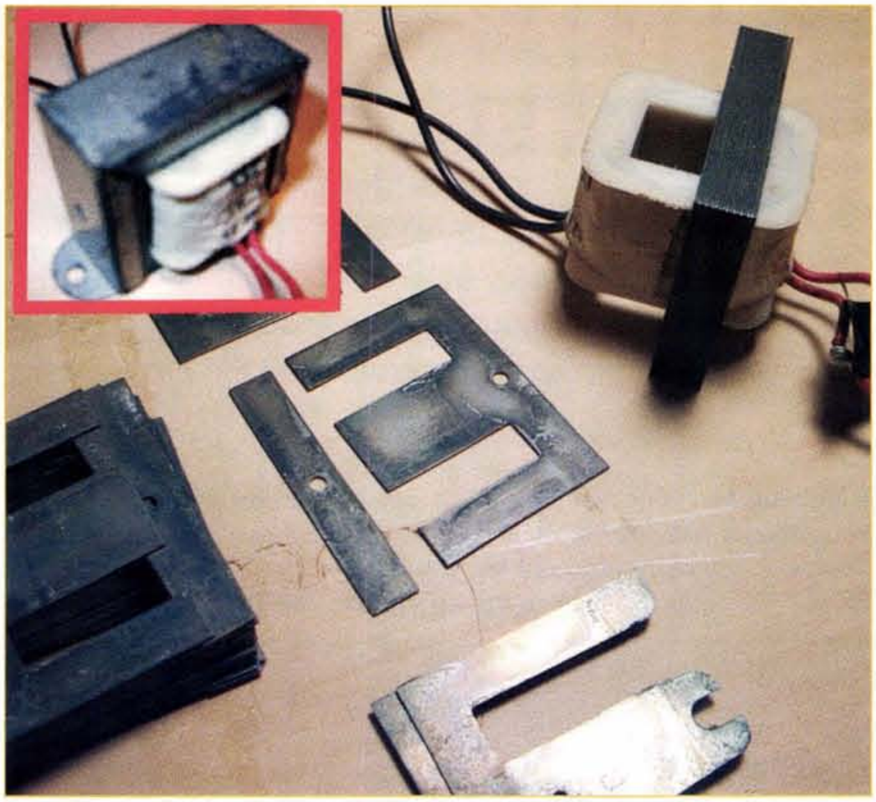


Figure 3. Transformer With Band and Laminates Partially Removed

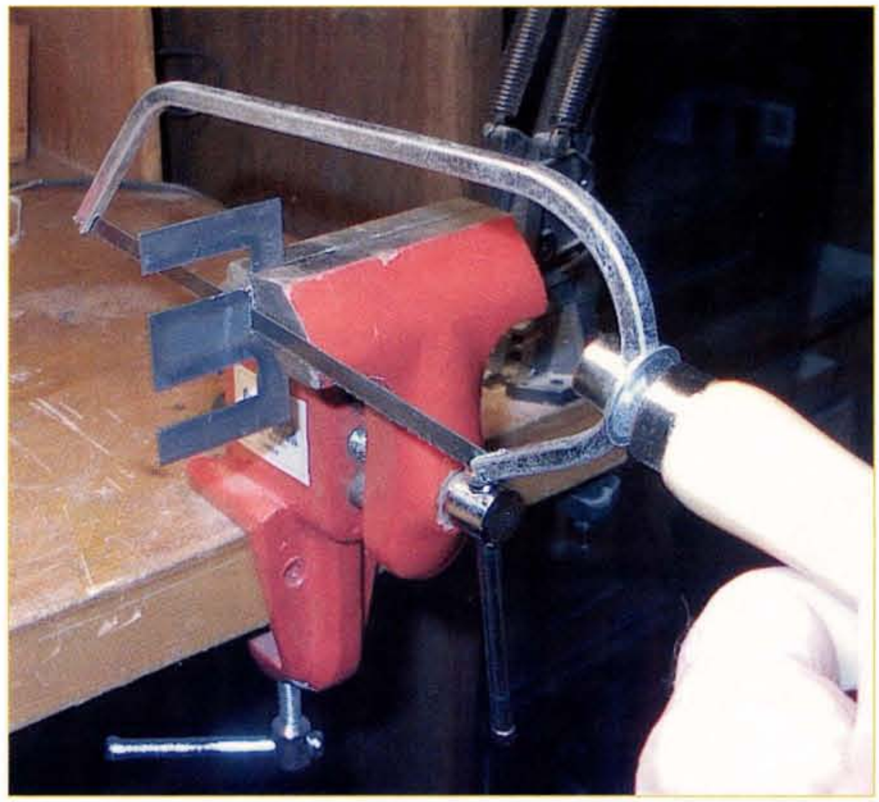


Figure 4. Converting E Laminate Pieces to C

Source 2. The program on the microprocessor does the following:

When powered up, the LCD displays a message "DUSTMEISTER 1. READY" to indicate that the DUSTMEISTER is working properly. The background task reads switch S2 to determine the number of seconds to delay and displays the messages shown in Table 1.

Approximately 10 times a second the background task is interrupted and the microprocessor jumps to the interrupt routine. Figure 2 is the source coding for the interrupt routine. The interrupt routines save important processor state information and read the current sensors and the current sensitivity limit from the A/D converter on pins RA0, RA1, and RA2. The interrupt routine also checks the status of the TEST switch S1. The software next compares each current sensor value to the current sensitivity limit. If the sensor voltage is greater than the limit, then the DUSTMEISTER knows that a tool is on.

If one or more tools are on and the vacuum system is off, then the TOOL_ON subroutine displays a countdown in the LCD and activates the ON relay for one second. The DUSTMEISTER remembers that the vacuum is now running. If the vacuum system was already running, then nothing is done.

If all the tools are off and the vacuum is on, then the TOOL_OFF subroutine displays a countdown in the LCD. When the countdown reaches zero, the TOOL_OFF subroutine checks the current sensors again. If all tools are still off, then TOOL_OFF activates the OFF relay for two seconds to turn off the vacuum system. The DUSTMEISTER remembers that the vacuum is now off.

If a tool has been turned on before the countdown reaches zero, then TOOL_OFF displays the message "SHUTDOWN ABORTED!" in the LCD and does not turn off the vacuum system. This feature avoids cycling the dust collector needlessly when one tool is turned off and another in turned on a few seconds later.

Finally, the interrupt routine resets the interrupt timer and restores the important processor state information that was saved at the beginning of the interrupt routine. The microprocessor returns to its background task of displaying the messages in Table 1 at the rate of one message per second.

ROLLING YOUR OWN TOOL SENSOR

For the more adventurous type, you may want to build your own tool sensor from scratch. If you want to build your own tool sensor, all you need is a scrap step-down transformer and some patience. Begin with a transformer as shown in the insert to Figure 3. Remove the binding strap

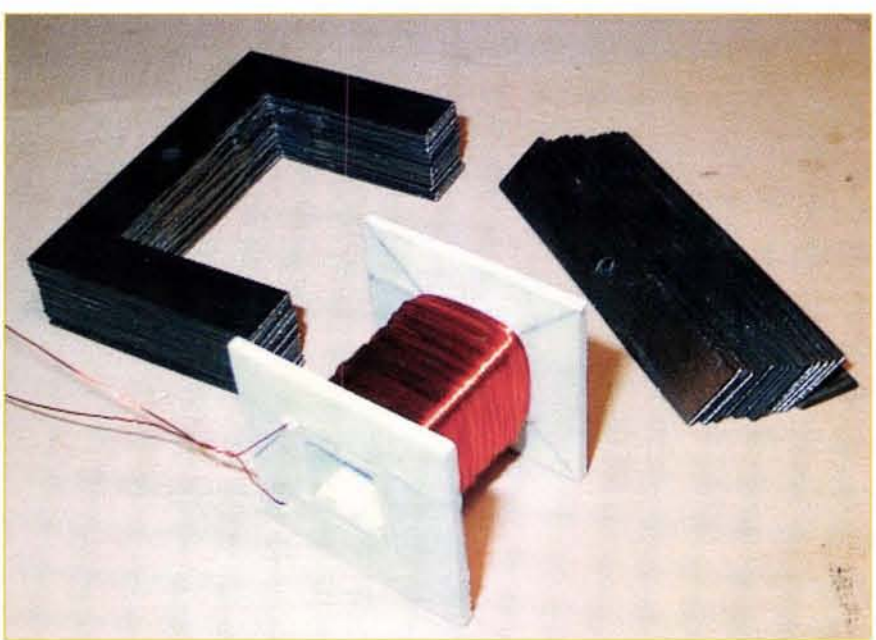


Figure 5. Wound Coil and C and I Pieces of Core

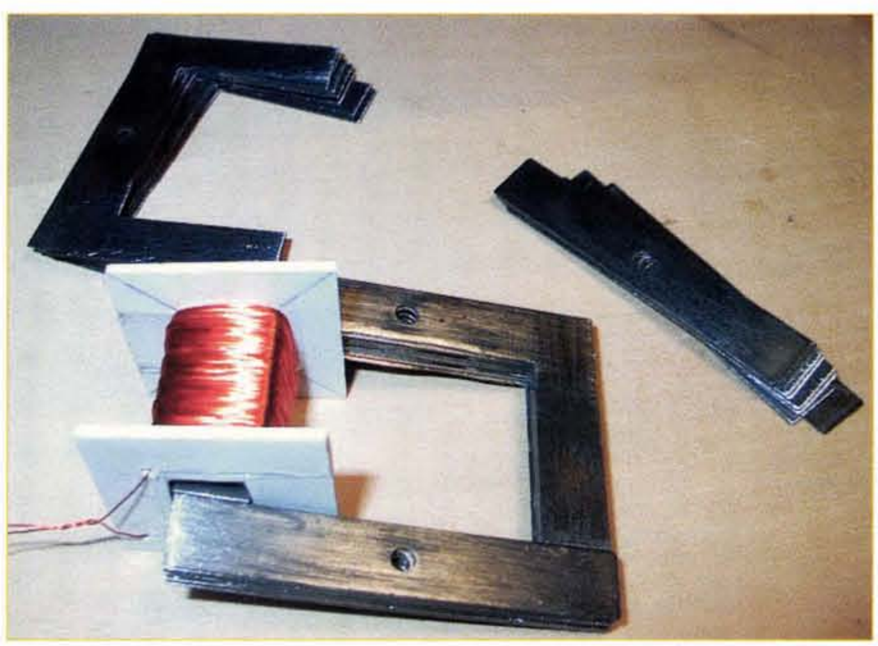


Figure 6. Assembling the Core

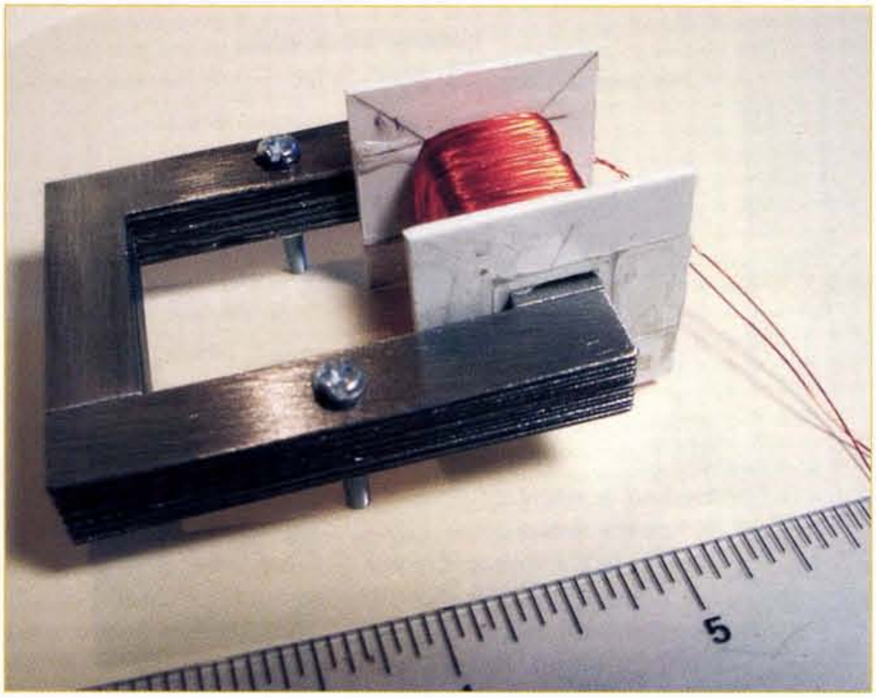


Figure 7. Finished Current Sensor

Figure 8. Sensor Calibration Set-up

and the first laminate from each side as shown in Figure 3. Do not be discouraged since these are the hardest to remove. The remaining laminates can be removed one at a time by popping them off with a chisel and hammer. Each interior laminate layer is made up of two pieces: one shaped like an "I" and one shaped like an "E." Each layer reverses the orientation of the "I" and "E" pieces. Using a hacksaw as shown in Figure 4, convert the "E" pieces to "C" pieces.

I had hoped to be able to reuse the transformer coil, but because the ends of the "E" pieces were not as large as the middle of the "E" piece, a new coil was required. Because the ends of the "E" pieces were 1 cm across, I decided to wind a 1 cm square coil. Since each laminate piece was .064 cm thick, the 1 cm core was formed from 15 pieces. I built a bobbin out of pieces of plastic. The question is what size wire and how many turns to put on the coil?

The wire on the secondary of the transformer that I took apart was 0.008 inch diameter. This would probably work, but since I was hand winding the coil, I went for a little larger 0.01 inch diameter #30 magnet wire.

About 100 feet of #30 wire was wound on the bobbin as shown in Figure 5 to give about 600 turns. I reassembled the core by alternating the laminated "C" and "I" pieces around the coil as shown in Figure 6. The completed unit was held together by using two small nuts and bolts as shown in Figure 7. If the transformer you disassembled did not have convenient holes pre-punched, you may want to use epoxy to re-assemble the core. I tested

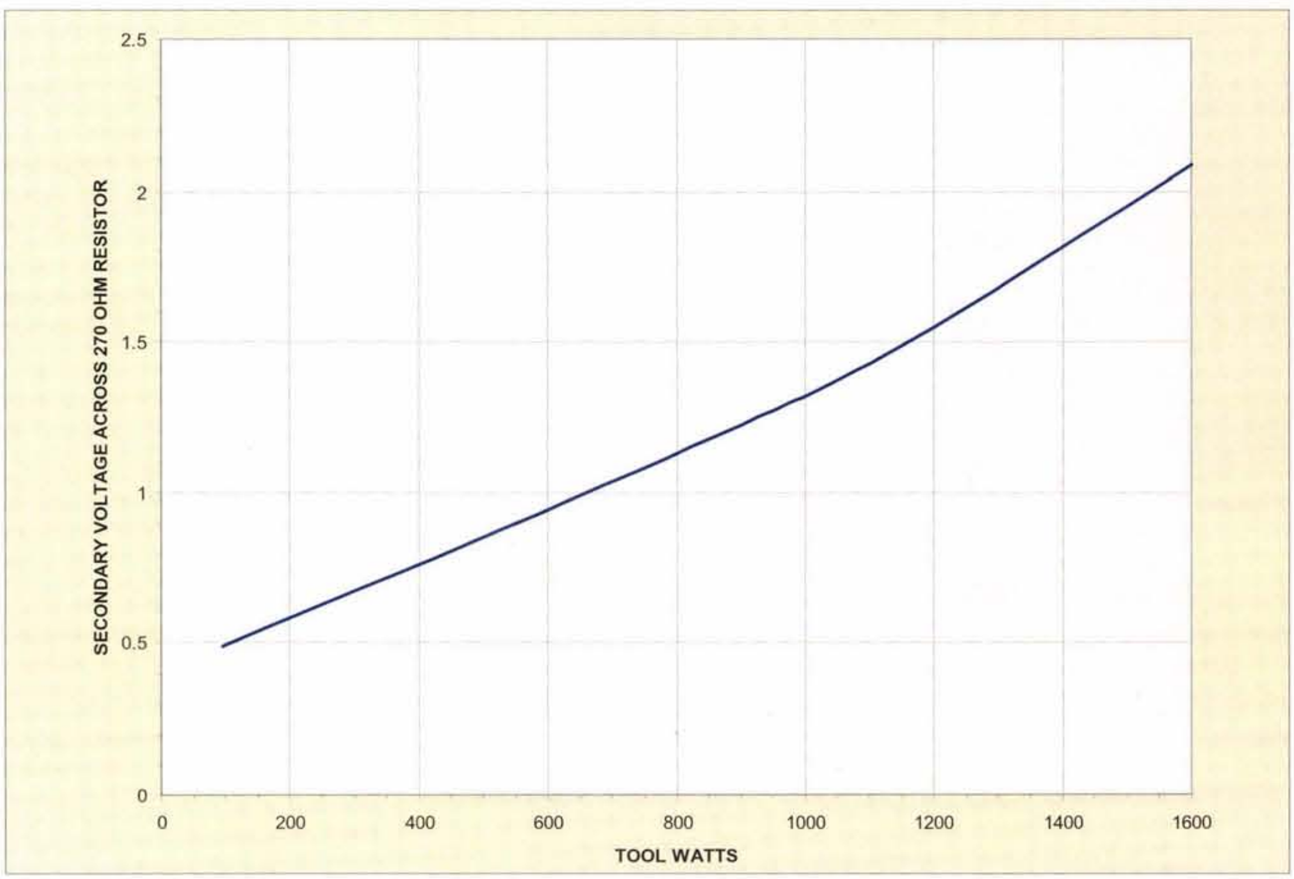


Figure 9. Sensor Calibration Graph

The first 7 messages are cycled continuously at a frequency of one message every second. Message 8 is displayed when there is a count-down in progress for starting or stopping the vacuum system. Message 9 is displayed if the vacuum shutdown countdown is stopped due to another tool being turned on.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	COMMENTS
1					L	A	N	G		&		O	B	E	R						
2	D	U	S	T	M	E	I	S	T	E	R		1	.		R	E	A	D	Y	
3	O	N		D	E	L	A	Y		=		x		S	E	C	O	N	D	S	
4	S	E	N	S	O	R		#	x		=		x	x	x						Sensors 1 and 2
5	M	A	N	U	A	L		S	W	I	T	C	H		O	F	F				Also ON
6	O	N		S	E	N	S	I	T	I	V	I	T	Y		=		x	x	x	
7	V	A	C	U	U	M		O	F	F											Also ON
8	C	O	U	N	T	D	O	W	N		9	8	7	6	5	4	3	2	1	0	
9	S	H	U	T	D	O	W	N		A	B	O	R	T	E	D	!				

