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Nuts & Volts

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Vol. 23 No.2

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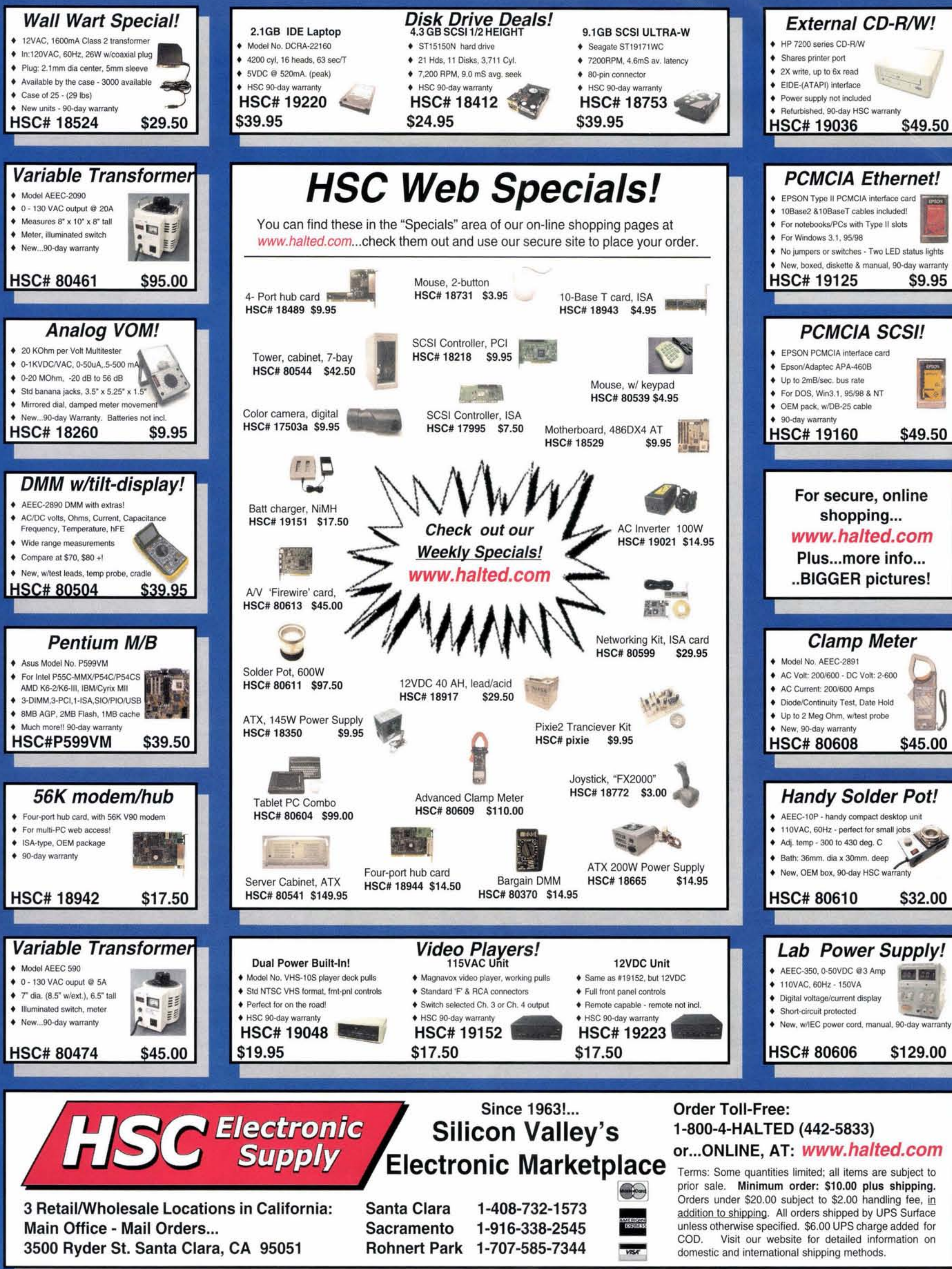

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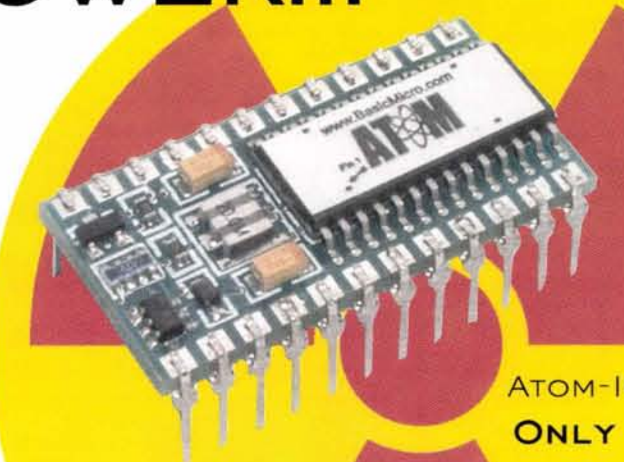

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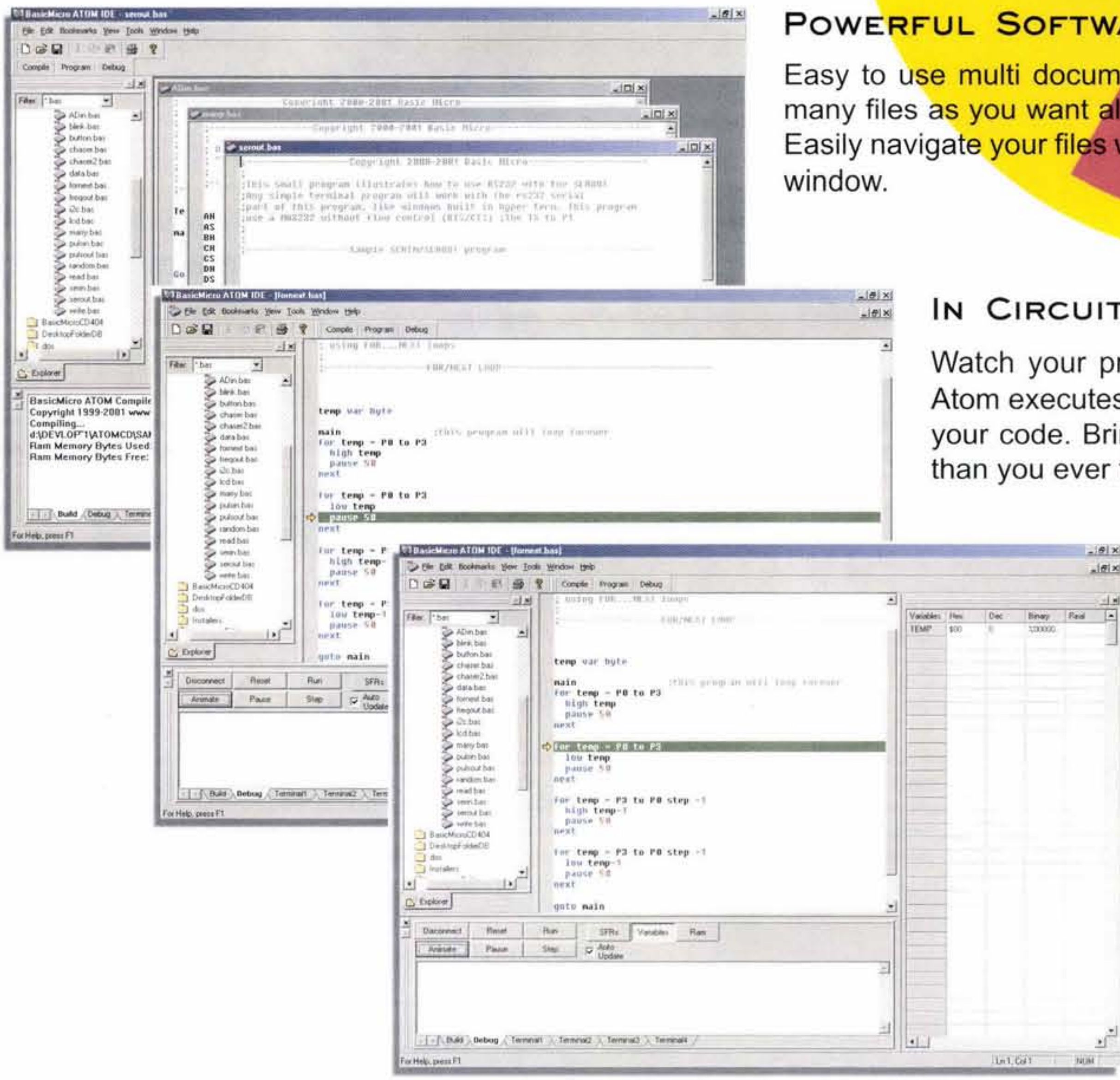

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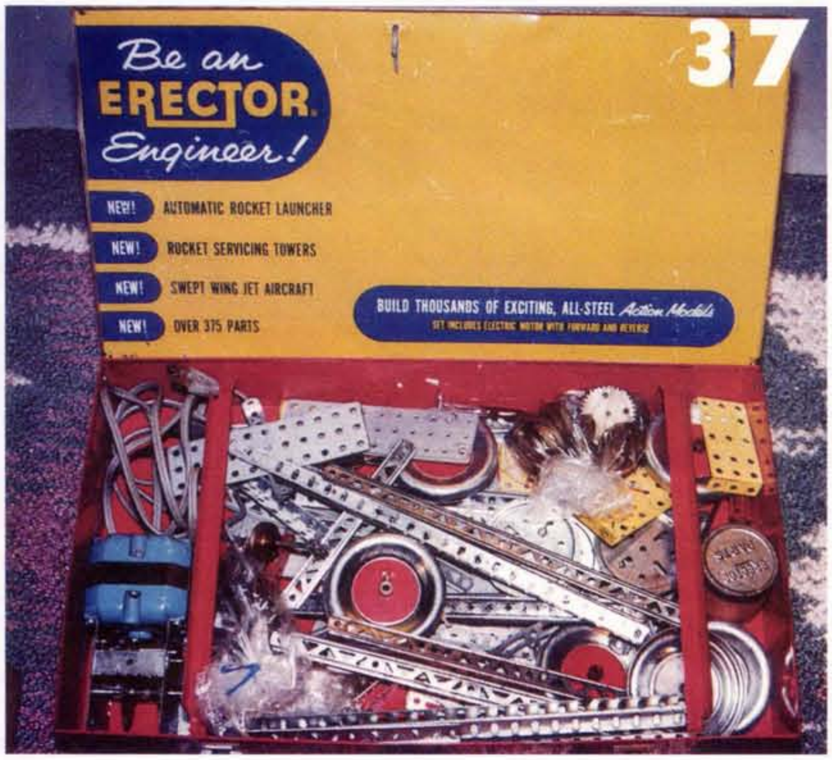

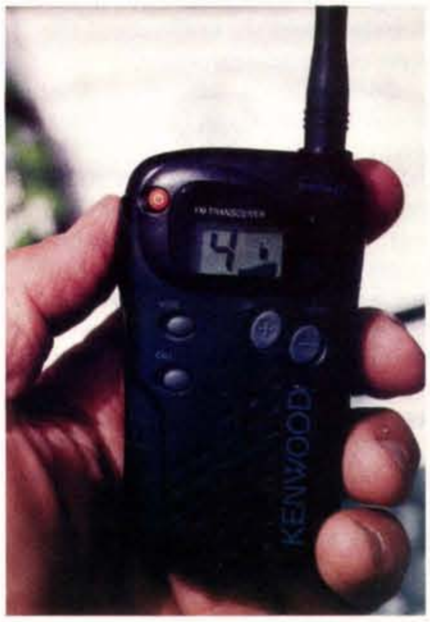

COLUMNS

DEPARTMENTS

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TechKnowledgy 2002

Events, Advances, and News From the Electronics World

by Jeff Eckert

Advanced Technologies

Spaceborne Instruments Capture Solar Wind

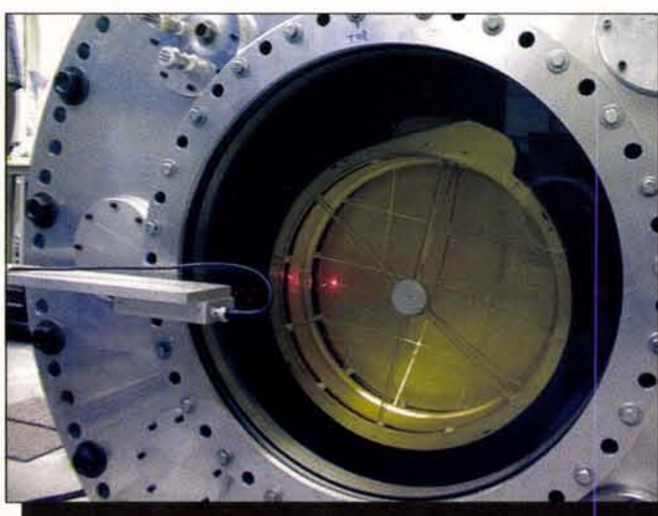
Genesis, a remote-controlled space mission, went into orbit Nov. 16 around the Lagrange 1 (L1) point, a place nearly one million miles from the earth where the gravitational pulls of the earth and sun are equal. In December, its instruments began capturing particles of solar wind. Genesis will remain in this location for nearly 2.5 years and then return to earth. During this time, Genesis' instruments will collect samples of the solar wind to reveal the make-up of the cloud that formed the solar system nearly five billion years ago, which will help scientists understand the origin of the solar system.

Conventional wisdom is that the solar system was formed from a solar nebula (a cloud of gas and dust) that collapsed in on itself. Most of it formed the sun, but outlying particles became planets, moons, and comets. We have a general understanding of how that happened, but the composition of the initial nebula remains a mystery. However, its history is thought to be preserved in the outer layers of the sun, and the solar wind provides a continuous flow of that material into space. By analyzing this material (with a particular focus on oxygen content), it is believed that we can learn more about the nebula.

Los Alamos designed and built a solar wind concentrator to collect a high concentration of oxygen and return the sample back to earth for analysis. The concentrator takes solar wind and passes it through a series of electrically charged grids into a bowl-shaped mirror. The mirror reflects a filtered stream of elements heavier than hydrogen upward into a centrally-poised collector tile where oxygen and other elements embed themselves.

Also aboard Genesis are solar wind ion and electron monitors. Genesis' ion and electron monitors instantaneously determine the speed, density, temperature, and approximate composition of the solar wind and translate that knowledge into actions for the solar wind concentrator and solar wind collector arrays.

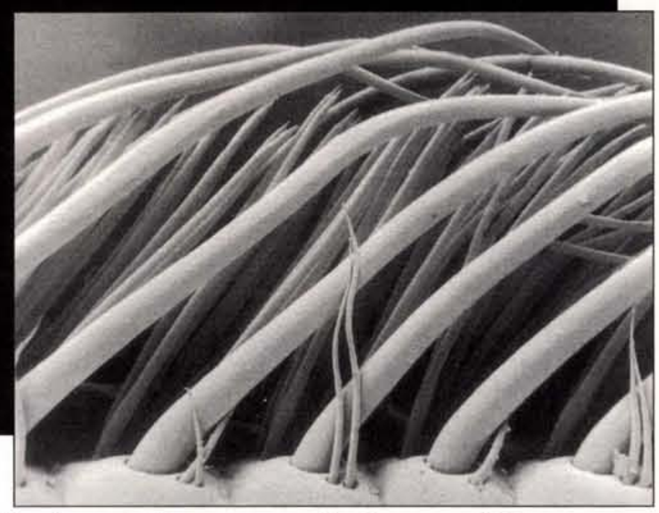
Genesis will collect just 10 to 20 micrograms of solar wind, the equivalent of a few grains of salt. The extraterrestrial material will return to earth in 2004 for study by scientists around the world.



The solar wind concentrator undergoes testing inside a vacuum chamber. A laser sensor located on the arm in front of the vacuum window is being used to check the flatness of the thin, high-voltage screens (invisible in this photo) that stretch across the front of the instrument. Courtesy of Los Alamos National Laboratory.

Lobsters Provide Design Ideas for Sensors

Studies being performed by researchers at the University of California, Berkeley **(www.berkeley.edu)** and Stanford University **(www.stanford.edu)** are aimed at reverse engineering the olfactory sensors used by spiny lobsters to "sniff" their way around in the sea. According to Mimi A. R. Koehl, professor of integrative biology at UC Berkeley, "If you want to build unmanned vehicles or robots to go into toxic sites where you do not want to send a scuba diver, and if you want those robots to locate something by smell, you need to design noses or olfactory antennae for them. We are learning how animal antennae capture odor molecules from the water around them. We want to understand which designs of odor-catching antennae work successfully in nature so that they could provide inspiration for man-made antennae."



A scanning electron micrograph of the chemosensory hairs on the end of the antennules of the spiny lobster, Panulirus argus. The hairs sensitive to odors are in the center, protected by a phalanx of strong guard hairs. Courtesy of Jeff Goldman/Duke University, Oxford University Press©.

Lobsters and other crustaceans sniff by flicking a pair of antennules, dragging them through the water to bring chemosensory hairs on the ends of the antennules into contact with odor molecules. On the outer edge of one of the split ends of each antennule is a brush of hairs sensitive to chemicals. Understanding exactly how the lobsters collect and process data could provide a blueprint for electronic sensors that accomplish the same thing. The next step will be to work with neuroscientists who can help relate odor concentration in the hairs to electrical signals triggered by the hairs.

Computers and Networking

New Operating System On Its Way

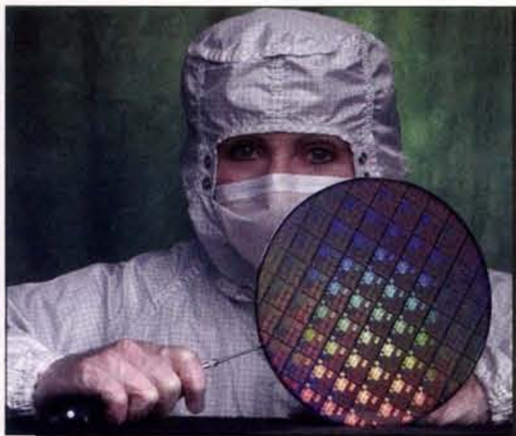
In 1998, Michael Robertson founded MP3.com, Inc., the well-known Internet music service provider. Now, he intends to shake up the personal computer world with a new company, **Lindows.com, Inc. (www.lindows.com)**. While the product was not commercially available as of this writing, LindowsOS is described as a low-cost (under $100.00) that can run both Linux® and Windows® programs. It is based on a Linux core, but will run Windows applications without any additional software. LindowsOS offers the usual graphical user interface (GUI) and will run on computer systems that use a Pentium or AMD processor and have a minimum of 64 MB RAM and 1 GB of hard drive space. The product will be available for purchase directly from the company's web site.

According to Robertson, "Putting another choice on the shelf for consumers is the ultimate tonic for high prices, restrictive licenses, and intrusive security measures. The power to choose means consumers will be in the driver's seat and not beholden to the policies of one company."

Is anyone taking this little start-up company in San Diego, CA, seriously? One indication might be that Microsoft has already filed a trademark infringement complaint against Lindows.com. You see, Microsoft thinks that its 384 million users might be confused and unable to tell the difference between the two names, LindowsOS and Windows XP.

Another "World's Most Powerful" Computer

Logic tells us that there can be only one world's most powerful computer at any one time, but there are several hundred supercomputers whose owners proclaim them to be the "world's most powerful." This is accomplished by modifying the claim to include only a particular task. For example, the machine on my desk is the world's fastest computer used to generate these columns. And IBM **(www.ibm.com)** is assembling a system that is being touted as the "world's most powerful weather supercomputer." Marketing hyperbole aside, the "Blue Storm" system, being produced for the European



Software engineer Daria Dooling examines a wafer of IBM Power4 chips destined for the company's eServer p690 computer. Each Power4 chip contains 174 million transistors. The Power4 chip functions like an individual computer and contains two high-speed processors, a system switch, memory, and I/O functions. Information flows between the memory and the processor at nearly 125 GB per second. Courtesy of International Business Machines Corporation. Unauthorized use not permitted.

Centre for Medium-Range Weather Forecasts **(ECMWF, www.ecmwf.com)**, is a formidable machine, based on an IBM eServer Cluster 1600 supercomputer built with multiple eServer p690 enterprise UNIX servers and code-named "Regatta." The computer will provide advanced weather information to help with activities that include early warning of severe floods, navigation assistance for ships at sea, and planning of family picnics. ECMWF researchers will access Blue Storm via an IBM IntelliStation workstation running Linux, and others in Europe will be able to access it via a wide area network. According to an ECMWF representative, the system will offer advancements in three areas:

It will take better advantage of information provided by an enhanced network of satellite observation systems. Blue Storm will help scientists more accurately determine the initial state of the atmosphere and oceans, thus significantly improving the Centre's forecasts.

It will offer enhanced representation of heating and cooling, cloud formation and dissipation, rain, snow, and other processes in the Centre's model of the global atmosphere. The model uses 21 million grid points distributed throughout the atmosphere between the surface and a height of 65 km.

It will improve the techniques developed by the Centre, based on chaos theory, to estimate the uncertainty in the forecasts and the probabilities of alternative developments over the coming week, month, and season.

The system, to be delivered in stages from 2002 through 2004, will be based on a cluster of p690 enterprise servers initially capable of seven teraflops. This will be expanded to 20 teraflops in the final installation. Also included will be a range of data storage products. The price of the system was not announced.

Free Program Teaches Arithmetic

At the other end of the scale of computational requirements is a free arithmetic education program available from Argonne National Laboratories. "The ArithmAttack" is designed to answer the provocative question, "How many randomly generated arithmetic problems can your elementary-school children answer in 60 seconds?" The game randomly creates problems using numbers that the user sets between 0 and 25. Users can focus exclusively on addition, subtraction, multiplication, or division, or random combinations of these. You can download the free software **(www.anl.gov/OPA/attack.htm)** and play the game on any computer running a Windows 95 or higher operating system. For non-Windows computers, an earlier version, written in JavaScript, can be played or downloaded on the World Wide Web at **www.dep.anl.gov/aattack.htm** or downloaded free for use on individual computers. The JavaScript version runs as a Web page on Microsoft Internet Explorer, version 3.0 or higher, and Netscape Navigator, version 3.0 or higher.

Circuits and Devices

Rotary Position Sensor Only 2.1 mm Thick

Murata Electronics North America **(www.murata.com)** has introduced a new contact rotary position sensor (PVS1 series) for the automotive and entertainment markets. Using highly resistive materials and wipers, the surface mount rotary position sensor is said to have a rotational life of one million cycles. Murata also claims a greater level of accuracy and reliability than in competitive products, and a very thin design profile of only 2.1 mm. The PVS1 series is designed for use in a variety of industries. Among its applications for the automotive market are automatic seat and mirror position adjustments, as well as trunk opening and climate control regulation. The sensor works by detecting the angle and position of equipment through a change in the output voltage. In addition to automotive applications, the sensor is suited for use in the entertainment industry. The sensor can be used in robotic pets, electronic motor driven bicycles, and radio-controlled toys. The PVS1 series also provides lead-free construction, making it suitable for the high peak temperature re-flow soldering process and compliant with environmental regulations. It also incorporates sealed construction, giving it a stable performance, as well as a D-formation through-hole rotor (which enables the selection of many kinds of gear shapes). The series is available in a tape-and-reel package. The sample price for the PVS1 series is approximately 50 cents. The lead time for volume purchases is eight to nine weeks.

Industry and the Profession

Zilog Nearing the End?

In the early 1980s, when IBM executives still believed that the personal computer was a passing fad, most microcomputers ran Digital Research's CP/M operating system and were driven by Zilog's venerable Z-80 processor. Prominent among them were RadioShack's TRS-80 (affectionately known as the "Trash-80"), the Osborne 1, and various Kaypro models. But when IBM finally awoke, the company decided to demolish the existing competition by basing its machines on Microsoft's MS-DOS operating system and Intel's 8086 microprocessor, thus imposing a new industry standard. (Had IBM decided to develop its own operating system, Bill Gates would probably be selling home appliances at a Sears store now, but never mind.) The result was a relatively quick death for Osborne, Kaypro, Digital Research, et al. However, because the Z-80 was essentially a very nice piece of hardware that could also be adapted for use in a range of low-end microcontroller applications, Zilog managed to hang on.

The company is still breathing, but it recently announced plans to enter Chapter 11 bankruptcy after defaulting on an interest payment on its $280 million debt. Creditors have agreed to trade the $280 million owed to them for a $30 million unguaranteed note, which could put the company on firmer financial ground. "We have made significant progress in returning Zilog to full financial health," said Jim Thorburn, chief executive officer. "We have a cash flow positive business and, on approval of this plan, we will substantially strengthen our balance sheet, with the elimination of our senior notes." But will the company continue to survive with a small niche in a very competitive market? Well, maybe. **NV**

Learning RVK-Basic Part 2

By Bob Vun Kannon

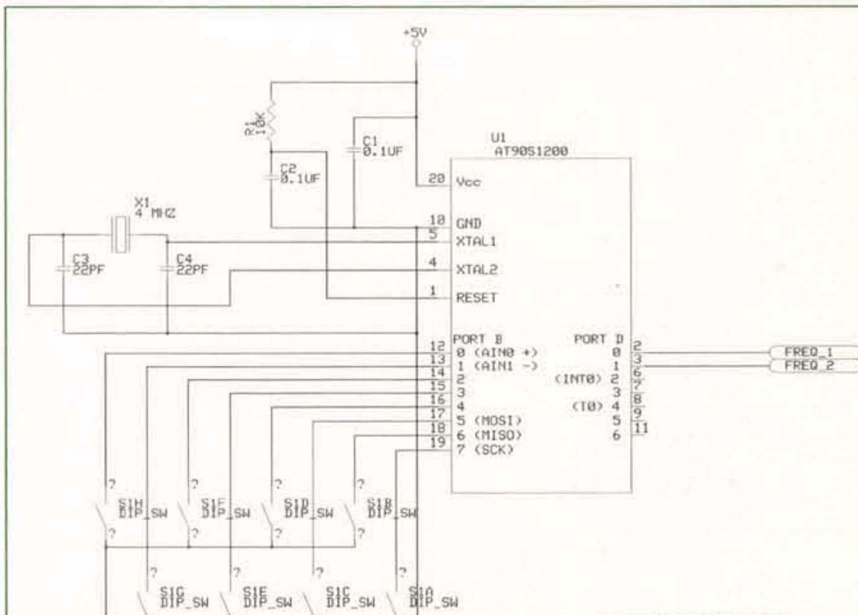
RVK-Basic is a free Basic compiler for the Atmel AVR line of microcontrollers. You can download a copy of this compiler from the *Nuts & Volts* web site. With this compiler you can write and compile very fast, efficient programs for most of the AVR microcontrollers.

In this lesson, we are going to introduce a program that will use a small AVR to generate two different output frequencies simultaneously. You will want to build this one and get it working and keep it around because it will be very useful for checking out the code in the third article of this series.

By all means, do not be alarmed if you do not understand all of this program at this point in your learning process. It really is too much program for some rookies at this point, but I am giving this to you now so that you will be able to use the working device as a stimulus for the next article in the series.

The idea behind this design is that we will use the counter-timer (called TIMER 0) on the chip to establish a time-base. Using this time-base, our software will vary the two output frequencies according to an eight-bit DIP switch. This will allow the user to change either of the two output frequencies independently by throwing switches.

TIMER0 is a free-running counter. It is a piece of hardware on the chip that will count continuously in real time without any software intervention. In software, we can read this timer any time we want to. To help clarify the idea, the following picture shows a real-time picture of the TIMER and the two outputs when one output is half the TIMER frequency and the other is 1/6 of the



SCHEMATIC

timer frequency. The top output changes on every change in TIMER0. The lower output changes on every third change in TIMER0. The numbers across the top are the states of TIMER0 and the waveforms are the resulting outputs.

In order to use TIMER0 we need to use the TIMER0 statement in RVK-Basic to turn it on. The statement will take the form TIMER0 ON N, where N is 1, 8, 64, 256, or 1024. N is called a prescaler because it scales the AVR's clock down by dividing its frequency by N. So if N is 64 and the processor is running at 4 MHz, TIMER0 will be running at 4 MHz divided by 64, or 62.5 KHz.

Another statement we will use is the PAUSE statement. This simply

```
DEVICE 1200
    MHZ    4
    REVISION FGEN 011016.1-RVK


    DIRPORT D,OUT
    'DIRPORT B,IN
    OUTPORT B,&HFF
'=============================================================
'=      B is input port. Bottom four bits control output1.   =
'=      top four bits control output2.                       =
'=      On startup, the bottom four bits control the freq    =
'=      range.                                               =
'=      Output3 is set to timer0 freq / 2.                   =
'=============================================================
    EQU "D,0","OUT1"
    EQU "D,1","OUT2"
    EQU "D,2","OUT3"

    PAUSE 50          '..allow system to settle

    INPORT sftcnt,B
    INCR sftcnt     '..a software frequency divide by sftcnt
                    '... 1 <= sftcnt <= 256 ....

    TIMER0 ON 64    '..TIMER FREQ IS 62500 Hz...
                    '..Max OUTPUT is 31250 HZ/sftcnt...
                    '..Min OUTPUT is  1953 HZ/sftcnt...

    I1 = 10         '..logical frequency divider for output1
    I2 = 11         '..logical frequency divider for output2

'———BEGIN MAIN LOOP————
MAIN:  DO
         '..toggle output 1?....
       DECR I1
       IF I1 = 0 THEN
         INPORT temp,B
         I1 = temp AND &H0F
         INCR I1
         TOGGLE "OUT1"
       END IF

         '..toggle output 2?....
       DECR I2
       IF I2 = 0 THEN
         INPORT I2,B
         SHIFT I2,4,RIGHT
         INCR I2
         TOGGLE "OUT2"
       END IF

       FOR temp = 1 TO sftcnt
           '...wait for next timer tick...
         TIMER0 READ ctime
         WHILE ctime = oldtime
           TIMER0 READ ctime
         WEND
         oldtime = ctime
         TOGGLE "OUT3"        '...OUTPUT3 runs at TIMER0/2 freq...
       NEXT
    LOOP

'————END MAIN LOOP————
```

You can run this program on an STK200 or STK500 board, to see it work. To compile this program, put FGEN.BAS in the directory where the compiler is and enter:

```
RB FGEN
```

What you do next depends on how you intend to program the device. If you are using Windows software to program through a serial cable, enter:

```
ASMHEX FGEN
```

The file you need for programming will be in FGEN.HEX.
If you are using the parallel described in RBP.TXT, enter

```
ASM FGEN
RBP FGEN /1200/Y
```


causes the program to wait for the number of milliseconds specified after the word "PAUSE." In our case here, I will insert a 50 millisecond pause after power up to allow the voltages on the input switches to stabilize before we read them.

Another new idea in this program is the OUTPORT command for an input port. PORT D is our output port where the frequencies come out and PORT B is the port where we will read the DIP switches. When we write a 1 out to any bit of a port which is in an input state, we turn on a pull-up current source for that port. By doing this to all eight pins of PORT B, we allow the DIP switches to be connected without any further need for external pull-up resistors. L1 and L2 in this program are byte variables used for storing the commands for each output frequency.

SFTCNT is a byte variable that controls the scaling of the frequencies. It is read only at power up and thereafter remains fixed until the next power cycle. Before you turn power on to the unit, set the switches to control SFTCNT.

Where F is the frequency of the processor clock and B is the number on the DIP switch at power up, the maximum frequency of either output will be:

$$Fmax = F / 2 / (B + 1)$$

The minimum frequency out of either output will be

$$Fmin = F / 32 / (B + 1)$$

Other statements new to the student in this program are "INCR," "IF," "END IF," "WHILE," and "WEND." These will be explained in detail in further articles, but to see the details of their usage now, look them up in the file RB.TXT that comes with the compiler.

In the following program (which I have named FGEN.BAS), we read the DIP switches into SFTCNT, set up the TIMER0 to run at the processor clock divided by 64, and set L1 and L2 to temporary values which will be in effect only until the first transition on each output. Thereafter, the output frequencies are set by the last known state of the DIP switches.

In the MAIN loop of the program, we first decrement the output control variable (I1 or I2) and check to see whether we have reached 0 yet. When we reach 0, we toggle the output line and read in the control variable again.

The SHIFT I2, 4, RIGHT statement causes the upper four bits of the DIP switch to move to the lower four bit positions of I2, thereby making the upper four switches behave for output 2 exactly like the lower four control output 1. The SHIFT command will be treated in more detail in a later lesson, but you could look it up now in RB.TXT.

After we've finished toggling or skipping each output, we come to a FOR statement (see RB.TXT again). This is a simple counting loop that counts from 1 to SFTCNT. Inside the loop, we have a WHILE loop that waits until we see a change in the TIMER0 state. So the FOR loop will delay the program for SFTCNT transitions in TIMER0.

Toward the bottom of the FOR loop, you will notice that I have placed a command to TOGGLE the D2 pin. This is there solely for debug. No matter where you have the switches set, the D2 pin should be running at a constant frequency of the processor clock divided by 128. Check out the complete program listed in the shaded box.

In our next installment, we will need two separate frequency inputs. So if you don't happen to have to signal generators laying around, you will want to build a piece of hardware to run this program. I am including a schematic that you could use to do this. Program your processor on your development board and then plug it into the board you build according to the schematic.

You'll notice that there is no power supply on the schematic and no output connector. These are details left up to you. You could decide to put a three-terminal regulator on this board if you wanted to. Do make certain that you have power and ground correctly connected to the processor before you actually insert a processor.

You get this one going and I'll be back with a device that measures frequencies next time. **NV**

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Reader Feedback

Dear *Nuts & Volts*:

I am 75 years old and for almost 50 years my interest and my passion has been regenerative radios. I hope we never lose this link to our electronic past.

I have built hundreds of these little "signal grabbers" and most are my own designs. I would like the opportunity to share some of these circuit designs to those with similar interests. I am not interested in profit and would just like to share my ideas with others. Almost all of my circuits are in the aircraft frequencies of the general aviation band, as well as the military band. These are the super regen types (too lazy to wind tickler coils even if they would work at these frequencies).

Do you think electronic hobbyists are still interested in building simple electronic projects that can be completed in a few hours, have the joy of seeing them work or be dismayed at having to start over? Even when the projects are unsuccessful, they are a learning experience and patience and perseverance will help you find and correct the error.

W.T. (Bill) Stratton
1211 New Hope Rd.
Columbus, MS 39702

Dear *Nuts & Volts*:

I've read through the article from TJ Byers on his Versatile AC Power Supply, and have a couple of questions:

1) He briefly mentions some surge absorbers used (PC1, -2 and -3) and they are included in the parts list, but without part numbers or a source. How should these be spec'd and where can we procure them?

2) In the schematic, F2 is shown as fusing the neutral side of the AC mains. I thought that this was not good practice, since, with both F1 and F2 fuses being the same value and effectively in series, it becomes a 'crap shoot' as to which one will go first in the event of a fault. This can still leave a 'hot' chassis for an unsuspecting experimenter in spite of a blown fuse, if the neutral fuse goes first. It would be better, I think, to leave out F2 and just have F1. If I'm all wet here, please set me straight. Thanks. Thought I'd mention these items.

Dan P via internet

Dear *Nuts & Volts*:

In the last issue of your magazine, TJ Byers published a schematic for a battery maintenance charger at the request of another subscriber.

I built same but cannot not get the first stage (mulitvibrator) to oscillate. Manually triggered, the second stage works fine. Is the schematic correct ????, or am I missing something?

Anonymous

The first stage (multivibrator) is voltage triggered. Measure the voltage on pin 2 of the first stage while monitoring the output. When the voltage on pin 2 goes below 2 volts, the multivibrator oscillates at about 100 Hz. When the input voltage exceeds 2 volts, the oscillator stops. The output from this stage is used to trigger the second (timer) stage. If you are trying to monitor a voltage other than 13 volts, you will need to adjust the value of the 5.6k resistor up or down, accordingly. — TJ

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HP 8660D/86603A-002 Signal Generator, 1-2600 MHz, 1 or 2 Hz res., phase modulation $6000.00
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 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
HP 8684D Signal Generator, 5.4-18.0 GHz, cavity tuned, AM/ WBFM/ Pulse $3750.00
MARCONI 2019 Signal Generator, 80 kHz-1040 MHz, 10 or 20 Hz res $850.00
WAVETEK 952 Signal Generator, 1-4 GHz, +10 dBm, AM, FM $750.00
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/ 83592A Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled $9000.00
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, 12-18 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 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

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 2100L Amplifier, 50 dB gain, 10 kHz-12 MHz, 100 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 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
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 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 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 G $1000.00
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 3022 Bi-Directional Coupler, 20 dB, 1-4 GHz $450.00
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 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 #44 on the Reader Service Card.

News Bytes

Prime Services Group Opens DSL Consumer Equipment Sales to the Internet

Prime Services Group, Inc., a Livermore, CA-based Disabled Veterans Enterprise has announced the opening of its Internet storefront, featuring proven Small Office /Home Office and consumer DSL hardware and accessories. The web store will offer time-tested integrated DSL and Ethernet routers from Cayman Systems, Westell and Efficient Networks DSL modems, networking products, as well as hard-to-find POTS splitters, and filters.

Prime Services Group — a pioneer in the installation of ADSL premise equipment — launched its broadband installation unit in 1997, also providing training, technical support, and product fulfillment, shipping over 40,000 installation kits a month. The web store is a natural extension of the brick and mortar fulfillment business offering consumers and businesses a convenient way to purchase new equipment and upgrade existing installations.

Prime Services Group also provides a wide range of installation services ranging from structured cabling and riser management to MDU/MTU broadband and central office services. Prime Services Group is an experienced provider of broadband solutions featuring Tut Systems, Telco Systems, and GoBeam broadband products, just to name a few.

Circle #78 on the Reader Service Card.

Circle #79 on the Reader Service Card.

Blockbuster and RadioShack Complete Consumer Electronics Pilot

Based on Results, Blockbuster Announces Plans to Develop Home Entertainment Electronic Offering

With the completion of a pilot program that introduced "RadioShack Cool Things" stores inside 130 Blockbuster locations, Blockbuster, Inc., has announced plans to develop a home entertainment electronic offering at its stores nationwide. The decision was made based on Blockbuster's overall work in consumer electronics, including the RadioShack trial, as well as the company's successful sale of other electronics offerings, including DIRECTV, over the past 16 months.

"Through our work in consumer electronics and specifically our trial program with RadioShack, we were able to gain valuable insights in a very cost-effective manner that will enable us to establish a profitable program selling select consumer electronics that complement our core business," said John Antioco, chairman and CEO for Blockbuster.

According to Antioco, the RadioShack pilot program, which consisted of placing a miniaturized RadioShack store inside Blockbuster, included a wider breadth of product than Blockbuster customers wanted and required.

Based on results from this pilot program and other tests, Blockbuster will customize its line-up of consumer electronics with a business model that provides for minimal capital investment and a more efficient use of store space and labor than the RadioShack in-store trial required. Blockbuster anticipates being in a position to introduce a selection of consumer electronics later this year.

Blockbuster has had a history of selling consumer electronics prior to the RadioShack test. The company began selling DIRECTV in 2000, and in less than one year had become the nation's No. 2 DIRECTV retailer.

In addition, the company has sold an assortment of consumer electronics products, including home theater products, DVD, and VHS combo players and mobile phones.

In February, Blockbuster and RadioShack announced their plan to test a RadioShack store within-a-store concept inside Blockbuster locations. By July, the two companies had opened approximately 130 "RadioShack Cool Things" stores in four pilot markets. **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:

Use your PC to help in the fight to find a cure for cancer. Answers concerning temperature sensors, controllers, non-contact sensing, and thermal imaging. Need to design a squarewave oscillator? Got your numbers. And Gordon Moore's legacy.

Point-and-Shoot Thermometers

Q. I've seen non-contact thermometers, but I have little knowledge about how they work. From what I've gathered, the human body radiates energy at around 9-10 microns. How does a passive IR device measure so accurately in such a narrow bandwidth? Would a mirror reflect "object" readings, or indicate its own temperature under this kind of test? What kind of sensor reads down in the "basement regions" and differentiates the frequencies so well? How does it differ from the sensors in FLIR systems?

Les KA9GLW
via Internet

A. Let's first put these two topics into their proper perspective. FLIR (forward looking infrared) is an infrared camera that takes a snapshot of an object using the heat it radiates to produce an image, as shown in the picture below of two mugs filled with hot coffee.

A non-contact IR thermometer, on the other hand, is something like a radar gun, in that it can measure the temperature of a distant object by pointing the "pistol" and pulling the trigger.

All matter — animate or inanimate — with a temperature above absolute zero (273.1 degrees below zero C) emits thermal energy with its surroundings in the form of electromagnetic radiation. The characteristic spectrum of the radiation depends on the object and its surrounding temperatures. By analyzing this spectrum, the temperature of an object can be measured without the need for direct contact.

Without delving into quantum mechanics and Planck packets, suffice it to say that each temperature has its own characteristic spectrum pattern. As the temperature increases, so does the energy level contained within the spectrum envelope, and the more pronounced is the peak frequency.

The heat spectrum — the part we are interested in — extends from 0.7um (700nm) to about 30um. And yes, the temperature of the human body has a peak wavelength between 9um and 10um. By analyzing the peaks and energy levels of the emitted spectrum, the temperature of the body can be accurately measured. That's what an IR thermometer — a.k.a., radiation thermometer — does.

A radiation thermometer consists of an optical system and detector. The optical system focuses the energy emitted by an object onto the detector; the output of the detector is proportional to the amount of energy radiated by the target object (less the amount absorbed by the optical system), and the response of the detector to the specific radiation wavelengths. Three types of detectors are commonly used: thermal, photon, and pyroelectric.

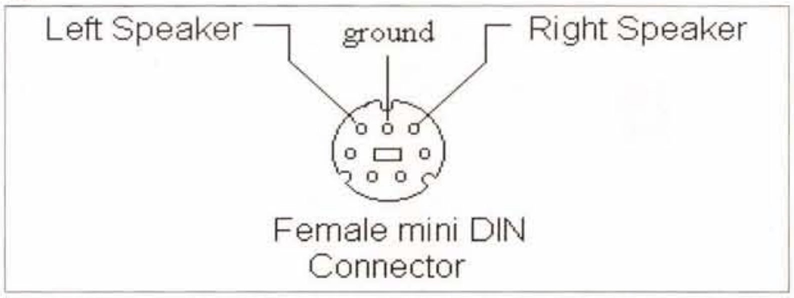
Thermal detectors, which generate an output voltage when heated, are the most commonly-used radiation thermometer detectors. A thermopile consists of one or more thermocouples in series, usually arranged in a radial pattern so the hot junctions form a small circle. These detectors have lower sensitivity compared to other detector types, and the speed of their response is limited by their mass. However, they are less affected by changes in the radiated wavelengths and can be found for under $100.00. For an in-depth look at this fascinating technology, go to **Omega Engineering's** web site at **www.omega.com/literature/transactions/volume1/historical1.html.**

IBM Sound Card Connector

Q. I have a model MM55 monitor made by IBM that came with my Aptiva PC. Inside this monitor is an excellent Bose speaker system that I can't use with this computer because there is no cable that connects to the monitor's seven-pin DIN socket and the PC's sound cards. What I need to know is the pinout of the DIN connector so that I may fabricate a cable of my own.

Burton Daggett, Sr.
Shelton, WA

A. Here it is.

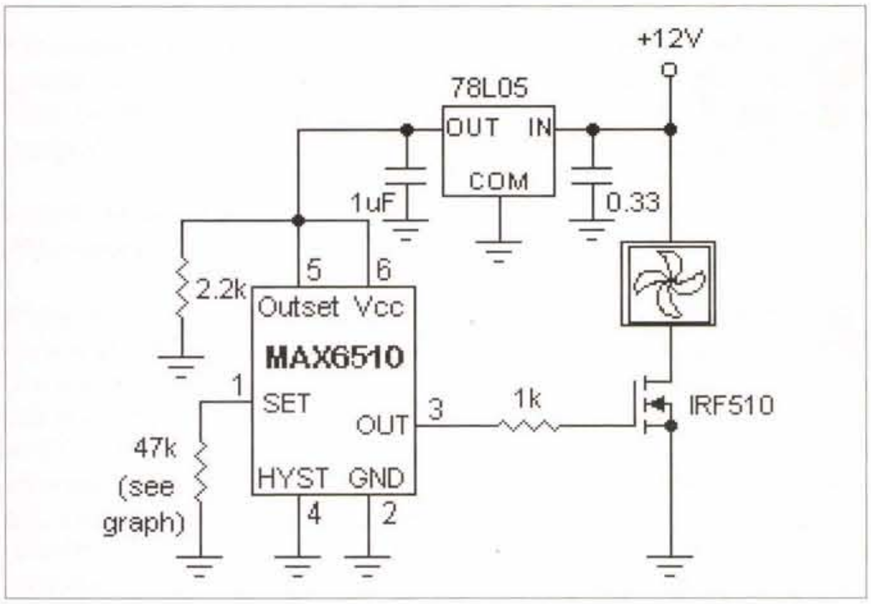


Hard Drive Cooler Thermostat

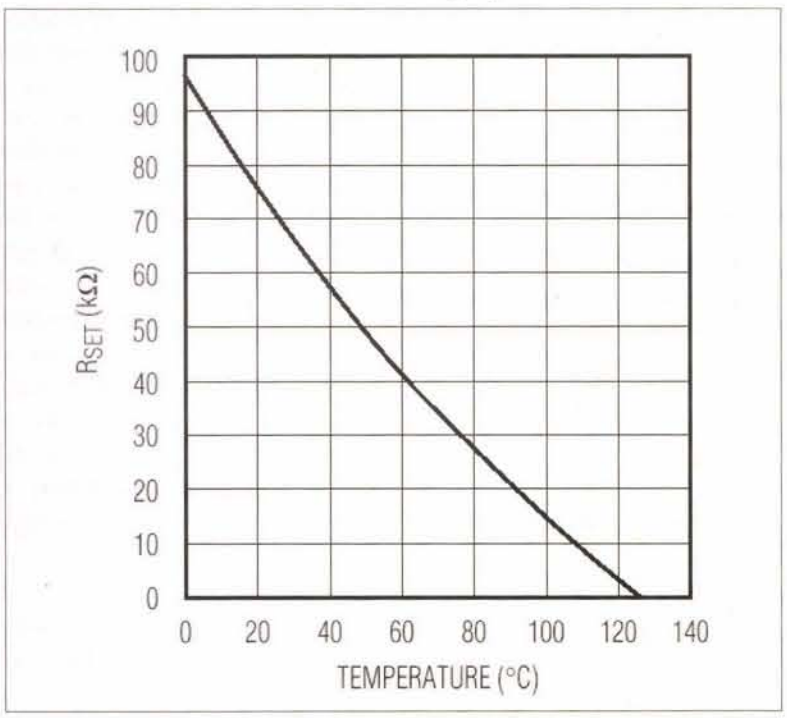
Q. I purchased a hard drive cooler from Jameco (#170595) which came without a temperature control switch, which means the three fans stay on constantly when the PC is turned on. I would like to add a MAX6510 temperature control switch as shown in the Jul. 2001 issue (page 27), but I want it to be powered from the 12-volt source that powers the fans (no external battery). Can this be done? Also, what type of diode is used in the original diagram?

Dan Ghergher
via Internet

A. Now that I know the exact voltage and current ratings of your motors, I can streamline the design. First, the relay is replaced by an IRF 510 transistor, which also eliminates the "mystery" diode (1N4001) and 2N2222A transistor. The FET can handle loads up to 5.6 amps.



Next, a 78L05 regulator is added to power the MAX6510 controller from the PC's 12-volt line, and the setpoint pot has been replaced with a fixed Rset resistor. The value of the resistor sets the temperature at which the fans kick in, as shown in the graph below.



Two PCs, One Monitor, One Switch

Q. I have a Pentium PC that I use daily and an old 486 computer that I use on occasion — but only one monitor. This usually requires switching the monitor from one PC to the other by swapping cables. Is there a way to safely switch on the fly? I was thinking I could build a circuit switch with voltage-follower op amps with a switch in the center. Or is there a better way to do this?

Matthew Flynn
via Internet

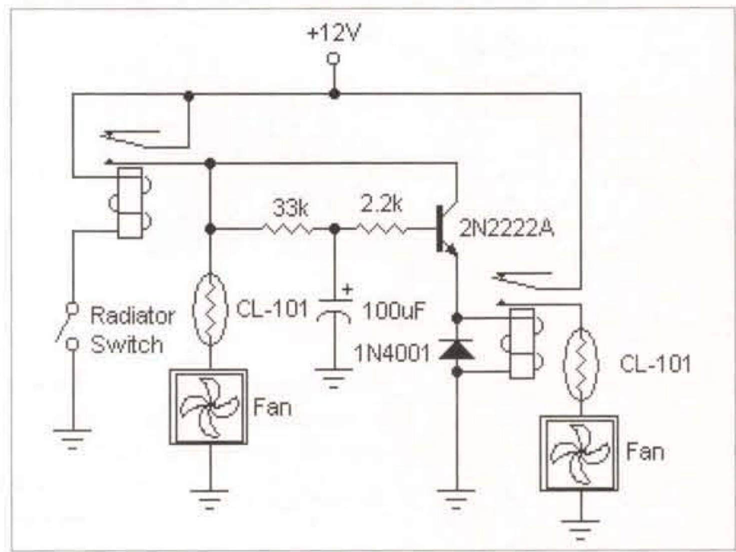
A. This is a common request — so common, in fact, that several manufacturers make switch boxes just for this purpose. Some of the switch boxes are buffered with video amplifiers, while others (at the bottom of the line, and less expensive) are simple A/B switches. Prices range from over $200.00 to as little as $11.00. **Jameco (800-831-4242; www.jameco.com)** has a good selection of switch boxes of different types and prices.

Trucker Keeps His Cool

Q. After many years of fighting overheating problems with my truck, I installed an oversized radiator that requires a twin-motor electric cooling fan assembly that draws over 15 amps per motor. Since it has knocked out two alternators in short order — the second being a higher amperage unit — I would like to find a temperature-controlled, time-delay circuit to keep both fans from starting at the same time. I would prefer using a Type-J thermocouple as the sensor, as I have lots of these, but a thermistor would be fine. The two outputs should be able to operate 12-volt relays with 72-ohm coils, another part I have on hand.

Tim LeMaster
via Internet

A. This circuit can be quite simple if we use a radiator switch (which you probably already have installed) instead of a thermocouple. Although the triggering temperature will be fixed, it eliminates the design problems associated with using low-voltage sensors in a harsh environment found under the hood of a car. But this is a small price to pay for a protector that lessens the burden on your electrical system.



The radiator switch turns on the first relay when the water temperature exceeds the preset limit, typically 195 degrees (F). This applies power to the first fan and the second relay timer circuit, which consists of a 2N2222A transistor, timing capacitor, and timing resistors. When power is applied, the capacitor begins to charge. About five seconds later, the voltage across the capacitor turns on the transistor and engages the second relay. Both motors have an inrush current limiter, an NTC (negative temperature coefficient) thermistor, that prevents the alternator from being hit with a big surge of starting current. As the thermistor heats up, its internal resistance decreases and delivers full power to the now-spinning fan. The delay time between fan #1 and fan #2 can be increased or decreased by changing the value of the timing resistor — more capacitance means a longer delay.

Cool Web Sites!

Would you like to help in the search for a cure for childhood leukemia or Alzheimer's Disease? In conjunction with participating scientific organizations, Intel has formed a philanthropic program that lets you share your PC's resources to help fight these and other life-threatening diseases. To participate, log on to their secured site.
www.intel.com/cure

Iron Pyrites Negative Resistance Oscillator
http://home.earthlink.net/~lenyr/iposc.htm

Free magazines!
www.motionnet.com/cgi-bin/search.exe?a=cat&no=1947

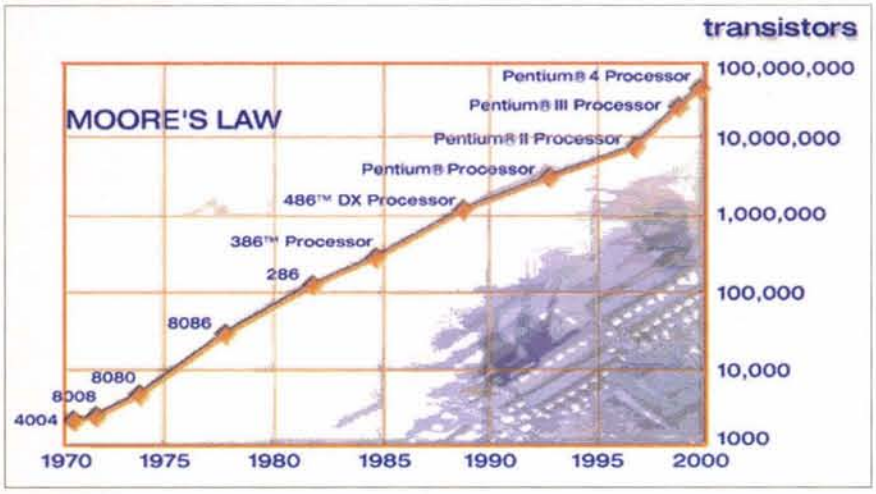
If you're searching for a magazine article you've read in the past, or need to find related articles using keywords, check out FindArticles.
www.findarticles.com

Gordon Moore's Legacy

Q. What is Moore's Law? I can't find it anywhere in my reference books.

Barbara Brant
via Internet

A. Well, it's not a law in the truest sense of the word like Ohm's Law. Instead, it's an observation set forth by Gordon Moore, cofounder of Intel, which predicted that the number of transistors per integrated circuit would double every 18 months. He forecast that this trend would continue through 1975. However, Moore's Law has lasted far longer than expected, and still holds true to this day despite accelerated advances in chip technology.

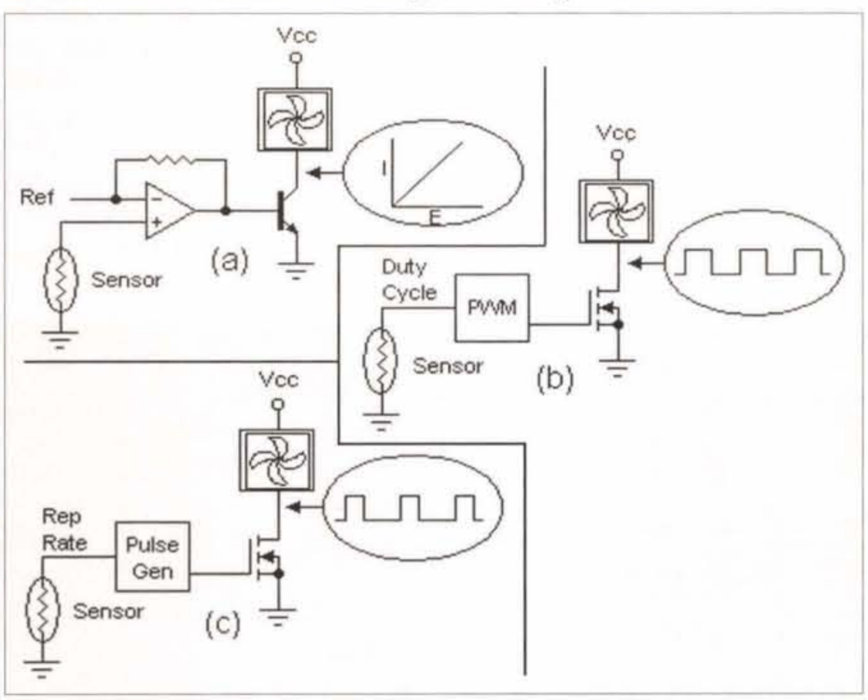


Fan Speed Senses Temperature

Q. I'm currently taking an engineering course in electronic design and want to do a circuit that controls the speed of a fan with respect to the temperature. Please explain how this is done.

Peter Moses
via Internet

A. Do I get the credits if you pass the class? Seriously, this is something you have to do on your own. However, I will suggest three methods that are commonly used for this application. It's then up to you to decide on the method and design a working circuit.



The top circuit (a) is a linear amplifier that drives a power transistor to control the voltage and current flowing through the fan. The next two circuits are pulse modulated, which adds to the efficiency of the controller (i.e., less power dissipated (wasted) by the power transistor). The first (b) uses PWM (pulse-width modulation) where the duty cycle of the squarewave determines the power applied to the fan. The smaller the duty cycle, the slower the fan spins. The bottom circuit (c) uses a pulse generator with a variable pulse rate. The higher the pulse rate, the more average power applied to the fan, and the faster it spins.

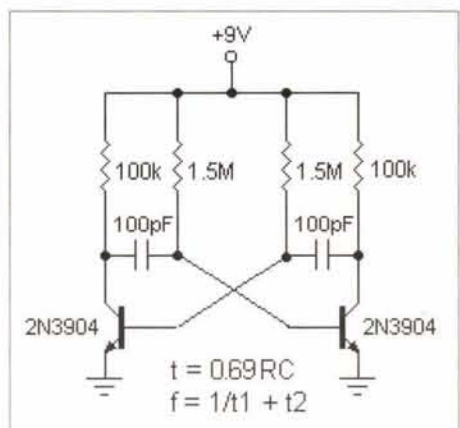
Squarewave Oscillator Designs

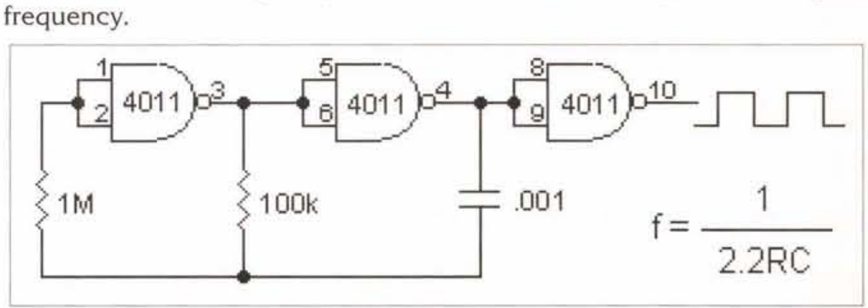
Q. In the following figures are two oscillators. I want to replace the top oscillator with the bottom circuit (it's an upgrade to an existing instrument). What I need to do is find the frequency of circuit (a), then calculate the values needed for circuit (b) so that it's the same frequency. Can you help me out?

Craig Kendrick Sellen
Simpson, PA

A. Before we start, let me point out that your second circuit isn't a good replacement for your application, so I took the liberty of substituting an equivalent circuit for figure (b). Your original circuit is a veteran of many wars, and has served the industry well. But the days of discrete transistor designs are all but over, and making the move to ICs is logical. This astable multivibrator has no stable state, which means as the feedback capacitors charge and discharge, the transistors' bias point shift the collector currents on and off. If the timing capacitors and resistors are perfectly matched, the output will be a square wave. However, this is seldom the case, resulting in a duty cycle that is less than symmetrical. Moreover, this design is voltage and temperature sensitive, which leads to frequency drift. The frequency can be calculated using the formulas shown below — 4.83 kHz, for the values listed.

The next step is to calculate the values for the new CMOS oscillator. Unlike the transistor version, the new circuit uses a single timing resistor and capacitor to provide good squarewave symmetry. The circuit is also less sensitive to voltage and temperature variations, and uses one-half the number of components. Only one resistor, one capacitor, and two gates are needed; the extra resistor (1M) and gate provide buffering that sharpens up the squarewave. Substituting the values listed in circuit (b) results in a calculated frequency of 4.54 kHz; an actual breadboard version measured a frequency of 4.71 kHz — close enough to the original frequency.





EchoStar, Where Are You?

Q. I'd like information on hardware and software to "steer" an 18-inch TV satellite dish. The purpose is to scan the sky for 2.0 to 2.5 GHz signals. An inexpensive servo system would make sense, similar to that used with telescopes.

John Wax
via Internet

Q. Do you have any ideas for a simple field strength meter to help set up direct satellite systems? Nothing fancy, just something that I can aim at the sky to get within the ballpark.

B. Mcphee
via Internet

A. In the last few months, a unique instrument has appeared on retail shelves and several web sites. Generically dubbed satellite finders, these devices are field strength meters operating in the 950 to 2,000+ MHz range. Prices range from $19.00 up to $49.00. Simply wire the meter between the dish and the receiver, turn on your equipment (it provides power to the meter), and adjust the satellite dish until the meter indicates optimum signal strength.

Here is a short list of suppliers.

Lashen Electronics
www.lashen.com/vendors/JVI/sf20.asp; **973-627-3783**

Sat-City (UK)
www.sat-city.com/TST-Dynapacific-SF2300

Smarthome
www.smarthome.com/775381.html

Trianglecables
www.trianglecables.com/ansatfinmetw.html

Yahoo! Shopping
http://shop.store.yahoo.com/1soular/dirtvsatfint.html

Satellite finding software is mostly written by members of radio clubs and amateur astronomers. Unlike satellite finder meters, the software uses mathematics to plot the position of satellites using celestial and/or terrestrial maps. Here are a couple of promising web sites.

RealityNET
http://translate.google.com/translate?hl=en&sl=fr&u=http://www.reality.be/telecom/satellite/calc.htm&prev=/search%3Fq%3Dsatellite%2Bfinder%26hl%3Den%26sa%3DG

Satellite Finder
www.arachnoid.com/satfinder/

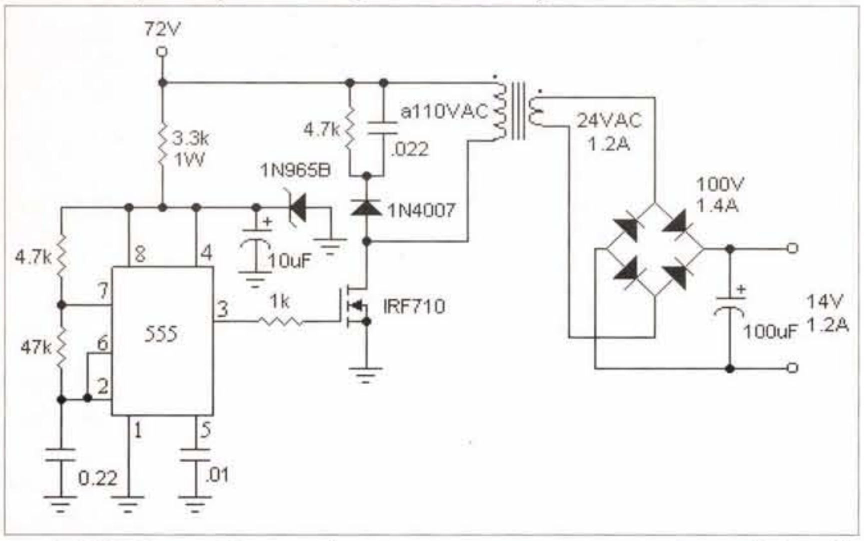
Satellite Hunting
http://fathom.org/Stephen/sathunt.html

Engine, Engine Number 9

Q. As a locomotive engineer, I sometimes spend a lot of time sitting on a side track waiting for trains coming from the opposite direction to pass. In other words, I have a lot of time to kill, which is why I bring my laptop with me. My conductor and myself play games while we wait. The problem is that we often run down the battery. On a locomotive, in the cab, is a source of 74 volts DC, generated by an auxiliary generator to maintain the 64-volt starter batteries (just like your automobile, but 64 volts instead of 12 volts). What I need is a small DC-to-DC converter to drop the 74 volts down to 14 volts at about 1.2 amps that will replace the wallwart.

Unsigned
via Snailmail

A. At first I thought of using an off-line switching IC, like the NCP1001 from ON Semiconductors (formerly Motorola). But for something as simple as substituting a laptop wallwart, it's overkill. A simple step-down power transformer is plenty good enough. What got me to thinking along this line was the fact that the voltage ratio between 74 volts and 14 volts is about 5:1, which means an ordinary 24 VAC power transformer will work. All we have to do is apply a squarewave across the primary and rectify the secondary.



A 555 timer chip running as a squarewave generator switches the IRF710 HEXFET transistor on and off at a rate of 60 Hz, which generates about 14 VAC in the secondary. The diode-resistor-capacitor network across the primary acts as a snubber that removes unwanted harmonics to prevent RFI and destructive high-voltage spikes. A 1N965B zener diode holds the Vcc of the 555 steady at 15 volts. At the other side of the transformer, a bridge rectifier turns the AC voltage into DC — and that's all there is. Simple, clean, and reliable.

MAILBAG

Dear TJ:

I think you got scammed by the submission of the 90# AT&T technician story. This story is only partially true. Here is AT&T's official statement.

David Nelson
Colorado Springs, CO

Find out about the 9-0-# phone scam.

The 9-0-# scam has been around for years and is directed at businesses, hospitals, government agencies, and other organizations that use telephone switching equipment called private branch exchanges (PBXs) to handle their calls.

This type of fraud involves a perpetrator who calls an office and cons an unsuspecting worker into transferring him or her to an outside line. The perpetrator then starts dialing calls that are charged to the owner of the PBX. In this latest version, the caller claims to be an AT&T service technician "repairing" the phone lines and convinces the recipient of the call to help out by transferring him to an outside line and then hanging up.

Below are some points about this scam worth remembering:

- This scam doesn't affect residential customers; its target is businesses.
- An AT&T service technician would never call customers and ask them to help check phone lines.
- The scam is generating a lot of interest in the media and over the Internet, but our network fraud experts report no increase in the number of fraud cases as a result of this notoriety.
- The best prevention against this type of fraud is for business managers to make their office staffs aware of it and to review what to do if it happens.
- If someone receives such a call, he or she should ask the "technician" for a call-back number or for the name and number of the caller's supervisor. Then hang up.
- To report this or any other phone scams, AT&T business customers should call their account representatives. You also can call the AT&T Business Customer Care Center at **1-800-222-0400**, or report the scam to your local law enforcement agency.

Circle #51 on the Reader Service Card.

LASER INSIGHT

By Stanley York

This month, we're going to look at another kind of laser system that has deeply penetrated our industrial lives — the laser marker. Some people call them laser engravers or laser etching systems, so I'll be different and use all three terms interchangeably. Laser markers are fascinating to watch in operation (through safety goggles, of course), and mere words cannot convey adequately the impression that these machines will leave on your mind.

In looking at how the laser marker works, we are going to be revisiting some old ground, but we'll also be exploring new territory.

Why a laser marker?

For many years, a number of different marking methods have been in use in industry for identifying and serializing products coming off the production lines. Among them are acid etch, inkjet, paint jet, pin stamping, rotary tool engraving, and so on ...

However, each of these methods leaves something to be desired. In recent years, the EPA has come down hard and heavy on industrial pollution. The results of the crackdown show up in the cost of the finished product (after all, somebody has to pay to dispose of the chemical waste from these machines).

Waste products from acid etch, paint marking, and inkjet carry a high price for disposal. Therefore, these methods have begun to lose favor in recent years. Not only through the expense of disposal, but also through lost time due to worker injuries, and general health issues evolving from the various inks and chemicals used in these processes.

These marking methods are also slow and messy, and require extensive clean-up between batches of product. They also require masks for each character, to shield the unmarked portions of the product. Serializing by acid-etch, inkjet, or paint jet requires a new mask for every product.