Table 1. DUSTMEISTER LCD Messages

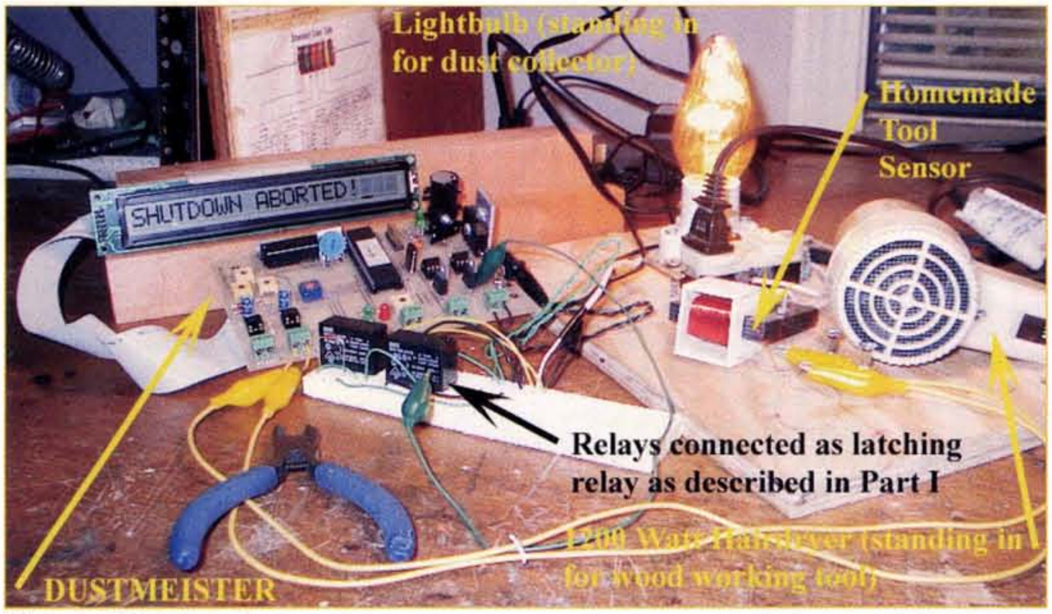


Figure 10. Final Testing of DUSTMEISTER Before Installing in Woodshop

Figure 11. Completed DUSTMEISTER Unit (Access Door Closed)

SOURCES

Source 1 Microchip MPLAB Integrated Development Environment including Assembler at http://www.microchip.com/

Source 2 DUSTMEISTER Homepage for preprogrammed PIC16F877 chips and circuit boards at www2.netdoor.com/~rlang

Source 3 Morgan State Programmer from P. H. Anderson at www.phanderson.com.

Source 4 Article on PIC programming in November 2001 *Nuts & Volts* by R. B. Lang

the sensor with several different tool loads as shown in Figure 8 with several hair dryers standing in for tools. The results are in Figure 9.

If the wire carrying the tool current is looped about the core one or more times rather than just passing though the opening, the output voltage across the 270 resistor will increase.

TESTING AND CALIBRATING THE DUSTMEISTER

Before powering up the DUSTMEISTER, check the circuit board for any copper bridges. With IC1, OK1, OK2, and the LCD connecting cable removed, power up the unit and check the 5-volt and ground connections on the IC1, OK1, OK2, and LCD connecting cable sockets. Also check the ~+12 volt DC power.

If the voltages are correct, power down the unit and install OK1 and OK2. Apply five volts to terminal 2 of OK1 and 12 volts should appear at the "ON" relay screw terminals and the green "ON" LED should light. Repeat the process with pin 2 of OK2 and 12 volts should appear at the "OFF" relay screw terminals and the red "OFF" LED should light. Next, check the voltages at the output of the BCD switch, S2. Remember, the output of this switch is the compliment, so setting the switch to 0 should cause all four outputs to be high. Also, when testing the switch, note that the four horizontal traces on the top of the board near the switch are in the order 1,8,4,2 from top to bottom. Finally, shut down the unit and install IC1 and the LCD display.

Begin the testing and calibration of the DUSTMEISTER by setting the sensitivity control, R25, and the sensor gain controls, R5 and R8, to mid range. When the DUSTMEISTER is powered up, the display will cycle through the messages shown in Table 1. Adjust R10 (the LCD contrast) and R9 (the LCD brightness) for the best LCD display. The ON/OFF delay is controlled by setting switch S2 from 0 to 9 seconds. Two times the start delay time is used when turning the vacuum system off after the last tool is turned off.

If a sensor reading is greater than the SENSITIVITY reading controlled by R25, then the vacuum system will be turned on after the display counts down from the delay value. If all the sensor readings are less than the SENSITIVITY, then the vacuum system will be turned off after the display counts down from the delay value. The display sequence continues while the DUSTMEISTER is powered up. The display sequence requires between 60 and 800 mAmp at 12 volts AC depending on the setting of the LCD brightness control.

You are now ready to connect the DUSTMEISTER to the relays. Two wires connect from the ON relay terminal on the DUSTMEISTER to the coil of the normally open relay. Likewise, two wires connect from the OFF terminal relay terminal on the DUSTMEISTER to the coil of the normally closed relay. The ON relay normally open terminals are connected in parallel to the momentary contact manual ON switch on the motor controller. The OFF relay normally closed terminals are connected in series with the momentary contact manual OFF switch on the motor controller. If you are not using a motor controller, the DUSTMEISTER relays should be wired in a latching configuration as described in Part I. Figure 10 shows the final testing set-up using a latched relay set-up before moving into the woodshop for final installation.

In the workshop, the current sensors are connected to the current sensor terminals on the DUSTMEISTER. Up to two current sensors can be used. Each current sensor can handle several tools. The last connection is the DUSTMEISTER test switch that is just a normally open switch that can be used to test the DUSTMEISTER.

Turn on the manual switch and the ON relay should close for one second after the countdown is done. The green LED will confirm this. The manual switch should be turned off and the OFF countdown will begin. The off coundown is 1/2 as fast as the ON countdown. When 0 is reached, the OFF relay should open for two seconds which is confirmed by the red LED.

Now turn on all tools that have a power lead going through current sensor #1. As the messages are displayed, the reading for current sensor #1 should be non zero. If it is at the maximum (255), reduce the 20k ohm gain control, R8, for sensor #1, until a desired reading is accomplished. In my case, I was running a planer, bandsaw, and shaper through sensor #1 and adjusted R8 until I had a reading of 220 for sensor #1. If the ON relay turns on after the countdown, this is fine. Repeat the process with sensor #2. Do not change R5 and R8 gain settings from here on. Now turn on only the tool that uses the least current that has a power lead going through current sensor #1. In my case, it was the bandsaw which gave a sensor #1 reading of 27.

When the tool is turned on, there is a current surge and then the sensor reading settles down to a steady state reading. All settings are based on this steady state reading, otherwise it is possible to set the sensitivity so that the dust collector will turn on based on the surge current and immediately turn off when the steady state current is reached.

If the ON relay turns on, this is fine. If it does not, then adjust the sensitivity control, R25, down until the ON relay turns on the dust collector and does not turn off when the steady state current is reached. In my case, I set the sensitivity control to 15. Repeat the process for the minimum current tool on sensor #2 if you are using a second sensor. Now your DUSTMEISTER is calibrated and will turn the vacuum/dust collector system on whenever any of your sensed tools are turned on and will keep the dust collector on when the tools are operating at minimum current.

FUTURE EXPANDABILITY

During the design of the DUSTMEISTER, I had several ideas that I thought would make the DUSTMEISTER even more useful. While these ideas did not make it into this design, the hardware interface for future expansion is incorporated into this design. The expansion interface makes ground, +5 volts, +12 volts, PICMICRO digital I/O pins RE3 and RC0-7, and analog inputs pins, RA3 and RA5 available for future use.

One idea for future expansion is to incorporate workshop climate information into the DUSTMEISTER. Temperature and relative humidity are important in the storage of wood. Some of my wood is stored in the workshop and other wood is stored on the second floor. It would be really nice if the DUSTMEISTER could report the current temperature and relative humidity in these two locations. It would also be nice to have the maximum and minimum values of temperature and humidity.

On the Internet, I found the humidity iButton from Dallas semiconductor. This chip measures temperature and relative humidity and sends the values digitally to a microprocessor using a one-wire interface. This sounded ideal, unfortunately when I inquired about the humidity iButton evaluation kit, I was told they were no longer available and that the humidity iButton would not be available until mid-2002.

Another idea is to use the DUSTMEISTER to control a HEPA filter system in the workshop to remove ambient dust kicked up by sanders or hand sanding. HEPA is an acronym for "high efficiency particulate arresting." These air purifiers effectively remove 99.97% of all pollen, mold spores, animal hair and dander, dust mites, bacteria, smoke particles, and dust that pass though the air purifier. The idea is to use a modified smoke detector of the photoelectric or ionization type as input to the DUSTMEISTER which activates the air purifier based on the amount of dust in the air.

The DUSTMEISTER can be used outside the workshop. It can be used in a spray paint booth to start and stop ventilation whenever spray paint equipment is operating. You can probably think of other features you would like in your workshop. Remember that the PIC16F877 microprocessor can be re-programmed at any time to add more features.

MASTERING THE DUST COLLECTOR

Figure 11 show the completed "intelligent" vacuum controller installed in a protective metal box. The DUSTMEISTER controls a shop-wide dust collector system by sensing when woodworking tools are turned on or off. The system automatically starts and stops the vacuum system based on tools running. The system intelligently avoids cycling the dust collector system unnecessarily by keeping track of situations when one tool is turned off and another is turned on after a short time. The system keeps the woodworker informed of system status with simple, easy to understand English messages. The system is expandable, limited only by your own imagination. Finally, after these many years, I am no longer a servant to my dust collector, but my dust collector is an obedient servant to my woodworking tools. And as for dust bunnies, they don't hang around my workshop any more. **NV**

by Stanley York

Laser Insight

In last month's issue, we began to look at the pulsed laser. The pulsed laser was the first type to be demonstrated back in 1960, and back then, it was a Cr:Ruby laser. Not many other materials were thought possible to use as lasing mediums, and it wasn't certain that ruby would be as cooperative as it was. Cr:Ruby has a fairly high lasing threshold, and must be pumped quite hard to make it lase at all. The ruby laser is still in use today, and has found a niche in the medical industry, where its main uses are for cosmetic surgery; hair removal, tattoo removal, and birthmark or skin blemish removal being the most common uses. But there are many other types of pulsed lasers, and I will briefly describe a few of them in forthcoming issues.

This month though, I want to start to put together a simple pulsed gas laser that you can build from stuff you may have in your garage already. If you are like me, and never throw away anything even remotely (or potentially) useful, then you're likely to have everything you need. If you don't have some of the items required, I'm pretty sure you can either scrounge something, or else find another way to make this laser work. But before we go any further, a few words of warning are required.

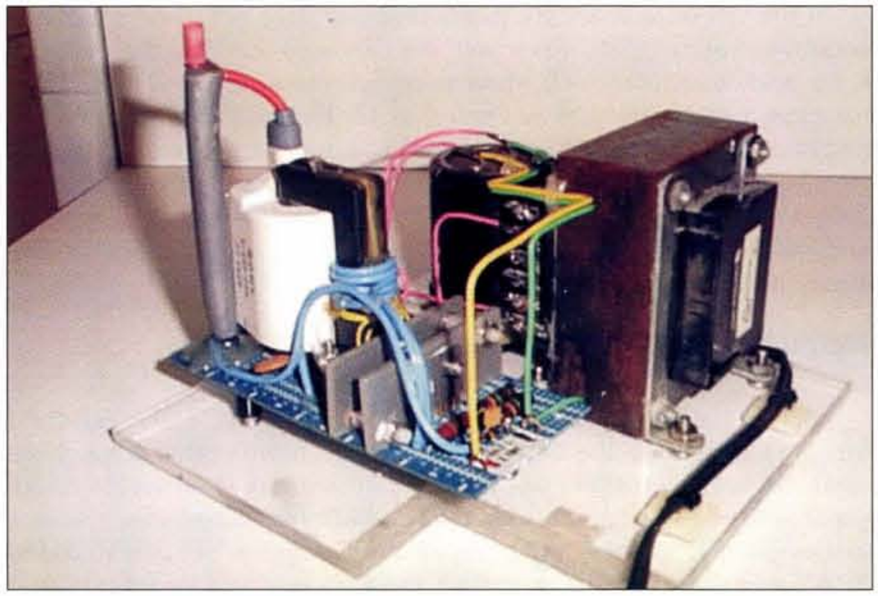
DANGER! DANGER! DANGER!

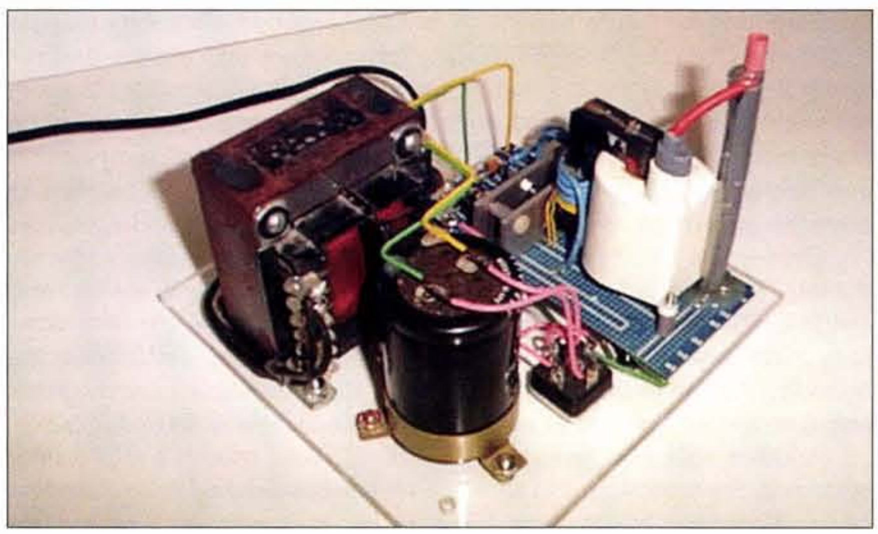
The laser about to be described should not be constructed by anyone unfamiliar with safe, high voltage working procedures.

The laser to be described below is experimental and dangerous! There have been many designs similar to this, and most of them have reported some measure of success. But the laser does require some careful adjustments and a good deal of insight to make it work reliably, or even at all!

We will also be working with dangerously high voltages, so if you are not familiar with the precautions required when dealing with high voltages, then perhaps this article is not for you. The charged capacitor used to fire the laser can discharge in the pump chamber in about 5-6 nSec. If you calculate the peak power of the pulse, it is in the order of 100 megawatts or more, and it has a kick like two mules. Therefore, it will give you a very nasty shock if you are not careful. So if you decide to build this laser, PLEASE be very careful, and remember, if you show it to anyone, keep them away from the assembly altogether, especially your younger audience. YOU are supposed to know what you are doing and what parts you can safely touch. THEY do not.

So again, if you are not comfortable yet with high voltage working procedures, then perhaps you should save this article until you get more experienced. The power supply is dangerous, and you will be working at your own risk, so be careful, this cannot be emphasized enough!! This is not a plaything, the charged capacitor is lethal!! Neither myself nor this magazine can be held responsible for any injuries! 'Nuff said, let's go on.





The power supply

Figure 11-1 shows the schematic for the high voltage power supply for this project. To drive the laser, we have to provide a high voltage to excite gas molecules at normal atmospheric pressure. A low voltage power supply consisting of T1, D1-D4, and C1 provides the high voltage inverter with approximately 9VDC at about 3A. I used a transformer with a center tap, so hat I could have two power levels for the laser.

When power is first applied, one of the transistors (say Q1) will conduct a little harder than the other, resulting in an inbalance in the circuit. The feedback winding is connected in the proper phase to reinforce the base current to that transistor. As the current in the windings increases, the drive voltage to that transistor base will also increase, turning the transistor hard on, while at the same time forcing Q2 off. The collector current will thus increase until the core becomes saturated, and the flux in the magnetic circuit no longer increases. Thus, the spread of magnetic influence stops, the base drive reduces to the current delivered by R1 alone, and the magnetic field begins to collapse. The collapse induces a voltage in the reverse sense, and causes a drive signal to appear at the base of Q2, turning it on. The drive signal from the feedback winding is again correctly phased to reinforce the base drive current, forcing Q2 hard on and Q1 hard off. When the magnetic flux reaches saturation level, the magnetic field again collapses, and repeats the cycle as long as power is applied.

The same magnetic flux is also coupled to the high voltage winding of the transformer, where it induces a high voltage in this winding. Inside the transformer molding there is usually a high voltage rectifier, or sometimes a voltage doubler or tripler circuit, that rectifies the resultant high voltage. It is shown as D5 in the schematic for explanation only.