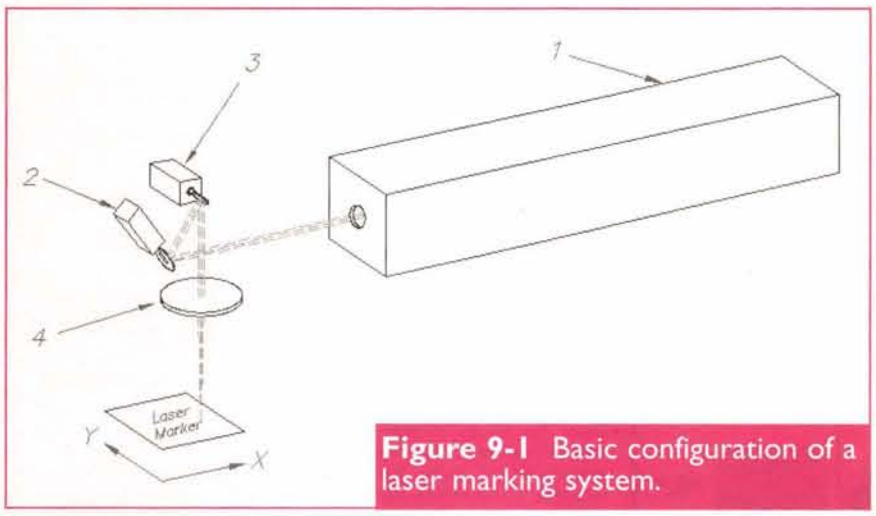


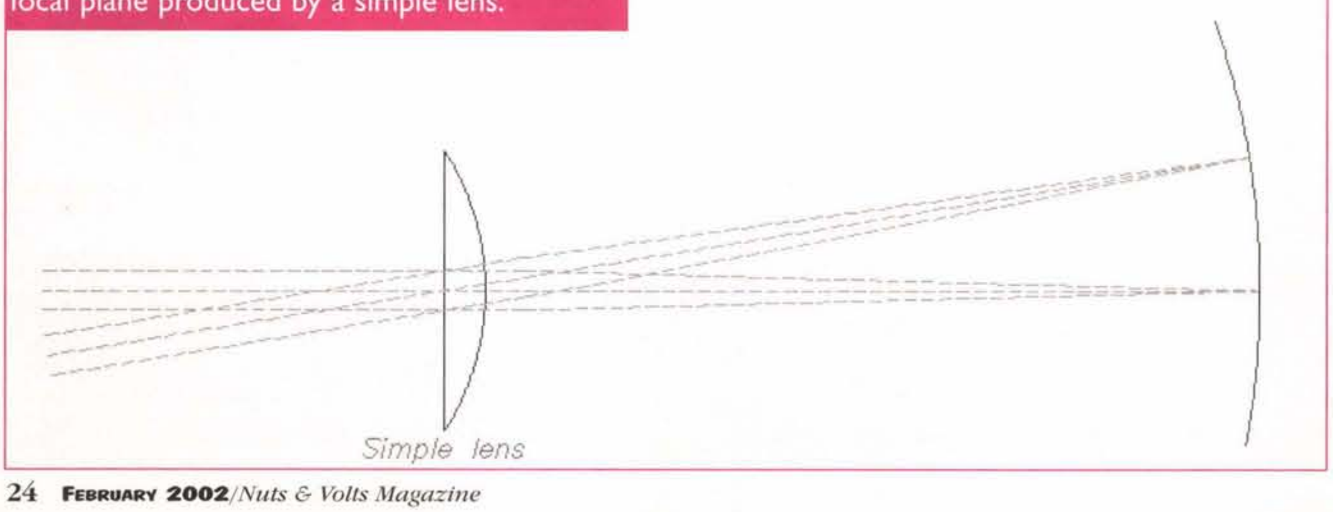
Figure 9-1 Basic configuration of a laser marking system.

If you have ever seen pin stamping performed, you will understand why this is not a popular method. It's relatively cheap, and produces no waste, but the machines are noisy, dirty, and require a lot of maintenance to keep them running. The pins are made of tungsten, and indent the product material with a sharp point on the business end of the pin. However, they break often and jam the machine. They do not lend themselves to high-speed operation because of the mechanical nature of the machine. When the pins break, it means that the corresponding part of the marked character will be missing, and it may be difficult to tell if the character was supposed to be a number or letter. The mechanical impact of the pins can cause fragile components to break or fracture, and so they cannot be used on delicate or sensitive parts, so these items require a different process.

Rotary engravers suffer from some of the same problems as the pin stamping machine, although the appearance of the marked characters is different. After a number of engravings, the sharp burrs on the engraving tip are worn down and do not cut away material cleanly anymore, but rather abrade it, more like a grinder, but not as sharp.

Ultimately, the tool becomes so worn that it merely scratches at the surface rather than actually mark it. In addition to these problems, any kind of marking using the above-mentioned methods, requires the parts to be held firmly in place while marking is performed.

Figure 9-2 This illustration shows the curved focal plane produced by a simple lens.



A laser, however, is much different. It is a non-contact engraving tool. There is no physical contact with the part being marked, and so there is nothing to wear out or get bent or broken. With nothing to wear out, the last engraved part is as good as the first. There are no w aste products to clean up afterward, and parts being marked do not require physical clamping to a reference surface as in the other methods.

Laser marked samples

You may be asking yourself how a laser can be made to mark (or etch, actually) various materials. You may have already seen examples of laser etching, but not realized it. A number of IC chip manufacturers use laser marking systems to engrave part numbers and date codes on their products. Soda bottling plants use a laser marker to etch date codes and bar codes on the side of those 2-liter plastic bottles that are so numerous these days. Motor vehicle manufacturers use laser engraving systems to remove opaque material from the back side of illuminated controls in your car, to let light come through from behind and show up so well in the dark.

Almost all of the marking methods mentioned above require the object to be marked to be held stationary while the mark is made. Mechanical impact from the pin stamping machines in particular, require the part to be held rigidly. This is okay as long as production volumes are low, and conveyor lines can be stopped and started while the clamping mechanism operates.

High-volume industries that have to mark or otherwise identify parts in large numbers cannot allow production lines to have a bottleneck situation over such a simple task as applying a mark.

Technology has come a long way since the first laser markers were built, and now it is possible to mark part numbers and bar codes on items that are moving at quite a high speed past a laser on a conveyor belt (known collectively as marking on-the-fly). For serializing parts, an incremental counter is used not only to count the parts going by, but also for incrementing the marker, so that consecutive parts get different serial numbers.

If there's one thing a laser is

good at, it is its ability to be moved between two points very quickly, and this is where the laser marker excels. In my business, we have a laser marking system for product date code and part number identification prior to products being packed for shipment. It can engrave about 200 alphanumeric characters per second!

But it can do so much more than that. It can be programmed to produce line drawings, graphics, and company logos on chromium steel that are fascinating to watch.

Character size and font are changeable on just about all commercially available systems. Our machine can mark alphanumeric characters down to about 0.5mm in height, and still are readable without a magnifying glass (with normal eyesight, anyway).

Some machines — ours included — can also reproduce photographs on metal in grayscale. This fact can be applied to the security industry, which is a hot item these days, for making ID badges. A photograph of a security officer etched into a metal badge using a laser is unique and impossible to fake without the proper equipment.

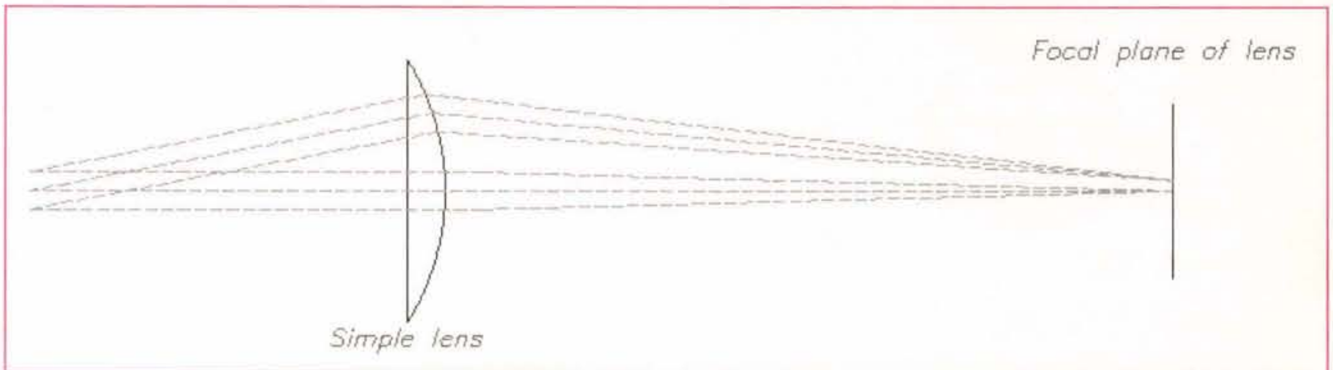


Figure 9-3 This illustrates how a simple lens tries to restore an off-axis laser beam to the same focal point.

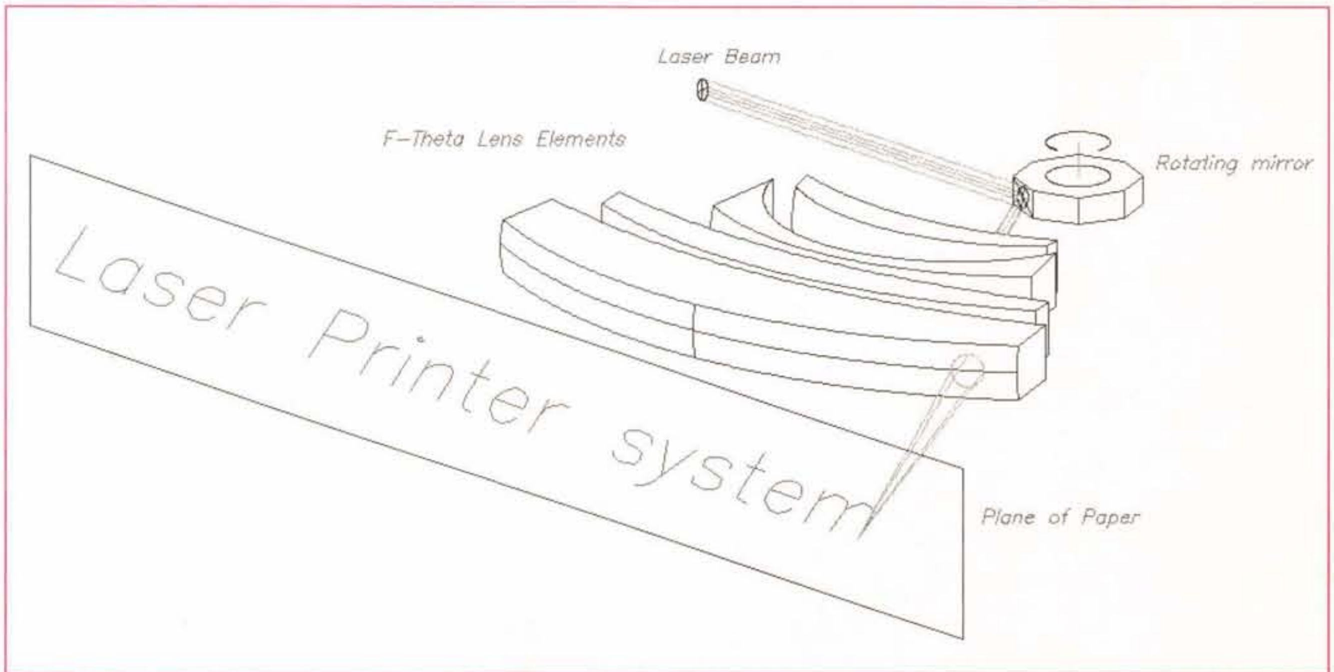


Figure 9-4 Basic optical configuration of an F-Theta (Flat Field) lens as found in a laser printer.

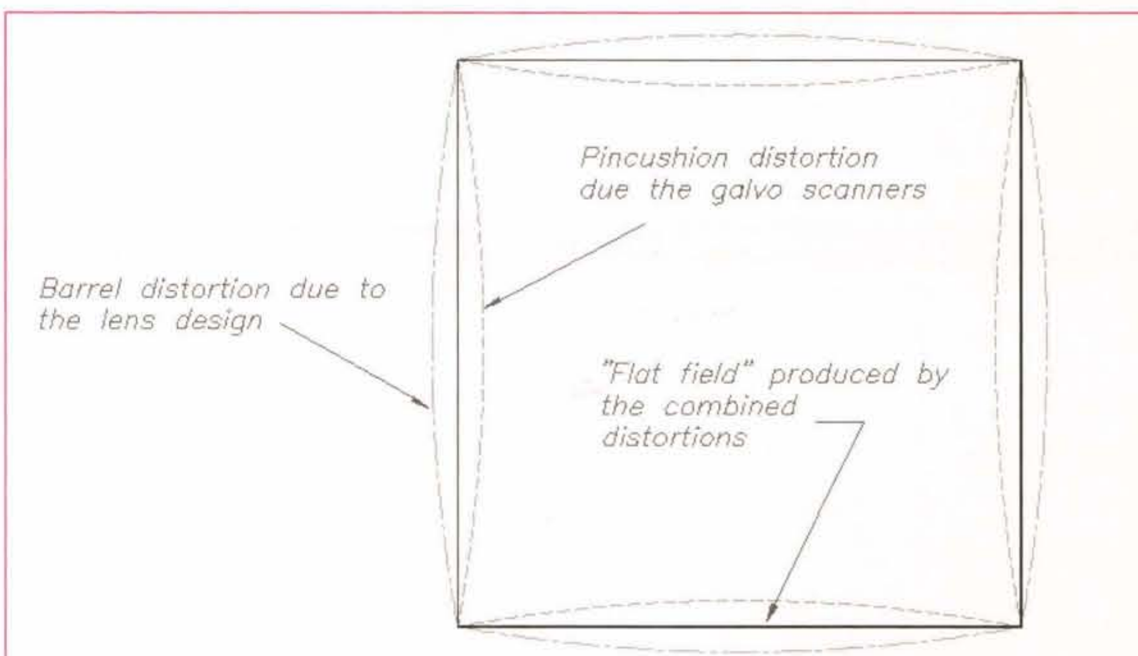


Figure 9-5 Pincushion distortion and barrel distortion combine to form a flat field.

So, how does it work?

Figure 9-1 shows the essential parts that make up a basic laser marking system. In a laser marker system, the laser beam is usually (not always) set up for low order mode operation. What this means is that we need the energy profile of the beam to exhibit a near-Gaussian energy distribution. I covered this topic some time ago, so I won't dwell on it here. In any event, the laser beam that is focused onto the work piece will produce the smallest spot and consequently, the finest detail, if the beam is purely Gaussian. There are other things that contribute to the smallest focused spot size, and regular readers will surely be able to think of one or two more.

In Figure 9-1, when the beam leaves the laser head (1), it first impinges on the center of a small mirror mounted on a galvanometer (galvo) shaft (2). A galvanometer is a special kind of motor that has a limited amount of motion, and I briefly covered this in the article describing the light show (*Nuts & Volts*, Sept. 01).

When the galvo is energized, it causes the galvo mirror to twist in one direction. A signal voltage in the opposite sense would cause the galvo to twist in the opposite direction. In the drawing, this mirror would cause a laser beam deflection in a direction perpendicular to the laser head (Y-axis).

Those readers who built the light show project a couple of months ago are probably ahead of me already. The laser beam reflecting from this first mirror falls onto the center of a second galvo mirror (3) mounted at right angles to the first. The beam impinging on this mirror is further deflected by movement on this galvo (X-axis), so now the beam has two components of deflection that can work either together or independently.

With the proper signals, then, it would be possible to position the laser beam at any point on the focusing lens (4). Laser marking systems usually have a graphical user interface (GUI) with a computer, to allow marking information to be entered and stored. The computer then puts out two channels of DC control voltage for directly controlling the position of the galvo mirrors.

If the lens depicted in Figure 9-1 was a regular plano-convex lens, there would be two problem situations to consider.

(1) Light rays passing through the center of the lens at an angle would tend to produce a focal 'plane' that was in fact curved, as indicated in Figure 9-2. This lens, and this method of controlling and focusing the beam would not work on a flat object because of the change in focal plane relative to the marked surface.

(2) As the laser beam moved across the lens away from the optical axis, the focusing characteristics of the lens would try to bring the focused spot back to the focal point of the lens, as indicated in Figure 9-3. In the case of light rays parallel to the optical axis, all rays would converge to the focal point of the lens. However, because the beam enters the lens at an angle rather than parallel with the optical axis, there would be a shifting of the focal point. This lens would not work for marking anything larger than a pin head.

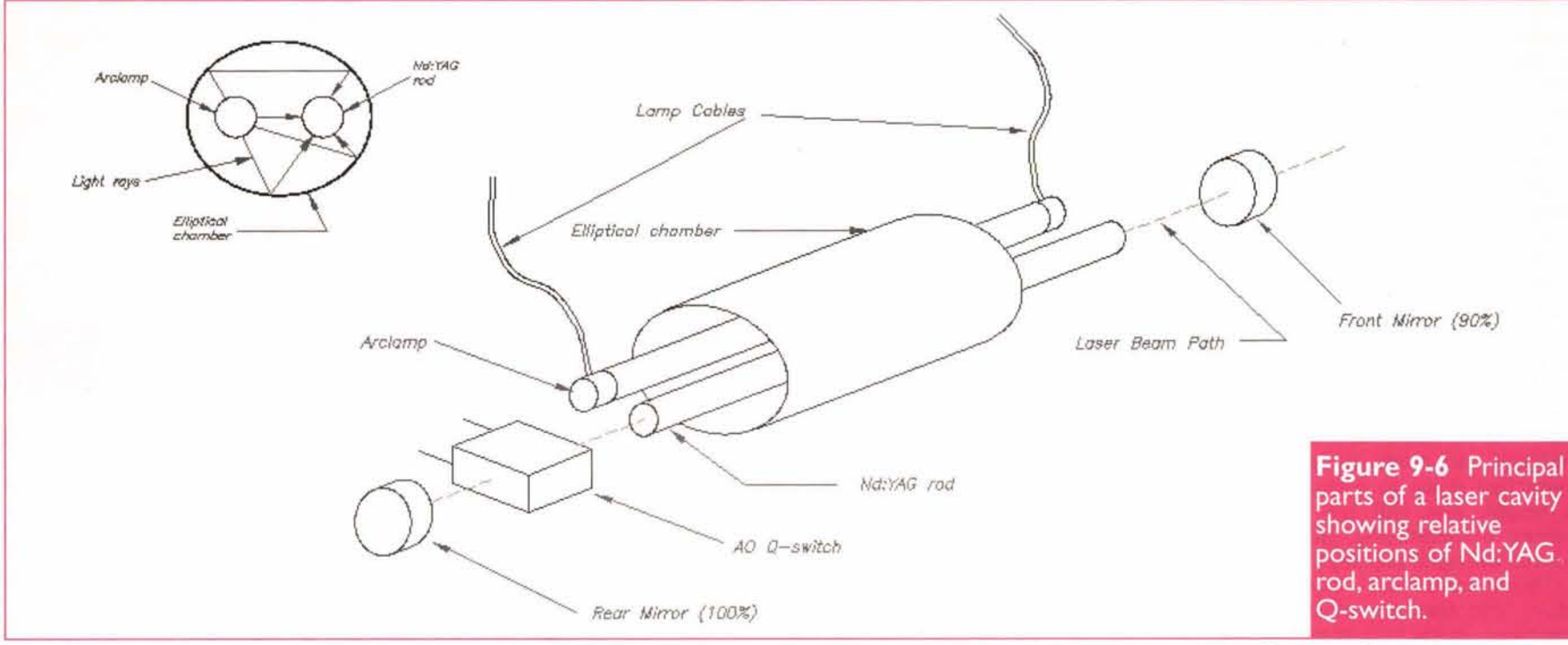


Figure 9-6 Principal parts of a laser cavity showing relative positions of Nd:YAG rod, arclamp, and Q-switch.

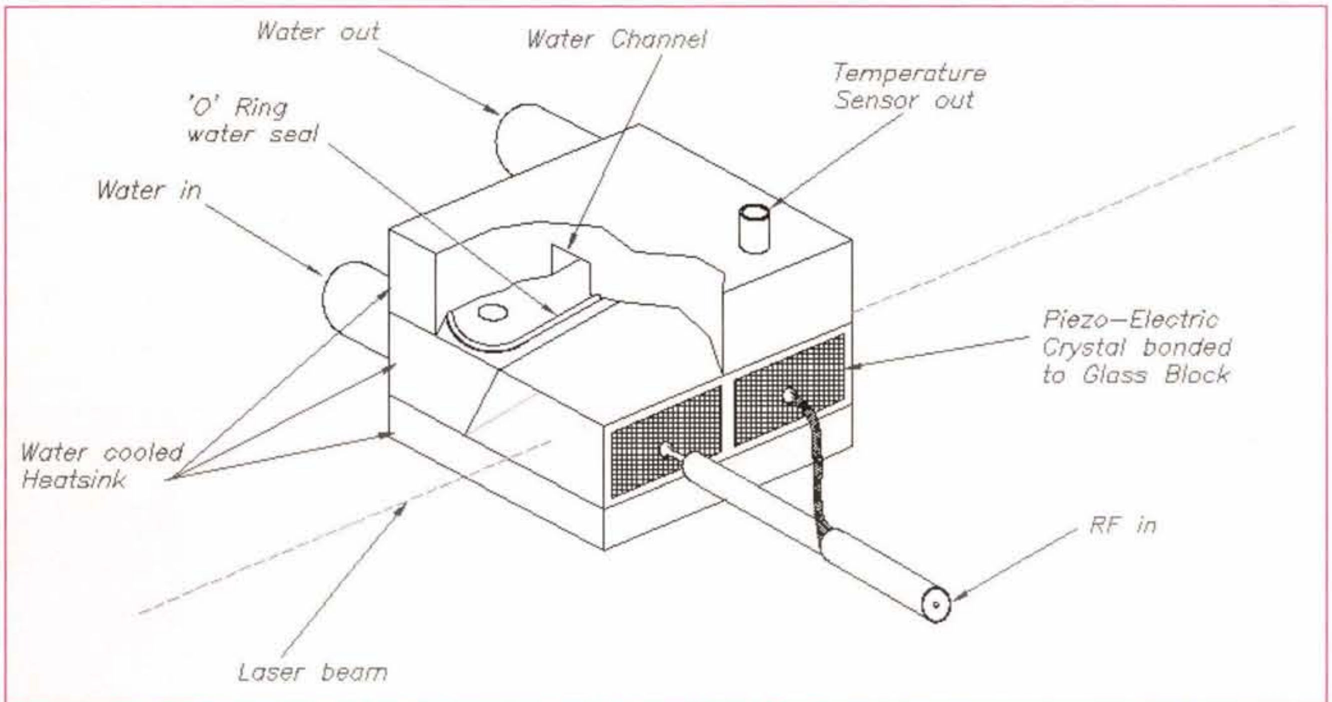


Figure 9-7 This drawing shows the general form of an AO Q-switch.

Figure 9-8 This plot shows the relationship between the Q-switched pulse and the steady-state (CW) power levels.

Neither of these situations is good because in the first case, we want to be able to mark flat surfaces without changing the focal point of the lens. In the second case, it would be nice if we could mark an area larger than a pin head!

In order to overcome these drawbacks, we use a lens system rather than a simple lens.

This lens system has a special name, and you'll come across it if you have to work with laser printers, copiers, and other devices. It is called a flat-field lens or an f-theta lens.

You'll see what these terms mean soon. If you are lucky enough to come across a discarded laser printer, open it up and examine the optical system. You will find a series of lenses in a similar arrangement to that shown in Figure 9-4. This is the general arrangement of a typical f-theta lens as it applies to a laser printer. It may not be exactly the same as shown, and it may not be to scale, but it will be close.

As you can see, it's really quite complex, and yes, it's very expensive. The reason the focusing lens is made like this is to allow the laser focus to stay on a straight line while the rotating scanner moves the beam in an arc across the page. Using this lens, the laser beam can be swept across the width of the page, yet the beam will always be focused on the page. In a laser printer, the final lens is about the same width as the page itself, while in a laser marker, the marking field is generally larger than the lens.

Image field distortion introduced by the galvo mirrors is somewhat compensated for by the lens system described here. When the mirror system scans the laser beam, there is some inherent distortion (pincushion distortion) in the focal plane. The lens system is usually designed to compensate for this distortion by designing in barrel distortion to the lens, thereby opposing the pincushion and producing a flat field at the focal plane

(Figure 9-5).

But it will only work correctly if the mirror/lens distances, and scanning angles are correct and satisfy the f-theta condition designed into the lens system. As the name suggests, the f-theta condition depends on the lens aperture (f), and the scanning angle of the galvo mirrors (theta).

If the unmodulated laser beam were scanned through the flatfield lens as described, it probably would not be very impressive. It most likely wouldn't mark very well either. The reason for this is really just one thing: there is not enough energy for surface reaction.

Laser markers mark best and clearest when run in a low-order mode condition. This gives us the finest focused spot. Remember what happens when we reduce the higher order TEM modes in a laser? I covered this in an earlier article.

Well, the answer is we lose some laser energy. By restricting the operating modes, and allowing only the low-order modes to resonate, we reduce the laser power to a fraction of the full power available. In the system we have at my office, the laser produces about 80W when run at full power. In a marking mode though, the output power is reduced to about 10-15W through the use of spatial filters. This is not a real Gaussian mode, but is close enough for most purposes.

This small amount of power will not mark anything in a CW mode of operation, so it's time to introduce another concept: Q-switching.

The AO Q-switch

Q-switching as it applies to a laser system is a very old technique, in fact acousto-optic experiments were first carried out in the 1920s, before the laser was even dreamed of! There are many forms of Q-switching, some using active components (as in the laser marker), some using passive components (I'll be covering some of these other techniques in a later column).

The most common type of active Q-switch (sometimes called a 'Q' spoiler) used in laser markers is the acousto-optic (AO) Q-switch. Those of you familiar with the term Q, know that essentially it means 'goodness,' as in the 'Q' of a resonant circuit, for instance.

Q factor tells you how good a resonant circuit is at rejecting unwanted frequencies while amplifying or passing those frequencies closest to its resonant frequency.

In a laser system, the 'Q' of the resonant cavity (i.e., between the mirrors) depends on the optical gains and losses present in the cavity. In an Nd:YAG laser, the gain medium is the Nd:YAG rod that is continuously pumped to an excited state by an arclamp (diode-laser markers are beginning to appear on the market, but lamp-pumped systems are more commonplace at this time).

The Nd:YAG rod and the arclamp are fixed in an insulating block in such a manner that the axes of the two are parallel, and lie on the two focal points of an elliptical chamber (see Figure 9-6). All the light emitted by the arclamp is thus focused onto the rod.

In a CW laser, there are no loss elements, and so the laser energy is emitted as a continuous beam of infrared light. Remember, the light from an Nd:YAG laser lies in the near infrared band of the electromagnetic spectrum. The most common wavelength for this type of laser is 1,064nM, and is invisible to the human eye.

In a Q-switched laser system, a Q spoiler is introduced between one of the resonator mirrors (usually the 100% rear reflector) and the gain medium (the Nd:YAG rod). The Q spoiler is usually in the form of a quartz glass block, cut at a particular angle, and has a piezoelectric crystal bonded on one side (Figure 9-7). The glass is completely transparent to the laser beam when inactive. The assembly is housed with a water-cooled heatsink to keep a stable temperature, and is normally mounted on an adjustable base. It is an active device, and being so, is driven by an RF oscillator/amplifier system. As a general rule of thumb, one watt of laser power requires about 1/2-1 watt of RF power driven into the Q-switch for complete laser beam extinction (remember, I am alternating between calling it a Q-switch and a Q spoiler, but it is the same thing).

When the RF supply is energized, an acoustic standing wave is set up in the block that changes the refractive index of the material, which acts as a diffraction grating, introducing losses to the cavity, and an overall round trip gain of less than one. With insufficient gain in the resonator, the laser cannot emit any stimulated light, even if the exciting lamp is driven to maximum power.

Under normal laser conditions, the lamp excites the Nd atoms, raising the outer valence electrons into a higher than normal (metastable) state. Being unstable, they cannot stay there, and so relax back to the ground state, releasing their excess energy in the form of a photon of light. The cycle then repeats as long as the lamp can provide enough excitation.

Under these conditions, as the photons of light from this spontaneous emission travel down the length of the resonator, they encounter other unstable electrons. The impetus provided by the photon's collision with them is enough to stimulate these other electrons to relax to the ground state, so now there are two photons traveling down the resonator.

These two photons then encounter more unstable electrons stimulating them and so on. As the light bounces back and forth between the mirrors, more and more collisions of photons and electrons can take place until equilibrium is reached. Thus we get the stimulated emission referred to in the name of the laser. Remember, it is Light Amplification by Stimulated Emission of Radiation.

With the AO Q-switch energized, there can be no laser action due to the losses imposed by the Q spoiler. Because the energy cannot escape — except as spontaneous emission — there is little release in the form of stimulated emission. Because of this, there is a build up gain in the Nd:YAG rod in the form of excess atoms in an unstable state. Consequently, when the RF field in the AO Q-switch is shut down, there is a massive release of laser energy (here, we are rapidly switching the Q of the resonant cavity, not the Q of the Q spoiler — I will discuss other ways of Q switching in a later article).

The normal CW level of laser output power may be in the order of 10-15 watts, but during a Q-switched pulse, the peak power output may easily reach several hundred kilowatts! Refer to the plot in Figure 9-8. Here, a nominally 10W CW output is producing almost 40kW pulses, and this is not uncommon in low power laser marking systems. The average pulse energy delivered during this short time period (about 40nSec) is only about 1.5 mJoule. Peak power is related to energy by the simple formula $P = E/t$, where P = peak power, E is the pulse energy in Joules, and t is the pulse width time in seconds.

It is generally accepted in laser circles that the pulse width is equal to the full-width, half-max (FWHM) points on the pulse outline. To get the FWHM value, simply measure the height of the pulse, divide this number in half, and measure the pulse width at that height. On this plot the FWHM points are shown as A-A, and is approximately 40nSec.

Referring to Figure 9-8:

At t0, the laser is emitting no output power, and the AO Q-switch RF drive signal is triggered to shut down to allow a pulse to form.

At t1, because of the high gain of the cavity, the initial pulse energy growth is very rapid, and reaches the peak after about 10-20 nSec.

At t2, the rapid release of laser energy drops the round trip cavity gain, and almost all the built-up energy in the cavity has been depleted.

At t3, the laser cavity settles into its steady-state CW laser mode, and produces continuous CW output at the 10 watt level about 100nSec after trigger.

At t4, RF power is reapplied to the AO Q-switch, and the CW power drops to near zero output. Typically, a Q-switch trigger pulse lasts for about 10-20uSec.

The low CW power of the laser will not mark very much, but a 40kW pulse can make a fairly deep crater in a metal surface (0.0005"-0.001"). Typically, a laser marker is made to etch a series of closely-spaced craters that to an unaided eye will look like a continuous line. Under a microscope however, the individual spots where the laser blasted away surface material are easily seen.

Laser markers can produce these high intensity pulses up to about 40-50kHz. But usually the peak power intensity starts to decline above about 2-3kHz. There is usually some pulse widening at higher frequencies too, and the combined effects of high frequency, reduced pump time, and lower overall gain each contribute to the fall-off in peak power.

The wavelength absorption properties of the material surface determine how well a laser will mark, and there are various techniques in use to allow almost any surface to produce some reaction. The Nd:YAG laser described in this article is very effective on all ferrous metals, but is poor when used on gold, copper, brass, or alloys of these materials. Silver also reacts very well to the Nd:YAG wavelength.

Most plastics can be marked to some extent with this type of laser, but some steps have to be taken to ensure good results. Colored plastic works best, depending on the density of the color. Clear Plexiglas in contrast, passes Nd:YAG wavelengths easily, and does not react at all. Window glass is also transparent.

But the opposite is true for a CO_2 marker system. Clear Plexiglas is easily marked with a CO_2 laser, also window glass. No doubt you have seen samples of wood that have had laser engraving applied. Well, those samples you saw were done with a CO_2 laser. An Nd:Yag laser does not react well with cellulose based materials, including paper.

I hope you found this article interesting. There is so much more I could write about these fascinating machines, but my space is limited. If you have any questions regarding lasers or optical systems in general, please feel free to send me some email, or write to this fine magazine, and I'll try my best to answer all of your questions.

One final note:

I have been looking quickly at various laser websites trying to find a reasonably good demonstration of a laser marker in action to refer to those readers who have not been fortunate enough to see one working. I didn't find a good one yet, so if there are any readers out there who have seen a good demo on the WWW, please share your find with us through this column. **NV**

Triac Principles and Circuits — Part I

By Ray Marston

Ray Marston describes basic triac principles and looks at practical triac circuits in this special two-part article.

A triac is a controllable medium- to high-power semi-latching solid-state AC power switch. This two-part article explains its basic operation and shows various ways of using it. Most of the practical circuits show two sets of component values for use with normal domestic/commercial 50Hz or 60Hz AC voltage supplies with nominal values of either 240V (as used in most of Europe) or (in parenthesis) 120V (as used in most of the USA). In each design, the user must use a triac with ratings to suit his or her own particular application.

Triac basics

A triac is a three-terminal (MT1, gate, and MT2) solid-state thyristor that uses the alternative symbols in Figure 1 and acts like a pair of SCRs wired in inverse parallel and controlled via a single gate terminal. It can conduct current in either direction between its MT1 and MT2 terminals and can thus be used to directly control AC power. It can be triggered by either positive or negative gate currents, irrespective of the polarity of the MT2 current, and it thus has four possible triggering modes or 'quadrants,' signified as follows:

I+ Mode = MT2 current +ve, gate current +ve
I- Mode = MT2 current +ve, gate current -ve
III+ Mode = MT2 current -ve, gate current +ve
III+ Mode = MT2 current -ve, gate current -ve

The trigger current sensitivity is greatest when the MT2 and gate currents are both of the same polarity (either both positive or both negative), and is usually about half as great when they are of opposite polarity.

Figure 2 shows a triac used as a simple AC power switch, driving a resistive lamp load; assume that SW2 is closed. When SW1 is open, the triac acts as an open switch and the lamp passes zero current. When SW1 is closed, the triac is gated on via R1 and self-latches shortly after the start of each half-cycle, thus switching full power to the lamp load. The triac automatically unlatches at the end of each AC half-cycle as the instantaneous supply voltage (and thus the load current) briefly falls to zero.

In Figure 2, the task of R1 is that of limiting the peak instantaneous switch-on gate current of the triac to a safe value; its resistance (combined with that of the load) must be greater than the peak supply voltage (roughly 350V in a 240V AC circuit, 175V in a 120V circuit) divided by the triac's peak gate current rating (which is usually given in the triac manufacturer's extended data sheets).

Note in Figure 2 (and in most other triac circuits shown in this mini-series) that — for safety reasons — the load is wired in series with the AC supply's neutral (N) line, and master on/off switch SW2 can isolate the entire circuit from the live (L) line.

Triac rate effect

Most triacs, like SCRs, are susceptible to 'rate-effect' problems. Internal capacitances inevitably exist between the main terminals and gate of a triac, and if a sharply rising voltage appears on either main terminal it can — if its rate-of-rise exceeds the triac's dV/dt rating — cause enough breakthrough to the gate to trigger the triac on. This unwanted 'rate-effect' turn-on can be caused by supply line transients; the problem is, however, particularly severe when driving inductive loads such as electric motors, in which load currents and voltages are out of phase, thus making a large voltage suddenly appear on the main terminals each time the triac unlatches as its main terminal current falls to near-zero in each operating

Figure 3. Simple AC power switch with inductive load and C1-R2 snubber network to give rate-effect suppression.

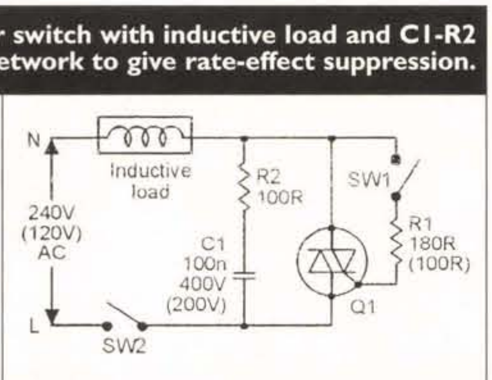
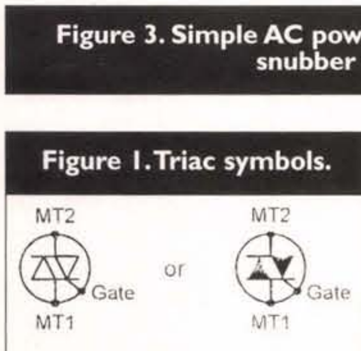


Figure 1. Triac symbols.



Note: MT = Main Terminal

Figure 2. Simple AC power switch with resistive (lamp) load.

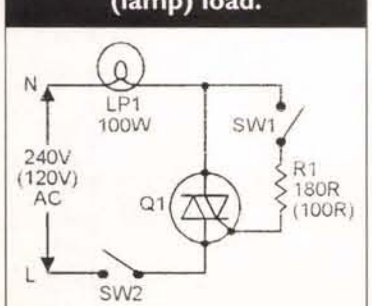


Figure 4. Basic AC lamp dimmer with RFI suppression via C1-L1.

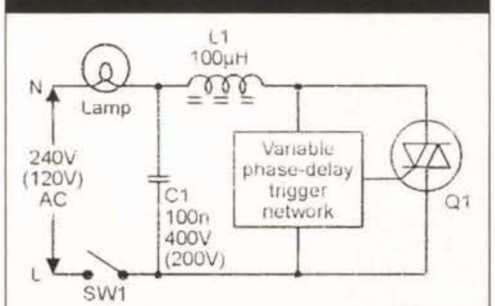
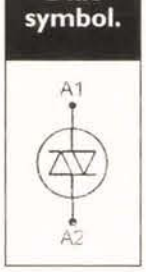


Figure 5. Diac symbol.



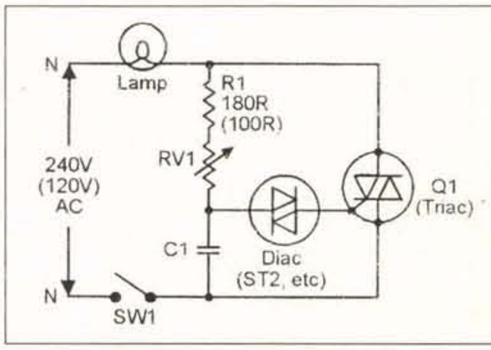
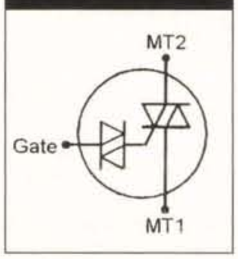
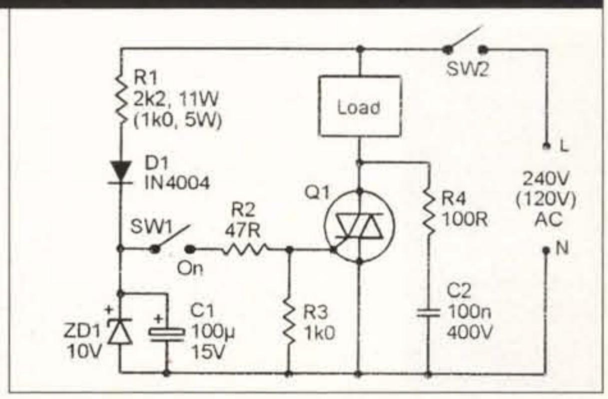


Figure 6. Basic diac-type variable phase-delay lamp dimmer circuit.

Figure 8. AC power switch with AC-derived DC triggering.

Figure 7. Quadrac symbol.





half-cycle.

Rate-effect problems can usually be overcome by wiring an R-C 'snubber' network between MT1 and MT2, to limit the voltage rate-of-rise to a safe value, as shown (for example) in the triac power switch circuit in Figure 3, where R2-C1 form the snubber network. Some modern triacs have enhanced dV/dt ratings (typically 750V/mS) and are virtually immune to rate-effect problems; these triacs are known as 'snubberless' types.

RFI suppression

A triac can be used to give variable AC power control by using a 'phase-delayed switching' technique, in which the triac is triggered part-way through each half-cycle. Each time the triac is gated on, its load current switches sharply (in a few microseconds) from zero to a value set by its load resistance and instantaneous supply voltage values. In resistively loaded circuits such as lamp dimmers, this switching action inevitably generates a pulse of RFI, which is least when the triac is triggered close to the 0° and 180° 'zero crossing' points of the supply line waveform (at which the switch-on currents are minimal), and is greatest when the device is triggered 90° after the start of each half cycle (where the switch-on currents are at their greatest).

The RFI pulses occur at twice the supply line frequency, and can be very annoying. In lamp dimmers, RFI can usually be eliminated by fitting the dimmer with a simple L-C filter network as shown in Figure 4. The filter is fitted close to the triac, and greatly reduces the rate-of-rise of the AC power line currents.

Diacs and quadracs

A diac is a two-terminal bidirectional trigger device; it can be used with voltages of either polarity and is usually used in conjunction with a triac; Figure 5 shows its circuit symbol. The diac's basic action is such that, when connected across a voltage source via a current-limiting load resistor, it acts like a high impedance until the applied voltage rises to about 35V, at which point it triggers and acts like a low-impedance 30V zener diode, and 30V is developed across the diac and the remaining 5V appears across the load resistor. The diac remains in this state until its forward current falls below a minimum holding value (this occurs when the supply voltage falls below the 30V 'zener' value), at which point the diac turns off again.

The diac is most often used as a trigger device in phase-triggered triac variable power control applications, as in the basic lamp dimmer circuit of Figure 6. Here, in each power line half-cycle, the R1-RV1-C1 network applies a variable phase-delayed version of the half-cycle to the triac gate via the diac, and when the C1 voltage rises to 35V, the diac fires and delivers a 5V trigger pulse (from C1) into the triac gate, thus turning the triac on and simultaneously applying power to the lamp load and removing the drive from the R-C network. The mean power to the load (integrated over a full half-cycle period) is thus fully variable from near-zero to maximum via RV1.

In the early development days of the triac, some specialist devices were manufactured with a built-in diac in series with the triac gate; such devices were known as quadracs and used the Figure 7 circuit symbol. Quadracs were not a commercial success, and are now obsolete.

AC power switch variations

The simplest type of triac power switch is that of Figure 2, in which the triac is gated on via R1 when SW1 is closed; only 1V or so is generated across the triac when it is on, so R1 and SW1 consume very little mean power; Figure 3 shows the same circuit fitted with a 'snubber' network. There are many useful variations of these basic circuits. Figure 8, for example, shows a version that can be triggered via an AC-derived DC supply. C1 charges (via R1-D1) to +10V on each positive AC power line half-cycle, and this charge triggers the triac when SW1 is closed. Note that R1 is subjected to almost the full AC line voltage at all times, and thus needs a fairly high power rating, and that all parts of this circuit are 'live,' making it difficult to interface to external control circuitry.

Figure 9 shows the above circuit modified to give 'isolated' interfacing to external control circuitry. SW1 is simply replaced by transistor Q2, which is driven from the phototransistor side of an optocoupler. The coupler's LED is driven via an external DC supply via R1, and the triac turns

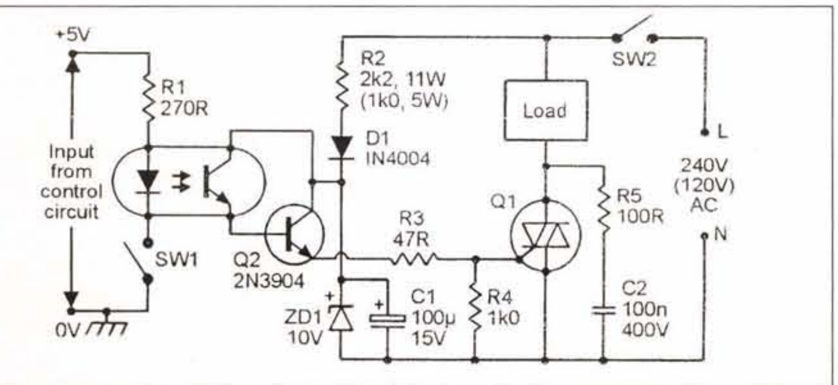


Figure 9. Isolated-input (optocoupled) AC power switch, DC triggered.

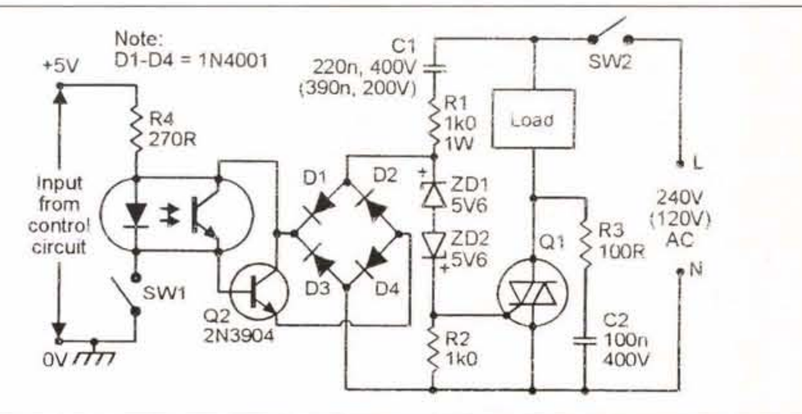
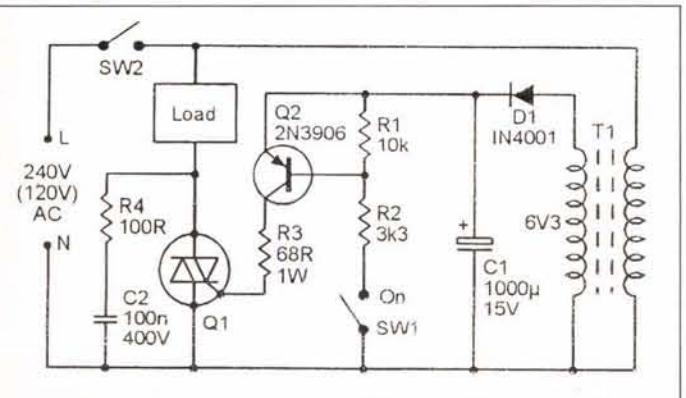


Figure 10. Isolated-input AC power switch, AC triggered.

Figure 11. AC power switch with transistor-aided DC triggering.



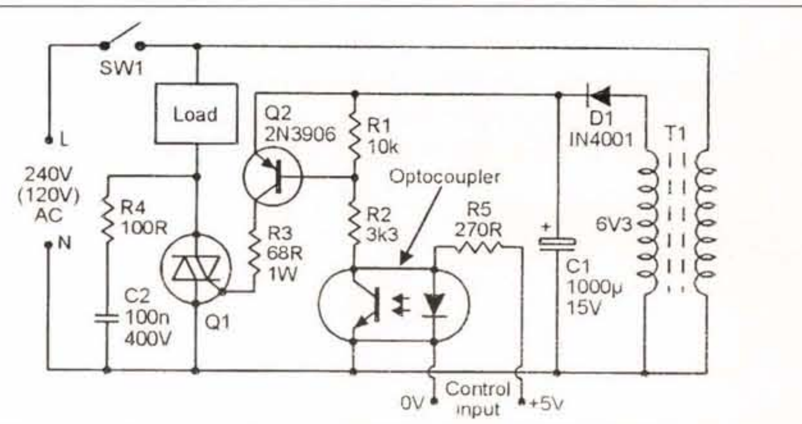


Figure 12. Isolated-input AC power switch with DC triggering.

Figure 13. Isolated-input (transformer-coupled) AC power switch.

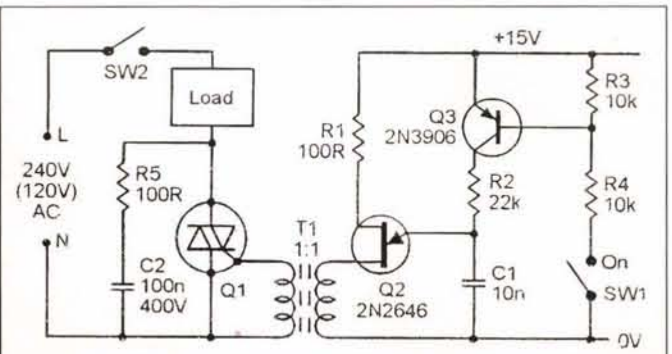
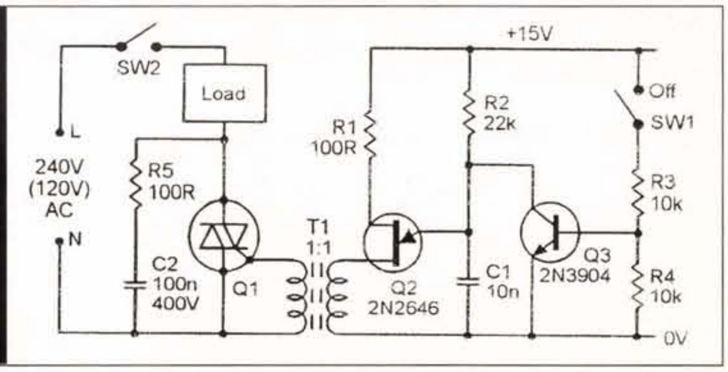


Figure 14. Isolated-input AC power switch.



on only when SW1 is closed; SW1 can be replaced by electronic switching circuitry, if desired.

Figure 10 shows a variation in which the triac is AC triggered in each half-cycle via the AC impedance of C1-R1 and via back-to-back zeners ZD1-ZD2, and C1 dissipates near-zero power. Bridge rectifier D1-D4 is wired across the ZD1-ZD2-R2 network and is loaded by Q2. When Q2 is off, the bridge is effectively open and the triac is gated on in each half-cycle, but when Q2 is on, a near-short appears across ZD1-ZD2-R2, and the triac is off. Q2 is driven via the optocoupler from the isolated external circuit, and the triac is on when SW1 is open and off when SW1 is closed.

Figures 11 and 12 show variations in which the triac is triggered via a transformer-derived DC supply and a transistor-aided switch. In Figure 11, Q2 and the triac are both driven on when SW1 is closed, and are off when SW1 is open. In practice, SW1 can be replaced by electronic circuitry, enabling the triac to be activated via heat, light, sound, time, etc. Note, however, that the whole of this circuit is 'live.' Figure 12 shows the circuit modified for optocoupler operation, enabling it to be activated via fully-isolated external circuitry.

UJT triggering

Another way to obtain fully-isolated triac switching is via the UJT circuits in Figures 13 and 14, in which the UJT is an old 2N2646 type or a modern near-equivalent. In these circuits, the triggering action is obtained via UJT oscillator Q2, which operates at several kHz and feeds output pulses to the triac gate via pulse transformer T1, which provides the desired 'isolation.' Because of its fairly high oscillating frequency, the UJT triggers the triac within a few degrees of the start of each AC power-line half-cycle when the oscillator is active.

In Figure 13, Q3 is in series with the UJT's main timing resistor, so the UJT and triac turn on only when SW1 is closed. In Figure 14, Q3 is wired in parallel with the UJT's main timing capacitor, so the UJT and triac turn on only when SW1 is open.

Optocoupled triacs

The gate junctions of a 'naked' triac are inherently photosensitive, and an optocoupled triac can thus be made by mounting a 'naked' triac and LED close together in a single package. Figure 15 shows the outline and lists the characteristics of a typical six-pin DIL version of such a device, in which the LED has a maximum current rating of 50mA, the triac has maximum ratings of 400V and 100mA RMS (and a surge current rating of 1.2A for 10mS), and the entire package has an isolating voltage rating of 1.5kV and a typical input current trigger sensitivity of 5mA.

Optocoupled triacs are easy to use and provide excellent electrical isolation between input and output. The input is used like a normal LED, and the output like a low-power triac. Figure 16 shows the device used to activate an AC line-powered filament lamp, which must have an RMS rating below 100mA and a peak inrush current rating below 1.2A.

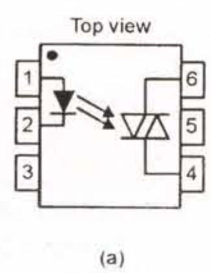
Figure 17 shows an optocoupled triac used to activate a slave triac, thereby driving a load of any desired power rating. This circuit is suitable for use only with non-inductive loads such as lamps and heating elements. It can be modified for use with inductive loads such as electric motors by using the connections in Figure 18. Here, the R2-C1-R3 network provides a degree of phase-shift to the triac gate-drive network, to ensure correct triac triggering action, and R4-C2 form a snubber network to suppress rate effects.

Synchronous 'zero-voltage' power switching

A synchronous 'zero-voltage' (or 'integral cycle') power switch is one in which the triac invariably turns on just after the start of each power half-cycle (i.e., near the waveform's zero-voltage point) and then turns off again automatically at the end of it, thus generating minimal RFI. In most power switching circuits shown so far in this article, the triac turns on at an arbitrary point in its initial switch-on half-cycle, thus producing a potentially high initial burst of RFI, but then gives a synchronous zero-voltage switching action on all subsequent half-cycles.

A truly synchronous zero-voltage circuit uses the switching system in

Figure 15. Typical optocoupled triac outline and operating characteristics.

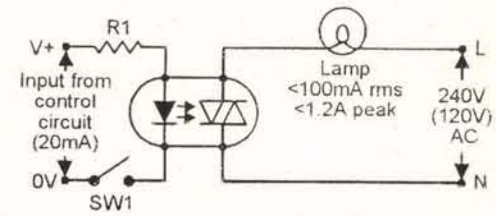


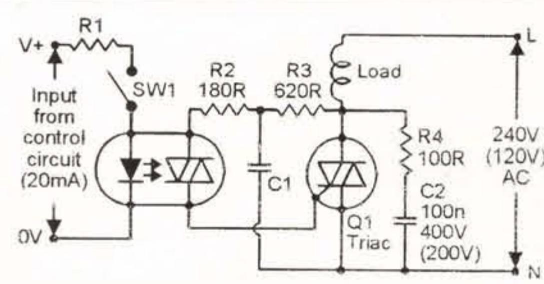
(a)

Parameter	Optocoupled triac
LED characteristic	
I_F (max)	50mA
Triac characteristic	
V_{MAX}	400V
I_{MAX} (rms)	100mA
I_{SURGE} (see text)	1.2A
Coupling characteristic	
Isolating voltage	±1.5kV
Input trigger current	5mA typical (20mA max)

(b)

Figure 16. Low-power lamp control via an optocoupled triac.





C1	Load power factor
220n	0.75
330n	0.5

Figure 18. Driving an inductive load.

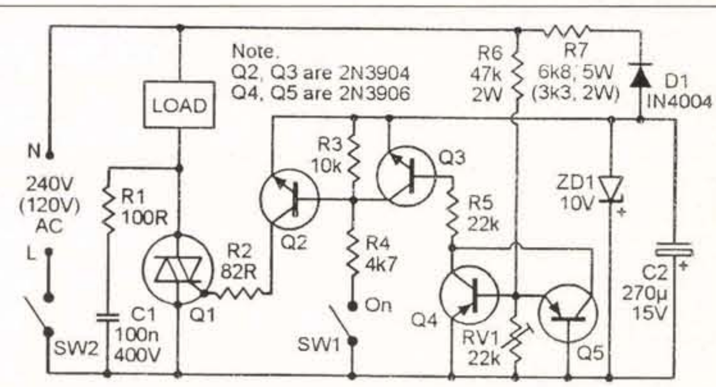


Figure 20. Synch[illegible]ous AC power switch.

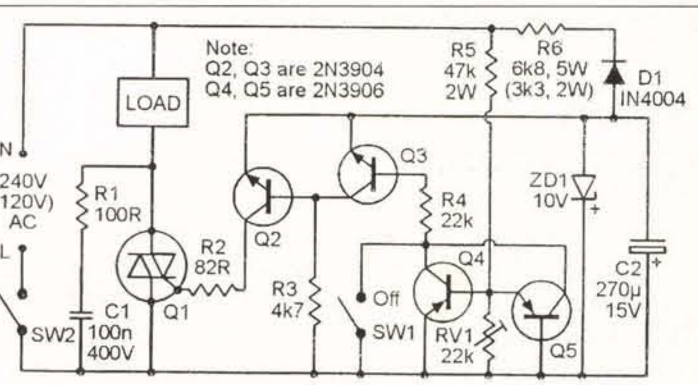


Figure 21. Alternative version of the synchronous AC power switch.

Figure 17. High-power control via a triac slave.

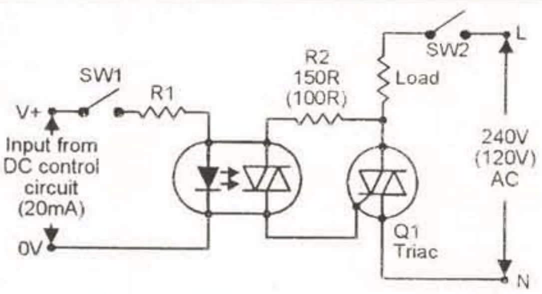


Figure 19. Synchronous zero-voltage AC power switching system.

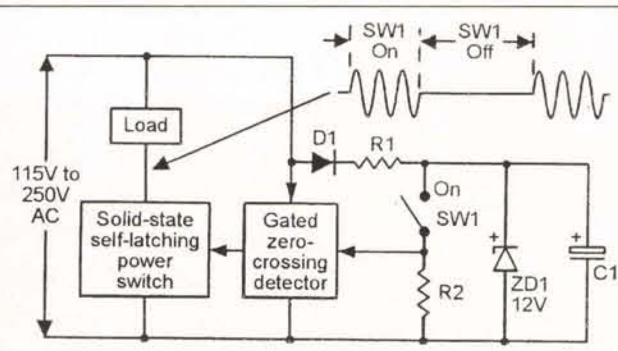


Figure 19, in which the triac can only be gated on near the start or 'zero-voltage' point of each half-cycle, and thus produces minimal RFI. This system is widely used to give on/off control of high-current loads such as electric heaters, etc.

Figure 20 shows a practical synchronous zero-voltage AC power switch; 10V DC is AC-derived via R7-D1-ZD1 and C2 and is switched to the triac gate via Q2, which is controlled via SW1 and 'zero-voltage' detector Q3-Q4-Q5 and can supply gate current only when SW1 is closed and Q3 is off.

In the zero-voltage detector, Q4 or Q5 are driven on whenever the AC line voltage is more than a few volts (set by RV1) above or below zero, thereby driving Q3 on via R5 and inhibiting Q2. Thus, gate current can only be fed to the triac when SW1 is closed and the instantaneous AC line voltage is within a few volts of zero; this circuit thus generates minimal switching RFI.

Figure 21 shows the circuit modified so that the triac can only turn on when SW1 is open. Note in both cases that only a narrow pulse of gate current is fed to the triac, and the mean gate current is thus only 1mA or so. SW1 can be replaced by an electronic switch or optocoupler, if desired, thus enabling the load to be activated by light or temperature levels or by time, etc.

In practice, the simplest way of making a really efficient synchronous 'zero-voltage' triac-driving circuit is with the aid of a special-purpose IC that functions as an optocoupled low-power synchronous 'zero-voltage' triac that can easily be used as a slave for synchronously driving a normal high-power triac.

Next month's concluding episode will give practical details of such circuits, together with other triac-related circuits and information. **NV**

TECH FORUM

QUESTIONS

[2021] Does any company still support the series of mini-oscilloscopes made (15 years ago) by NonLinear Systems? I have a 30 MHz model MS-230 which appears to need a new CRT.

Jack Meagher
Southern Shores, NC

[2022] I would like 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.

I took apart a cheap LCD bathroom scale to see how it works and found a small board mounted to a metal bracket that was pressed in the center by a needle directly attached to the applied weight. I don't understand how the pressure is converted to a voltage or current. The whole thing runs on a watch battery.

I appreciate any suggestions.

Willy
via Internet

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.

[2023] I have a Dunn MP-979 laptop, manufactured by Chicony. This system was sold under various brand names, including Chicony MP-979, Dunn MP-979, EPS MP-979, and Keydata/Keynote MP-979.

This laptop has an internal CD-ROM, but will also support an internal DVD drive in place of the CD-ROM.

I want to upgrade, but I don't know what brand or model DVD drive will fit into this system. Unfortunately, Chicony has closed down its laptop division and no longer provides any information or support.

I'd appreciate any information on what drive would fit, as well as any possible sources for the drive. Please note that I am not looking for an external DVD drive, only an internal one.

Mike Kluger
Brooklyn, NY

[2024] Are there any die-hard Commodore 64 users out there who have used their Commodore to program the 16F84 PIC chip?

I have developed the software for the parallel programmed chips, but the serial programmed chips using the serial user port have failed.

Richard Van Dyke
Charlo, MT

[2025] I have a Commodore MPS-803 friction feed printer. I heard that the printer can be converted to a traction feed type. Does anyone know how this can be accomplished?

Samuel J. Ugolini
El Paso, TX

[2026] 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.

S. N. Palaski
Crestline, CA

ANSWERS

[12018 - DEC. 2001]

I like to listen to a local AM radio station that operates on 1510 KHz.

The power supply of my computer puts out a signal that is about on top of the local station.

I would like to find or build a filter that could be attached to the power supply of my computer to eliminate this interference.

The power supply of most computers are well shielded and enclosed in a metal case, so it is unlikely the interference is coming from the power supply.

The video display, however, is in a plastic case and the horizontal deflection is unshielded and radiating RF noise. In fact, there is a program called "Tempest_for_eliza," which when run will show a pattern on the screen and an AM radio placed near the computer will pick up music. If you line the video display case with aluminum foil and ground it, that should help. Be sure to punch holes in the foil where there are holes in the case for cooling.

Russell Kincaid
Milford, NH

[1021 - JAN. 2002]

I'm trying to repair a couple of GE model 4885 clock radios with digital displays and keypad entry. The pads are defective. They use a thin foam insert under the buttons which is *dried up, rendering the pad useless.*

Can the pads be repaired or substituted, or is there another source for them or something similiar?

I have the GE 4880, which is nearly identical to your clock radio. Last year, mine finally succumbed to keyboard membrane rot. I removed the old membrane and used it as a template to cut a new one (a sharp hobby knife worked great). I used some closed cell shipping foam wrap. This stuff comes on a roll and is about 1/16" thick. The stuff I used was the pink anti-stat variety, but the common white type should work fine, too. I made the repair over a year ago and the keyboard still works great.

Thomas B.
Folsom, CA

[1023 - JAN. 2002]

My 35" Zenith TV quit working. I know the tube is good and a TV shop wanted $500.00 to replace the main board. I didn't think it was worth it so I bought a new TV.

I didn't want to trash the old set, and found a new main board on the internet for $80.00,

I ordered and installed it, but with a very poor picture.

Are these new boards like the old TVs which you had to align, adjust colors, and such? I didn't see many adjustments, could it be a CMOS like the computers?

Should I dump it, talk to a TV shop about aligning it, or can I align it myself?

I would dump it. The new board should have been aligned at the factory. Trying to do it yourself, without documentation, would be an exercise in frustration. I suspect that a TV shop would charge more to align it than to replace the board.

Russell Kincaid
Milford, NH

[1022 - JAN. 2002]

I have a Tatung autocolor TV model 1300CM. The sound is very low, even if it's on high.

The speaker is an eight-ohm, two-watt oval type, and tests fine outside the TV. I put it back in the set and barely a whisper. Same thing on other known working speakers.

The second problem is the LED which shows the channel. The leftmost digit does not show anything. So, I can go to 1 through 9 but when I go to 10, I see 0. I think the LED segment is burned out. Any fixes for this?

In general, modern electronics are not worth fixing because parts are surface mounted and ICs are custom made and not generally available. However, this sounds like a simple problem, so if you are so inclined this is what I recommend.

Trace the speaker connections back to a component. If it is a capacitor, check to see if it is shorted or open. If it is an IC look at the identification and try to find it at **www.digikey.com** or **www.radioshack.com**.

If you can't find it, it is probably custom, but all is not lost. Some TV repair shops save defunct sets for parts, ask if they have your model and will part with it.

That also is your best bet for the LED display because it has all the digits on one board, is custom, and probably out of production.

Russell Kincaid
Milford, NH

[10210 - JAN. 2002]

I need to monitor an area with a security camera. I have the camera which is of the NTSC standard. I want to use a standard VCR and possibly a motion sensor to monitor an area. I need to know how to start the VCR without super glueing the record button. Send ideas to junglejimie@yahoo.com.

#1 I did something similar to this one time. I used a motion detector light and used the relay contacts that turn the lights on to also close a relay to start the VCR. Alternately, if it's indoors and you can use a PIR motion detector to trigger a 555 timer circuit with a relay on the output.

What I did was use a generic remote for the VCR. Since most remotes require you to hold down the record button and press the play button to start, I shorted the record button and had the relay turn on the play button. When the relay timed out, the other set of relay contacts were wired to the VCR stop button. I removed the IR LED from the remote and extended the wires so the LED was taped to the IR window of the VCR. The only problem is there is a bit of a delay to start the tape, but with the right amount of "ON" time on the timer, you should be able to accomplish what you need to do.

Randy Bray
Corvallis, OR

#2 I too wanted to trigger a standard VCR to record when a motion detector detected movement. For a long time, I was puzzled as to how to impliment my idea, until while surfing eBay one day, I came across the ideal solution. What I found was an automatic VCR controller made by Goldbeam.

First, you program it to work with your particular VCR in a manner similar to auto-search programming for a universal IR remote control. A small wired IR LED "bug" runs from the controller and is stuck to the IR receiving window of the VCR. When any of the controller's four inputs are opened, the controller sends a start-recording IR signal to the VCR. Recording continues as long as the input is open and an IR signal to stop-recording is sent 30 seconds after the input is closed.

Auctions for these controllers still show up on eBay from time to time and they usually end up selling for $20-$30.

John McMichael
Laramie, WY

[1026 - JAN. 2002]

I have had the BASIC Stamp II and the Parallax carrier board for a few years. But now, the circuit seems dead. I have tried several things to troubleshoot, but I'm not getting anywhere. Things observed:

1) *The current drain is very low – less than 1 mA.*

2) *When I either press Alt-I (show version number) or Alt-R (run program), I get the message "Error – Hardware not found."*

3) *I've checked the following with a DVM: TX: -5.0 Vdc, RX: -11.0 Vdc, ATN: -12.0 Vdc;*

[10212 - JAN. 2002]

I have a pair of US Robotics Sportster 28.8 external fax modems without power cords. I need to know what sort of power they require. There are no markings on the case that would provide any clues.

USR's website only has information on current products, mostly software.

#1 Your US Robotics Sportster external fax/modem requires a 20V 750mA AC supply. The original supply is an Ault, Inc., T48200750A010C. You can find them at Ault at **www.aultinc.com/**.

One possible replacement is the MT7114-ND from Digi-Key at **www.digikey.com**.

John Montalbano
Middletown, NJ

#2 The US Robotics 28.8 external fax Modem uses a 9VAC, 1,000mA (one amp) wall wart. The US Robotics part number for this power supply is 1.015.1286.

You do not need to use the original manufacturer power supply; any nine-volt AC wall wart that can supply one or more amperes will work fine.

Tim Naami
Poplar Grove, IL

Editor's Note

There were many answers submitted for this question. The concensus was about equally divided between these two answers, (20VAC and 9VAC), with no clear indication of which is correct.

[1024 - JAN. 2002]

My wife uses a portable tape player to listen to books as she travels. The unit takes six C-size batteries. I would like to plug it into the car cigarette lighter, but my only problem is a regulator from 12 to 9 volts.

#1 Although it may seem tempting to build your own 9V automotive adapter, the low cost of a store-bought solution makes such a task unnecessary. What you need is an automobile accessory DC-DC adapter, a gadget that is sold at electronic stores. RadioShack sells several and here is a sample of their offerings: #273-1805 ($8.99), #273-1863 ($11.99), #273-1810 ($12.99).

Thomas B.
Folsom, CA

#2 You can use a National Semiconductor LM2940T-9 which is a three-terminal, one-amp voltage regulaor. You will also need two capacitors: a .1µF 50V, and a 22µF 16V. All parts are available from Digi-Key **(www.digikey.com)**.

The regulator is Digi-Key part number LM2940T-9.0-ND ($1.71 qty. 1), the .1µF cap is part number 1109PHCT-ND ($3.44 qty. 10), and the 22µF cap is part number P5135-ND ($.21 qty. 1). The capacitors are not at all critical, and there are many others that will work.