Flyback transformer modification

The DC voltage provided by the low voltage supply is passed to the inverter section where it is stepped up by the TV flyback transformer T2. If you have an old color TV or computer monitor, and you are sure the flyback is okay, you should be able to produce close to 20,000 volts with 9VDC input to the inverter. If your flyback has a bad winding on it, you'd better discard it and find another one, or you could have problems later on. Usually, the high voltage rectifier, shown as D5 in the drawing, is contained within the transformer molding, and is not required externally. It is only shown here for clarity. To make the power supply, begin by getting a length of #12-16 insulated

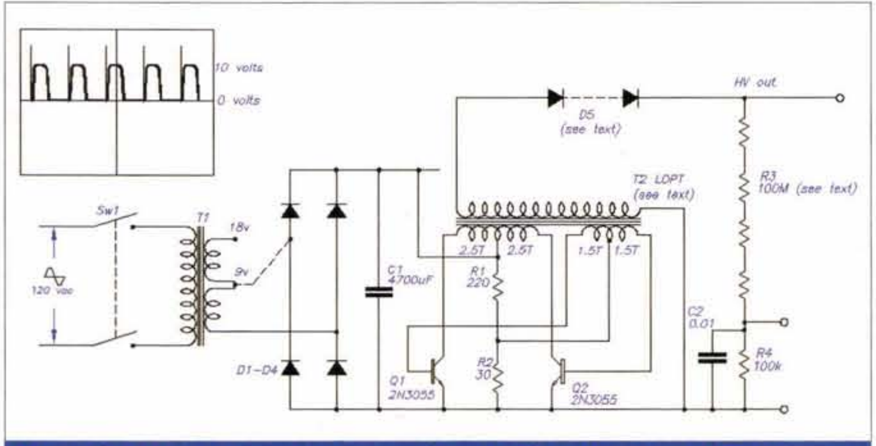


Figure 11-1. A simple power supply made from an old TV transformer is all that is needed to drive this laser. In spite of its simplicity, this supply can produce over 30,000 volts. So be careful with the HV wiring.

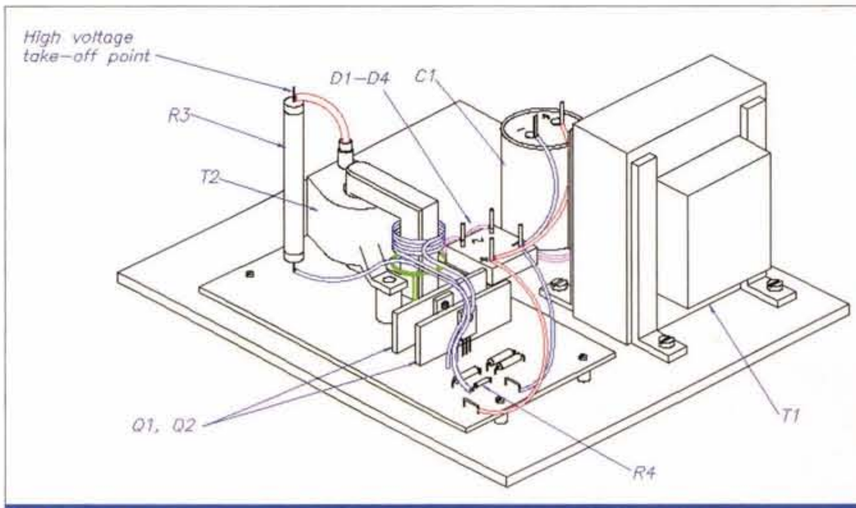


Figure 11-2. This drawing shows the final layout of the high voltage power supply used in this project. Remember to apply a generous coating of hot-melt glue or silicon sealer on all high voltage connection points.

flexible wire and wind about 8-10 turns around the exposed section of ferrite core of the flyback, and bring out a connection at the center tap. This will be the primary winding of the new transformer. Get a length of smaller flexible wire (#18-24) and wind on about 6-8 turns, again bringing out the center tap. This will be the feedback winding.

Construction of the circuit couldn't be much easier. Lay out the components for the high voltage section on a piece of perfboard, and use point-to-point wiring on the underside. Mount the transistors to heatsinks, because they will get warm, depending on how long you run the supply. I mounted my transistors on separate heatsinks to give maximum heat transfer. Leave the new primary winding wires, and the feedback wires a little long until correct operation has been established, and output voltage optimized. For convenience, mount the high voltage assembly, and the low voltage power supply on a common plate. This makes it easier to carry around. Component lay-out is not critical, and a suggested lay-out is shown in Figure 11-2.

Optimizing the power supply output

When you start the power supply, you will find that you will not be able to make accurate measurements of the high voltage output. There are not many multimeters or digital voltmeters — for home use anyway — that can measure much above 1000VDC, so we have to fool it somehow.

What I did on my system was to connect a 100 Mohm resistor, R3 (high voltage of course, about four inches long), to the output terminal, and connect a 100 Kohm resistor R4, in series with it, and terminate the 100K to the common line. The voltage at the junction of the two resistors would then be 1/1000th of the output voltage (ignoring the small loading effects of the DVM). With a small capacitor across the 100K to filter out the spiking, the voltage reading at this point is fairly representative of the output voltage of the supply. It is not perfectly accurate, but we only need a ball-park figure to find the highest output. You will also need to find the return side of the high voltage winding, and what I did was monitor the output voltage as suggested above, and use a couple of clip leads and a 1K resistor to jumper each vacant pin on the transformer to the negative side of the power supply (see below). You cannot use a DVM or ohmmeter to find the return line because of the presence of the high voltage diodes in the output circuit. The use of a 1K resistor between windings during this test prevents the oscillator from stalling if, for instance, you short-circuit across a winding. A 1K resistor in the high voltage has little effect.

When you finish building the supply, turn it on while monitoring the output across the 100K resistor, and jumping out the vacant pins on the transformer (always turn the power off between tests, otherwise you may be in for a nasty surprise). When you find the return pin, you should get something around 3-5 volts across R4, corresponding to 3-5 kilovolts output from the transformer (remember, the scale is 1000:1). Begin optimizing by removing one turn from

Parts list for the power supply

R1	220 1W
R2	30 1W
R3	100M high voltage resistor, or a chain of 10M high voltage resistors
R4	100K 1/2W
R5	100M high voltage resistor, or a chain of 10M high voltage resistors
C1	4700uF 35V
C2	0.01uF 50V
Q1, Q2	2N3055 or equivalent NPN power transistor, plus heatsinks
D1-D4	50PIV 3A diodes or equivalent bridge rectifier
T1	9-0-9 V/3A power transformer
T2	TV flyback transformer SONY 1-439-254-12 or equivalent
Sw1	DPST toggle switch

each side of the primary winding. Don't cut the wire yet, until you see an improvement in output.

As the turns ratio increases, you will see a corresponding increase in output voltage. Removing turns from the feedback winding will also change the output, but not so dramatically as the primary windings. Let the supply run for about 30 seconds at a time until you feel comfortable with the operation. The transistors will run a little warm, which is normal. Finish optimizing the output by trying to get the highest voltage consistent with the lowest input current and lowest operating temperature for the transistors. If you get to a point where you can see about 18K volts with 9VDC input, then this is about right. On my unit, I was getting close to 19K volts at 9.6 volts DC input. When it was run on 18 volts DC, I got over 33K volts! I didn't run it for long though because the transistors started to get hot. If you have an oscilloscope, monitor the transistor collectors. You should get a waveform similar to the one shown in the inset in Figure 11-1. The frequency was about 75KHz.

Again, I feel I must impress upon you the dangers of high voltage, especially when you start charging capacitors. During the optimization of my unit, I did receive a jolt from a series of small capacitors (0.001uF each) that I had strung across the R3. I was a little too hasty to make changes, and overlooked these small caps. I received an estimated 2-3 KV discharge into my left hand. It felt like a static shock that you get after walking across a synthetic fiber carpet and touching a doorknob on a cold, low humidity day. Not serious, but it sure makes you realize what you're dealing with. So please be careful. It's not so much the shock that hurts, but your reaction to it, and what may happen as a result of your reaction.

When you are satisfied with the working of the assembly, solder a banana socket to the top of the 100M resistor to act as a connection point. Cover the socket with heat-shrink sleeving. Tidy up the wiring on the reverse side of the power supply, bundle up and secure all cables with hot-melt glue. Finally, cover all the high voltage points with heat-shrink sleeving, cable insulation, and silicon sealer or hot melt glue to prevent you from accidentally touching any hot spots before they are discharged.

Until next time, you can amuse yourself by flattening a piece of copper wire, and making a small indent in the middle. With the indent face down, bend about 1/4" of the end of the wire at right angles to form an elongated Z. Solder a pin into a banana plug and place it in the socket on the high voltage supply. Carefully balance the wire on the pin and turn on the power supply. The piece of wire will start spinning at a very fast rate due to ion propulsion off the bent ends. If your balancing is not so good, the wire will go flying off the pin, so watch out in case it throws itself into your power supply!! **NV**

As always, if you have any questions or comments about this column, about optics, or lasers in general, or if you have ideas for projects, please contact me either through this magazine, or directly by email at: **stanley.york@att.net**

Build a 418 MHz Wireless Remote Control

By Anthony Caristi

UHF operation is superior over infrared since it is effective over much larger distances, and can pass through solid objects. The wireless remote control described in this project is an RF device, which operates at 418 MHz in the UHF band.

You have seen wireless remote controls everywhere: TV and VCR controls, wireless key entry on vehicles, some appliances such as air conditioners, and even your electric blanket. TV and home entertainment controls work by using an encoded beam of infrared light, while vehicular remote keyless entry operates on one of the unlicensed UHF bands provided for this service. UHF operation is superior over infrared since it is effective over much larger distances, and can pass through solid objects.

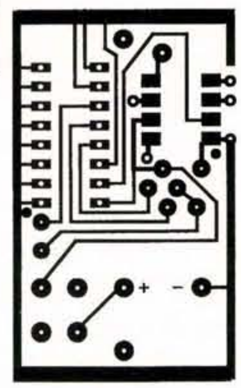
The wireless remote control described in this project is an RF device, which operates at 418 MHz in the UHF band. It meets FCC requirements for unlicensed devices since the transmitter (and receiver) module has already been given approval for this type of service. No RF expertise is required to construct this circuit. These low-cost RF modules are readily available from electronics parts distributors.

This project has been designed to illustrate one application of remote control: how you will be able to turn on and off any lights in or around your home as you arrive or leave during darkness. Any other application is easily implemented, since the receiver circuit employs an electromechanical relay with uncommitted contacts. The number of applications for this project is limited only by your imagination.

The transmitter is a tiny hand-held module, similar to that used for vehicular keyless entry. The receiver, powered by a wall transformer, is placed in the home (or any other location) where it will be able to control lights or any other electrically-operated device. The receiver may also be operated by a vehicular 12-volt DC power source or a portable battery. This feature opens up a multitude of uses for this remote control system.

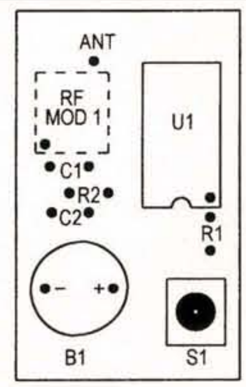
The transmitter and receiver are each encoded to the same nine-bit digital address. Using trinary data (0, 1, or open circuit), 19,683 different codes are possible. This virtually precludes anyone from being able to operate your system with an unauthorized transmitter.

Figure 1



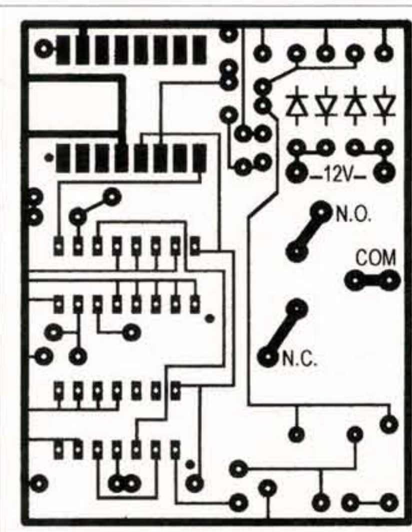
Printed layout of the transmitter board shown full size as seen from the bottom of the board.

Figure 2



Parts placement of the transmitter board. Note battery polarity. The RF module is placed on the opposite side.

Figure 3



Printed layout of the receiver board shown full size as seen from the copper side.

ENCODING AND DECODING SYSTEM

A digitally-controlled remote control system is useful and reliable only when the modulated radio frequency carrier is encoded with a unique address that can be recognized by a receiver that is similarly encoded. This type of modulation — sometimes called on/off keying (OOK) or amplitude shift keying (ASK) — uses a high amplitude carrier level for 1s, and a low level for zeros. Encoding the transmission prevents unauthorized and spurious operation.

The encoder, U1, and decoder, U2, are each hard-wired for a unique address as selected by the builder. If more than one remote control system is desired, it is a simple matter to use different addresses for each. In this way, there would be no interference between systems. U1 contains nine address bits that can be wired to ground, Vdd, or left open. When the circuit operates, a U1 generates a positive-going pulse train that contains the address information. This is used to modulate the RF transmitter module.

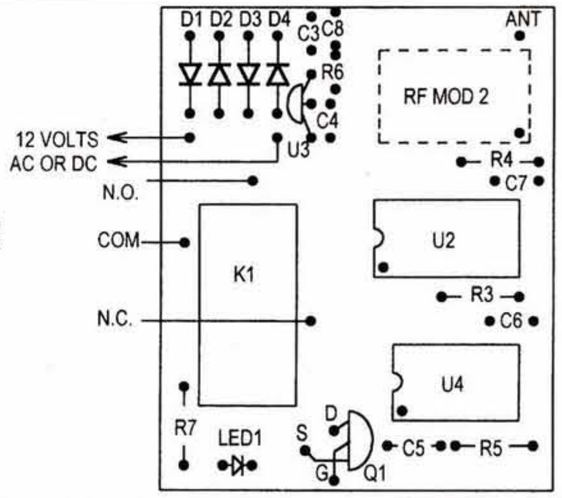
The decoder chip in the receiver, U2, also contains nine input terminals which are wired for the same address word as the transmitter. When the encoded pulse train is presented to the data input terminal of U2, the address is checked twice. If two successive transmitted pulse trains contain the correct address, the valid output terminal, pin 11, goes high and remains so as long as the transmitter is operating.

THE TRANSMITTER CIRCUIT

Refer to the schematic diagram for the transmitter. A single lithium coin cell, with a nominal voltage of 3.3 volts, powers the circuit through the transmit switch S1. Since the cell is called upon to deliver current for very short intervals whenever remote control operation is desired, battery life will be extremely long.

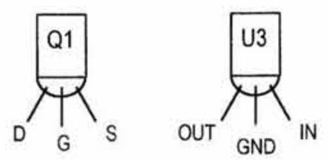
U1 is the digital encoder chip that provides the modulating pulse train. Pins number 1 through 7, plus 9 and 10, are the address input terminals A1 through A9. Although the printed circuit layout for the transmitter is designed with all address inputs connected to circuit common

Figure 4



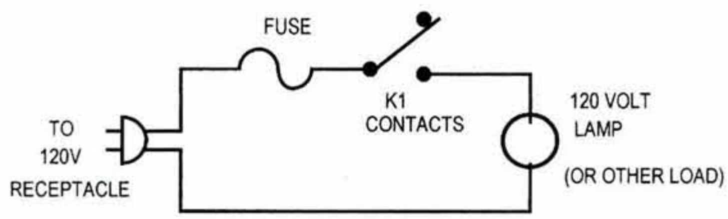
Parts placement of the receiver board. The RF module is soldered to the opposite side. Note the connections to the relay contacts and power input pads.

Figure 5



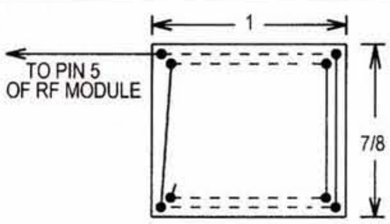
Terminal identification of Q1 and U3.

Figure 6



Typical lamp control circuit. CAUTION: This circuit utilizes high voltages. Be sure to use proper wire size and insulation.

Figure 7



Loop style antenna fits in compact space.

for an address of 000000000, the builder has the option of using any other of the 19,682 addresses available. This is accomplished by cutting the foil pattern to any or all address terminals, as desired. Then leave them open circuit or connect any or all to Vdd (pin 16). Remember, the corresponding receiver address input terminals must match those of the transmitter.

Timing components R1, R2, and C2 provide an encoded pulse train that has a pulse repetition frequency (PRF) of about 20 per second. When power is applied to the circuit, pin 15 of U1 drives the data input terminal of the RF module (pin 2), causing it to generate a train of 418 MHz pulses in accordance with the encoded address. The data pulse train continues to be generated as long as the power switch is held down. A typical transmission might take only one-half second, which allows several pulse trains to be generated.

The output of the RF module, pin 5, is connected to a short wire that acts as the antenna. The RF pulses are thus transmitted to any receiver which may be within the operating range of the system. This could be 300 feet or more, depending upon the antenna and line-of-sight transmission distance.

THE REMOTE CONTROL RECEIVER

Refer to the schematic diagram of the receiver. Since the receiver will most likely be located near the light (or other device) that is to be remotely controlled, a wall transformer is used to power the circuit. The AC output voltage of the transformer, about 12 volts, is fed to a full wave bridge that charges C3 up to about 16 volts DC. A linear regulator chip, U3, provides five volts to operate the circuit.

For vehicular or portable use, the receiver may be operated from the 12-volt DC power of the vehicle, or a separate battery. Current draw of the circuit is about 50 milliamperes, mostly for the relay coil.

A short wire antenna feeds the RF input of the receiver module, pin 16. The receiver circuit utilizes a single conversion superheterodyne design that incorporates a surface acoustic wave (SAW) resonator and ceramic filters for frequency accuracy and stability. The RF pulses are detected and appear at the data output terminal, pin 8. The recovered data, as sent by the transmitter, is fed to decoder U2 pin 9. This chip has nine address terminals, which must be wired exactly in accordance with the hardwired address of U1 in the transmitter.

Decoder U2 examines each pulse train individually. When two successive pulse trains contain the correct address, the valid data output terminal, pin 11, goes high. It remains so until the transmitter is turned off or an invalid transmission is received.

In order to accomplish two functions (ON and OFF) for the device under remote control, JK flip-flop U4 is utilized as a latch. The valid output data terminal of U2 feeds the clock input terminal of U4. Each time the transmit switch is pressed and released, the rising edge of the valid data pulse transfers the logic level of U4 pin 2 to pin 1. Thus, the first valid transmission will generate a logic level 1 at pin 1 of U4, and the next transmission will cause it to revert back to zero. In this way, the transmitter will toggle U4 pin 1 to the desired state.

The output terminal of U4 is fed to the gate of MOSFET transistor Q1. This, in turn, controls current through the coil of relay K1. The contacts of K1 are hardwired as desired to operate the device under control. In the circuit of Figure 6, a lamp control is illustrated.

In order to provide visual assurance that the receiver is operating in response to the transmitter, LED1 is connected across the relay coil and indicates when the relay is activated.

TRANSMITTER ASSEMBLY

Figure 1 illustrates the printed layout of the transmitter PC board, shown full size as seen from the bottom. The top of the board is solid copper, which acts as a ground plane. Round cut-outs must be manually cut into the copper to allow clearance between the ground plane and all non-grounded leads of the through-hole components. An etched and drilled board for both transmitter and receiver is available from the source indicated in the Parts List.

Before beginning assembly of the board, refer to the schematic diagram and use a small drill bit, such as 3/16 inch in diameter, to manually remove copper in a small circle around each hole in the ground plane that will contain a non-grounded wire lead. This is necessary so that such leads do not contact the ground plane, and short out. Be sure to clear any holes that might be used for address terminals of U1 that will be left open circuit, or connected to Vdd potential. When done, remove any burrs left over from the clearing operation.

The first component that should be mounted to the board is the RF transmitting module. This is a surface-mounted component that is soldered to the bottom of the board. Use the following procedure:

1. Gently clean the PC board using a steel wool pad. Be sure there are no contaminants, opens, or short circuits at or near the printed wiring. Rinse and dry the board thoroughly.

2. Locate pin 1 of the RF transmitting module, and that of the corresponding foil pad as indicated by a small dot.

3. Place the module in position, directly over and centered along the foil pattern.

4. Using a low-powered pointed soldering iron tip, carefully apply heat and solder between pin 1 of the module and the foil pad. Allow the melted solder to wick underneath the module, ensuring a good connection. CAUTION: Do not use too much heat or too much solder; to do so may cause the foil to lift off the board or damage the RF module.

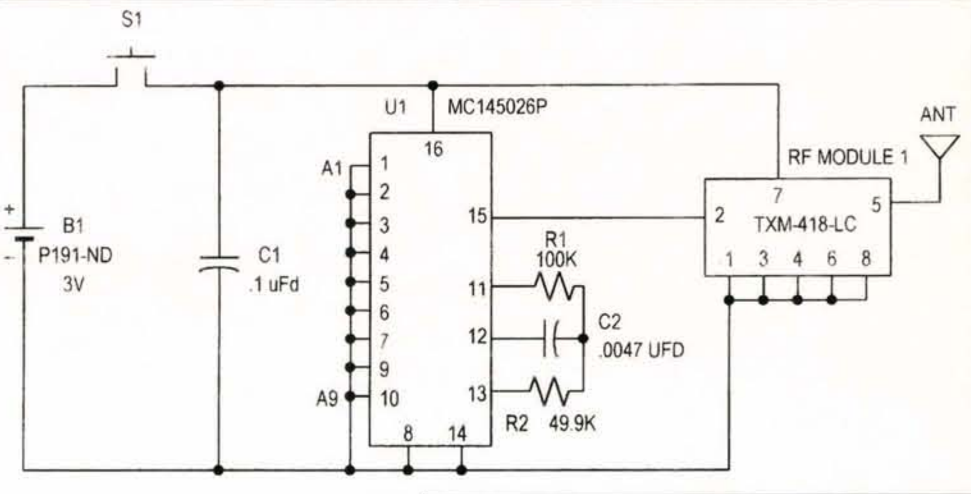
5. Examine the module to be sure that all terminals are in the proper position over the pads. If not, repeat step 4.

6. Solder the remaining terminals of the module as described in step 4.

7. Examine the assembly very carefully to be sure that all connections are solid, and there are no short circuits between adjacent foil pads.

Once the RF module is soldered in place, pass thin solid wire through the holes adjacent to terminals 1, 3, 4, 6, and 8, and solder on both sides of the board to effectively connect these terminals to the ground plane. Cut any excess wire on both sides of the board.

All remaining thru-hole components (except the battery) may be inserted in the board and soldered in place as indicated in Figure 2. Be sure to observe the orientation of U1. An error here will result in an inoperative circuit and possible damage to the RF module and U1. The battery will be installed later, during check-out of the transmitter.



REMOTE CONTROL TRANSMITTER

For the initial test of the transmitter, use a straight piece of solid wire 6-1/2 inches long. Solder it to the pad adjacent to pin 5 of the RF module, and orient the wire right angles to the ground plane of the PC board. A permanent antenna will be installed later, as described below in the section concerning transmitting and receiving antennas. When finished assembling and wiring the transmitter, check it carefully for any possible errors. It is easier to correct mistakes now rather than later on if you discover that your transmitter does not work.

A small enclosure may be used to house the printed circuit board after transmitter test. One such option is specified in the Parts List. A suitably-sized hole should be drilled in the top of the enclosure to allow the pushbutton to protrude.

Place the transmitter aside while working on the receiver.

TRANSMITTER PARTS LIST

B1 Lithium 3.3-volt coin cell, Digi-Key P191-ND or equivalent
C1 0.1 uFd 50-volt ceramic disc capacitor
C2 0.0047 uFd 50-volt mylar or polyester capacitor
R1 100K 1/4-watt 1% metal film resistor
R2 49.9K 1/4-watt 1% metal film resistor
RF Module 1 Linx TXM-418-LC
S1 SPST push-button switch, Digi-Key P8012S-ND or similar
U1 Encoder, Motorola MC145026P
Enclosure Polycase P/N FB-30T0 or similar
Wire antenna (see text)

RECEIVER PARTS LIST

C3 47 uFd 25-volt radial electrolytic capacitor
C4, C5, C7 0.1 uFd 50-volt ceramic disc capacitor
C6 0.022 uFd 50-volt mylar or polyester capacitor
D1, D2, D3, D4 1N4004 or similar silicon diode
K1 12-volt SPST relay, Digi-Key 255-1114-ND or similar
LED1 Light emitting diode, general purpose
Q1 N channel MOSFET, BS170
R3 42.2K 1/4-watt 1% metal film resistor
R4 221K 1/4-watt 1% metal film resistor
R5 470K 1/4-watt carbon resistor
R6 200 ohm 1/4-watt carbon resistor
R7 2.2K 1/4-watt carbon resistor
RF Module 2 Linx RXM-418-LC-S
U2 Decoder, Motorola MC145028P
U3 5-volt linear regulator, 78L05
U4 JK Flip-Flop, CD4013BE
T1 12.6-volt step-down transformer, Digi-Key T601-ND or similar
Misc: Enclosure, hook-up wire, antenna (see text)

SOURCES OF SUPPLY

Digi-Key 1-800-344-3439; www.digikey.com
Mouser 1-800-346-6873; www.mouser.com
Polycase 1-800-248-1233; www polycase.com

Note: The following parts are available from **A. Caristi, 69 White Pond Road, Waldwick, NJ 07463.** Set of two etched and drilled PC boards @ $19.75. U1 @ $5.50, U2 @ $5.50, U3 @ $2.50, U4 @ $2.50. Transmitter RF module @ $11.95, Receiver RF module @ $19.95. Transmitter enclosure @ $7.50. Please add $6.00 postage/handling.

RECEIVER ASSEMBLY

Refer to Figures 3 and 4, the printed layout and parts location for the receiver board. Figures 4 and 5 illustrate the orientation and terminal identification of Q1 and U3. Carefully solder all components — except the RF module — in place. Sockets may be used for the integrated circuits, if desired. Be sure all polarized components are properly positioned as indicated in Figure 4. Any part placed backwards in the circuit will render the receiver inoperable, and may cause damage to components.

The single pole double throw (SPDT) contacts of the relay are connected to pads on the foil pattern that are not dedicated to any part of the circuit. It is up to the builder to wire these pads in accordance with the desired circuit that is to be controlled. Figure 6 illustrates a simple lamp control circuit. The suggested relay contacts are able to handle up to 10 amperes in a 120-volt AC circuit. IMPORTANT: The foil pattern is able to carry only about an ampere or so. If the load circuit draws more than this, use 18 gauge wire and solder directly to the terminals of the relay. It is recommended that a fuse be installed in the circuit for protection against accidental short circuits.

The circuit is powered by a source of 12-volts AC, derived from a step-down transformer. Load current for the circuit is about 50 milliamperes when the relay coil is activated. The Parts List illustrates one possible wall type transformer that can be used. A power switch may be included in the circuit, if desired.

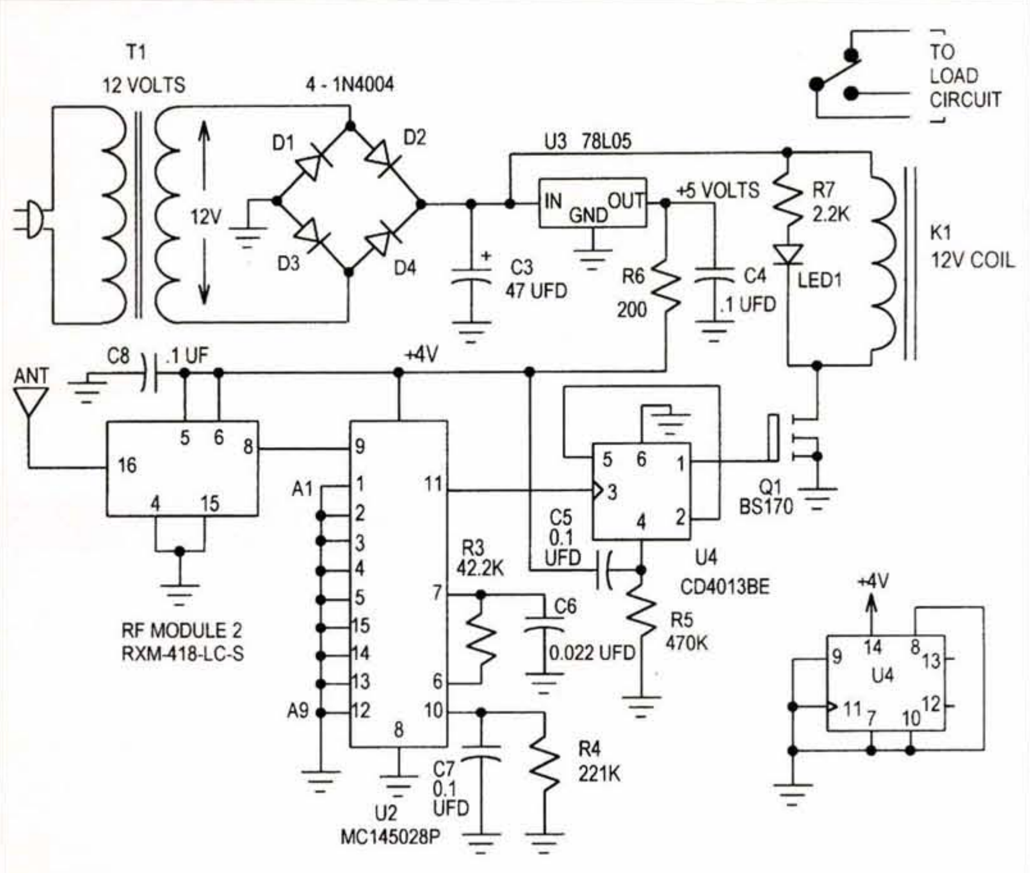
If it is desired to power the receiver from a 12-volt DC source, it may be done so by using the same PC pads as for AC, without regard to polarity. Alternatively, the diode bridge may be deleted from the circuit and the positive lead of the DC power source connected to the positive side of C3. The negative side of the supply would then be connected to circuit common.

The receiver circuit board may be installed in a suitably-sized plastic enclosure. If desired, the LED may be mounted to the outside of the enclosure so that it is readily visible. The antenna can be composed of a six-inch length of stiff wire connected to pin 5 of the RF module. Refer to the section below, concerning antennas, which may be used for both transmitter and receiver.

When finished assembling and wiring the receiver, check it thoroughly for proper wiring and components. Correct any problems now. Place the receiver aside until the check-out procedure is performed later. The RF module will be installed at that time.

ANTENNAS

The performance of this remote control system depends largely on the type of antenna that is used both in the transmitter and in the receiver. Best results are obtained when the antenna is "tuned' to the fre-



REMOTE CONTROL RECEIVER

quency of operation, so that it will emit or receive maximum RF energy.

One type of antenna that is commonly used is the quarter wave whip, or ground plane antenna. Using an accepted formula for wavelength at 418 MHz, a quarter wavelength antenna would be 6.7 inches long. It would usually be no problem to outfit the receiver with an antenna of this length. However, the transmitter is constructed in compact form and such an antenna length is not practical.

One type of antenna that will fit into a compact space is the loop style. Refer to Figure 7. Such an antenna is easily constructed by taking a 7/8 inch by one inch piece of stiff paper, and punching two holes in each corner with a needle. Then take a 6-1/2 inch piece of #22 enamel wire and weave it into the paper, as shown. Connect one end of the wire to the antenna pad on the PC board. Then place the coiled antenna in the space next to the RF module on the printed layout side of the board. Make sure the cut end of the wire does not short out to any part of the circuit. Remember, using a compact antenna as described will not allow as much operating range as that of a quarter wave whip antenna. The builder can experiment with different antenna styles to determine the practical operating range as compared to the performance of the quarter wave whip.

TRANSMITTER CHECK-OUT

The transmitter must be checked first so that it may be used for receiver testing. Examine the transmitter assembly carefully for opens, shorts, and bad solder connections. Pay attention to all non-grounded leads (especially the positive battery terminal) that pass through the ground plane, to be sure there is sufficient clearance. Any solder joint that is not shiny and smooth is suspect. Correct by removing the solder with braid and applying new solder. It is much easier to correct assembly problems now rather than later on if you discover that your remote control system does not work.

Before installing the battery into the transmitter board, use an ohmmeter to measure the resistance between pin 16 of U1 and circuit common. Normal reading will be essentially open circuit. If a low-resistance reading is obtained, examine the assembly very carefully to locate and correct any possible fault. When you are satisfied that the circuit is properly assembled, insert the battery into the pads provided for this part and solder it in place. Be sure to observe proper polarity as indicated in Figure 2. Use a DC voltmeter to be sure.

If desired, an oscilloscope may be used to verify the presence of the transmitting pulse train that appears at pin 15 of U1 when S1 is activated and held down. Normal indication is a train of pulses with a pulse repetition rate (PRF) of about 20 per second. If no waveform is present, check battery voltage and polarity. Check the orientation of U1, and verify that the resistors and capacitor are correct in value. If the waveform is normal, proceed with receiver checkout.

RECEIVER CHECK-OUT

Check the receiver board for shorts, opens, and bad solder connections. Correct any problems now. The first test of the receiver board is to ensure that the five-volt regulated supply is operating properly. This must be done without the RF module in place, to assure that it will not be damaged by excessive voltage,

Apply 12 volts AC or DC power to the circuit at the two foil pads as indicated in Figure 4. Measure the DC voltage — with respect to circuit common — at the positive end of C3. Normal indication is about +12 to +16 volts. Measure the DC voltage at the output terminal of U3. Normal indication is 4.75 to 5.25 volts.

If you do not obtain the correct voltage readings, disconnect power and repair the fault before proceeding. Check the orientation of C3, D1 through D4, U2, and U3. When the fault has been corrected and the five-volt regulator circuit is working properly, proceed to the installation of the RF module.

Refer to the instructions for installation of the transmitter RF module, and install the receiver module in place observing proper orientation. IMPORTANT: Solder only pins 4, 5, 6, 8, 15, and 16. All other terminals are unused and must not be soldered. When done, check the circuit for solder shorts and bad connections. Apply 12 volts AC or DC power to the circuit. The LED should be off, and the relay not energized.

Stand a few feet away from the receiver, press and hold the transmitter switch for one-half second. The LED should be illuminated, indicating that the relay is energized. Press the transmitter switch once again for one-half second. The LED should be extinguished. Repeat the test for greater and greater distance between the transmitter and receiver.

If the circuit performs as indicated, the check-out procedure is completed. If not, remove power from the receiver and visually check the board for improper components and/or improper orientation of U3, U4, LED1, and the RF module. If necessary, use an oscilloscope to verify that the data input terminal of U2, pin 9, is receiving the detected pulse train. Check that the valid data terminal of U2, pin 11, goes high when the transmitter switch is held down. Check that both transmitter and receiver are hardwired for identical addresses.

USING THE REMOTE CONTROL SYSTEM

When power is first applied to the receiver, the relay will be unenergized and the LED will be off. The transmitter switch is pressed and held for one-half second to toggle the relay and light the LED. When the transmitter switch is pressed and released again, the circuit returns to the unenergized position. This sequence may be repeated as many times as desired. Figure 6 illustrates one possible circuit that can be used to control a lamp. Any other electrical device may also be controlled providing that the total current handled by the relay contacts is less than 10 amperes.