The circuit is very simple — +12V (from the cigarette lighter) goes to pin 1 of the regulator, +9V comes out of pin 3.

Both the input and the output share a common ground, which is connected to pin 2 of the regulator. The .1µF gets connected between pin 1 and ground, and the .22µF cap goes between pin 3 and ground (make sure the + side of the cap goes to pin 3).

You can get more information on National's website **(www.national.com)**.

Robert Zusman
Scottsdale, AZ

#3 The LM2931CT is an adjustable voltage regulator specifically designed for the harsh automotive environment and has all the required protection features. A data sheet with all the necessary information can be downloaded from the National Semiconductor website.

You will need the IC, a fuse, two resistors, and two capacitors for approximately $2.50. If this is too much, I'd recommend the "Far East Approach" — fuse, 1N4004, 6.8 ohm/two-watt resistor, electrolytic cap of 1,000 microfarad/16 volts to GND, bypassed by 12 x 1N4004 in series — and you've got a parallel regulator for $0.75, providing 0.3A of current.

The disadvantage is a maximum power dissipation of about 12 watts at high voltage and no load (not much of a problem in a car, and it's flexible).

Walter Heissenberger
Hancock, NH

TX, RX, and ATN show transient activity on the DVM (when I press ALT-I or ALT-R); PWR: + 9.9 to + 9.5 (tried several settings in this range); GND: 0 Vdc; RES: + 5.0 Vdc; +5 Vdc: +5 Vdc.

Resistance continuity checks between the IC's pins and the serial port pins are good (TX, RX, ATN, and GND).

Your Stamp is getting power and seems to be getting signals from the PC, but less than 1mA current consumption indicates that the Stamp's oscillator is not running.

Assuming you don't have a scope, you can confirm this by carefully measuring the voltage on each end of the ceramic resonator (the light-brown component) with respect to ground. Close to zero or five volts on either or both means that the oscillator is stopped. About 2.5 volts on both means that the oscillator is probably functioning normally, as your voltmeter sees an "average" of the 20MHz signal.

While a stopped oscillator is normal in SLEEP mode, this would not prevent programming because the pulse on the ATN line is intended to reset the Stamp, which would wake it up.

I know all this because on a dry day a few years ago, I walked across a carpet and touched a switch connected to a Stamp. I had yet to learn that "resistors are cheap insurance" as mentioned in the Jan. '02 Stamp Applications column, so static electricity fried the interpreter chip.

Assuming that the chip is, in fact dead, you can order a replacement chip from Parallax, but unless you are experienced with surface mount technology, I recommend you just bite the bullet and replace the entire Stamp.

Tom Scarince
Washington, NJ

[10211 - JAN. 2002]

I need to know how to alter the number of pulses a PC sends to the stepper motors in a printer. I'm trying to convert a *bubble/inkjet printer to a plotter.*

Since you don't specify exactly which printer you're trying to do this with, I'm going to have to give you a generic answer — the short version which is, "you probably can't get there from here."

The PC does not directly control the printhead and paper-feed motors in the printer; rather, it sends down control codes which the printer's circuitry interprets as instructions to advance the paper by "x" number of lines or fractions of an inch, or to print dots and characters at thus-and-such a position on the line. Unfortunately, while the Epson ESC/P printer-control language (about as close to a "standard" as you're likely to find) does define some control codes for this kind of thing, most printers — including many of Epson's own models — are incapable of moving the paper and printhead in any direction at will, and will simply ignore commands they don't physically support. Even if they do, you'll probably find that the mechanics are not precise enough to give very good results, anyway.

If you want to give it a shot, though, the Epson ESC/P programmer's reference manual can be found at **www.ercipd.com /isv/edr_docs.htm**.

You can also find model-specific programmer's guides for many of Epson's Stylus inkjet printers there, which might help if you're trying to pull this off with an Epson printer.

Gary Akins
Austin, TX

[1027 - JAN. 2002]

My city just installed new outside readouts for our water meters. These have no face, just a small black disk. What is the technology used in these faceless readouts and would it be possible to build a reader?

Almost every water, gas, and electric utility out there is presently at least experimenting with methods of speeding up the reading process of their meters. There are a great variety of technologies available, including electronic data port connections, "drive by" RF reading, wireless packet, cell phone, and land line phone.

It sounds from your description that they are possibly using an optical coupler that establishes a two-way serial connection by way of infrared. This optical coupler is tied to an electronic register that counts the revolutions of the water meter dial via a pickup under ground.

Building a reader brings up two problems. First, you must know the infrared wavelength, the data rate, and the data protocol. Each manufacturer devises their own protocol, and these are not open or published. Second, unauthorized data communication with electronic metering devices is considered tampering, and could lead to a misdemeanor tampering or felony theft of service charge if you happened to find a way to reset the readings in the register to some invalid value.

Some of these electronic registers have the capability of porting their data to a read-only remote display. If you have an economic reason where it would be beneficial for you to monitor your consumption as it happens, I would recommend inquiring about this to your utility.

Phil Shewmaker
Louisville, KY

Build An Antique Robot

By Daniel Ramirez

Rusting in some basement or in an antique store or in some toy collector's display is a treasure trove of valuable robotic and animatronic parts. These parts come from antique Erector Sets which were originally sold as mechanical construction toys as far back as the early 1900s.

The Meccano Construction Set was invented by an Englishman named Frank Hornby in 1901 and the Gilbert Erector Set was invented by an American named Alfred Carlton Gilbert, in 1912. Gilbert's contribution to mechanical construction sets was the addition of square girders and curved metal parts. (An interesting fact for readers interested in the Olympics, was the Gold Medal that A.C. Gilbert received for Pole Vaulting at the 1908 Olympic Games.)

The Erector Sets were originally sold under the brand names Gilbert and Meccano, although other brand names such as Gabriel Erector Set, Marklin Metall, Temsi, and Exacto exist. They are highly prized by collectors and sets in good or excellent condition may be worth hundreds of dollars.

My first experience with an Erector Set was when my mother bought a used set for my brothers and me. I was eight years old at the time, and have always been intrigued by building toy models. The Gilbert Erector Set came in a large, bright red metal box with a manual that showed how to make many models including simple toys such as cars and airplanes to very complicated models such as a Ferris Wheel and a fair parachute drop ride.

My father ended up building both these models since they were far too complicated for my brothers and me to build. I remember being very impressed by the magic of a large Ferris Wheel turning under power from a powerful AC geared motor, and from this experience got the idea that I would like to build such models. Of course, I never did get the chance since we moved, and to my great disappointment had to sell the set.

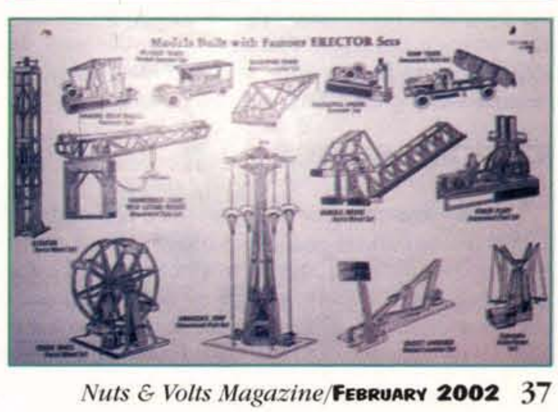
From my occasional visits to antique stores, I found sitting in a dusty bin, a red box with the Gilbert Erector Set label on it. Upon opening the box lid I discovered many rusty Erector Set parts including gears, pulleys, wheels, iron rods, steel girders, aluminum plates, and other assorted steel parts of many sizes as shown in Photos 1a-1e. They all had the familiar machined holes used to fasten them to other parts. The biggest surprise was that it also contained a large AC geared motor, and upon closer inspection, I found buried under all those parts a manual containing the familiar models, including the Ferris Wheel model. I then realized that this box was very similar to the one I had many years ago. I was hooked and bought the set for $35.00. New Meccano Erector Sets may be found on the web or at TOYS "R" US. Used Gilbert and Meccano Erector Sets can be found at antique stores, flea markets, or on the web (e-Bay).

Now, every time I go to an antique store, I purposely look for those "red" boxes shown in Photo 1b. They may also come in different packaging, including a red box with a white colored top or a plastic blue box. I have even found parts in a shoebox. I have seen them go for as little as $15.00 and as much as $500.00. The price you pay will depend upon how complete each Erector Set is, what condition the parts are in (damp basements cause them to rust fast), and how well you can strike a bargain.

Parts from Meccano Sets and Gilbert Erector Sets can be — for the most part — used interchangeably, except for some differences due to metric sizes with the screws used on the Meccano Set. For more detailed information on these differences, read the informative "The Metal Construction Set FAQ," written by Jeff Duntemann and located on the web at www.robotics.com/erector.txt. Sadly, Gilbert stopped making Erector Sets years ago. The only company currently making the original Erector Set is Meccano of France. Other companies such as Exacto (Argentina) also make Erector Set parts.

Today's plastic robot construction kits do not even come close to the versatility of an Erector Set. While LEGO models are easy to build, do not rust, and are less expensive than new Meccano Erector sets, they tend to be more restrictive in the kind of robot that you can assemble due, in part, to its modular nature. They also tend to be less rugged — especially over

Photo 1a-e — Photos of Antique Erector Set boxes, manuals, and parts; the stuff robot dreams are made of.



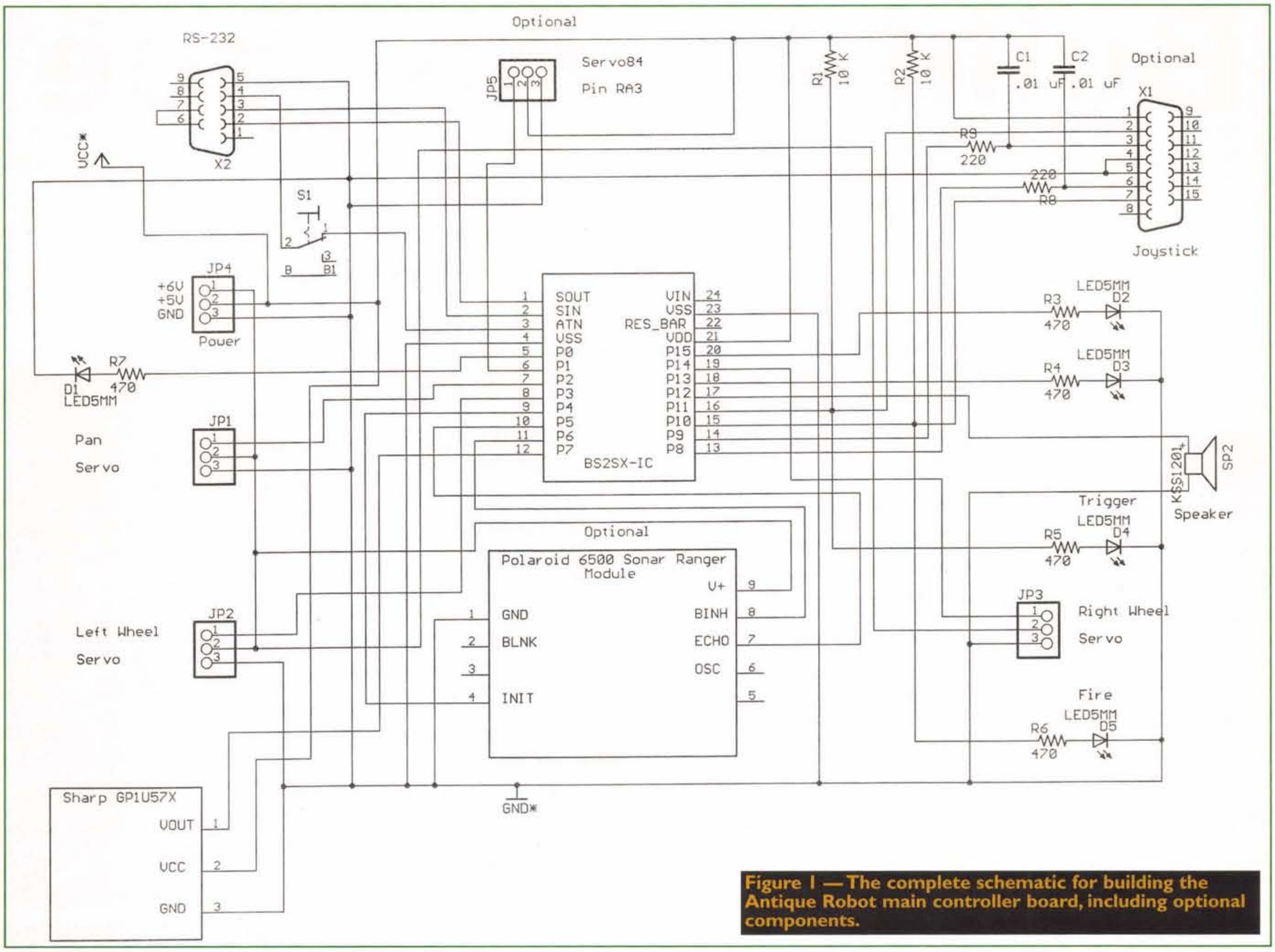


Figure 1 — The complete schematic for building the Antique Robot main controller board, including optional components.

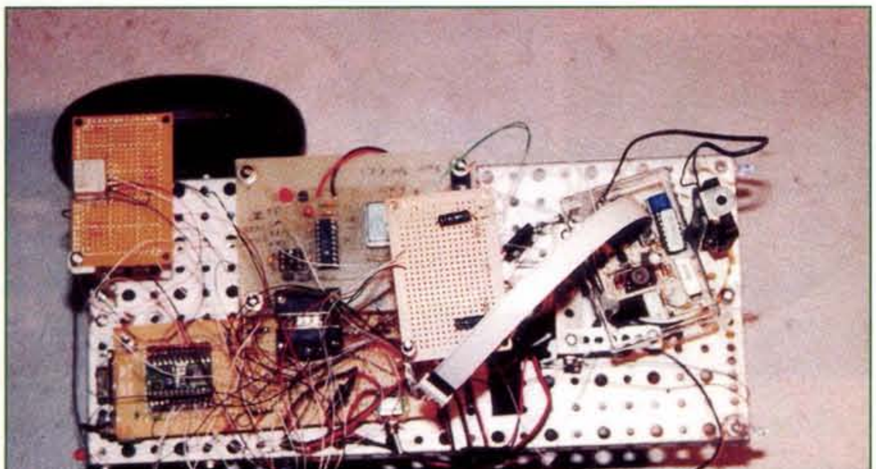


Photo 2 — Top view of the Antique Bot showing all of its electronic modules.

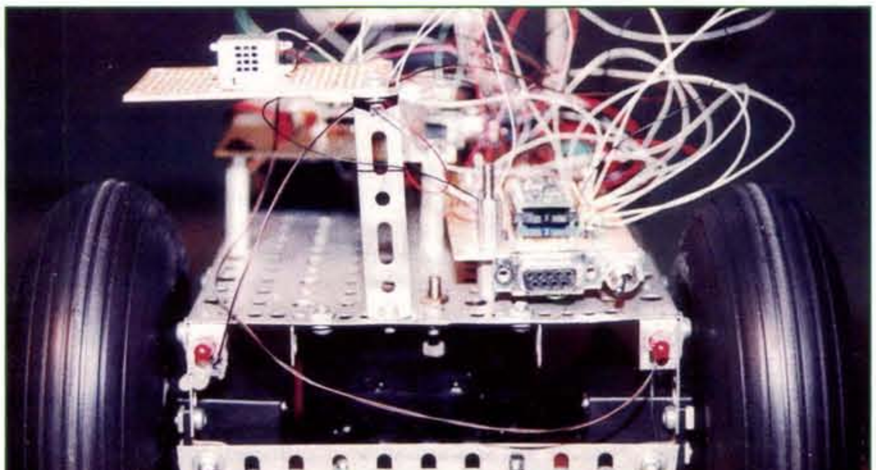


Photo 3 — Rear view snapshot showing the LED stop lights/signals and the rear bumper.

rough terrain – than those made with Erector Sets unless they are permanently glued. New materials, including those made of lightweight ABS plastic and poly-carbonates, are now available and would make great robot construction sets if they were molded into shapes similar to Meccano and were fastened using standard nuts and bolts.

RETRO-ROBOTICS

A DIY low-cost Boe-Bot that may be used to demonstrate advanced robotic behaviors can be easily put together in a couple of evenings, using antique Erector Set parts as shown in Photos 2-4. This robot is not just a rusted toy. Serious robotic experiments may be carried out with it as I will show throughout the remainder of this article. It can roam around any room under control of a TV remote while all the time scanning for obstacles with the Polaroid 6500 Sonar that is mounted on the constantly-panning sensor platform.

When an object is detected, the Antique robot takes steps to avoid it using the pre-programmed robot behaviors and generates audible beeps with a PC-mounted speaker. The three-wheeled robot uses two large model airplane tires directly connected to the wheel horns of two modified standard 44 oz-in RC servos, and a smaller, free spinning steering wheel located up front. The Antique Robot body frame is made from Erector Set girders and plates. Construction details are described below.

Some optional features including the Polaroid 6500 Sonar Ranger and the SERVO84 Controller Board, that I added to the robot to improve the robot's performance are described below. They will increase the robot's cost if implemented, but if a DIY approach is used, and freely available resources on the web are utilized, then the cost can be minimized, depending upon the construction skills and requirements of the builder. Otherwise, a low-cost,

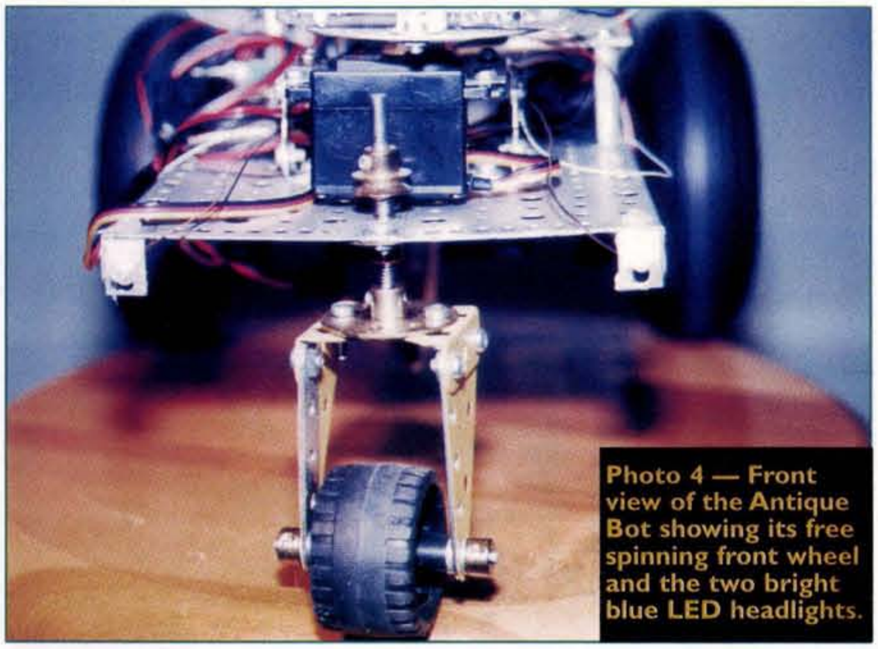


Photo 4 — Front view of the Antique Bot showing its free spinning front wheel and the two bright blue LED headlights.

functional robot with minimal capabilities may be assembled using the information contained in this article. The optional sensor platform shown in Photo 5 is mounted on the front of the robot, using another unmodified standard RC servo for panning the platform 0 to 180 degrees. The sensors mounted on the platform are used for obstacle detection or target tracking. Notice how easy it is to add new sensors and hardware modules to the Antique Robot. PC boards can be mounted on the robot's frame using PC board standoffs.

It is very disconcerting to have this mechanical beast charge at you when you shine a flashlight at it, while it executes the Follow behavior, or to have the robot scurry away from you when executing the Cricket behavior.

These behaviors and others are described in great detail in the book *Mobile Robots* by Annita Flynn **[1]**. Another book that I recently bought titled *Robotic Explorations* from Fred G. Martin is geared towards LEGO Construction, but applicable to any other construction method, and promises to be a great reference on Robotics. It seems to have plenty of general robotic information, pictures, construction details, and algorithms including classic PD Control **[2]**.

ANTIQUE ROBOT'S ELECTRONICS

The main electronics consist of the Antique Robot Controller board shown in Figure 1 and Photo 2, a Polaroid 6500 Sonar Ranger Card, and a SERVO84 Controller board, also shown in Photo 2. The microcontroller is currently a Stamp BS2, but eventually I plan to upgrade it to a low-cost PIC18C452. It is responsible for sending PWM commands directly to the RC servos or sending serial commands to the SERVO84 Controller board (if used) in order to move the two main drive servos and the sensor platform servo. It is also responsible for taking readings from each of the available sensors and determining if a command has been sent via the Sony TV remote, or if there is an obstacle that needs to be avoided, which then causes the robot to change its direction or stop. As you can clearly see in the photos, I used the visually un-esthetic but very reliable wire-wrap method to build most of the robot electronics and connect the modules, although I also use stranded wire for connecting electronic components that move. This robot will certainly not win any beauty contests.

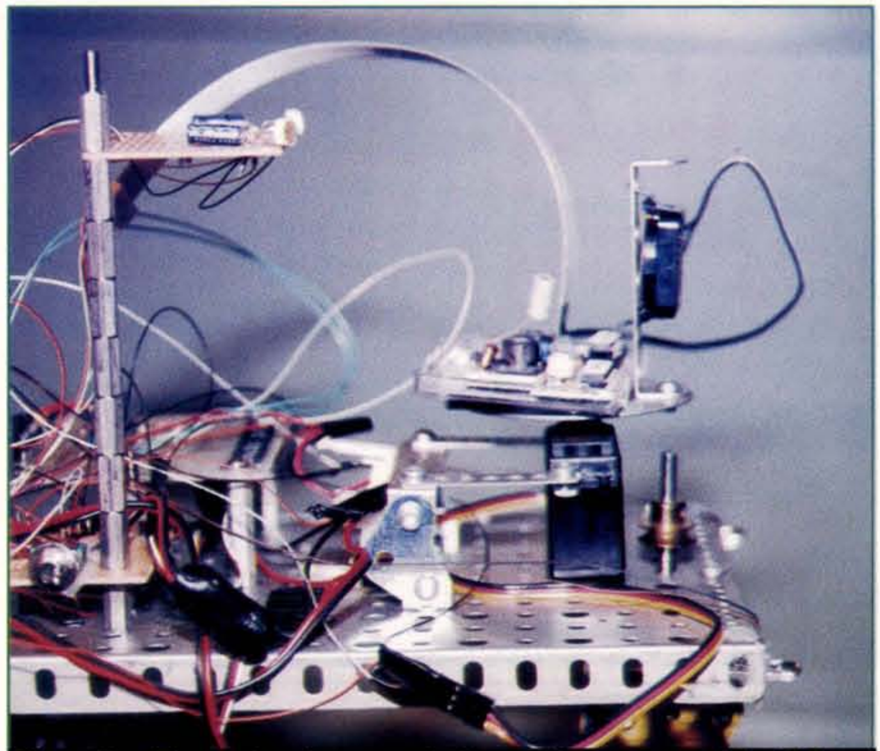


Photo 5 — The optional sensor platform using an unmodified RC servo. It also shows a small prototype board mounted on a mast of PC standoffs that holds two CDS light sensors (photocells).

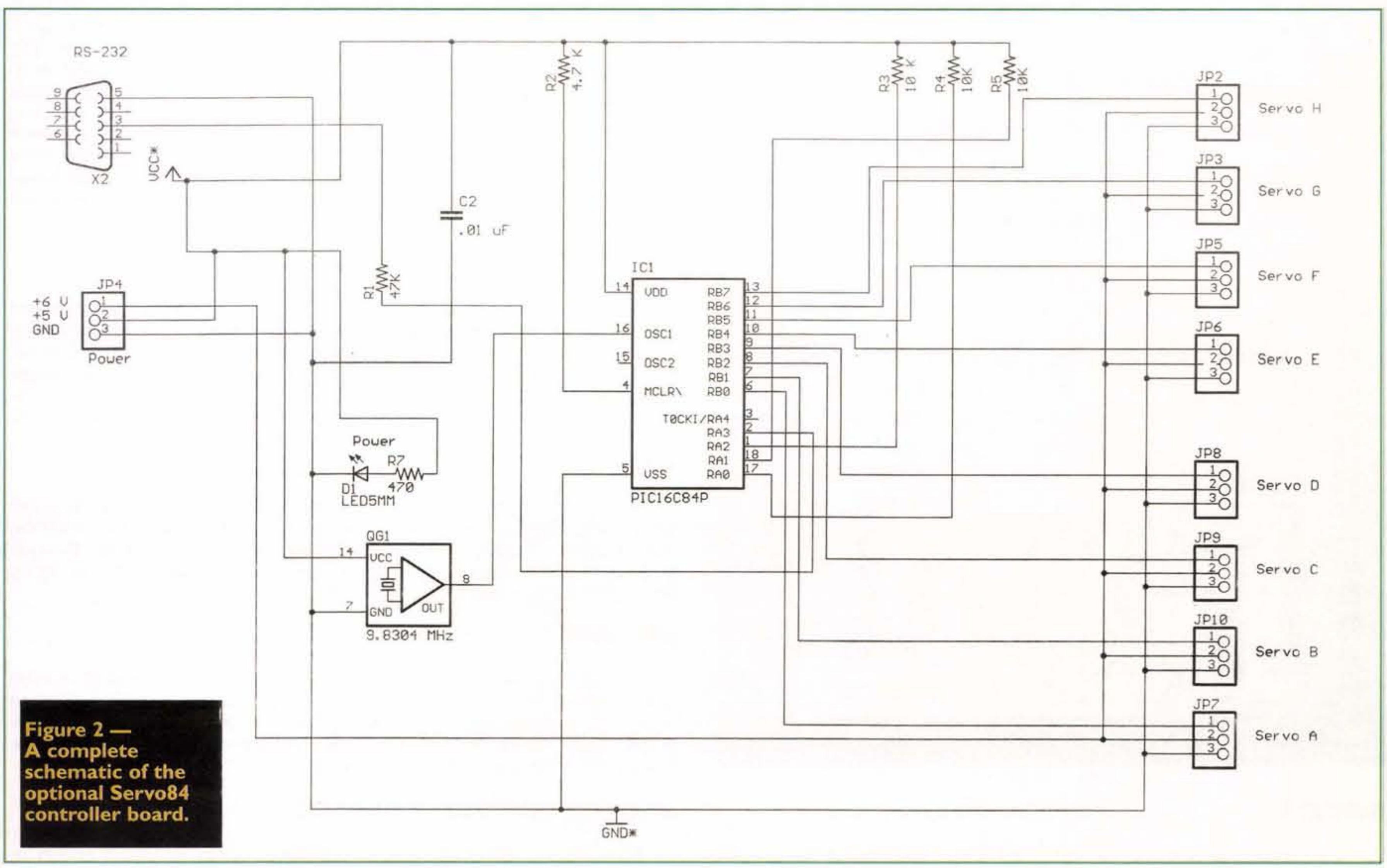


Figure 2 — A complete schematic of the optional Servo84 controller board.

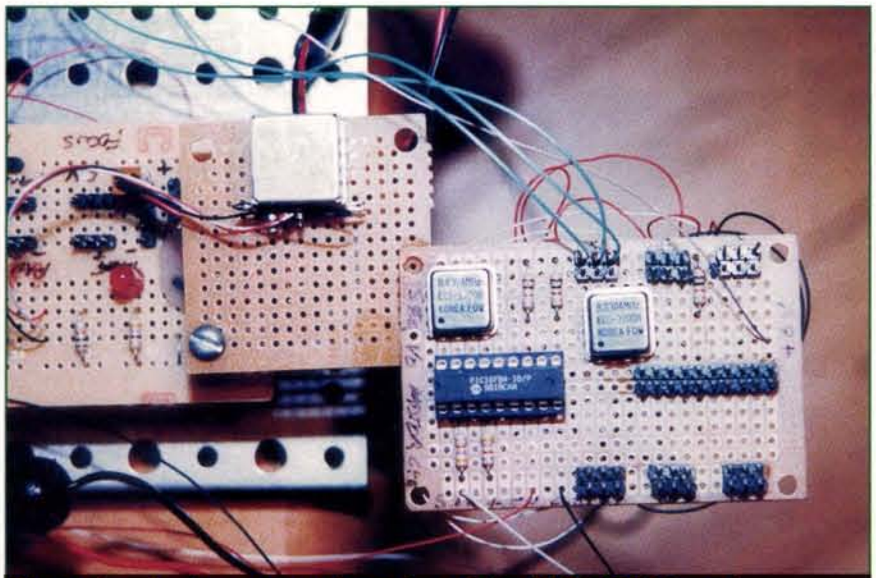


Photo 6 — A wire-wrapped version of the PIC16C84-based SERVO84 controller board used for my tilt/pan camera platform. Ignore the second oscillator.

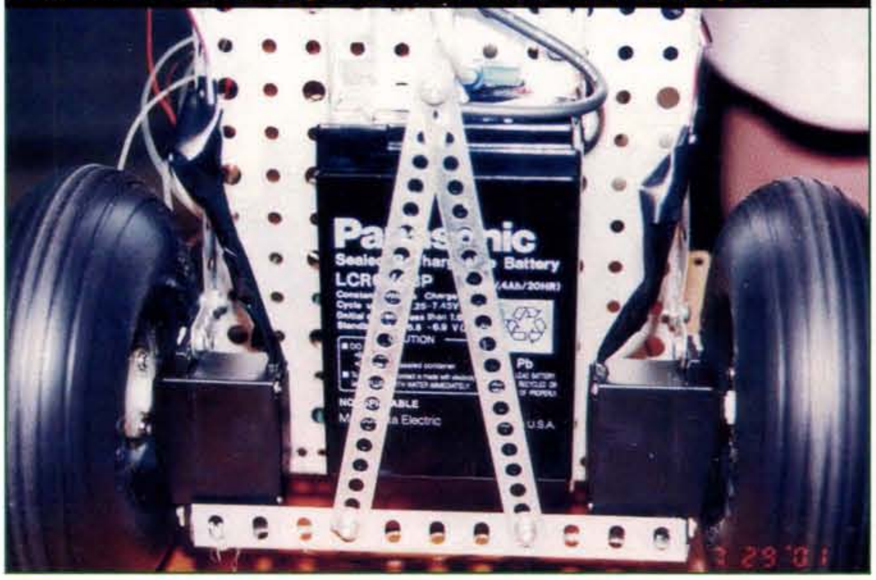


Photo 7 — A surplus rechargeable lead-acid battery used to power all the electronics used in the Antique Bot including the RC servos. It also shows the battery holder made from Erector Set parts.

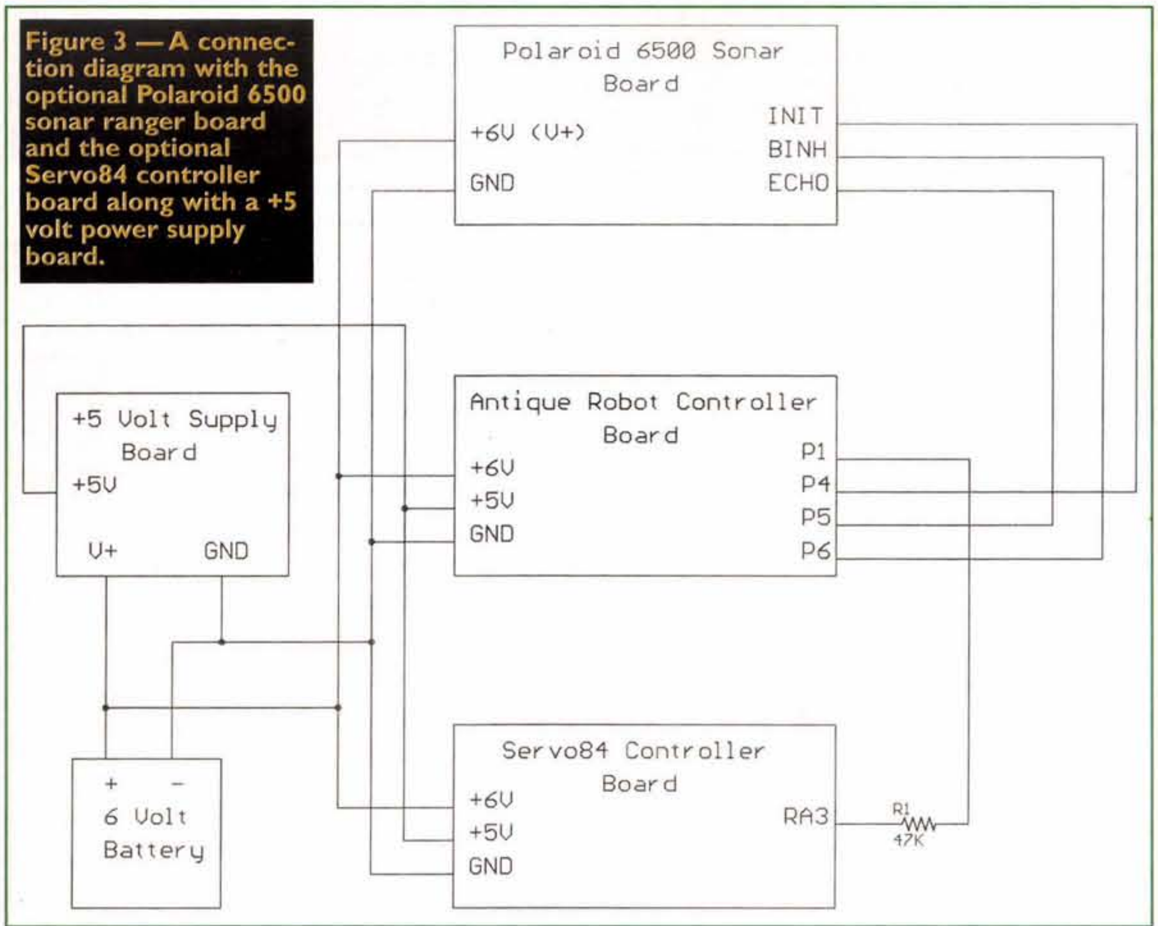


Figure 3 — A connection diagram with the optional Polaroid 6500 sonar ranger board and the optional Servo84 controller board along with a +5 volt power supply board.

is mounted on the panning sensor platform, used to obtain distances to nearby objects by determining the time of flight (TOF). Also included is a Sharp GP2D02 IR Ranger that gathers similar information using light rather than sound. These distances are collected by the software executing on the Stamp, and are averaged and compared to thresholds in order to determine if a collision is imminent. Two Cadmium Sulfide (CDS) light sensors along with microswitches that will be mounted directly on bumpers made from Erector Set components complete the robot's sensors.