The operating distance of the system can be as much as 300 feet when using ideal antennas, and line-of-sight range. If the RF is required to pass through objects, the distance will be shorter. A simple test of the system using a lamp as an indicator, will quickly reveal the practical operating range of the system. **NV**

Continued from Page 12

```
' Http://www.acroname.com
' Devantech SRF04 Example
'

wDist   var     word

INIT    con     0
ECHO    con     1

' CONVERSION FACTORS:
'
' The PULSIN command returns the round-trip echo time in 2us units
' which is equivalent to the one-way trip time in 1us units.
'
' distance = (echo time) / (conversion factor)
'
' use 74 for inches       (73.746us per 1 in)
' use 29 for centimeters  (29.033us per 1 cm)
'

convfac con     74      ' use inches



'-----------------------------------------
main

        gosub sr_sonar
        debug dec wDist, cr
        pause 200
        goto main

sr_sonar:

        pulsout INIT,5              ' 10us init pulse
        pulsin ECHO,1,wDist         ' measure echo time
        wDist=wDist/convfac         ' convert to inches
        pause 10
        return

sr_sonar_2:

        pulsout INIT,5              ' 10us init pulse
        output INIT                 ' dummy command (delay)
        rctime ECHO,1,wDist         ' measure echo time
        wDist=wDist/convfac         ' convert to inches
        pause 10
        return
```

Listing 1

```
'3/27/2001
'devantech SRF04 Tone Generation program
'Speaker on pin 1
'Init pin on 4
'Echo pin on 5
'Conversion factors; 74 for inches, 29 for centimeters
wdist var word
wdistold var word
sound var word
hz var word
init con 4
echo con 5
convfac con 74    'conversion factor for inches
speaker con 1

MAIN
gosub sr_sonar
'debug dec wdist, cr
freqout 1,200,sound
pause 200
goto main

SR_SONAR
pulsout init, 5       '10us init pulse
output init
rctime echo,1,wdist
wdist = wdist/convfac       'convert to inches
if wdist < 10 then object
sound = wdist * 100
pause 10
return

OBJECT
'Play this sound if an object has been detected
for Hz = 1 to 4000 step 1000
freqout speaker,70,hz,4000-hz
next
goto main
```

Listing 2

SRF04, and a speaker in Listing 2. I carried this around with me and actually tested the SRF04 detection capabilities in the real world. I was then able to point the ranger at trees, chair legs, couches, etc, and hear exactly what the ranger was doing. Methods such as this are always handy so that you can tell for yourself exactly what your robot is receiving. If you cannot understand the data output, your robot will certainly not be able to either.

Users may be curious of the speed of detection using the SRF04 and a Stamp. Using the sound driven program in Listing 2, I can pass my hand in front of the detector at a moderate rate and receive detection every time. Passing a hand in front of the detector very fast will occasionally miss detections. This is not a fault of the detector but is dependent on the Stamp and its software code. I wish to point this out so people will realize that for a small, home-based robot using a Stamp, detection speed is more than adequate. If you try to detect objects on a high-speed robot used for robot wars, you may have problems. In this case, most everyone uses assembly-based processors, and the SRF04 will perform nicely. Design parameters listed are always nice, I have, however, attempted here to give a real world example of the detection capability. I wish to give credit to Acroname for the use of their photographs, schematics, and beam patterns. Acroname is a good company to deal with. I believe they enjoy using their products as much as selling them. If you are looking for a simple-to-use, yet highly effective sensor, try the DEVANTECH SRF04. **NV**

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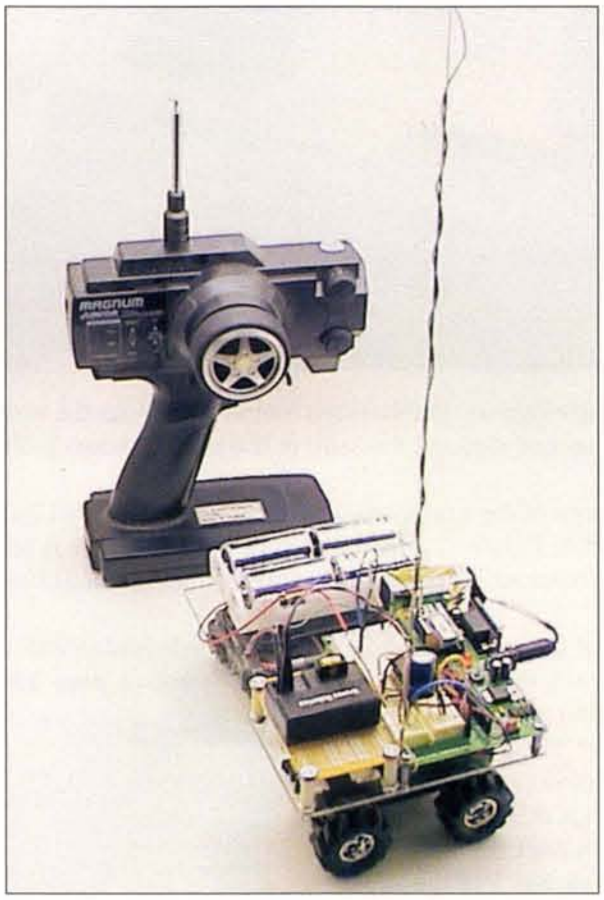
Interfacing an RC Receiver

By Michael Simpson

How do I connect my RC gear to my bot? Question asked, and answered ...



In the last few months, I have been working with the Kronos Crawler and the one single question I keep getting is how do I connect my RC gear to my bot? For this application, I will once again be using my microcontroller of choice — the Atom from Basic Micro so that I can take advantage of the built-in PWM generators.

In an attempt to make this article not bot-specific, I'm going to not use the Kronos Crawler. Instead, I will be using the SN754110 motor controller and a small bot that I threw together for this article. All code and hook-up examples should apply to any two-motor bot.

Decide on the Gear

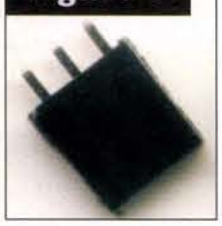
First, you must decide on the radio gear. I decided on a Futaba two-channel AM transmitter and receiver because of its popularity and the fact that I had several lying around. Just about any radio will work, but it must have BEC ability. That is, it must be able to draw power from the channel 2 servo connector. And while this is not an absolute requirement, it does eliminate the need for an additional battery.

Radio Hook-up

After deciding on a radio, it's time to hook it up. And again, this will depend on the radio you are using since the servo connector pin-outs are different from manufacturer to manufacturer. Again, my examples and diagrams are based on the Futaba design. Please consult your owner's manual to verify pin-outs on your receiver.

I was not in any hurry to cut the connectors from any of my servos, so I decided to make a couple. Making your own connectors is very easy if you have the right parts.

Figure 1



You will need a small three-pin header (Figure 1), some shrink tubing, and some 22-24 gauge hook-up wire.

Start by cutting three wires about 6" long. You will need a red, black, and green wire. Strip about 1/16" from the end of each wire and solder them to the leads of the header as shown in Figure 2. Keep in mind that the red lead connects to the middle for Futaba radios.

Figure 2

Figure 3

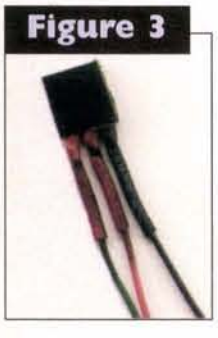
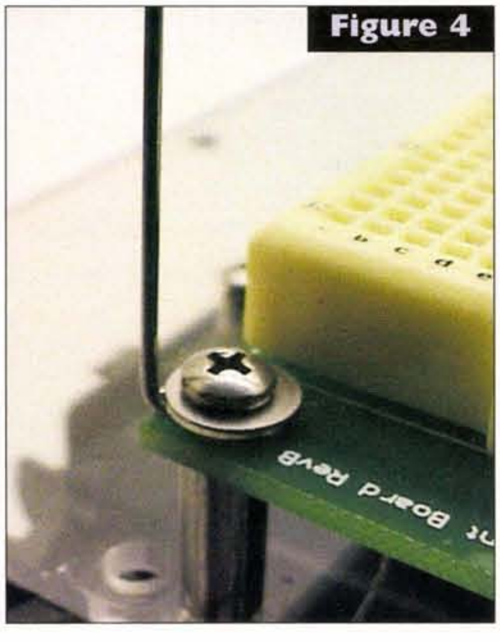


Figure 4



If you can't find any three-pin headers, you can make them by cutting larger headers down. Just make sure you test fit the connectors before you solder the wires.

Now place some 1/16" heat shrink over each of the connections and heat as shown in Figure 3. This will help strengthen the connection and aid you in identifying the pins on the connector.

You will need to create two connectors.

Take a piece of 1/32" diameter piano wire and cut it down to about 14". Place a loop on both ends and bend one of them 45 degrees and attach to your platform as shown in Figure 4.

Attach your radio to your platform as close to the antenna wire as

Figure 5

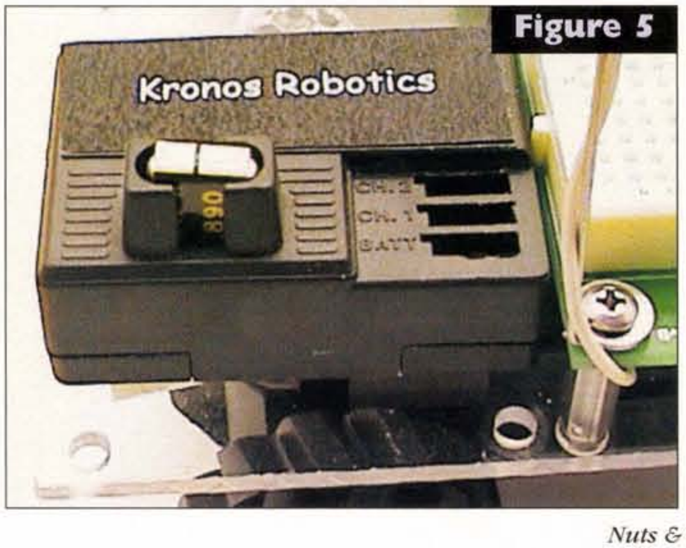


Figure 6

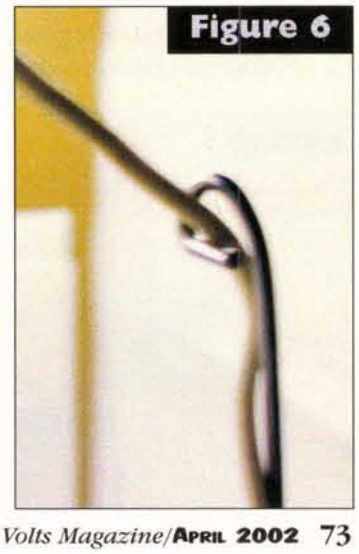


Figure 7

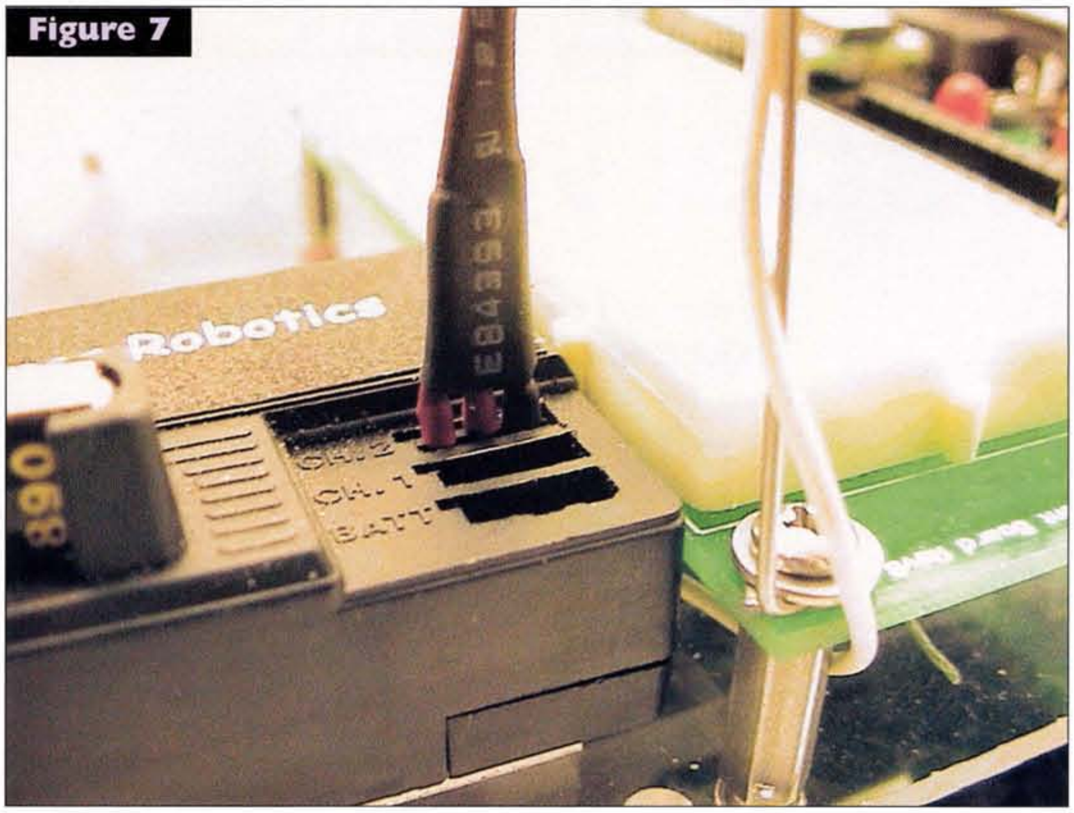
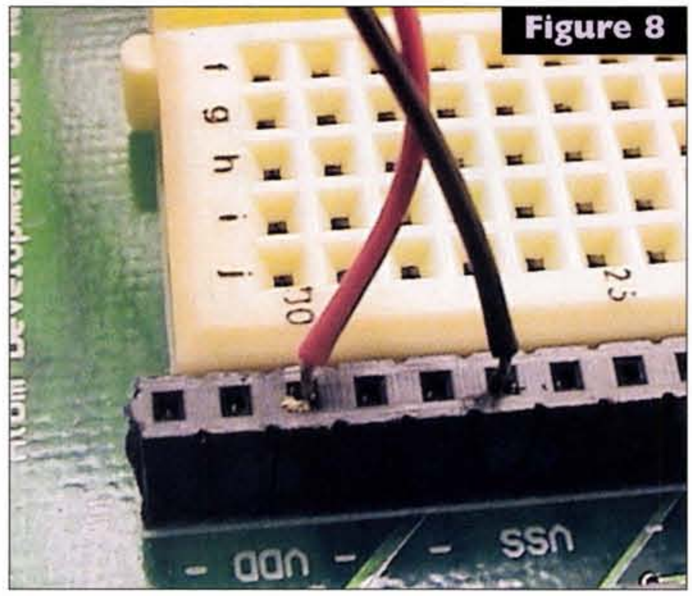


Figure 8



possible. I used some double-sided foam tape. Wrap the wire around the antenna wire and through the loop in the top as shown in Figures 5 and 6.

Insert one of the connectors you made into channel 2 of the receiver as shown in Figure 7. Just make sure the black wire is facing the outside of the receiver. Consult your owner's manual for actual pin assignments.

Connect the red lead to VDD and the black lead to VSS on the development board as shown in Figure 8. These two pins will supply the power to the receiver.

Connect the green wire to P3 on the development board as shown in Figure 9.

Now connect the second connector to channel 1 of the receiver as shown in Figure 10. We will only be using the green wire on this connector. Connect that green wire to p4 on the development board.

Schematic 1 shows the complete wiring hook-up for Listings 1 and 2.

In Listing 1, we will look at the raw numbers as they are read from the microcontroller. The output will be the raw pulse width values of channel 1 and 2 of the receiver.

Activate the steering and throttle on the transmitter to determine the center position of each channel. In my case, it seemed to be around 1500. You can change this with the steering and throttle trims.

In Listing 2, things get a bit more complicated. Most two-channel radios are designed to be used with an RC vehicle that has a single drive motor and a steering servo. What we have to do is convert these two channels into a control for a two-motordrive Bot.

All variables beginning with "throt" are used for throttle calculations. Variables beginning with "st" are for steering.

The first thing the program does is call the routine calrcvr. This routine calculates the center position and sets up a few variables so the rest of the program knows when some sort of control deviation occurs.

It also loads up a multiplier for PWM speed control when using a PWM motor controller.

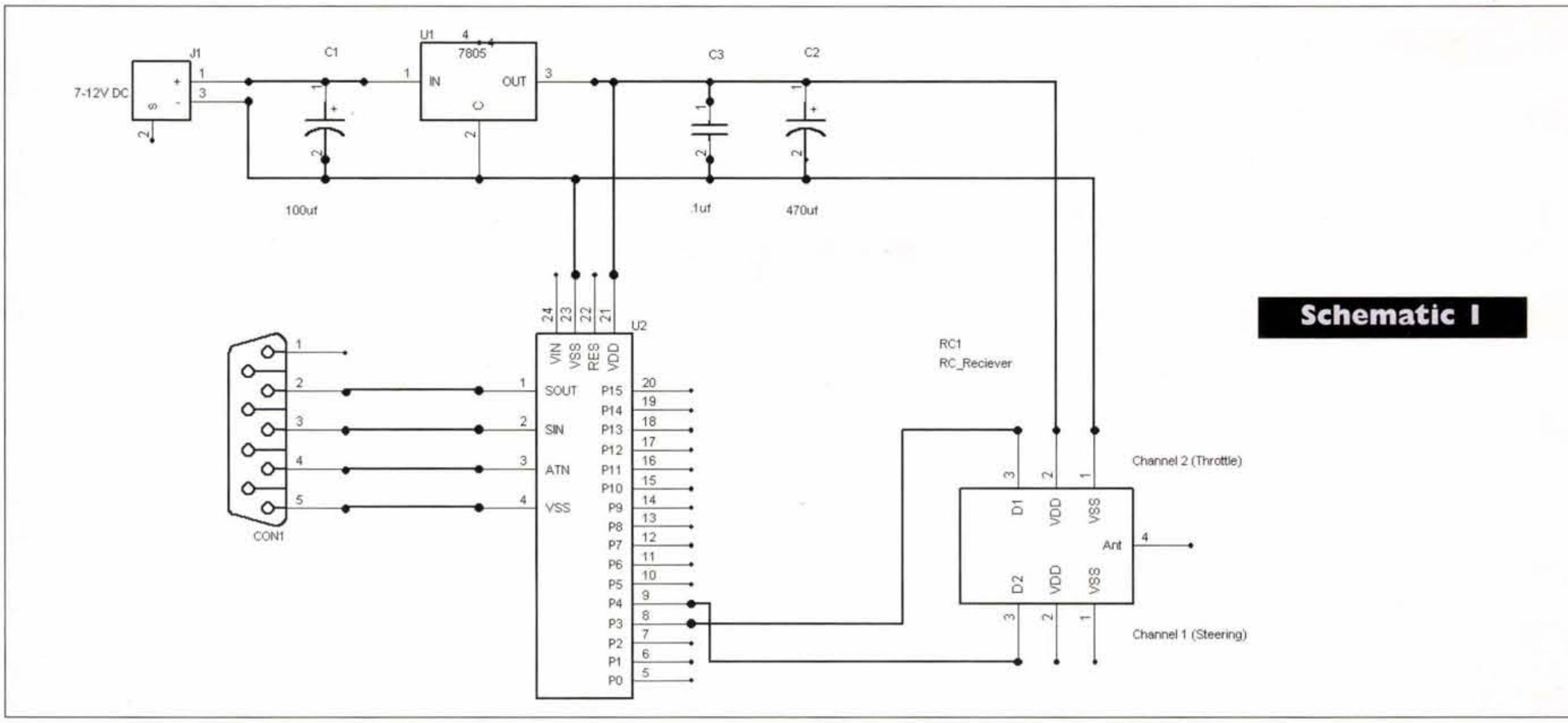
Another parameter of note is called deadband. This is how much

Listing 1

```
throtval var word
stval var word

main:

  pulsin 3,1,throtval
  pulsin 4,1,stval
  serout s_out,i9600,["TH:",dec throtval,"
ST:",dec stval,10,13]

Goto main
```

Listing 2

```
deadband con 5

throtctr var word
throtval var word
throtspeed var word
throtdir var byte
thspeedmult var word

stctr var word
stval var word
stspeed var word
stdir var word
stspeedmult var word

speeddutyl var word
speeddutyr var word

throtdir =1
stdir = 1

'These variables setup low and high speeds for the PWM motor 'controller.
lowspeed con 2000
highspeed con 10000

gosub calrcvr

main:

  pulsin 3,1,throtval:throtval = throtval /10
  pulsin 4,1,stval:stval=stval/10

  '-------------------------------------------------
  'Throttle Calculations
  '-------------------------------------------------

  'Calculate throttle speed
  if throtval > throtctr then
    throtspeed = throtval - throtctr
  elseif throtval < throtctr
    throtspeed = throtctr - throtval
  else
    throtspeed = 0
  endif

  'Calculate throt dir (back, fwd)
  if throtspeed > deadband then
    'First find out direction (fwd or bkward)
    if throtval < throtctr then
      throtdir = 1 ' fwd
    else
      throtdir = 0 'bkwd
    endif

  else
    throtspeed = 0
  endif

  '-------------------------------------------------
  'Turn Calculations
  '-------------------------------------------------
  if stval > stctr then
    stspeed = stval - stctr
  elseif stval < stctr
    stspeed = stctr - stval
  else
    stspeed = 0
  endif

  'Calculate turn dir (back, fwd)
  if stspeed > deadband then
    'First find out direction (fwd or bkward)
    if stval < stctr then
      stdir = 1 ' fwd
    else
      stdir = 0 'bkwd
    endif

  else
    stspeed = 0
  endif

  serout s_out,i9600,["Throt: dir=",dec throtdir," ThSp=",dec _
  throtspeed,"        Steer:"]
  serout s_out,i9600,["dir=",dec stdir," Sp=",dec stspeed,10,13]

Goto main

'This routine calculates the center pos.
calrcvr:
  pulsin 3,1,throtctr : throtctr = throtctr/10
  pulsin 4,1,stctr : stctr = stctr/10

  thspeedmult = (highspeed - lowspeed) / 50

  stspeedmult = (highspeed - lowspeed) / 30

return
```



Schematic 1

control deviation must occur before the bot starts to move. Before running this program, make sure the transmitter is on so that the calibration routine can do its job.

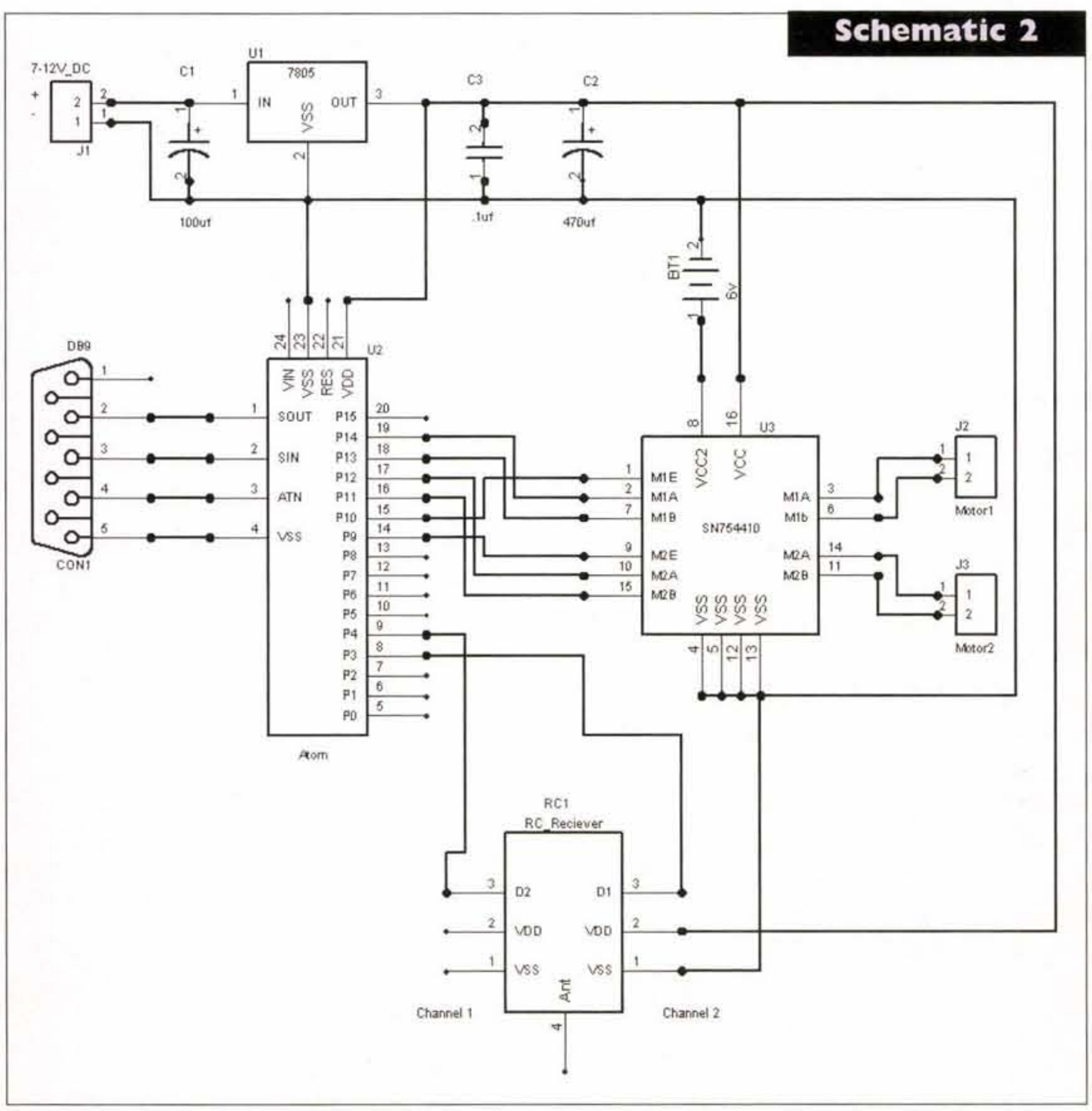
In Listing 3, we take it one step further and actually start to control the SN754110 motor controller via PWM as shown in Schematic 2.

The important portion of this code is the Bot Movement Calculations section. Here we take the calculated direction variables along with the calibrations modifiers to create a PWM duty parameter for the two PWM signal generators built into the Atom.

That's about all I have time for this month. So make sure you check out the website for updates and code enhancements.

One final thought is on radio glitches. The radio I used was a very inexpensive AM radio. Its range is only about 30 feet. One area of enhancement would be to monitor the receiver readings and dampen them a bit to prevent glitching. **NV**

Continued next page



Schematic 2

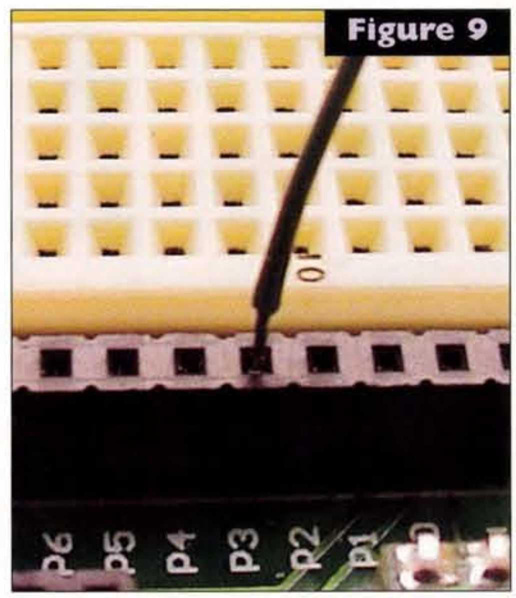


Figure 9

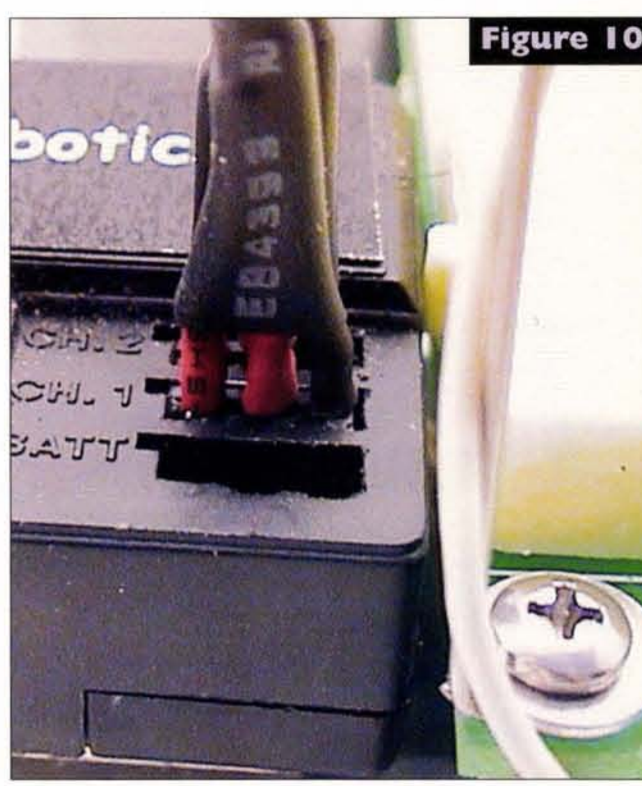


Figure 10

The Parts

All items listed below are available from Kronos Robotics; **www.kronosrobotics.com**

Item	Qty	Description	Part#
U1	2	SN754410 Motor Controllers At least two depending on Bot Base	#MDR1
	2	Headers (three-pin)	#H4
U2	1	Atom	#ATM1
	1	Atom development board	#ATM3
C1	1	100uF Capacitor	#C100-50
C2	1	.1uF Capacitor	#C.1-50
C3	1	470uF Capacitor	#C470-50
	1	Dip Heatsink	#HSDIP
	1	9V battery connector with power connector	#CO5
RC Gear	1	Transmitter and Receiver	Local Hobby shop

Note that even though you may be using the Atom (www.basicmicro.com) or other development board, the capacitors C1-C3 are still required. Place C3 as close to the receiver as possible.

Listing 3

```
'-----------------------------------------------------
' Motor Settings
'-----------------------------------------------------
'-------- Sets up the constants for the motor controller
M2InputA Con 12
M2InputB Con 11

M1InputA Con 14
M1InputB Con 13

'-------- Setup the ports for motor controller
Output M1InputA
Output M1InputB

Output M2InputA
Output M2InputB

'-------- Setup the initial speed
gosub CrHigh

deadband con 5

throtctr var word
Throtval var word
throtspeed var word
throtdir var byte
thspeedmult var word

stctr var word
stval var word
stspeed var word
stdir var word
stspeedmult var word

'These routines set the min and max duty cycle for speed and turn
'ratio calculations.
lowspeed con 2000
highspeed con 10000

speeddutyl var word
speeddutyr var word

throtdir =1
stdir = 1


gosub calrcvr

main:


 pulsin 3,1,throtval:throtval = throtval /10
 pulsin 4,1,stval:stval=stval/10


 '-----------------------------------------------------
 'Throttle Calculations
 '-----------------------------------------------------

 if throtval > throtctr then
   throtspeed = throtval - throtctr
 elseif throtval < throtctr
   throtspeed = throtctr - throtval
 else
   throtspeed = 0
 endif

 'Calculate throt dir (back, fwd)
 if throtspeed > deadband then
   'First find out direction (fwd or bkward)
   if throtval < throtctr then
     throtdir = 1 ' fwd
   else
     throtdir = 0 'bkwd
   endif

 else
   throtspeed = 0
 endif

 '-----------------------------------------------------
 'Turn Calculations
 '-----------------------------------------------------
 if stval > stctr then
   stspeed = stval - stctr
 elseif stval < stctr
   stspeed = stctr - stval
 else
   stspeed = 0
 endif

 'Calculate turn dir (back, fwd)
 if stspeed > deadband then
   'First find out direction (fwd or bkward)
   if stval < stctr then
     stdir = 1 ' fwd
   else
     stdir = 0 'bkwd
   endif

 else
   stspeed = 0
 endif


 '-----------------------------------------------------
 'Bot movement calculations
 '-----------------------------------------------------

 'First calculate base speed only if throttle is pressed
 if throtspeed > 0 then
   speeddutyl = throtspeed*thspeedmult
   speeddutyr = throtspeed*thspeedmult

 'Now calculate the track turn ratio if any

   if stspeed > 0 then
     if stdir = 1 then
       speeddutyl = speeddutyl - (stspeed*stspeedmult)
     else
       speeddutyr = speeddutyr - (stspeed*stspeedmult)
     endif
   endif


 'Just incase we go over
   if speeddutyl > 20000 then
     speeddutyl = 0
   endif

   if speeddutyr > 20000 then
     speeddutyr = 0
   endif


 'Set the speed
   HPWM 1,10000,lowspeed+speeddutyl
   HPWM 0,10000,lowspeed+speeddutyr


 'Now set motor direction
   if throtspeed > 0 then
    if throtdir = 1 then
     gosub crfwd
    else
     gosub crrev
    endif
   else
    gosub crstop
   endif

 'This we do if the throttle not pressed
 elseif stspeed > 0

     'Set the base speed
     speeddutyl = (stspeed*stspeedmult) - 2000
     speeddutyr = (stspeed*stspeedmult) - 2000


     'Set the speed
     HPWM 1,10000,lowspeed+speeddutyl
     HPWM 0,10000,lowspeed+speeddutyr

     if stdir=0 then
       gosub CrLspin:
     else
       gosub CrRspin

     endif



 else
   speeddutyl=0
   speeddutyr=0


   'Set the speed
     HPWM 1,10000,lowspeed+speeddutyl
     HPWM 0,10000,lowspeed+speeddutyr
     gosub crstop
   endif



 Goto main


 'This routine calculates the center pos.
 calrcvr:
   pulsin 3,1,throtctr : throtctr = throtctr/10
   pulsin 4,1,stctr : stctr = stctr/10

   thspeedmult = (highspeed - lowspeed) / 50

   stspeedmult = (highspeed - lowspeed) / 30

 return


'-----------------------------------------------------
' Motor Routines
'-----------------------------------------------------

'-----------------------------------------
' Speed routines
' You can tweek the left and right tracks if
'  find the crawler pulls to left or right.
'-----------------------------------------
Crlow:
  HPWM 1,10000,7500 'Left track
  HPWM 0,10000,7500  'Right track
  return

CrMed:
  HPWM 1,10000,8000  'Left track
  HPWM 0,10000,8000  'Right track
  return

CrHigh:
  HPWM 1,10000,10000  'Left track
  HPWM 0,10000,10000  'Right track

  return

'-----------------------------------------
' Crawler movement routines
'-----------------------------------------

Crfwd:
  gosub rfwd : gosub lfwd : return

Crrev:
  gosub rrev : gosub lrev : return

CrLspin:
  gosub rfwd : gosub lrev : return

CrRspin:
  gosub rrev : gosub lfwd : return

Crstop:
  gosub loff: gosub roff : return


'-----------------------------------------
'        Motor Routines
'-----------------------------------------

'--------------Left Motor (M1)
Lfwd:
  High M1InputA : Low M1InputB : Return

Lrev:
  Low M1InputA : High M1InputB : Return

Loff:
  Low M1InputA : Low M1InputB : Return

'------------ Right Motor (M2)
Rfwd:
  High M2InputA : Low M2InputB : Return

Rrev:
  Low M2InputA : High M2InputB : Return

Roff:
  Low M2InputA : Low M2InputB : Return
```

by Robert Nansel

Amateur Robotics

This month, I have two items of business. The first concerns the saga of my Heavy Iron CNC project. Those of you following the project know it is taking me far, far longer to complete the project than my original optimistic estimate. I had supposed in the beginning that it might take me three months to build and four or five columns to present all the plans. Fourteen months later, I'm still not finished.