POLAROID 6500 RANGING MODULE

The Polaroid 6500 is one of the more expensive robot components. It is available from Acroname.com, for $45.00 and includes the Polaroid 6500 Ranging Module and the Polaroid 7000 Series Transducer. The Polaroid Sonar Ranger is very accurate and works great with a Stamp or PIC. There are less expensive DIY designs on the web and in a recent article titled "A New View" by Robert Lacoste **[3]**. There is also a Polaroid Sun hack that shows how to remove the Polaroid 6500 Module and the sonar transducer from old SUN cameras that can be found in antique stores or on e-Bay with prices ranging from $10.00 to $25.00. The SUN hack information titled "Hacking a Polaroid Sun 660" by Daniel Weatherford may be found at www.seattlerobotics.org/encoder/200008/daniel.html.

ACTUATORS

The actuators for this robot include two modified RC servos and one unmodified RC servo (optional) for the Sensor platform. These servos may be purchased as either modified for continuous motion for $21.00 or unmodified for $11.00 from Acroname.com, or they may be modified by the reader using the FAQ titled "Hacking a Servo" by Kevin Ross to reduce cost. It is located on the web at www.rdrop.com/users/marvin/explore/servhack.htm.

JOYSTICK

An optional joystick may be connected to the Antique Robot Controller Board, using Figure 1 as a guide. The joystick positions are read using the Stamp rctime command. With additional software, the joystick can be used as a teaching pendant for training the Antique Robot to move around using the trigger or fire button for Record or Play.

SPEAKER

A built-in speaker mounted directly on the Antique Robot Controller Board generates audible beeps to indicate that an IR command was received or to warn the user of an impending collision. It may also be used for producing other interesting "sound" effects. The sounds are generated via the Stamp BS2 freqout and sound commands.

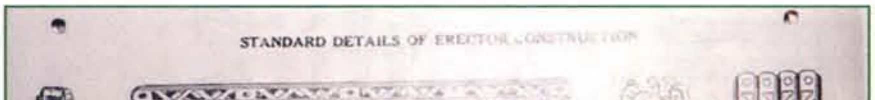


Photo 8 — Some of the antique Gilbert Erector Set parts including the famous Square Girder.

SENSORS

The sensor suite includes the optional Polaroid 6500 Sonar Ranger that

SERVO84 CONTROLLER BOARD

The optional PIC16C84 based SERVO84 Controller board shown in

INGREDIENTS NEEDED TO BUILD THE ANTIQUE ROBOT

The main ingredients used to build the Antique Robot are listed below. It is not an exact part list since it depends on various construction options used. I obtained most of my parts from Acroname, Jameco, Parallax, Digi-Key, RadioShack, surplus electronics stores, and antique stores. Both new Meccano and older Gilbert parts were used in the robot's construction. I have listed part numbers, prices, and sources for the more important Antique Robot components. Any equivalent components may be substituted. I used the following ingredients:

1) Old Erector Set with enough parts to build a robot. (A newer Meccano Erector Set may be used, if there are no old sets to be found), antique stores, flea markets, e-Bay, TOYS "R" US.
2) RadioShack prototype board, Cat. No. 276-147 for the project for $3.99, qty. 1.
3) Wire-wrap sockets and pin headers are available from Digi-Key or Jameco.
4) Parallax Stamp BS2 or Stamp BS2, qty. 1, Parallax, Inc., www.parallaxinc.com.
5) Sony TV remote control (or compatible). You may be able to borrow and use your TV remote for this project in order to reduce cost.
6) Sharp GP2D02 IR Ranger, qty. 1, for $21.00, Acroname, www.acroname.com.
7) Sharp GP1U52X IR receiver, qty. 1, RadioShack.
8) RadioShack Cadmium Sulfide (CDS) light sensors, qty. 2.
9) 4" diameter model airplane tires, qty. 2.
10) 44 oz-in standard RC servo motors (modified for continuous motion), qty. 2, for $19.00, Acroname, www.acroname.com.
11) 44 oz-in standard RC servo motor (not modified), qty. 1, for $10.90, Acroname, www.acroname.com.
12) Polaroid 7000 Package (6500 Sonar Ranger, optional), qty. 1, for $45.00, Acroname, www.acroname.com.
13) Panasonic 6-volt, 4 AH, sealed lead-acid battery, qty. 1, Electronics Surplus and Supply (ESS), Manchester, NH (603) 624-9600.
14) 1.5-volt alkaline D cells, qty. 4 (optional).
15) Bright blue LEDs, qty. 2, RadioShack.
16) Bright red LEDs, qty. 2, RadioShack.
17) 78L05 low dropout voltage regulator, qty. 1 (Digi-Key or Jameco).
18) Mini SSC II board (optional) , qty. 1, for $44.00, from Scott Edwards Electronics, Inc., www.seetron.com/ssc_faq.htm.
19) Wire-wrap wire, Electronics Surplus and Supply (ESS), Manchester NH (603) 624-9600.
20) Stranded wire, RadioShack.
21) MAX233 IC from Jameco, part #106163, for $4.95, qty. 1.
22) PC mount RS-232 9-pin D shell connector (Digi-Key or Jameco).
23) RS-232 cable (Surplus, Jameco, or Digi-Key).
24) Discrete components (resistors, capacitors, diodes, and switches) from RadioShack or Digi-Key or Jameco.

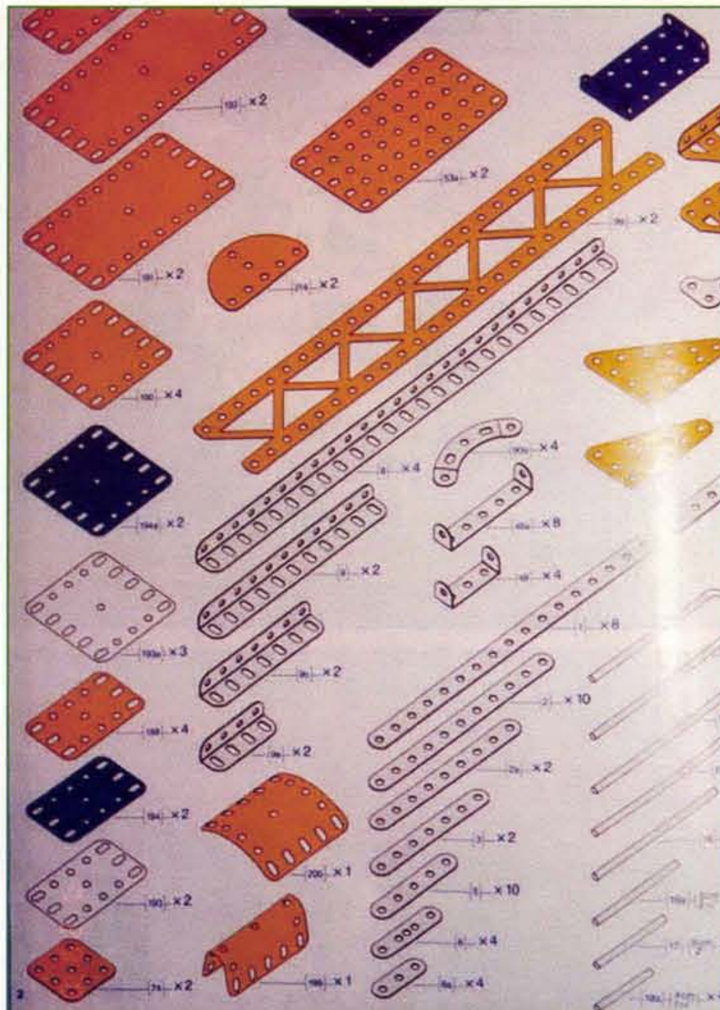


Photo 9 — Some of the Meccano Construction Set parts including the bright yellow plates of various sizes and shapes.

Figure 2 and Photo 2, is ideal for robotic and animatronic applications. It was designed for a PIC servo controller application developed by Mark Sullivan for robotics applications. Sullivan's code is highly optimized and can handle up to eight RC servos reliably. A wire-wrapped version of the board used for my Tilt/Pan Camera Platform is shown in Photo 6. I obtained Figure 2 by reverse engineering Mark's PIC 16F84 Assembly **[5]**. It is available freely on the web at http://mks.niobrara.com/microtools.html.

The SERVO84 accepts simple three byte servo position commands via the serial port from the Stamp BS2 and it maintains the proper PWM waveforms every 20 milliseconds, required to keep the RC servos positioned correctly. This board, in effect, acts as a co-processor to the Stamp to alleviate extra processing on the Stamp BS2 required to refresh each RC servo, so that the Stamp may be free to perform other more important tasks, and also increase its response to external events.

The SERVO84 Controller board is easy to make and not very expensive, if you already have the tools required, including a PIC programmer. I use the Warp13 programmer for all my embedded PIC programming tasks since it works directly with Microchip's MPLAB which is also freely available as a download from www.microchip.com.

A DIY PIC 16F84 programmer that is easy to build and does not require a UV eraser is described in many FAQs and articles written by David Tait who was one of the first persons to design a cheap PIC programmer. He is responsible in part for the PIC revolution today. These articles can be found on the web at http://members.optushome.com.au/donmck/dtait/index.html. Another DIY PIC16F84 programmer that includes a PC board layout is described in Bob Blick's web site www.bobblick.com/projects/PicProg/index.html. Check out Bob's other great projects including his Persistence of Vision (POV) experiments, one of which is a "Propeller Clock."

There is another board available from Scott Edwards Electronics, Inc., www.seetron.com for $44.00, that performs a similar function called a Mini SSC II Serial Servo Controller. It is a compact, well-designed surface mount board that measures 1.4" x 2.1", and is ideal for animatronics and robotics applications. In fact, there are many web-based projects including a unique wooden mirror http://fargo.itp.tsoa.nyu.edu/~danny/mirror.html that uses this board. A single board can handle up to eight servos, but can also be cascaded with other boards to handle up to 256 servos. If Scott Edward's board is used, then small changes will have to be made to the Antique Robot BASIC code (check out Listing 2 available for download from *Nuts & Volts* website).

The changes to the serial I/O are only needed to conform to Scott's servo command syntax. By the way, Scott Edwards now has an updated version of his Stamp Classic *Programming and Customizing the BASIC Stamp.* I happen to own the first edition, which I still reference frequently and highly recommend **[4]**. It has plenty of information on controlling RC servos and building a Sonar Ranger from discrete components and was the book

Figure 4 — A complete schematic for building a low-voltage drop +5 volt power supply board. The power supply can be integrated on board with the Servo84 board, if desired.

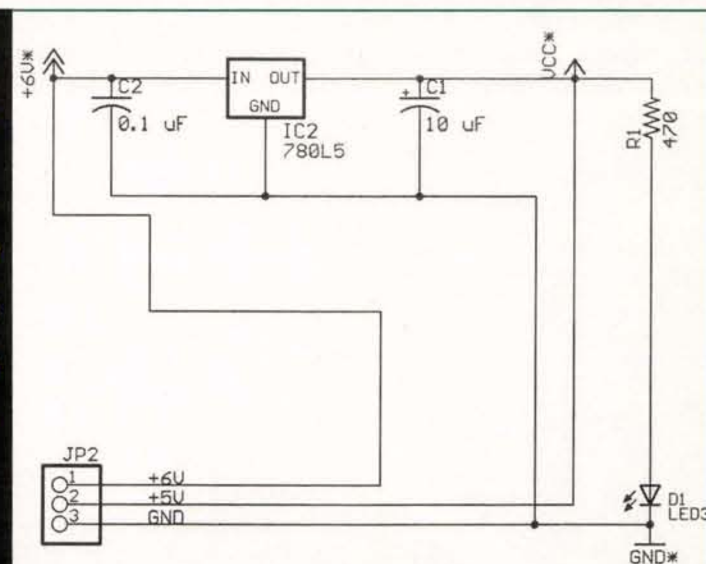
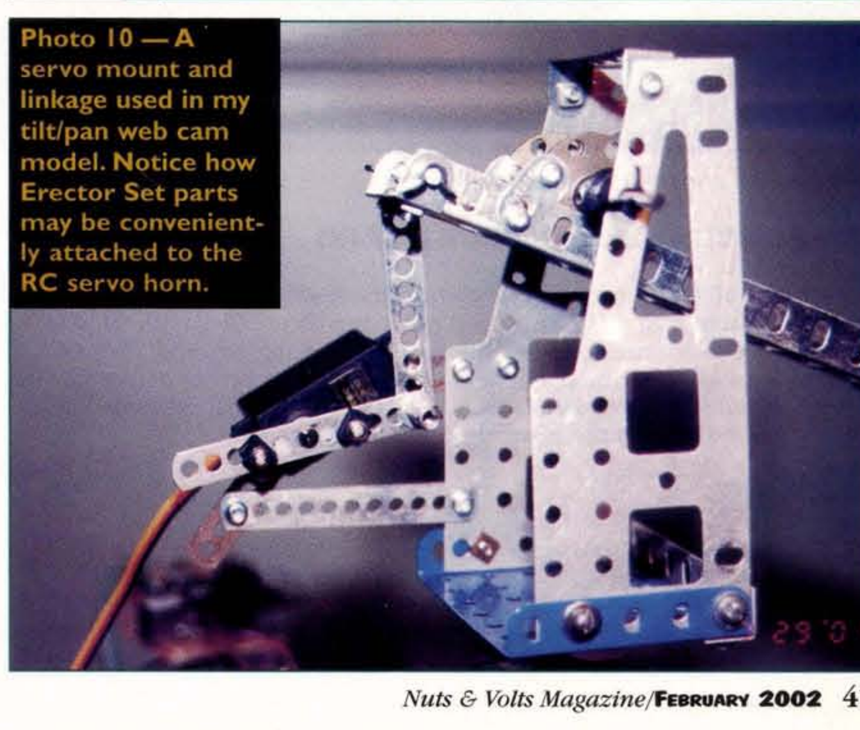


Photo 10 — A servo mount and linkage used in my tilt/pan web cam model. Notice how Erector Set parts may be conveniently attached to the RC servo horn.



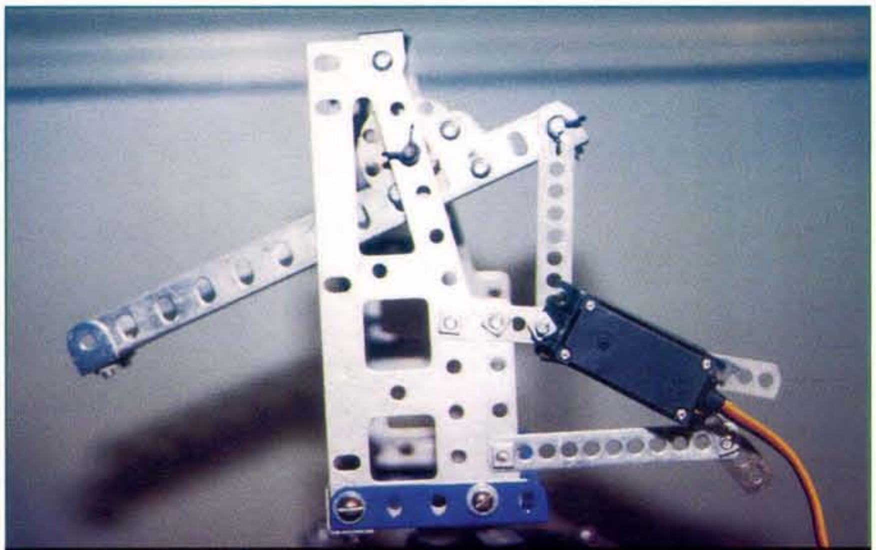
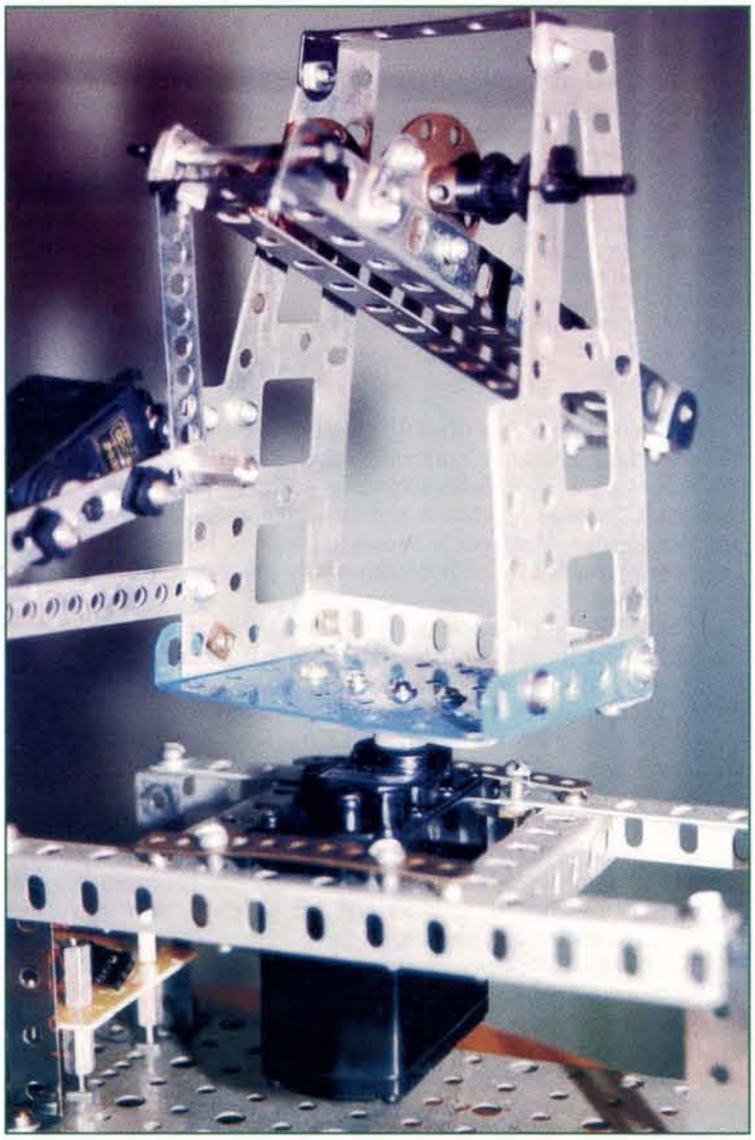
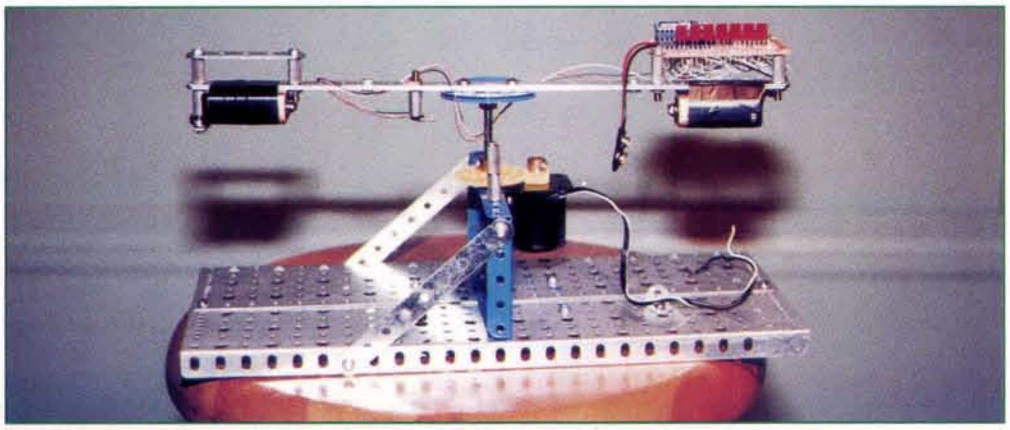


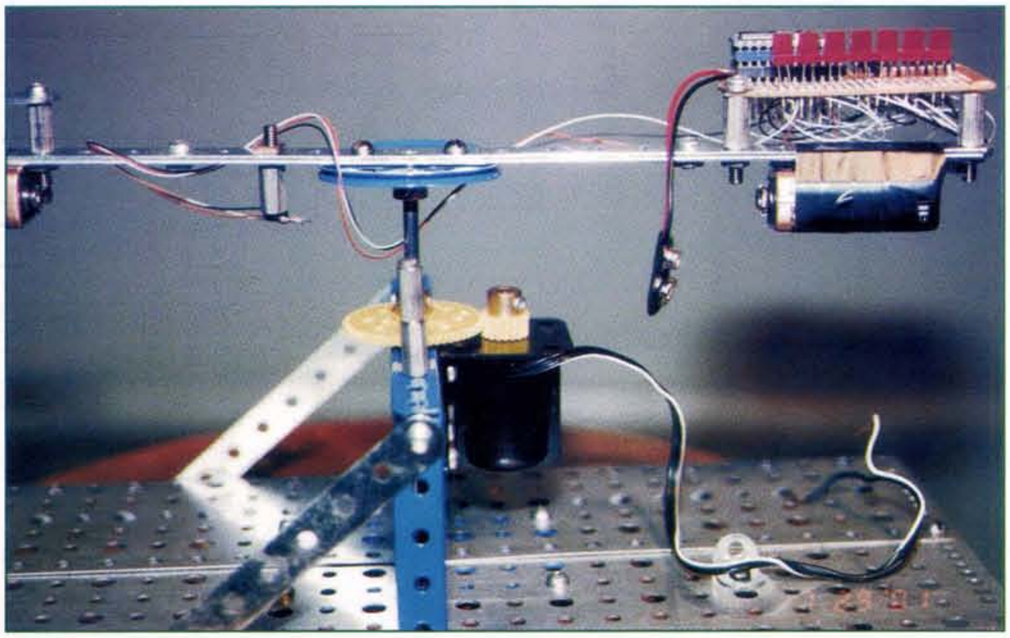
Photo 11 — Another snapshot of the tilt/pan servo mount and how it is attached to the frame.

Photos 12a,b (top and bottom, respectively) — Two views of a tilt/pan/zoom web cam platform that I built.





Photos 13a,b (top and bottom, respectively) — Two views of a Persistence of Vision (POV) display model based on a POV project in Scott Edwards book *Programming and Customizing the BASIC Stamp* [4] that I built. Note the use of the Meccano six-volt DC motor and heavy duty plastic gears.



that got me started using the Stamp.

IR RECEIVER ELECTRONICS BOARD

The small board mounted on a mast made from PC board standoffs is shown in Photo 5 and Figure 1, and holds the Sharp GP1U52X IR receiver used to receive commands from a Sony TV remote control and the two CDS light sensors are used for Light Look, Moth, and Cricket robot behaviors. The Stamp decodes the commands from the 40K Hz IR signal generated by the Sony TV remote using the 12-bit (SIRC) Sony IR protocol.

LIGHTING

Glued to the front of the robot frame are two bright blue LEDs used as headlights, and glued to the rear of the robot are two bright red LEDs used for stop lights and turn signals. The LEDs are controlled by the control software currently loaded on the Stamp microcontroller. The robot looks really neat in a dark room with these LEDs lit. For a more interesting visual effect, I intend to add bright red LEDs to the panning sensor platform. Now where did I see this panning red light before?

THE POWER SUPPLY

Surplus rechargeable lead-acid batteries shown in Photo 7 are far better for powering robotic projects while also helping the environment by reducing the number of 9-volt and 1.5-volt D cell batteries needed for robotic applications that would end up at the dump. They usually have a very long life even after having been used for commercial emergency lighting applications.

A small Panasonic 6-volt, 4 AH rechargeable lead-acid battery mounted under the robot body conveniently powers the on-board electronics and motors, including the RC servos, the Polaroid 6500 Sonar Ranger, the Antique Robot Controller Board, and the SERVO84 Control Board (if used). I charge it using a Sears one-amp motorcycle charger. If desired, a battery pack consisting of four 1.5-volt alkaline D cells may be substituted for the 6-volt sealed lead-acid battery.

A +5 volt power supply circuit, shown in Figure 4, is required for the optional Servo84 Controller Board. It may be located on the Servo84 Board if there is enough room or on a separate prototype board. The voltage regulator should be of the "low drop out" kind such as a 78L05, so that it can be powered from a single +6 volt battery.

TOOLS NEEDED

In addition to the standard tools used for electronics projects, the following tools will be needed to build the Antique Bot:

Erector Set Wrench
Allen Wrench (for Meccano Sets)
Electric Screw Driver (optional)
Standard Screw Driver
Pliers
Wire Cutters
File
Wire-wrap Tool (optional) available at RadioShack, part #276-1570
Wire-wrap Gun (optional) available at electronic surplus stores
1/4" Electric Drill (optional)
Hot Glue Gun (optional)
Dremel Tool (optional)
Emery Cloth (optional)
Parallax Stamp Programming Cable
Warp13 PIC Programmer or equivalent (optional)

CONSTRUCTION TECHNIQUES USED

To the horror of toy collectors everywhere, rusted Erector Set parts may be carefully cleaned with a Dremel Tool or fine Emery cloth, and then spray painted with aluminum enamel paint or any enamel paint of any other color, for a more durable and esthetic finish. Gilbert sets are particularly prone to rust since they were not originally painted. Holes can be easily widened to fit non-standard parts, using a power drill or a file. Of course, altering the parts devalues the set if you later plan to sell it to collectors.

In fact, new Erector Set parts can be machined from old parts by using an old part as a pattern and some scrap steel or aluminum pieces, if you happen to have an 8" drill press or machine shop available to you. Please wear goggles when using any power tools, especially the high-speed Dremel tool, and remove any remaining burs from cut metal using a file, emery cloth, or the Dremel tool.

The robot's frame and servo mounts are all made from Erector Set girders and plates as shown in Photos 8 and 9. Any convenient design may be used for the robot's base, just be sure to leave enough room for your electronics boards, batteries, sensors, and actuators. The front wheel which works very well on smooth floors, is a free spinning wheel made from new Meccano Set parts, as seen in Photo 4. The spring is basically a shock absorber used to improve steering over rough terrain. Any convenient wheel including a swivel chair caster may be substituted.

One task that I always dreaded when working with Erector Sets was the endless cycle of loosening and tightening nuts and bolts. I found that using an electric screwdriver became an invaluable tool in fastening the Erector Set parts while also saving time. I also found an electric screw driver hex bit of similar dimensions to the Allen Wrench that is included with Meccano Sets, that works with the hex Mecanno bolts. Beware of the sudden kickback you may get if you over-tighten a screw.

Stiffness of assemblies can be increased by using multiple layers of steel girders or plates. For example, a heavy duty bumper may be assembled by layering thin girders and fastening them with long 1/2" 8-32 nuts and bolts. Sometimes layering Erector Set parts with other materials such as plywood can increase the strength and rigidity of mechanical assemblies (composites). Bumpers for the robot are assembled from layering girders together and bolting them together. Microswitches may then be attached to the bumpers for collision detection.

Servo mounts are easily adapted to the Erector Set form factor as shown in Photos 10-11. Various brackets may be put together depending upon the ingenuity of the builder. RC servo push rods, cams, and horn attachment hardware sold in hobby shops are great for making animatronic devices such as robot arms and hands, fingers, or any other device that requires linear motion.

The battery holder shown in Photo 7 is sturdy enough to hold the six-volt lead-acid battery to the bottom of the robot. A foam or cardboard box surrounded by Erector Set aluminum plates may also be used to protect the battery from harm. A similar battery holder for six D-cell batteries can also be put together. PC board standoffs fit very nicely with Erector Set parts and can be used to fasten PC boards, and other hardware to the robot.

LEDs, microswitches, and other sensors may be "hot glued" to the robot body, and later removed when re-using the Erector Set parts. Hot glue is also good for locking stubborn nuts and bolts that get loose due to vibrations.

BUILDING THE ANTIQUE ROBOT CONTROLLER BOARD

To build the Antique Robot Controller, use the schematic shown in Figure 1. Parts placement and board fabrication techniques are not critical. Wire wrap, point-to-point, and PC board construction can all be used for this project. I chose to wire-wrap the Antique Robot Controller Board. The Antique Robot board may be built using the following procedure.

Start by soldering the pin-headers and IC sockets onto the RadioShack

REFERENCES

Books:

[1] Jones, Joseph, L., *Mobile Robots – Inspiration to Implementation*, AK Peters, Limited.
[2] Martin, Fred, G., *Robotic Explorations: A Hands-On Introduction to Engineering*, Prentice Hall, Inc., 2001.
[3] Lacoste, Robert, "A New View," *Circuit Cellar*, Issue 132, July 2001.
[4] Edwards, Scott, **Programming and Customizing the BASIC Stamp Computer*, McGraw-Hill.
(Available from the Nuts & Volts bookstore* ***www.nutsvolts.com**)*

Datasheets:

[5] Microchip Technology, Inc., "PIC16F8X 8-Bit CMOS Flash/EEPROM Microcontrollers," document #DS30430B, 1996.

Sources:

Microchip Technology, Inc., **1-800-344-4539**, web site: **www.microchip.com**
Parallax, Inc., **1-888-512-1024**, web site: **www.parallaxinc.com**

prototype board or PC board. Next, solder the 0.1uF bypass capacitors as close to the IC socket power pins as possible. Do not clip the leads, since they make handy wire wrap or point-to-point posts. Solder other discrete components such as resistors, capacitors, and diodes as designated in the schematic. Wire wrap labels can be purchased from Jameco to make the wire-wrapping task easier if the wire wrap method is used.

Next, wrap the power lines using red wire, and wrap the ground lines using black wire. Tie all ground wires to a single post if possible. Finally, wrap each logic signal using white, yellow, or blue colored wire, checking each one off from the diagram until all signals have been wired. Screw any PC standoffs to the prototype board and glue or solder the RS-232 connector directly to the prototype board.

At this point, it's time to check the circuit for shorts or open lines by using your digital voltmeter to check continuity on all power, ground, and logic signals. You can inspect the board using a magnifying glass.

Before populating the board with the ICs, power the board by connecting a 6-volt battery to the (+) and (-) power terminals and check to see if the power LED lights up. If it does, check for +5V at the VDD pin of each IC and V at the VSS pins. Once this has been done, you can populate the board with the ICs and fire it up for the first time. Build the +5 volt power supply circuit shown in Figure 4, if the optional Servo84 Board is going to be used. Check for +5 volts output when the 6- volt battery is connected to the input. The current is usually limited by the low voltage drop 78L05 voltage regulator to 50 or 100 mA. This is sufficient to power the PIC16F84 located on the Servo84 board. I used point-to-point techniques to build the IR receiver board using a small RadioShack prototype PC board and Figure 1 as a guide.

BUILDING THE OPTIONAL BOARDS

A PC board was used to assemble the SERVO84 board using Figure 2. Detailed instructions for making the optional SERVO84 board are not provided due to article length limitations, although I did provide enough information to allow the reader to build one or to use a substitute Mini SSC II Serial Servo Controller. See Figure 3 for a general Antique Robot hook-up diagram.

Be sure to connect all ground and VCC lines between each module as shown in Figure 1. Make sure that the +5 volt and the +6 volt RC servo and +6 volt Polaroid Sonar Ranger terminals are connected. Check power to any other optional modules including the +6 volts for the Polaroid 6500 Sonar Ranger Board, the +5 volts for IR receiver board, and the +5 volt and +6 volt for the SERVO84 board.

SOFTWARE FOR THE ANTIQUE ROBOT

A complete listing of the Antique Robot Control Software that contains all the necessary Stamp BS2 code to give the robot a few simple behaviors including accepting simple commands from the user via the Sony Remote Control is shown in Listing 1, which is available for download from *Nuts & Volts'* website. The user commands that cause the robot to move are Forward, Reverse, Left, Right, Faster, Slower, and Stop. Code for other behaviors that are currently under development such as Follow and Avoid are also provided. This version of the software also takes advantage of the SERVO84 controller board. It provides added functionality and increased performance over using the Stamp to refresh the servo motor positions by eliminating the extra code needed to maintain the RC servo motor positions every 20 milliseconds. All the source code that accompanies this article, except for the SERVO84, may be found on the *Nuts & Volts* web site at **www.nutsvolts.com**.

The software required for the optional SERVO84 controller board may be found on Mark Sullivan's web site at **http://mks.niobrara.com/microtools.html** site, or if a board is purchased from Scott Edwards Electronics, Inc., the associated software and documentation may be found at his web site, **www.seetron.com**. The Avoid behavior that I am currently developing prevents the robot from hitting obstacles in its way by comparing Sonar Ranger readings and IR Ranger readings to pre-selected thresholds. When an object is determined to be too close for comfort, the robot either stops, backs up, turns left or turns right, or combines any of these behaviors in order to avoid the object.

As I mentioned earlier, other robot behavior algorithms from previously published projects may be executed on this robot if the Stamp BS2 I/O pins are changed accordingly and any variable name conflicts are resolved. This opens up all the Parallax Boe-Bot robot software and experiments for use on the Antique Robot. Many other web sites, for example Acroname, Arrick Robotics, and Parallax, Inc., have advanced robot behavior software developed for various types of robots that may also be adapted to this robot.