Last fall, I tried to expedite the project by taking a couple months off from covering it in this column. This helped, but it wasn't quite enough. After consultation with my editor, I've decided to stop covering Heavy Iron in this column altogether. Instead, I will get back to hands-on robotics projects while continuing work on Heavy Iron in the background. After Heavy Iron is finished (in a few months), I will write up a stand-alone article to give all the remaining details in one swoop. We felt this was better for all of you building the project than waiting for the dribs, drabs, and occasional flash floods that you've been getting.

The second item is the state of my carpets. Here at the Robot Ranch we have that pattern and shade of carpet designed to hide the stains and arrows of outrageous fortune that any family with small children knows all too well. Even so, my boys are resourceful. Shoshana and I spent half an hour not long ago debating the origin and composition of a particularly sticky stain in the dining room, and while we debated, we combed the goop out and scrubbed with a brush. Shoshana thought it might be a raisin, while I was of the opinion it must have once been a chocolate chip. It was one tough stain.

Now, I vacuum as often as I get the chance and I use a carpet sweeper after every meal and snack, but I still can't keep up. When things get too sticky and crunchy underfoot, we call in professionals. I figured there had to be a better way.

Robot Vacuum Cleaner

The only sensible answer was to build a robot for the job. Sure, lots of people have built robot vacuum cleaners, but I have never run across a robot capable of steam cleaning.

It would be folly to spend three hours a day for five months building a robot that would save me just 15 minutes of vacuuming a day. Saving the cost of professional carpet cleaning each month tips the balance, though.

The last time we hired someone to clean our carpets it cost $100.00, and we have a small house. It took our boys less than a week to grind enough grapes, raisins, rice, and Spaghetti-Os into the carpet to make it look as bad as before.

My robot wouldn't just save 15 minutes a day, it'd save $100.00 a week and give our kids a cleaner, healthier carpet to play on. And not just my kids, but kids all across the country. Not only should I build a steam cleaning robot, it became my moral responsibility as a parent and my patriotic duty as an American to build it. That's how I explained it to Shoshana, anyway.

It was simple: add a water tank and heating element to what would otherwise be an ordinary wet/dry vacuum system. There were still details to figure out — the robot drive and plumbing — but no showstoppers. Except for steam.

Making Steam

I dug out my engineering reference books and did some quick calculations on how much heat it would take to produce the flow of saturated steam needed. Not liking those results, I did longer calculations and re-acquainted myself with steam tables and terms such as enthalpy and specific heat that I learned 20 years ago in thermodynamics class.

To heat water from 72 degrees F to its boiling point takes 140 BTU/lb (about 326 kJ/kg in SI). To vaporize that water takes an additional 970.3 BTU/lb (2256.7 kJ/kg), so the total heat energy needed is about 1110 BTU/lb (2583 kJ/kg) to make saturated steam at one atmosphere.

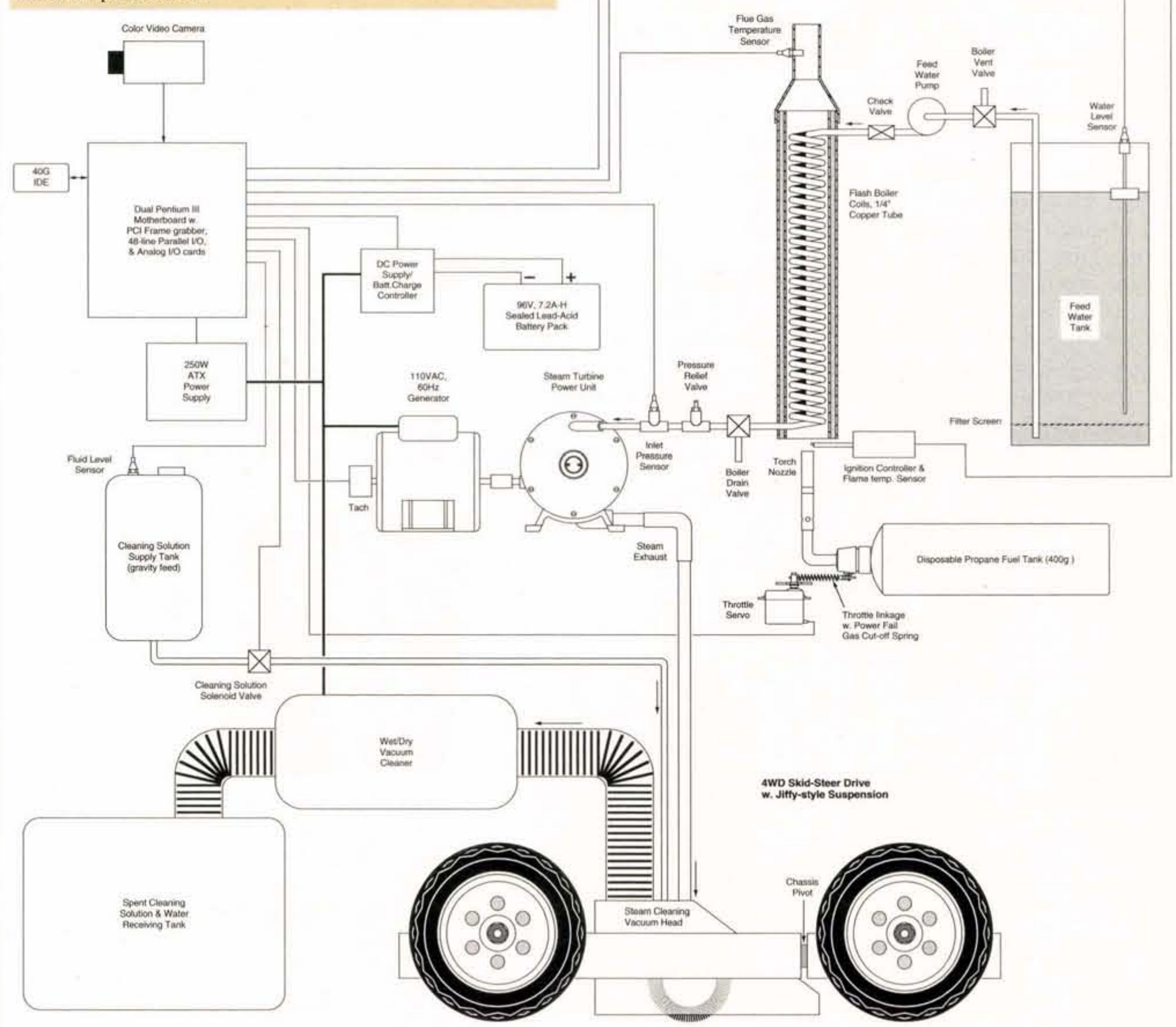
To convert half a gallon of water to steam in one hour would require 1,357 watts of heat. That's nearly two horsepower! For some perspective, 2HP is about the same as the peak horsepower of my wet/dry shopvac, and that draws 6A at 110VAC. Such a robot would require 170 lb of fully charged lead acid batteries — 16 W-hr/lb — just to run the vacuum cleaner and the steam generator. That's not counting the drive motors, the beater brushes, and the electronics. Call it 200 lb of batteries.

I remembered then just why it was we called that thermo class "thermogoddamics." It takes a lot of energy to make steam, and that's why you don't see battery-powered steam cleaners.

Getting Steamed

A robot with over 100 lb. of batteries breaks Nansel's Second and Third Laws of Hobby Robotics: never build a robot you can't easily pick

Figure 1: Schematic of Chug, the first steam-powered robot carpet cleaner.



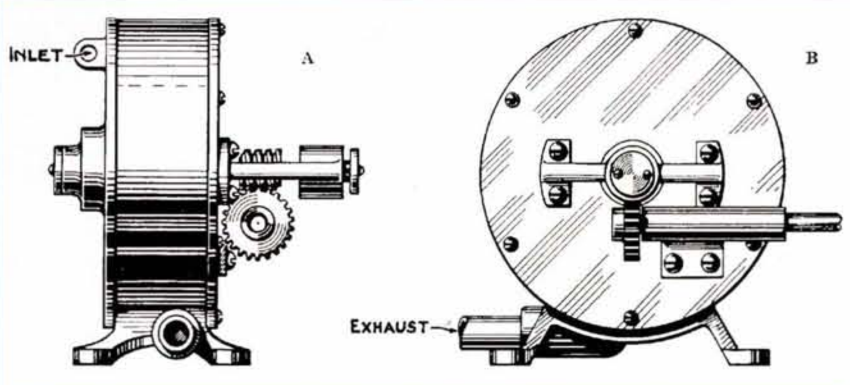


Figure 2: The steam turbine, front and side views. The worm reducer is clearly shown.

Figure 3: Photo of the turbine disassembled to show construction of the rotor. Two extra brass steam buckets in foreground.

up; never build a robot uglier than it has to be. (The First Law is never build a robot you can't outrun.)

Even without a steam generator, the vacuuming robot would be too heavy. I was glumly thumbing through my engineering handbook when I was struck by how much attention is given to not only making steam, but to using steam to do work.

As in steam engines.

An idea gelled then, and I went in search of paper, pencil, and calculator. What if I made steam with fire? Any common fuel burned in air has a couple orders of magnitude higher energy density than any battery.

Lots of fuels — wax, alcohol, butane, methane, and propane — can burn cleanly with an open flame. Suppose I used an open-cycle steam engine to provide some of the electricity and all the steam? I could reduce the weight of the battery and increase the steam capacity. Thus, Chug was born.

I named the robot Chug because I first thought I'd use a piston-type steam engine. There are plenty of designs and kits for model steam engines in the 1/10HP to 2HP range, and I've even come across at least one steam-powered robot on the web; Dan Creagan's Puff1 (http://academic1.bellevue.edu/robots/puff.html).

What decided me against them was vibration. Single-cylinder steam engines produce lots of vibration, and multi-cylinder engines, though smoother, are just too complicated.

Turbo Power

A turbine, on the other hand, would be smooth, light, and efficient. Figure 1 gives a schematic outline of my design for a turbine-powered robot steam cleaner.

I remembered seeing a design for a small, simple steam turbine that hobbyists could build in an old book I once read. But that was 25 years ago in the library of Butte, MT, where I grew up. I didn't remember the author's name or even the title. *Model Building* or *Making Models* or something.

Turns out my local library has the book: *Model Making* by Raymond Francis Yates (I love librarians). The project was first published as *How To Build A Model Steam Turbine* by Arthur J. Weed in *Everyday Engineering Magazine* in February 1918. Yates — the magazine editor — later reprinted that article and others in *Model Making*. There, in Chapter XVI — "A Model Steam Turbine" — I found the design and construction notes for a 3" single-rotor steam turbine. It runs in a casing the size of a tuna can. It even includes a 20:1 worm reduction so the power take-off shaft turns at 1,750 instead of 30,000 RPM.

Granted, it takes a small lathe and the skill to use it to make the turbine (facility with bronze casting would also be handy), but this beauty was just too cool to pass up. I've reproduced the plans from the book — with adaptations — in Figures 2 through 9. I have space for only a few construction details here, but *Model Making* has been reprinted by Lindsay Publications, so you can get all the nitty gritty details there (see sidebar).

The Hard Parts

The hard parts of building a turbine are: machining the blades; balancing the rotor for high-speed rotation; providing adequate bearing and lubrication.

The first problem is solved by pressing each of the 40 blades (or buckets) from soft brass sheet (Figure 9), then cutting and filing to shape (detail E of Figure 5). The buckets are soldered in slots around the rim of the rotor and a 3" diameter brass band goes around the whole assembly (detail F). If you have a dividing head and a milling machine, cutting the slots is easy; if you don't, use plain dividers to lay out the cut locations around the circumference of the rotor and an Armstrong Shaper (a.k.a., a hacksaw) to make the cuts.

The solder holds the buckets in place while turning their tops to the proper diameter on the lathe, when the 3" diameter brass band can almost be forced over them. The band is then heated to expand it enough to slip over the buckets, making a snug fit once the band cools. The whole rotor assembly is then turned true on the lathe, thus solving the balance problem.

The bearing and lubrication problem is solved with oil reservoirs and adjustable bearings (details L and J of Figure 7 and detail P of Figure 8). Two identical bushing sleeves (shown in perspective at L, and in section at J and P) are made from brass rod. They are machined for a close sliding fit in the smaller through-bores of the oil reservoirs, and their mounting screws allow one bushing to be tightened and its opposite loosened to adjust the axial (left and right) position and play of the rotor shaft. Note that the odd-looking loop at detail L is the oiling ring which sits in the slot cut into each sleeve. The oiling rings wick oil up from the reservoirs onto the shafts, and they must be installed after sliding the bushings in place, but before soldering brass washers (shown at K and P) to close up the oil reservoirs.

Detail A of Figure 2 shows the rotor shaft adjusted all the way to the right; there's a gap between the right bushing and the outboard bearing bracket, but there's no gap

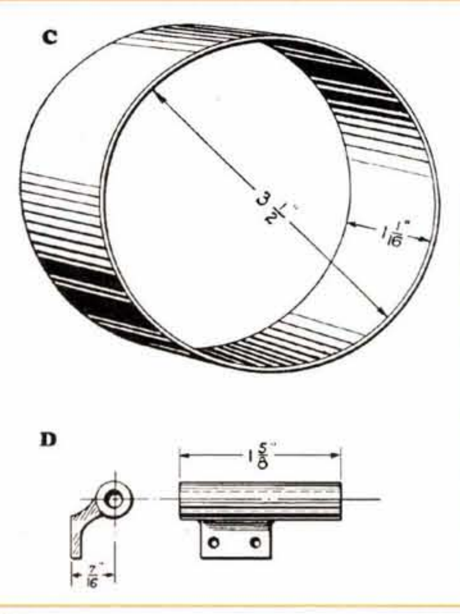
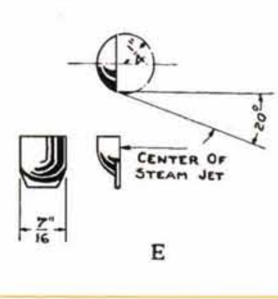
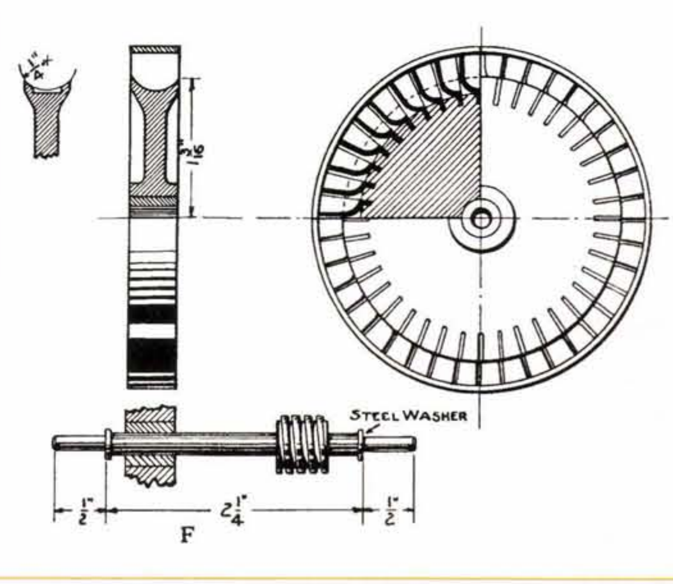


Figure 4: Detail C, the brass casing tube, 1/16" wall thickness. Note typo in book gives the width as 11/16" when it should read 1 - 1/16" as in the diagram. Detail D, the power take off shaft bearing bracket. This bracket is shown in position in detail B of Figure 2.

Figure 5: Detail E, the form of the brass vanes or buckets, fabricated from 26 gauge sheet brass. Detail F, the rotor, rotor shaft, and worm. The brass ring is 7/16" wide. The top sections shows alternate ways of machining the rotor rim to fit the buckets.





between the left bushing and the left head. This must sound complicated, but study the diagrams and it will make sense. Figure 3 is my photo of the finished steam turbine. It's shown disassembled after its first test run with compressed air at 60 PSI. After running the turbine, I know I've misnamed Chug; it should be called Whiner. It's not as loud as a jet engine (not quite), but it sure whines like one.

Blowing Off Steam

Did I say there were only three hard parts? The boiler is the fourth hard part. Compressed air is fine for testing, but to be useful, the turbine needs steam, lots of it. Boilers are the hardest part of any steam power system. First of all, there are so many kinds of boilers and even more kinds of valves: poppet valves, relief valves, needle valves, check valves, globe valves ...

Check the references to get the details. I chose a tube-type flash boiler with both a mechanical pressure relief valve and an electronic pressure sensor (Figure 1). The Pentium system controls the servo throttle with the pressure sensor closing the feedback loop. But if the software hangs, there's the mechanical pressure relief valve.

Safety tip: Always test boilers hydrostatically; if anything breaks, all you get is a water leak. If you test with air or steam, you get an explosion instead. I've tested my boiler to 120 PSI with water and a tire pump, and the mechanical pressure relief valve is set to 100 PSI. Should both the throttle loop and the mechanical valve fail, I've got a third failsafe not shown in Figure 1: a cut in one of the outer tubing coils sealed up with solder. If the temperature of the tube ever goes above 600 degrees F while under pressure, the solder joint will fail, thus relieving pressure and saving the day.