AN ERECTOR SET FOR THE NEW MILLENIUM

I can envision a new Erector Set geared towards robot builders as affordable, easy to use, and as versatile as the older generation Meccano and Gilbert Erector Sets. It combines the best features of Heathkit, Parallax, Meccano, and LEGO to allow robots as complicated as the Hero I or the Mars Lander or a robot hand to be assembled by the hobbyist:

- New girders, plates, and fasteners made of the latest alloys allow for lightweight, high strength and stiffness construction materials (poly-carbonate composites) space age NASA.
- Precision gears, pulleys, timing belts, chains, and cams.
- Muscle wire, memory shape metals, etc.
- Plastic coverings for models.
- Injection Molded clear domes, etc.
- The latest coreless DC motors, RC servos, and stepper motors would replace the old six-volt DC motor or the 120-volt geared AC motor.
- Electronics Modules.
- Electronic Speed Controllers (ESC) similar to those used on electric racing cars and Electric RC Planes.
- Sensor Controller Board.
- IR Remote Control.
- RF (900 MHz) transmitter/receiver communications link to PC or laptop host.
- Sensor modules similar to those provided by LEGO.
- Polaroid 6500 Sonar Ranger (or low-cost alternative).
- Sharp IR Rangers would be included in the set.

OTHER ERECTOR SET PROJECTS

An interesting fact that I read while doing research on the web is that one of the largest Meccano models resides in Ripley's Believe It or Not in St. Augustine, FL. It is a giant model of a Ferris Wheel that was built when Meccano started selling its sets in the US. Another interesting fact is that a new theme park dedicated to A.C. Gilbert is being built in Oregon.

The web is full of other Erector Set and Meccano Models from all over the world, check out the web ring site at www.meccanoweb.com for some excellent examples of models.

The following is a list of some other Erector Set projects that I have recently completed. Due to article length limitations, I can but provide a short description of each.

Here is my list along with a photo of some of my completed projects, along with some new ideas. I leave it to the reader to take up the challenge of building the remaining models.

1) A tilt/pan/zoom web cam platform that I built is shown in Photos 12a,b.
2) A POV display based on a POV project in Scott Edwards book *Programming and Customizing the BASIC Stamp* **[4]** that I built is shown in Photos 13a,b.
3) A PUMA 6 Degrees of Freedom (DOF) robot.
4) A Pick and Place robot arm.
5) A Mars Lander Robot.
6) A Robotic Hand.
7) A Hexapod Robot.
8) A Walking Robot.
9) A Lost in Space Robot.
10) Kronos Robot, from the 50's Science-Fiction movie.

BACK TO THE FUTURE

I have shown how an antique Erector Set combined with modern sensors, actuators, RC servos, and electronics makes a far better robot construction kit than many new "plastic" robot construction sets.

I also provided a design for a DIY Boe-Bot-like robot platform that may be used for education, training, and robotics experiments that costs far less than building a Boe-Bot or a Rug Warrior when using surplus electronic components and antique Erector Set parts. Much of the Stamp BS2-based robotics software available on the web or from Parallax may also be used on the Antique Bot with minor modifications to the hardware and software.

I also described other Erector Set based designs of projects that I have recently completed that demonstrate how versatile the Erector Set really is. It is a timeless invention that for over a century is still ahead of any other modern construction sets and is a great educational toy for learning mechanics and robotics.

Let's get these old Erector Sets out of the hands of toy collectors and antique dealers and into the hands of robot builders, so that they may again be used for their intended purpose. I'm sure that's a sentiment that Mr. Hornby and Mr. Gilbert (inventors of the Erector Set) would approve of. **NV**

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

by Jon Williams

Weather On The Wire

I've always had an interest in the weather. As a boy, I would read books on basic meteorology and simple weather forecasting. There was a moment, albeit brief, when I thought about being a TV weather man. After high school and a couple of years in the military, I went to work in the irrigation industry and spent most of that time in the golf course business – a business tied very directly to the weather.

Even though I've been out of that business for a couple of years, my morning routine is the same: I wake, I stretch, I go out onto the front porch to see what the weather is like, and what I can expect for the day. Today (early January as I write) was really nice. It's clear in Dallas and the temperature on my front porch was 65 degrees and the air is clear. You can't beat that.

A couple of months ago I was contacted by a Stamp programmer named Tim. He lives in Tucson and has a big interest in the weather – very big. He told me about a low-cost weather station that used Dallas Semiconductor 1-Wire technology. I was under the impression that these stations were no longer available, but I was wrong. A company called AAG in Mexico has them and you can order them via the Internet using PayPal. A 1-Wire weather station seemed like a neat add-on for a BS2p, so I bought a few.

1-Wire Weather Station

Since we don't have to build the station, I'm not going to include the schematic here. It is available on the AAG web site if you'd like to review it as we go through the code. The key thing to understand is that there are three devices connected to the 1-Wire bus: a DS1820 thermometer, a DS2423 counter for the anemometer (wind speed), and a DS2450 quad analog-to-digital converter that is connected to the wind vane.

The connection to the weather station is an RJ-11 (telephone) connector. If you have a BS2p Demo Board, this project is easy since there is an RJ-11 on the board. Even if you're making your own connections, please note that the 1-Wire pull-up is very stiff, 1 kOhm. This is necessary to overcome the impedance of the cable connecting the Stamp to the weather station. If you are using the Demo Board, remove jumper B2 and connect a 1 kOhm pull-up to the 1-Wire bus.

Weather Code

With nothing to build, let's jump right into the code. Now ... before we even start, we need to know what the 1-Wire serial numbers are. I've worked with two of these stations and neither came with the serial numbers printed on the side of the box (nor was I expecting it). This is not a problem. What we need to do is run the 1-Wire SearchRom code we developed last April. If you don't have it, you can download the code from the *Nuts & Volts* web site.

When you run SEARCHDEMO.BSP you'll see that it doesn't know what a DS2423 is and lists it as an "Unknown Device." Don't worry about this. Just copy the serial numbers so that they can be plugged into the weather station code.

Okay, this listing is pretty long so we better jump right into it. The Initialization section opens the DEBUG window, displays a header for the screen, then gets down to work. The first piece of real work is to make sure that the 1-Wire bus is not shorted. This is done by making the 1-Wire comm pin an input then reading it to make sure we see it pulled up to +5 (will read 1). If zero is returned, the program is aborted to an error handler.

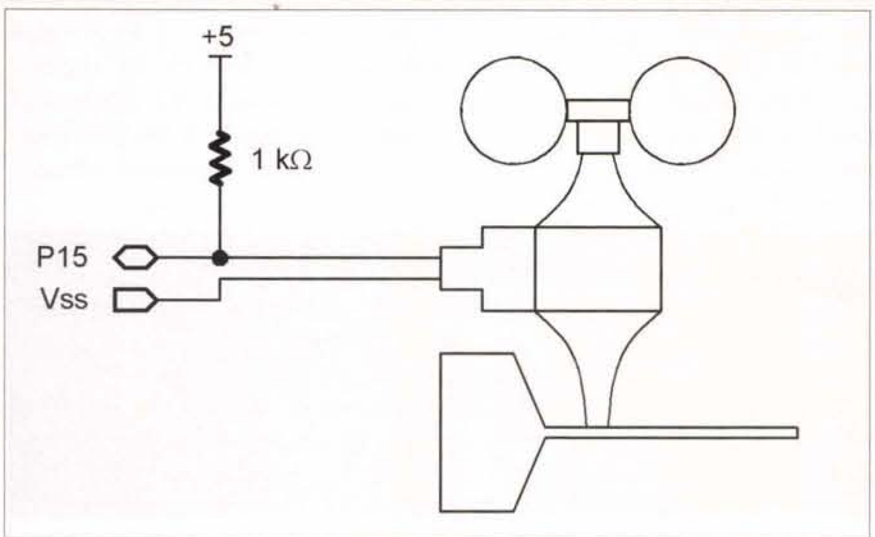
The next section of code is the reason we just did that check. There's a small power supply in the weather station. Okay, okay, it's just a diode and a capacitor. The cap provides Vdd to the 1-Wire devices and to pull-ups connected to the A2D converter. Since the supply "borrows" power from the 1-Wire bus, we start the program by charging it. This is done by making the 1-Wire bus pin high and waiting for 10 seconds. In our program, a message is displayed showing the charging time left.

Once the station is charged, labels for communication status and each of the sensors are printed. The program then enters the main loop. In the main loop, the program checks to see that the station has connected the branches to the current sensor. So long as the station stays connected, the program will run the main loop. If the station gets disconnected, the initialization sequence will be re-run until contact with the station is reestablished.

We can check to see if the station is connected by issuing the SearchROM command and reading back two bits. If nothing is connected, all we'll see is the pulled-up bus and a value of %11. If there are devices connected, we'll get another pattern. The reason for checking is the same as looking for a short: there's probably a lot of wire between your desk and the station and accidents can happen. We'll assume that the world is a perfect place for wires and that there are not shorts and the station is connected. Now we can read and display the sensors.

Temperature

The first sensor is the DS1820 temperature sensor. We've used this before so we'll be brief in the coverage. The routine starts by loading the device serial number into an array called romData. This process is facilitated by a small sub-routine called Load_SN. What we'll do is load the DATA address of the device into eeData, then call this routine. The serial num-



ber is read out of EEPROM and placed into the array.

With the serial number loaded, we'll issue a MatchROM command with the serial number, then the temperature conversion command. All of this happens in a singe OWOUT statement. Then the 1-Wire bus pin is taken high and we wait for 750 milliseconds. This is the worst-case conversion time for the DS1820 and making the bus high provides power during the conversion process.

The nine-bit Celsius temperature is retrieved with OWIN and converted to Fahrenheit for display. Note that the temperature is a signed value. This time of year the temperature in many areas of the country falls below zero Celsius (32 Fahrenheit).

The temperature is displayed using a subroutine — RJ_Print — developed by Stamp guru, Stamp list contributor, and all-around-nice-guy, Dr. Tracy Allen. To use this routine, we need to pass the width out of field in the variable width and our value to print in rjNum. Tracy's routine makes clever use of LOOKDOWN to determine how many spaces to print (pad) before the actual number. If the number is negative, a minus sign will be printed in front of the number.

Wind Speed

The 1-Wire weather station measures wind by counting the number of pulses during a known time window. Mechanically, there is an arm connected to the anemometer cups that carries a couple of magnets to trip a reed switch connected to the DS2423 counter. Since the counter cannot be reset, what we'll have to do is get the current count, delay for some period, read the count again and then subtract the first reading from the second to obtain the difference.

What Tim noticed and I confirmed is that the counter only seems to work properly when used in overdrive mode. Neither one of us can explain it, but I wanted to make you aware in case you decide to make modifications to the program.

To put the DS2423 in overdrive mode, we send the ODMatchROM value by itself. After that, we send additional data using the high speed setting of the OWOUT command. Since the DS2423 is actually a memory plus counter, we're forced to read the final byte of the page that precedes the counter value. It's a quirk of the DS2423 that you cannot reset the counter (it is reset on power-up) nor read it directly. There are actually two independent counters in the DS2423. The weather station ties the inputs together so reading either one will give us the same value.

Our OWIN ends up reading the lower 16 bits of a 32-bit counter. Then the program pauses for 2500 milliseconds and reads the counter again. The difference is computed and the wind speed is calculated.

The general formula for wind speed is given as:

Speed (mph) =
Revolutions_Per_Second * 2.453

There are two magnets on the t-bar that rotates above the wind speed counter switch, so each revolution actually gives us two counts. If we paused for one second, our wind speed resolution would be 1.23 mph (2.453 mph / 2). Since I wanted a little better resolution than that, I used a PAUSE value of 2500. This brings the resolution down to 0.49 mph — much better. What this means, though, is we have to wait for the wind speed reading. This is the reason the sensor indication was developed.

In order to maintain our resolution within the Stamp's integer math system, what we're actually going to do is use 24.53 to get tenths. Since our PAUSE value is 2500 — equivalant to waiting five seconds if one revolution equaled one count — we divide that by five and get 4.906. For use with the Stamp, we multiply 4.906 by 256 and use the */ (star-slash) operator. The result is multiplication by a fractional value.

The variable speed now holds the wind speed in tenths of a mile per hour. For display, we extract the whole part by dividing the wind speed value by ten, then sending it off to RJ_Print. Then we print a decimal point and the tenths digit by using the DEC1 modifier.

Wind Direction

While many weather stations use a free-rotating potentiometer to determine wind direction, the 1-Wire station takes a different approach. It uses eight reed switches connected to a resistor array that is read by an DS2450 quad A2D converter. The way the resistors are connected means that a given A2D channel will either see full scale, half-scale, or ground. Our trick will be to convert these four analog readings into a 1-of-16 direction value.

The DS2450 is configured to read all four channels, using eight-bit values with a 5.12 volt reference. Since the actual voltage at the station is going to be a bit less than five volts, our highest reading will be slightly less than 255 (full scale at 5.12 volts). I wrote a quick test program to decode the values for each of the 16 compass directions. High values tended to be around 235 to 240, middle values around 120, and low values between 0 and 3.

To get the A2D data, we issue a ReadMem command starting at address 0. We need to retrieve

Resources:

Jon Williams
3718 Valley View Lane, #3040
Irving, TX 75062
(972) 659-9090
jonwms@aol.com

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

Tim Bitson's Weather Page
www.timbitson.com/weather/index.html

AAG
www.aag.com.mx

eight bytes of data since the DS2450 can be configured for 16-bit values. Since we don't need the romData array anymore, the A2D data is read into it. Next, we'll grab every other byte to create a single word value that can be used in a table to determine direction.

As each A2D channel is retrieved from romData, it is divided by 90. With integer math, this division will always return a value of two (high readings), one (middle readings), or zero. The result of each division is placed into a separate Nib in the variable direction. At this point, direction holds a value that tells us the direction from which the wind is blowing. LOOKDOWN is used to convert this value into a zero to 15 value that can be used to point to a string. You can see how the large look-up table was split in two pieces and that the variable dFlag is set to an out-of-range value before LOOKDOWN is used.

If the value returned in direction is invalid (it happens — one of my stations has a bad part), the value of dFlag will not be changed by LOOKDOWN. This can be used to flag an error as we've done with this program. If the value was good, the LOOKDOWN tables will convert it to a value between zero and 15. We use this value to calculate the address of the string that tells us the direction and print it with the subroutine called Print_String.

That's A Wrap

Well, that about wraps it up for this month. For those of you interested in the weather, this should get you started. Be sure to take a look at Tim's site and the Dallas Semiconductor site for more sensors.

Next month ... GPS. Yes, I said I wouldn't write about it but I've been convinced that I should. We'll be using the BS2p again and taking advantage of the SPSTR modifier of SERIN.

Until then, Happy Stamping. **NV**

```
' -----[ Title ]-----------------------------------------------------------------
'
' File...... OW_WEATHER.BSP
' Purpose... 1-Wire Weather Station Interface
' Author.... Jon Williams / Parallax (portions by Tim Bitson)
' E-mail.... jonwms@aol.com
' Started... 13 DEC 2001
' Updated... 06 JAN 2002

' { $STAMP BS2p }


' -----[ Program Description ]---------------------------------------------------
'
' This program reads and displays the sensors from a Dallas 1-Wire Weather
' Station.
'
' NOTE: The 1-Wire bus requires a very stiff pull-up -- 1 kOhm or less.


' -----[ Revision History ]------------------------------------------------------
'
' 15 DEC 2001 - Version 1 working
' 06 JAN 2002 - Updated error handling for bad wind vane


' -----[ I/O Definitions ]-------------------------------------------------------
'
OWpin           CON     15                      ' 1-Wire bus


' -----[ Constants ]-------------------------------------------------------------
'
' 1-Wire Support
'
OW_NoRst        CON     %0000                   ' no Reset
OW_FERst        CON     %0001                   ' Front-End Reset
OW_BERst        CON     %0010                   ' Back-End Reset
OW_BitMode      CON     %0100
OW_HighSpd      CON     %1000

ReadROM         CON     $33                     ' read ID, serial num, CRC
MatchROM        CON     $55                     ' look for specific device
ODMatchROM      CON     $69                     ' overdrive match rom
SkipROM         CON     $CC                     ' skip rom (one device)
SearchROM       CON     $F0                     ' search

' DS1820 control
'
CnvrtTemp       CON     $44                     ' do temperature conversion
RdScratch       CON     $BE                     ' read scratchpad

' DS2423 control
'
ReadMemCntr     CON     $A5                     ' read memory + counter

' DS2450 control
'
ReadMem         CON     $AA                     ' read memory
WriteMem        CON     $55                     ' write memory
Convert         CON     $3C                     ' do conversion

NoDevice        CON     %11                     ' no device present
CommOkay        CON     1
NoComm          CON     0

Celsius         CON     0
Fahrenheit      CON     1
TMode           CON     Fahrenheit              ' temperature display mode
DegSym          CON     176

MoveTo          CON     2                       ' DEBUG cursor positioning
LF              CON     10                      ' linefeed


' -----[ Variables ]-------------------------------------------------------------
'
devCheck        VAR     Nib                     ' device check return ocde
commStat        VAR     Bit                     ' comm status
sensor          VAR     Nib                     ' current sensor to display
eeAddr          VAR     Word                    ' string pointer in EE
char            VAR     Byte                    ' character to print
idx             VAR     Nib                     ' loop counter
romData         VAR     Byte(8)                 ' ROM data to devices

tempIn          VAR     Word                    ' raw temperature
sign            VAR     tempIn.Bit11            ' 1 = negative temperature
tLo             VAR     tempIn.LowByte
tHi             VAR     tempIn.HighByte
tSign           VAR     Bit
tempC           VAR     Word                    ' Celsius
tempF           VAR     Word                    ' Fahrenheit

cntrA           VAR     Word                    ' wind count start
cntrB           VAR     tempIn                  ' wind count end
rps             VAR     tempC                   ' revs per second
speed           VAR     tempF                   ' wind speed

crc16           VAR     tempIn
verify          VAR     char
direction       VAR     tempC
dFlag           VAR     tempF.LowByte

rjNum           VAR     Word                    ' number to right justify
width           VAR     Nib                     ' width of field
rjSign          VAR     Bit
digits          VAR     Nib


' -----[ EEPROM Data ]-----------------------------------------------------------
'
DS1820          DATA    $10,$15,$32,$09,$00,$08,$00,$A9     ' temp sensor
DS2423          DATA    $1D,$82,$43,$01,$00,$00,$00,$6F     ' wind speed
DS2450          DATA    $20,$AF,$FF,$00,$00,$00,$00,$5E     ' wind direction

CommUp          DATA    "... Up", 0
CommDn          DATA    ". Down", 0

WindDir         DATA    "   N", 0, " NNE", 0, "  NE", 0, " ENE", 0
                DATA    "   E", 0, " ESE", 0, "  SE", 0, " SSE", 0
                DATA    "   S", 0, " SSW", 0, "  SW", 0, " WSW", 0
                DATA    "   W", 0, " WNW", 0, "  NW", 0, " NNW", 0

BadDir          DATA    "Error", 0


' -----[ Initialization ]--------------------------------------------------------
'
Initialize:
  DEBUG CLS                                             ' open DEBUG window
  PAUSE 250

Splash_Screen:
  DEBUG Home
  DEBUG "===================================", CR
  DEBUG " BS2p <--> 1-Wire Weather Station ", CR
  DEBUG "===================================", CR

Charge_Station:
  INPUT OWpin
  IF (Ins.LowBit(OWpin) = 0) THEN Bus_Shorted          ' possible wiring problem

  HIGH OWpin
  DEBUG MoveTo, 0, 4, "Charging station..."
  FOR idx = 10 TO 1
    DEBUG MoveTo, 20, 4, DEC idx, "  "
    PAUSE 1000
  NEXT
  INPUT OWpin
  DEBUG MoveTo, 0, 4, REP " "\25
```

```
Weather_Labels:
  DEBUG MoveTo, 0, 4, "Comm.......... "
  DEBUG MoveTo, 0, 6, "( ) Temperature... ", CR
  DEBUG MoveTo, 0, 7, "( ) Wind Speed.... ", CR
  DEBUG MoveTo, 0, 8, "( ) Direction..... ", CR


' -----[ Main Code ]-----------------------------------------------------------
'
Main:
  GOSUB Comm_Status                          ' check 1-Wire comm
  IF (commStat = CommOkay) THEN Show_Sensors
  PAUSE 2000
  GOTO Initialize                            ' "reboot" if comm went down

Show_Sensors:
  GOSUB Flag_Sensor                          ' show sensor in use
  BRANCH sensor, [Show_Temp, Show_Wind_Speed, Show_Wind_Dir]

Main2:
  sensor = sensor + 1 // 3                   ' select next sensor
  GOTO Main
  END


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

' *******************************************************
' A shorted condition on the 1-Wire bus has been detected
' -- we can't charge the station cap in this condition
' *******************************************************
'
Bus_Shorted:
  DEBUG CLS, "The 1-Wire bus is shorted.", CR
  DEBUG "Please repair before continuing.", CR
  END


' ****************************
' Print status of 1-Wire comms
' ****************************
'
Comm_Status:
  eeAddr = CommUp                            ' assume bus is up
  commStat = CommOkay
  GOSUB Device_Check                         ' check bus for devices
  IF (devCheck <> NoDevice) THEN Print_Comm
  eeAddr = CommDn
  commStat = NoComm
  DEBUG MoveTo, 19, 6, REP " "\15            ' clear station data if down
  DEBUG MoveTo, 19, 7, REP " "\15
  DEBUG MoveTo, 19, 8, REP " "\15

Print_Comm:
  DEBUG MoveTo, 12, 4                        ' show comm status
  GOSUB Print_String
  RETURN


' ************************************
' Check for presence of 1-Wire devices
' -- does not search for ROM codes
' ************************************
'
Device_Check:
  devCheck = 0
  OWOUT OWpin, OW_FERst, [SearchROM]
  OWIN  OWpin, OW_BitMode, [devCheck.Bit1,devCheck.Bit0]
  RETURN


' *********************
' Indicate sensor in use
' *********************
'
Flag_Sensor:
  DEBUG MoveTo, 1, 6, " "                    ' clear previous mark
  DEBUG MoveTo, 1, 7, " "
  DEBUG MoveTo, 1, 8, " "
  DEBUG MoveTo, 1, (6 + sensor), "*"         ' mark current sensor
  RETURN


' ********************************
' Transfer OW serial number to RAM
' -- point to SN with eeAddr
' ********************************
'
Load_SN:
  FOR idx = 0 TO 7                           ' load ROM pattern
    READ (eeAddr + idx), romData(idx)
  NEXT
  RETURN


' ********************************
' Retrieve and display temperature
' ********************************
'
Show_Temp:
  eeAddr = DS1820                            ' load device serial number
  GOSUB Load_SN
  OWOUT OWpin, OW_FERst,[MatchROM, STR romData\8, CnvrtTemp]

  HIGH OWpin                                 ' extra juice during conversion
  PAUSE 750
  INPUT OWpin

  OWOUT OWpin, OW_FERst,[MatchROM, STR romData\8, RdScratch]
  OWIN  OWpin, OW_BERst,[tLo, tHi]

  tSign = sign                               ' save sign bit
  tempIn = tempIn >> 1                       ' round to whole degrees
  IF (tSign = 0) THEN NoNeg1
  tempIn = tempIn | $FF00                    ' extend sign bits for negs

NoNeg1:
  tempC = tempIn                             ' save Celsius value
  tempIn = tempIn */ $01CC                   ' multiply by 1.8
  IF (tSign = 0) THEN NoNeg2                 ' if neg, extend sign bits
  tempIn = tempIn | $FF00

NoNeg2:
  tempF = tempIn + 32                        ' finish C -> F conversion

  DEBUG MoveTo, 19, 6                        ' move cursor to temp display
  rjNum = tempF                              ' prep for right justified print
  width = 5                                  ' five digits wide
  GOSUB RJ_Print
  DEBUG " ", DegSym, "F"
  GOTO Main2


' ******************************
' Retrieve and display wind speed
' -- mph = rps * 2.453
' ******************************
'
Show_Wind_Speed:
  eeAddr = DS2423
  GOSUB Load_SN

  ' get starting count
  '
  OWOUT OWpin, OW_FERst, [ODMatchROM]
  OWOUT OWpin, OW_HighSpd, [STR romData\8, ReadMemCntr, $DF, $01]
  OWIN  OWpin, (OW_HighSpd | OW_BERst), [cntrA.LowByte, cntrA.LowByte,
cntrA.HighByte]

  PAUSE 2500                                 ' = revs for 5 seconds
  GOSUB Comm_Status
  IF (commStat = CommOkay) THEN Get_End_Count
  GOTO Main2                                 ' abort if comm down

  ' get ending count
  '
Get_End_Count:
  OWOUT OWpin, OW_FERst, [ODMatchROM]
  OWOUT OWpin, OW_HighSpd, [STR romData\8, ReadMemCntr, $DF, $01]
  OWIN  OWpin, (OW_HighSpd | OW_BERst), [cntrB.LowByte, cntrB.LowByte,
cntrB.HighByte]

Calc_CPS:
  rps = cntrB - cntrA                        ' get diffential count
  IF (cntrB >= cntrA) THEN Calc_Speed
  rps = rps + $FFFF                          ' correct for rollover

Calc_Speed:
  speed = rps */ $04E7                       ' rps * 4.906 (tenths @ 5 seconds)
  DEBUG MoveTo, 19, 7
  width = 3                                  ' width of whole portion
  rjNum = speed / 10                         ' get whole portion
  GOSUB RJ_Print                             ' print it
  DEBUG ".", DEC1 speed, " mph "             ' then print tenths
  GOTO Main2


' **********************************
' Retrieve and display Wind direction
' **********************************
'
Show_Wind_Dir:
  eeAddr = DS2450
  GOSUB Load_SN
  OWOUT OWpin, OW_FERst, [MatchROM, STR romData\8, WriteMem, $08, $00]

  FOR idx = 1 TO 4                           ' setup four channels
    OWOUT OWpin, OW_NoRst, [$08]             ' 8-bit values
    OWIN  OWpin, OW_NoRst, [crc16.LowByte, crc16.HighByte, verify]
    OWOUT OWpin, OW_NoRst, [$01]             ' 5.12 volt scale
    OWIN  OWpin, OW_NoRst, [crc16.LowByte, crc16.HighByte, verify]
  NEXT

Start_Conversion:
  OWOUT OWpin, OW_FERst, [MatchROM, STR romData\8, Convert, $0F, $55]
  OWIN  OWpin, OW_NoRst, [crc16.LowByte, crc16.HighByte]

  HIGH OWpin                                 ' juice during conversion
  PAUSE 10
  INPUT OWpin

Get_A2D:
  OWOUT OWpin, OW_FERst, [MatchROM, STR romData\8, ReadMem, $00, $00]
  OWIN  OWpin, OW_BERst, [STR romData\8]
```

Stamp listing continued on page 61

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

FEB-MAR

FEBRUARY 2002

FEBRUARY 1-2

MS - JACKSON - State Convention. Jackson ARC, Ron Brown AB5WF, 601-956-1448. Email: ab5wf@arrl.net Web: http://www.jxnarc.org

FEBRUARY 2

KS - LACYGNE - Hamfest. Mine Creek ARC, Ron Cowan KB0DTI, 913-757-4455. Email: kb0dti@arrl.net
MI - DEARBORN - Antique Radio Swapmeet. Armenian Community Center, 19319 Ford Rd. Michigan Antique Radio Club, Don Colbert, 313-278-1948. Email: donsradio@aol.com
MI - NEGAUNEE - Hamfest. Hiawatha ARA, Robert Serfas N8PKN, 906-226-9782. Email: n8pkn@aol.com Web: www.qsl.net/k8lod/
SC - NORTH CHARLESTON - Hamfest. Stall High School. Talkin: 146.79, 145.25, and 147.45. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. Email: brycemyers@aol.com Web: www.qsl.net/wa4usn/index .html

FEBRUARY 2-3

FL - MIAMI - Tropical Hamboree. Dade Radio Club of Miami, Evelyn Gauzens W4WYR, 305-642-4139. Email: w4wyr@arrl.org

FEBRUARY 3

OH - LORAIN - Hamfest. Gargus Hall, 1965 N. Ridge Rd. 8am-1pm. Talkin: 146.700- and 444.800+. NOARS, John Schaaf K8JWS, 216-696-5709. Email: noars@qsl.net

FEBRUARY 4

AZ - PHOENIX (SUN CITY) - Auction, 7pm. St. Clement of Rome Catholic Church Social Hall, 15800 Del Webb Blvd. Talkin: 147.30+. West Valley ARC, Jerry W9JIF, 623-214-8136. Email: w9jif@juno.com

FEBRUARY 8-9-10

FL - ORLANDO - Convention. Orlando ARC, Harold Prosser KK1B, 321-235-7513 (days) or 407-365-2444 (eves). Email: hal@mpinet.net Web: www.oarc.org/hamcat.html

FEBRUARY 9

ME - CHELSEA - Hamfest. Augusta ARA, Tom Clay KD1KE, 207-382-6000. Email: kd1ke@uninets.net
MI - TRAVERSE CITY - Hamfest. Cherryland ARC, Joe Novak W8TVT, 231-947-8555. Email: jnovak@traverse.net
MN - ST. CLOUD - Hamfest. St. Cloud ARC, L. Scott Hall KA0DAQ, 320-252-4498. Email: lscotth@aol.com Web: www.w0sv.org
OK - ADA - Hamfest. Ada ARC, Charles Etier KC5TGA 580-436-4425 Web: www.adacomp.net/~jewell/

FEBRUARY 9-10

TN - MEMPHIS - Hamfest. Shelby County Bldg., Mid-South Fairgrounds. Sat: 9am-5pm, Sun: 9am-2pm. VE testing. Ben KU4AW, 901-372-8031, Melinda KE4DXN, 901-744-1737. Web: www.dixiefest.org

FEBRUARY 10

OH - MANSFIELD - Hamfest. InterCity ARC & MASER, Scott Yonally N8SY, 419-522-9893. Email: n8sy@arrl.net Web: www.maser.org
VA - RICHMOND - State Convention. The Showplace, 3000 Mechanicsville Tpke. 8:30am-3:30pm. Richmond Amateur Telecommunications Society, 804-790-0077, opt 4. Web: www.frostfest.com

FEBRUARY 16

CA - MONTEREY (SEASIDE) - Hamfest. Naval Postgraduate School ARC, Brian Broggie W6FVI, 831-626-1501. Email: w6fvi@arrl.net Web: www.k6ly.org/radiofest
FL - SEBRING - Hamfest. Highlands County ARC, Spencer Whitmire W4ERC, 863-452-0359. Email: w4erc@arrl.net
MA - MARLBOROUGH - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988 before 9pm.
OR - RICKREALL - Hamfair. Salem Repeater Assn., Larry Quiring KC7NOS, 503-585-8897. Email: KC7NOS@juno.com
TX - SMITHVILLE - Hamfest. Bastrop County ARC, Juan Vinton KB5YAE, 512-303-4743. Email: kb5yae@qsl.net Web: www.qsl.net/kb5yae/

FEBRUARY 17

CO - BRIGHTON - Hamfest. Aurora Repeater Assn., Wayne

COMPUTER SHOWS

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

Blue Star Productions
612-788-1901
www.supercomputersale.com

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

Computer Central Shows
630-782-4625
Fax 630-834-2594
E-Mail: cc@gats.com
www.computercentralshows.com

Computer Country Expo
847-662-0811
Web: www.ccxpo.com

Five Star Productions
810-379-3333
E-Mail: jeff@fivestar
www.fivestarshows.com

Gibraltar Trade Center, Inc.
734-287-2000 Taylor, MI
E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

Gibraltar Trade Center, Inc.
810-465-6440 Mt. Clemens, MI.
E-Mail:
mtclemens@gibraltartrade.com
www.gibraltartrade.com

KGP Productions
1-800-631-0062, 732-297-2526
E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229
www.marketpro.com

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

ComputerShow
770-663-0983
E-Mail: narisaam@aol.com
Web: www.shownsale.com

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

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

Heinen N0POH, 303-699-6335.
Email: n0poh@arrl.net
Web: www.qsl.net/n0ara

FEBRUARY 23

GA - DALTON - Hamfest. Dalton ARC, Harold Jones N4BD, email: n4bd@ocsonline.com

IN - LAPORTE - Hamfest. LaPorte Civic Auditorium, 1001 Ridge St. 7am-1pm. Talkin: 146.52, 146.61- PL 131.8. LPARC, Neil Straub WZ9N, 219-324-7525. Email: nstraub@world key.net
Web: www.geocities.com/K9JSI/

ND - BISMARCK - Hamfest. Central Dakota ARC, Kurt Carufel KB0KDG, 701-222-0938. Email: carufel@home.com

NY - HORSEHEADS - Hamfest. The National Guard Armory. 8am-3pm. Talkin: 146.700-, 444.20. ARAST, Randy 607-738-6857. Email: n2syt@arast.org
Web: www.arast.org

VT - MILTON - State Convention. Milton High School, Rt. 7. 8am-1pm. Talkin: 145.15-. Radio Amateurs of Northern VT, Mitch Stern W1SJ, 802-879-6589.
Email: w1sj@arrl.net
Web: www.ranv.org

FEBRUARY 24

FL - ZEPHRYHILLS - Hamfest. Zephyrhills Area ARC, Ron Russell N8VFE, 813-782-1602.
Email: ron301@aol.com

NC - ELKIN - Hamfest. Briarpatch & Foothills ARCs, Pat Hill AE4HK, 540-236-6747.
Email: CraigPatton @ kg4fla@hot mail.com

NY - HICKSVILLE - Hamfest. Levittown Hall. ARRL VE exams. Talkin: W2VL 146.85. Long Island Mobile ARC, Rich Rosner N2STU, 631-563-1859.
Email: hamfest@limarc.org
Web: www.limarc.org

NY - WILLIAMSVILLE - Hamfest. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667.
Email: luke@towncountryflorist .com
Web: http://gbhamfest.ham gate.net

OH - CUYAHOGA - Hamfest. Emidios Party Center, 48 E. Bath Rd. 8am-2pm. Cuyahoga Falls ARC, Inc., Ted Sarah W8TTS, 330-688-2013.
Email: w8tts@arrl.net

MARCH 2

AR - RUSSELLVILLE - Hamfest. Arkansas River Valley AR Foundation, John Evans WB5BHS, 501-967-6001.
Email: jevans@cswnet.com
Web: www.cswnet.com/~arvarf /hamfest.htm

CA - REDDING - Hamfest. Shasta Cascade ARS, Jim Bremer KE6OUA, 530-222-8001.
Email: ke6oua@arrl.net

FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rick Brown AG4JN, 727-934-8741.
Email: ag4jn@arrl.net
Web: www.gulfcoastarc.org/

KY - CAVE CITY - Hamfest. Cave City Convention Center, I-65, Exit 53. 7:30am-2pm. VE testing. Talkin: 146.94/34. Mammoth Cave ARC, Jim Erskine KD4GNN, email: mail@chirotoons.com

NJ - PARSIPPANY - Hamfest. PAL Bldg., 33 Baldwin Rd. Splitrock ARA, Maria Turner KB2VKP, 888-511-SARA.
Email: hamfest@splitrockara.org
Web: www.splitrockara.org

OK - ELK CITY - Hamfest. West

MARCH 2002

AZ - SCOTTSDALE - Hamfest. Scottsdale ARC, Ed Nickerson WU7S, 480-949-5162. Email: bnickers@qwest.net
FL - PORT CHARLOTTE - Hamfest. EARS & PRRA, Larry Brown KD4KVE, 941-625-0830. Email: kd4kve@aol.com
NC - CHARLOTTE - Hamfest. Charlotte County Fairgrounds. 7am-5pm. Talkin: 147.255+. PRRA & EARS, Vic Emmelkamp, 941-473-5560. Web: www.fcrosby.com/hamfest/index.html
ND - WEST FARGO - Hamfest. Red River Valley Fairgrounds. 8am-3pm. VE testing. Web: www.rra.org
WA - PUYALLUP - Hamfest. Mike and Key ARC, Michael Dinkelman N7WA, 425-867-4797 days or 253-631-3756 eves. Email: mwdink@eskimo.com Web: www.mikeandkey.com

OK ARC, Earl Bottom N5NEB, 580-821-0633. Email: n5neb@logixonline.net
TN - KNOXVILLE - Hamfest. Kerbela Temple, 315 Mimosa Ave. 8am-4pm. Talkin: 144.83/145.43 or 146.52 simplex. Shriners of Kerbela ARS, Paul Baird K3PB, 865-986-9562

MARCH 3

PA - GREENSBURG - Hamfest. Foothills ARC, Tim Bartlow K3TB, 724-834-6517. Email: k3tb@yahoo.com Web: www.geocities.com/foothills007
VA - ANNANDALE - Hamfest. Northern VA Community College, 8333 Little River Turnpike (Rt. 236). VE testing 9am. Talkin: 146.31/91 & 146.685-. Vienna Wireless Society, Jim Parsons W4JTP, 703-392-0150. Email: w4jtp@aol.com Web: http://winterfest.home.att.net
WI - WAUKESHA - Hamfest. SEWFARS, Gary Pierce N9LGE, email: sewfars@hotmail.com Web: www.sewfars.com

MARCH 9

AR - HARRISON - Hamfest. Boone County Fairgrounds, Hwy. 65B. VE testing. 8am-2pm. North AR ARS, Bill Rose N5VKF, 870-741-7074. Email: billrose@cox-internet.com Web: www.qsl.net/naars/hamfest/index.html

MARCH 9-10

LA - RAYNE - Hamfest. Rayne Civic Center, 300 Frog Festival Dr. VE testing. Talkin: 146.820-600, 147.030+ 600 PL. LCARC, web: www.w5ddl.org
NC - CHARLOTTE - Hamfest. Mecklenburg ARS, Tom Hunt KA3VVJ, 704-948-7373. Email: hamfest@w4bfb.org Web: www.w4bfb.org

MARCH 10

CANADA - BC - NEW WESTMINSTER - AR & Electronics Flea Market. Burnaby & New Westminster ARC, Bob Kungl VE7KW, 604-524-9177. Email: VE7KW@rac.ca
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Muffle The Loudmouths!