My boiler core was made by wrapping two layers of 1/4" copper tubing around 12" of a wooden dowel, or about 48 turns. The dowel was slightly under 1" in diameter. When completed, the coils spring open enough to remove the dowel. The first layer forms a right-hand helix, and the second layer a left-hand helix.

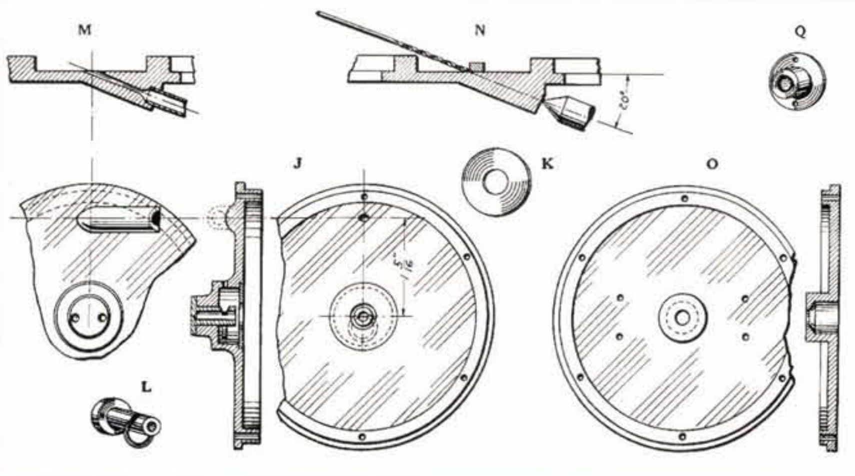


Figure 7: Detail J, "steam-side" casing head (see left side of detail A). Note that the book has a typo that gives the location of the steam nozzle hole as 15/16" above the center instead of 1 and 5/16" as shown in the diagram. Detail K, brass washer to be hard-soldered in place to close off steam-side oil reservoir cavity. Detail L, bearing bushing with oiler ring and slot. Detail M, final form of steam nozzle in casing head J. If you can't do castings, head J and steam nozzle lug M can be machined from separate pieces and hard-soldered together before drilling the nozzle. Detail N, method for drilling the steam nozzle. The rectangle shown at the drill tip is a small brass block soldered temporarily to the head to keep the drill from wandering off the center-punch dimple. Detail O, the "exhaust-side" head (see right side of detail A). Outboard bearing P mounts on this piece. Detail Q, the packing gland, machined from brass rod to fit in stuffing box bore of head O.

A Bigger Hammer

I had hoped to use a Weller Pyropen — a propane-powered soldering iron/torch — as the burner to fire Chug's boiler. The Pyropen has electronic ignition and easy adjustment, but it's limited to a maximum 60W output. As I've shown, this is just not enough heat to get Chug up to a full head of steam. Even three Pyropens in parallel aren't enough.

I needed a bigger heat source, and the cheapest one at hand was my 30-year-old Benz-O-Matic propane torch. I don't know exactly what its wattage rating is, but it surely does put out lots of heat.

The advantage of a full-size torch is you can pick up one of these torches and a bottle of propane for less than $15.00 at any hardware store. The disadvantage is you don't get electronic ignition or catalytic conversion at that price. Benz-O-matic does have their "Trigger-Start Torch" for about $30.00. It uses standard propane tanks, so one of these would drop right in place of my old torch. I figured I could live without electronic ignition for a while just to see if my old torch would fire Chug's flash boiler.

The first thing to do was to replace the torch's needle valve core with a quarter-turn valve core so a hobby servo could control the torch through its full range. The next thing was to bend the torch tube to the proper angle. The trick was to bend it without putting a crimp in the tube. This I accomplished by filling the tube with sand, clamping it in my vise, and bending it with a large pair of channel lock pliers while heating the bend with a second propane torch. (Hey, I needed a new torch anyway, right?)

Boy, does it ever work great with Chug's boiler. I've got so much steam I haven't had to turn the humidifier on in the house all winter. And the carpets? Well, the carpets will look better once I get the rest of Chug working.

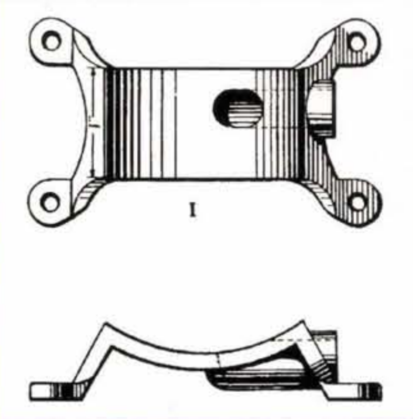


Figure 6: The base with steam exhaust tube molded in. This is the most difficult piece to duplicate without a casting. The alternative is to "unroll" the design flat onto 1/8" thick brass sheet stock. Cut, drill holes, and bend to shape. Cut and file to fit a 1/2" brass tube for the exhaust and hard-solder the tube and base assembly together. Align the exhaust tube cutout of the completed base assembly with a matching cutout in the casing tube. Solder the base assembly to the casing.

Coming Clean?

Chug is by far the most complicated project I've ever covered in this column. I wish to thank Gene Elliot of Gig Harbor and Dan Creagan of Bellingham (both in the state of Washington) for the assistance they gave me in getting Chug to work right. Anything wrong with Chug's design is my own fault, not theirs. I don't have the tools or experience to tackle a project like this, but these two fine gentlemen have enough of both to build dozens of Chugs, and they helped me over the hump. It wouldn't have been possible without you, guys. Thanks.

Yes, you really can build it, but it's not for everyone. If you are at all wobbly with a metal file or hacksaw, or if you're not confident you know how to prevent it from causing housefires or third degree burns to you or others, stay away. But if you've got the tools and the know-how ...

In my other life — that thin slice not taken by fatherhood and this column — I am a science fiction author (yes, I've even been pub-

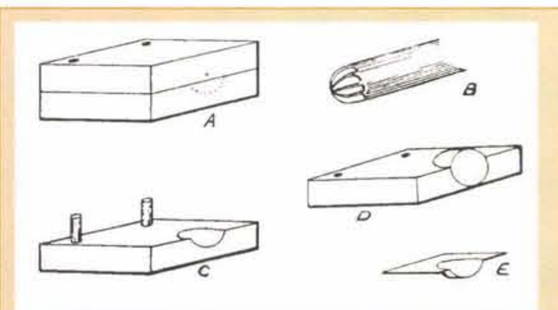
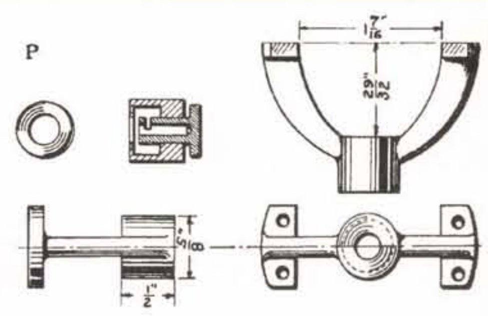


Figure 9: Method of forming buckets from 26 gauge brass sheet. Make the tool from two pieces of steel 3/8" x 1.5" and about 2" long. Clamp them together and drill two 1/4" holes to take guide pins as in Figure 9c. The opposite ends must then be squared up while the pieces are pinned and clamped. Make a center punch mark in one of the pieces 5/64" from the edge dividing the pieces as in Figure 9a. Drill a hole with a #24 bit to a depth of 3/8". With the two pieces firmly clamped, enlarge the hole with a 1/2" drill to the same depth, then make the final form with a 1/2" ball-end mill as shown in Figure 9b. Finally, a piece of 1/2" steel stock is turned to the same form as the end of the ball-end mill. Riveted to the upper plate, this forms the male "punch" (Figure 9d), and the lower plate forms the female "die" (Figure 9c). The guide pins maintain alignment. To use the tool, cut 1" square blanks of brass stock, sandwich the blank between the punch above the die below, and squeeze the sandwich in a vise. The pressed blank should now appear as in Figure 9e, ready to be trimmed.

Figure 8: Detail P, outboard bearing, (see Figure 2 for placement). This piece is also tricky without a casting, but it can be made from solid stock at least 5/8" x 2" x 1.5". Rough out with a hacksaw, and file, file, file. Also shown in upper left is the brass washer used to enclose this oil reservoir and the situation of the brass bearing bushing.



lished, by paying markets). In a way, Chug is the fulfillment of a long-standing dream, to publish a serious work of hard science fiction, with equal emphasis on "science" and "fiction." Consider Chug a jest appropriate to the fourth month of the year. I hope you've enjoyed it (I know I did).

Coming Attractions

I've got some exciting new projects in the works for the next several months. We're getting back to *real* hands-on robot projects (unlike *Chug*), projects you can build in a weekend with tools you already have. Tired of the "two-wheels, two-motors, a battery, and a microcontroller" scene? Well, I plan to shake things up around here with new sensor and actuator projects.

On the sensor front, we'll look at nifty new color sensors from Taos, Inc. Their TSLx257 series of three-pin light sensors take the hard work out of sensing light levels by including a photodiode, transimpedance amplifier, and color filter in one package. Color filter? That's right, with the R-,G-, and B-versions you can sense RGB color (www.taos-inc.com/products.htm#tslx257). If that isn't enough, I've got a cool robot to review that uses a true color vision system called CMUcam developed at Carnegie Mellon. One thing is certain, the world of amateur robotics will no longer be monochrome (www-2.cs.cmu.edu/~cmucam/). I'll also show you some simple ways to build your own linear actuators — and some good uses for them, too. See you next time! **NV**

If you have suggestions, questions, or comments about amateur robotics or other April Fools' topics, you can reach me at:
Robert Nansel
Box 228
Ambridge, PA 15003
E-Mail: **bnansel@nauticom.net**

Links

Basic steam engines:
http://jensensteamengines.com/commercial/c50.htm
A rough drawing:
http://www.pmresearchinc.com/piping001.html
A good kit:
http://www.tinypower.com/catalog.htm
Valved engines are more efficient, but oscillating engines are simpler to build. **Here's a very simple oscillating steam engine:** http://npmccabe.tripod.com/husky.htm
And here's a very weird and wonderful oscillator:
http://npmccabe.tripod.com/3sisters.htm
This one could probably be built by an average hobbyist. It has an advantage over a single cylinder engine in that it is self-starting. (Most single cylinder steamers have to be given a 'flip' to get going.)
Here's a good place to start with valved engines:
http://www.angelfire.com/mo/allsteamedup/
Has several good examples of valved engines (some from the "Tiny power" link above).
Animation of a double-acting valved engine:
www.geocities.com/Athens/Acropolis/6914/doppioe.htm
This helps you see how steam valves work in an engine similar to the Tiny Power engine. Steam valves are confusing until you build one. In this animation, the steam is entering from the left.

Books

Model Making, by Raymond Francis Yates Lindsay catalog #4325, $14.95. Get the book and you'll also find plans for a gyro-stabilized trolley, a radio-controlled submarine (1919!), several steam boats, a caterpillar tread tank, assorted steam boilers, and lots of steam engines, including 3-, 4-, and 6-cylinder radial steam engine designs for model airplanes. There's even a chapter on making your own lead-acid batteries. Compared to some of these projects, the steam turbine is a snap. As Lindsay notes, each topic in this book could be a book in itself. All I can say is, Wow.

Lindsay Publications
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tel: (815) 935-5353; www.lindsaybks.com
Lindsay has lots of books on steam engines and how to build them, large and small. If you want to build a steam engine, but don't have a metal lathe, there are even several books on how to build lathes, too.

Model Steam Turbines, Harrison Reference #TEE48.
The only new book on steam turbine models I'm aware of, this book gives designs and construction details for several types of steam turbine. Covers theory and practice in fine British style.
http://www.chronos.ltd.uk/acatalog/Chronos_Catalogue_Books_from_TEE_Publishing_56.html

Model Boilermaking, Pearce Reference #TEE44
A reprint of a practical handbook on design, construction, and treatment of small steam boilers. Lots of useful diagrams, very British.

New Product News

Continued from page 50

mounted over the prototyping area. Custom circuitry can be built on the breadboard using jumper wires. Hence, no soldering is required. In addition, all CPU lines are available at female header connectors. Thus, jumper wires can also be used to connect to the processor.

The board measures 4.75 by 6.75 inches. Board features include: prototyping space with optional solderless breadboard, female header connectors and solder pads for connections to the processor, eight LEDs, eight-position DIP switch, RS-232 serial port with DB-09 female connector, DS1233 EconoReset for reset generation, and one-amp voltage regulator.

For more information, contact:

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Columbus, OH 43221
614-488-7122
CONTACT: **JOHN ALLEN**
EMAIL: **allensys@aol.com**
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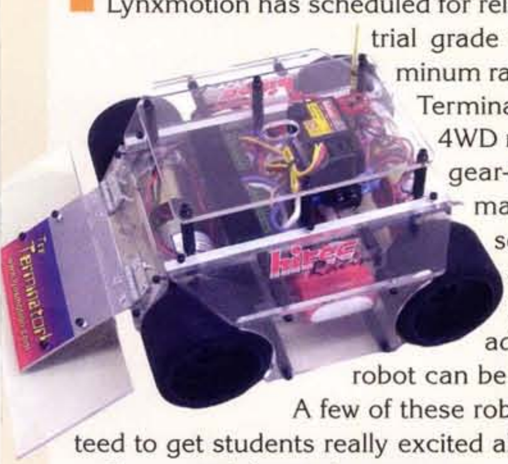
Terminator 3kg Class Sumo Robot



The Terminator is one of six 3kg Class Sumo Robots that Lynxmotion has scheduled for release. It is constructed from industrial grade impact-resistant acrylic and aluminum rails to form a unibody chassis. The Terminator (part #SR3-KT $163.00) is a 4WD robot that features powerful 6VDC gear-head motors that are custom made for Lynxmotion. Borrowing some components from the RC car industry, this robot can easily be remote controlled. With the addition of your favorite MCU, the robot can be autonomous with little effort.

A few of these robots and a five foot ring is guaranteed to get students really excited about technology and robotics.

For more information, contact:

Lynxmotion, Inc.
P.O. Box 818, dept. nv
Pekin, IL 61555-0818
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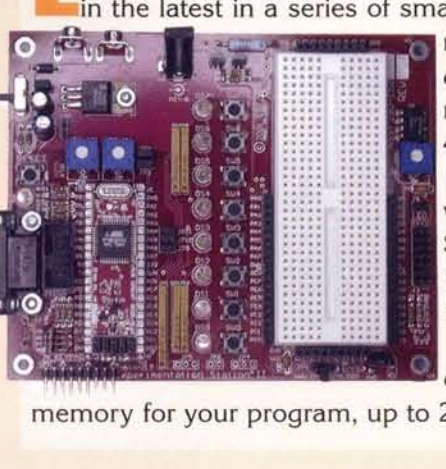

When the module is combined with a simple cable, PC, and the Sprint Basic compiler, a fast and powerful AVR development system is realized for a very modest price.

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The development system enables a quick start for your design by providing everything you need to develop your application in a single package — just add the PC. Development systems also include a 'C' compiler and an assembler.

The starter system includes the programming cable, power supply, and the full version of the Sprint BASIC compiler, in addition to full documentation on CD.

The full Experimenter's Station II, allows you to quickly connect a keyboard, LCD display, and provides a prototyping area, in addition to lights, switches analog voltage sources, and a 200mA regulated 5V supply. A printed Sprint Basic manual is also included with the Experimentation Station II.

For more information, contact:

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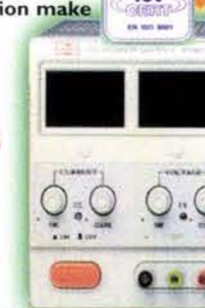

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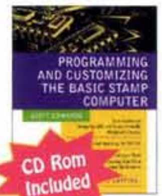

This edition moves you briskly from electronic foundations through BASIC Stamp "Boot Camps" and an intelligent traffic signal simulation to build a robotic bug with whisker sensors, a time/temperature display, and a data-logging thermometer. ***$39.95***

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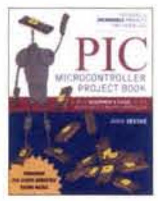

This project-oriented guide gives you 12 complete projects, including: using transistors to control DC and AC motors, DTMF phone number logger and distinct ring detector and router ... home automation using X-10 communications ... digital oscilloscope ... simulations of fuzzy logic and neural networks ... and many other applications. ***$29.95***

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In 1995, Scott Edwards began authoring a column on BASIC Stamp projects in *Nuts & Volts Magazine*. The column quickly became a favorite of *Nuts & Volts* readers and continues today with Jon Williams at the helm. *The Nuts and Volts of BASIC Stamps* is a collection of about 75 of these columns.

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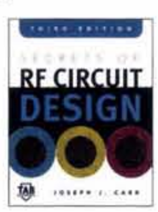

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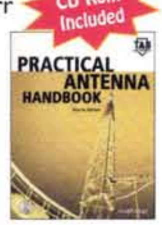

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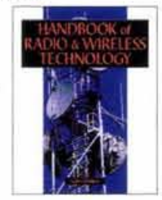

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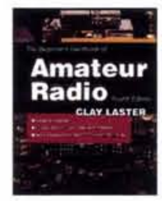

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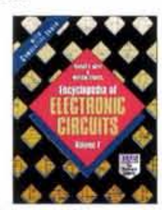

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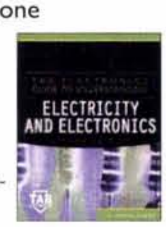

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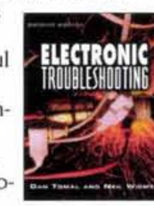

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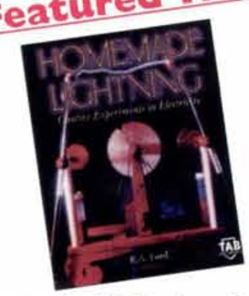

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