Keep those loud TV commercials on the straight and level with the Blab Buster

By TJ Byers

You know the scenario. It's late evening, the day is done, and you're settled in for a night of relaxation. On the screen, Sweet Jessica has finally found her secret love, Robert, Prince of Edonia, heir to the throne. Words fade to whispers, lusty lips part to meet, and a cloak of silence falls over the intimate scene. Suddenly, the TV cranks up the volume to an ear-shattering level to announce that Lloyd's Lotto Emporium is having a year-end clearance sale of previously-owned lottery tickets.

Don't you just hate that!? TV commercials are annoying enough, but adding blasting sound to this manic madness is more than anyone should have to bear. Well, enough is enough. So enough, in fact, that it prompted me to build the Automatic Audio Attenuator, which I have affectionately nicknamed the Blab Buster. When you insert the Blab Buster between your TV and the speakers, those late-night hawkers are hushed to a level of near acceptability.

The Blab Buster is, in reality, an automatic volume control, or automatic level control (ALC), that levels the playing field for audio sounds. Soft passages get boosted up so that you can hear them without cupping an ear, and the loudmouth car guys are shut down to no more than a murmur. While it was specifically designed to quiet boisterous TV commercials, it works as a loudness control for any audio source, including VCRs, DVDs, cassette players — and even short-wave receivers.

The Magic Behind The Blab Buster

Imagine you had a magic genie that would constantly monitor the sound output of your TV set and adjust the volume control as the audio level changes. Your genie would turn up the volume during soft passages and turn it back down when the noise level got too loud. Well, imagine no longer. That's exactly what the Blab Buster does — it's your personal volume control genie.

The Blab Buster is designed to be compatible with the audio input/output RCA jacks commonly found on today's VCRs and A/V receivers; that is, 200 mV at 10k for the input and 200 mV at 600 ohms for the output. However, the dynamic input range of the Blab Buster is wide enough that it automatically adjusts any input between 100 mV and 8 volts to 200 mV at the output. It's this extreme input range that makes the Blab Buster versatile enough to be used with a wide variety of audio devices — and more than powerful enough to knock the wind out of those night squawkers. My measurements show the frequency response to be within 3dB from 16 Hz to 20kHz, with good performance up to 50 kHz.

What's even more amazing is that all this power is packed into a single IC. The NE570 compandor chip was originally developed by Signetics way back in the late 1970s, and is still in production under the Philips Semiconductor moniker. (See "Inside The NE570 Compander" for a better look at this chip's inner workings.)

How It Works

The NE570 is a dual, controlled-gain circuit in which either channel may be used as a dynamic range compressor or expandor that is well-suited for cell phone and communications applications. However, with a little clever rewiring here, and a gain limiter there, the NE570 can also function as an ALC.

The difference between a signal compressor and an ALC is the point where the input signal is sampled for processing. In a compressor circuit, the gain of the pass amplifier is determined by the voltage at the amp's output (Figure 1a). Response time is fast and the compression ratio is typically 2:1. An ALC, on the other hand, takes its gain control from the input to the pass amplifier (Figure 1b). Response time is slower, allowing for a larger dynamic range within the controlled gain bandwidth, and the compression ratios extend to 10:1 and higher. This allows musical crescendos to peak within the given time frame.

The circuit diagram of the Blab Buster ALC is shown in Figure 2. Because the NE570 contains two identical compander devices — both of which we use for a complete surround sound effect — this discussion will focus on the right channel (upper) only. C1 provides the input of the pass amplifier (pin 6) with the feedback signal required for ALC operation as described above, whereas the gain is determined by the signal applied to the precision rectifier block (pin 2). C7 determines the amount of time it takes for a change in the input signal to cause a corresponding change in the gain of the ALC; if you wish a faster response time, reduce C7 to 1uF.

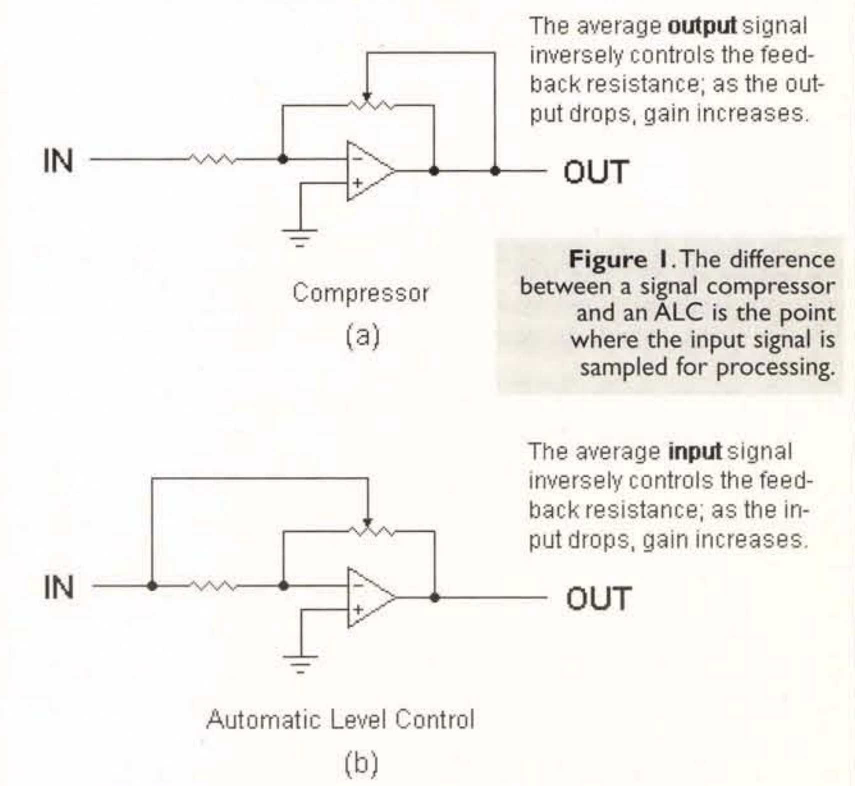
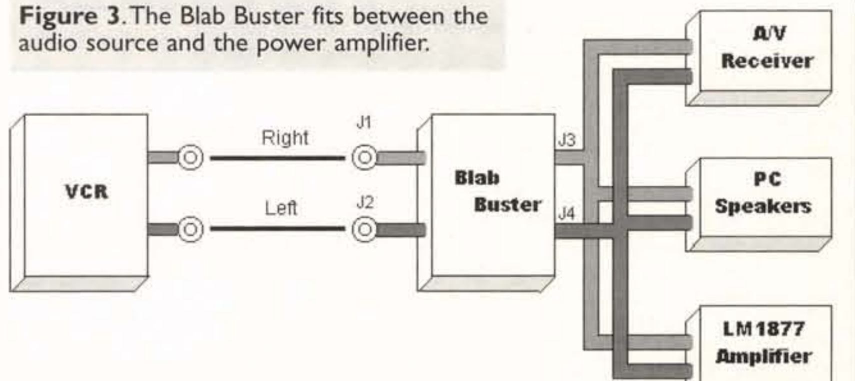


Figure 1. The difference between a signal compressor and an ALC is the point where the input signal is sampled for processing.

Figure 3. The Blab Buster fits between the audio source and the power amplifier.



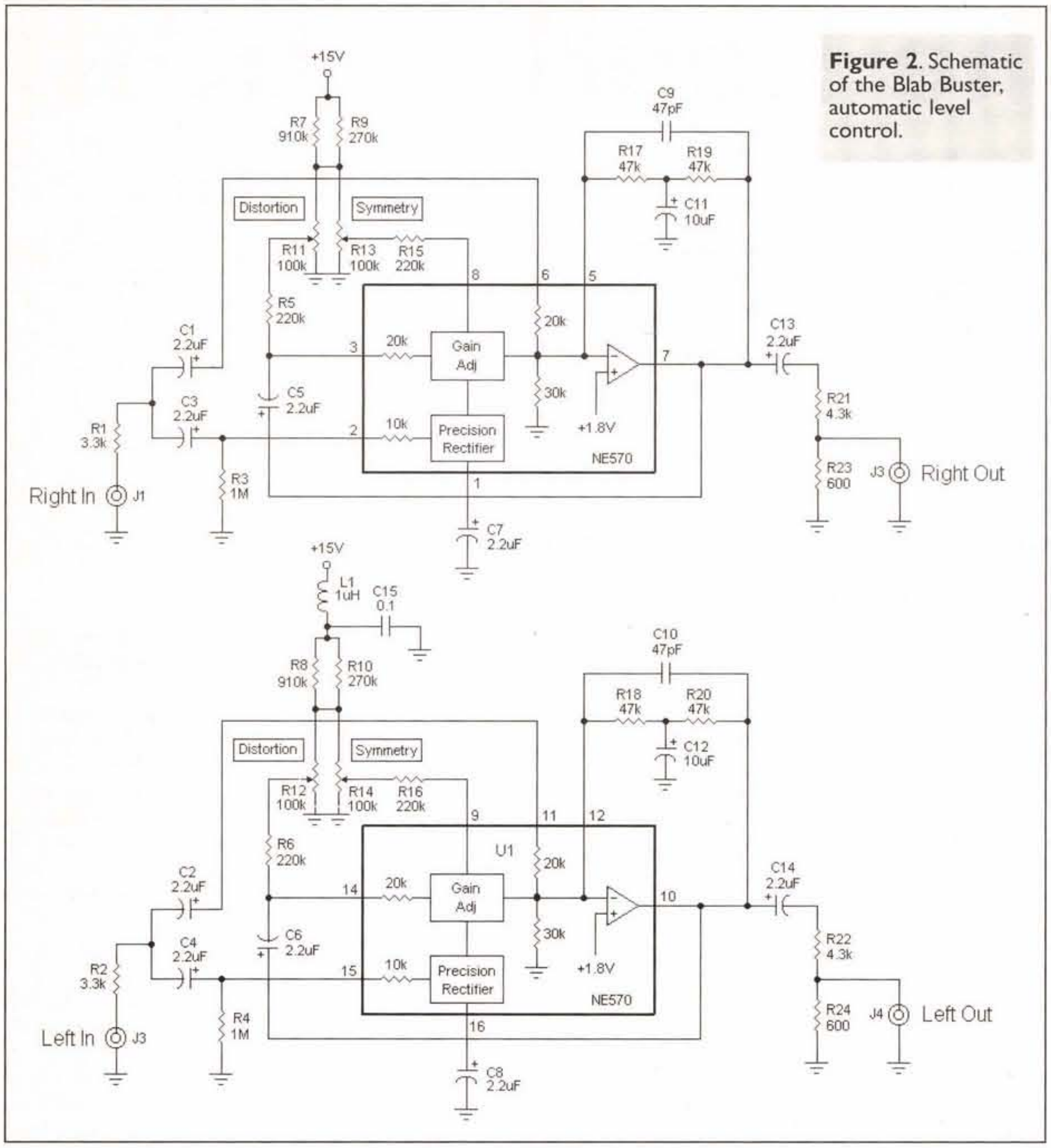


Figure 2. Schematic of the Blab Buster, automatic level control.

The output of the gain-controlled pass amp is a current that's converted to a voltage via R17 and R18. C11 acts as a low-pass filter and C9, placed across the feedback loop, prevents the op amp from breaking into oscillation at higher gains. In fact, runaway gain is a problem with ALC circuits at very low input voltages, which is the purpose of R1. It places a lid on the maximum gain of the pass amp (typical values are 1M to 10M, with 1M being the most stable).

In this configuration, the 20k and 10k inputs are paralleled, resulting in an input impedance of 6.66k. R1 brings up the input impedance up to a standard 10k level without shifting the capture input range. The output divider resistors, R21 and R23, are another story because the standard output impedance of audio generators has crept upward over the years from 600 ohms to 1k. I had a choice, and decided on the lower impedance because it can match to a 600-ohm transformer for balanced-line output if desired, and the slight mismatch has little effect on signal fidelity for single-ended (RCA) termination.

Essentially, this ends the discussion of ALC circuit operation ... except for the optional fine-tuning potentiometers, R11 and R13. The NE570 is internally compensated to cancel odd harmonics (the kind most associated with semiconductor amplifiers), leaving the major cause of distortion to offset voltages and even harmonics (a sometimes preferred characteristic mostly found in tube amplifiers). However, the Signetics engineers had the foresight to provide even finer performance tuning by giving access to trimmers that can null the offset control voltage to the pass amp via R5/R11, which helps reduce thumps in the output. Without trimming, the distortion of the NE570 is typically 0.3 percent — a very low value — but even this can be reduced to an even lower 0.05 percent by tweaking R13. Be forewarned, though, that both adjustments require a harmonic distortion analyzer. Fortunately, these trimmers are not required and can be eliminated with little or no noticeable degradation in performance for all but the most demanding applications (see Parts List for related components).

Construction

This is the best part of the project because there's no right way or wrong way to build the Blab Buster. It can be built as a stand-alone unit or incorporated into your TV set, stereo, or radio. You're limited only by your imagination and building skills.

What makes Blab Buster construction so attractive is the fact that it has no moving parts. There are no knobs, switches, bells, or whistles. There's simply a black box that you place between the sound source — like a VCR — and the power amplifier (Figure 3). For this reason, I opted to place the complete Blab Buster on a 4-by-5-inch printed circuit board. The circuit board can easily slip inside a VCR, a project enclosure box, or speaker cabinet. A foil pattern of the circuit board is shown in Figure 4 and a corresponding parts layout is shown in Figure 5.

The board is powered by a small 15-volt power source, like a wall-wart. For those of you who wish to roll your own power supply, I've shown one in Figure 6. With the addition of an ON/OFF switch, the Blab Buster can even be run for several hours from a pair of nine-volt batteries wired in series (in this mode, Vcc equals 18 volts).

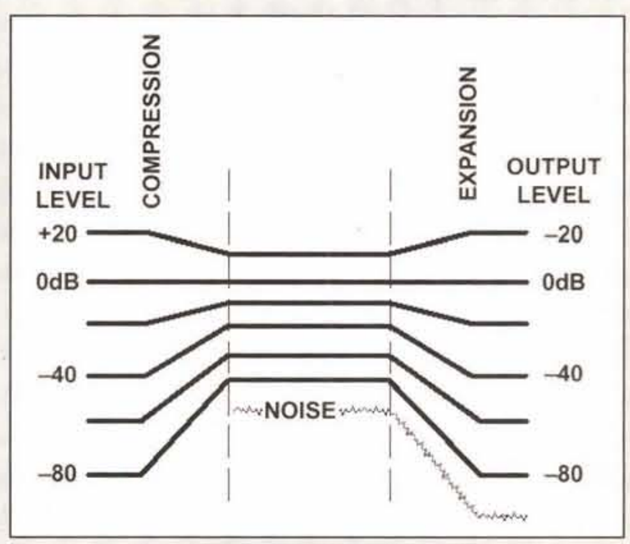
The output of the Blab Buster can plug into an A/V receiver, a pair of powered computer speakers, or the stereo amplifier design shown in Figure 7. This single chip power amp, built around an LM1877, delivers 1.5 watts per channel into an eight-ohm load. A companion printed circuit board and parts layout for the stereo amp are shown in Figure 8. The same power supply used for the Blab Buster can also power the stereo

Inside The NE570 Compandor — Behind The Smoke And Mirrors

Believe it or not, the NE570 compandor actually uses smoky mirrors to accomplish its tasks. The NE570 houses two identical sets of building blocks in a single 16-pin package. Each unit consists of a delta-gain amplifier, a precision rectifier, an op amp, and a shared internal voltage reference. Ordinarily, the first half of the compandor is used as a compressor, which reduces the dynamic swing of an input signal, while the second half is used as an expandor that restores the compressed signal to its original dynamic range. Hence the name, compandor for "compressor" and expandor."

Why compress a signal just to decompress it, you ask? Noise reduction. Whenever an audio signal (or any signal, for that matter) passes through a transmission medium, it picks up noise along the way.

The NE570 was originally designed to satisfy the requirements of the telephone system. When several telephone channels are multiplexed onto a common line, the resulting crosstalk between channels results in a background noise that attaches itself to the voice channels in the form of static. The figure shows how a compandor can reduce the amount of static on the line using compression and expansion.



Background noise is reduced considerably by first compressing the transmitted signal then expanding it afterwards.

Typically, the NE570 is configured to reduce the bandwidth of the input signal by a ratio of 2:1, which means a +20dB signal is compressed to +10dB and a -20dB signal is boosted up to -10dB; a 0dB signal is left unchanged. If the dynamic range of the original signal extends from +20dB to -80dB — a range of 100dB — the compressor reduces that to 50dB. Notice, however, that the compression takes place before the signal takes to the telephone wires. This ensures that the voice signals ride well above the noise on the lines.

At the receiving end (here's where the mirror comes into play), the entire output of the telephone line is expanded by a factor of 2:1, thus restoring the compressed +10dB signal back to +20dB, and the -10dB signal back down to its previous -20dB. Notice, too, that the noise on the line is given the same expansion treatment. What enters the phone line as -45dB of noise is reduced to -90dB by the expandor, for a signal-to-noise reduction of 45dB.

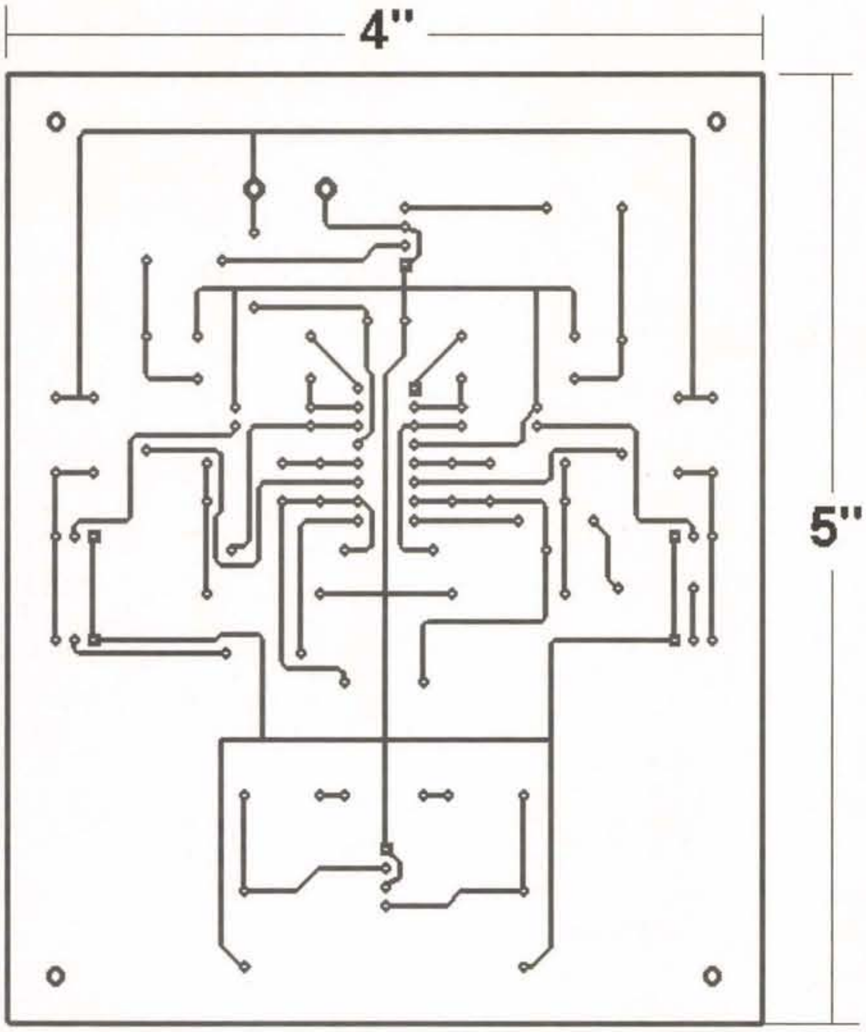


Figure 4. Foil pattern of the Blab Buster.

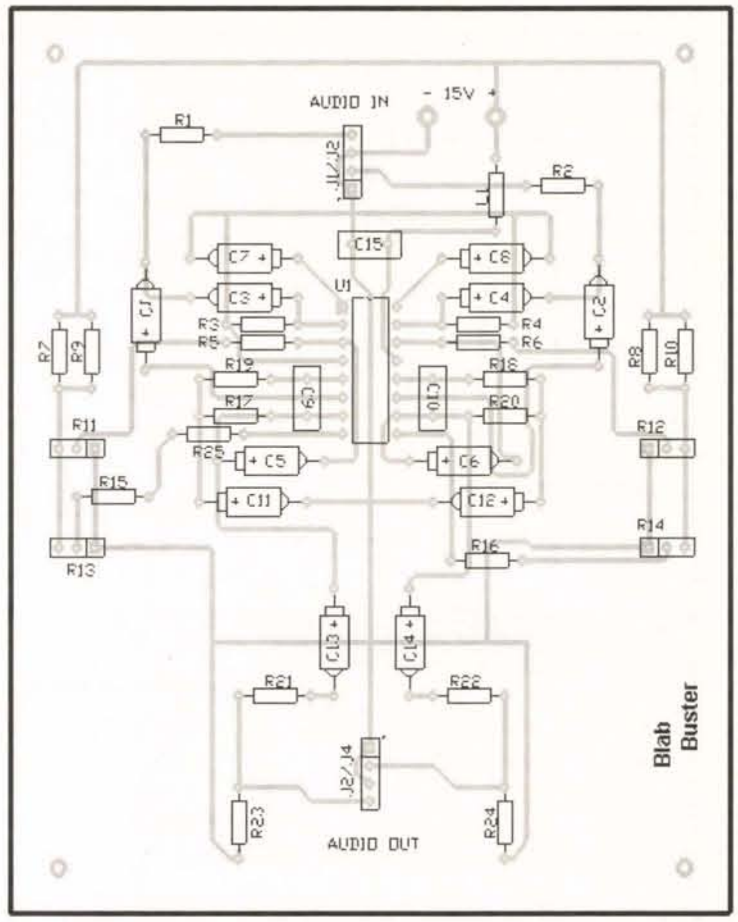


Figure 5. Parts layout for the Blab Buster circuit board.

amplifier (note that the nine-volt battery version will be short-lived at high volume levels).

Silent Nights

Meanwhile, back in Edonia, Robert (which isn't his real name) isn't really a prince, but a con artist who appeared on America's Most Wanted the week before. Fortunately, Jessica had already seen that episode, phoned the FBI during the commercial, received a huge reward for his capture and conviction, and lived happily ever after.

Yes, the Blab Buster has made a difference in my life. My temperament is mellower, and I get up less often to raid the refrigerator when the commercials come on. I also notice that I enjoy the movies more and actually understand some of the plots. Whether you use it to muffle your TV, stereo, or radio, I'm sure you'll be as pleased with the results as I am. Now if I can just slip one of these boards into my kids' boom box for permanent muting ... now that would be something really worth writing about. **NV**

Article continues on page 56

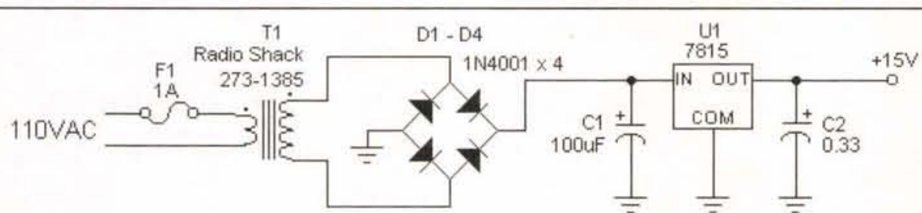
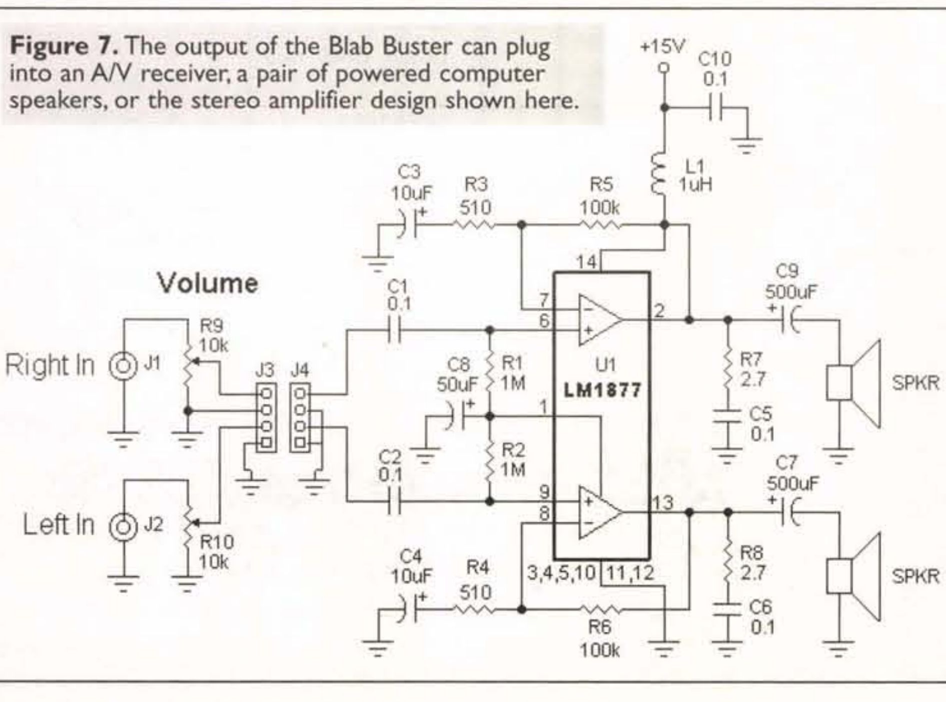


Figure 6. The power supply can take on many forms, including a 15-volt, DC wall-wart, two nine-volt batteries in series, or the do-it-yourself power supply above.

Figure 7. The output of the Blab Buster can plug into an A/V receiver, a pair of powered computer speakers, or the stereo amplifier design shown here.



Parts List — Blab Buster

Resistors
R1,R2 — 3.3k
R3,R4 — 1M
R5,R6, — 220k (optional)
R15,R16
R7,R8 — 910k (optional)
R9,R10 — 270k (optional)
R11,R12,R13 — 100k trimpot (optional)
R14
R17,R18,R19 — 47k
R20
R21,R22 — 4.3k
R23,R24 — 600 ohms
R25 — Jumper wire

Capacitors
C1,C2,C3,C4, — 2.2uF, 16V
C5,C6,C7,C8,
C13,C14
C9,C10 — 47pF
C11,C12 — 10uF, 16V
C15 — 0.1uF

Semiconductors
U1 — NE570

Misc.
J1,J2,J3,J4 — Four-pin berg connector (similar to PC motherboard speaker plug)
L1 — 1uH choke

Parts List — LM1877 Stereo Amplifier

Resistors
R1,R2 — 1M
R3,R4 — 510 ohms
R5,R6 — 100k
R7,R8 — 2.7ohms
R9,R10 — 10k audio taper pot

Capacitors
C1,C2,C5, — 0.1uF
C6,C10
C3,C4 — 10uF, 16V
C7,C9 — 500uF, 16V
C8 — 50uF, 16V

Semiconductors
U1 — LM1877

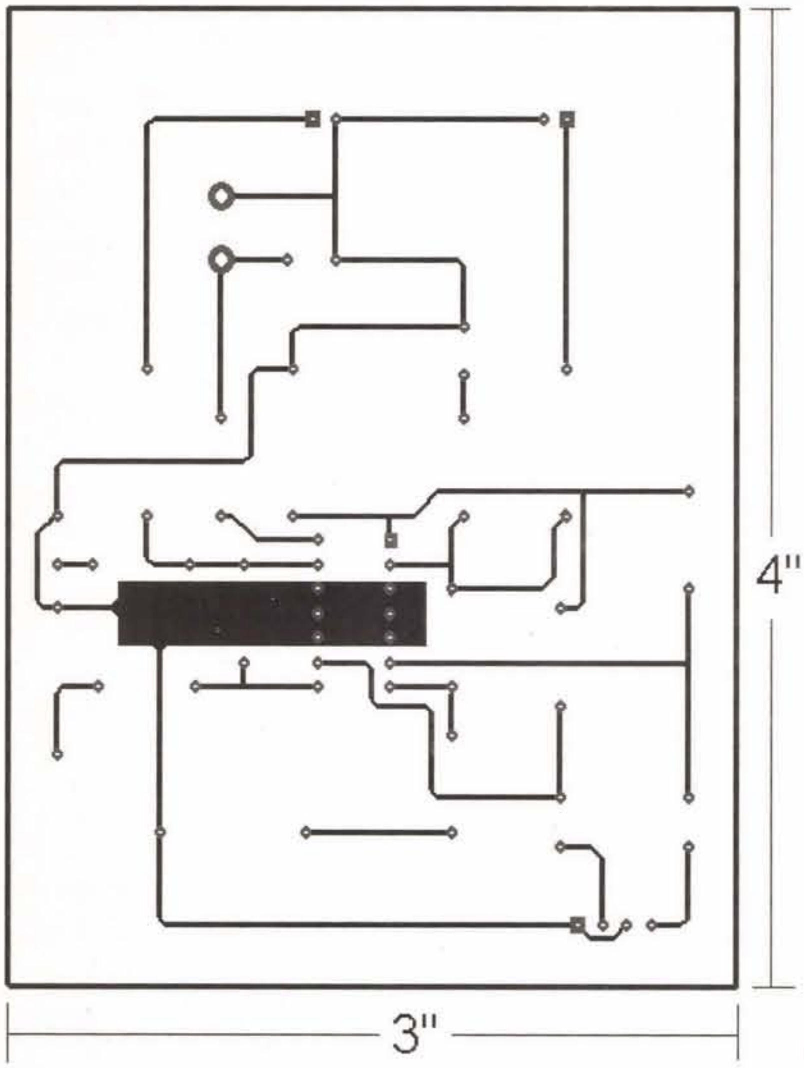
Misc.
J1,J2 — RCA audio jack
J3,J4 — Mating four-pin berg connector (similar to PC motherboard speaker plug)
L1 — 1uH choke
Spkr — eight-ohm speaker

Parts List — 15-Volt Power Supply

Capacitors
C1 — 100uF, 25V
C2 — 0.33uF

Semiconductors
D1-D4 — 1N4001 (four places)
U1 — 7815 voltage regulator

Misc.
F1 — 1A fuse
T1 — 12.6VAC, 300mA transformer



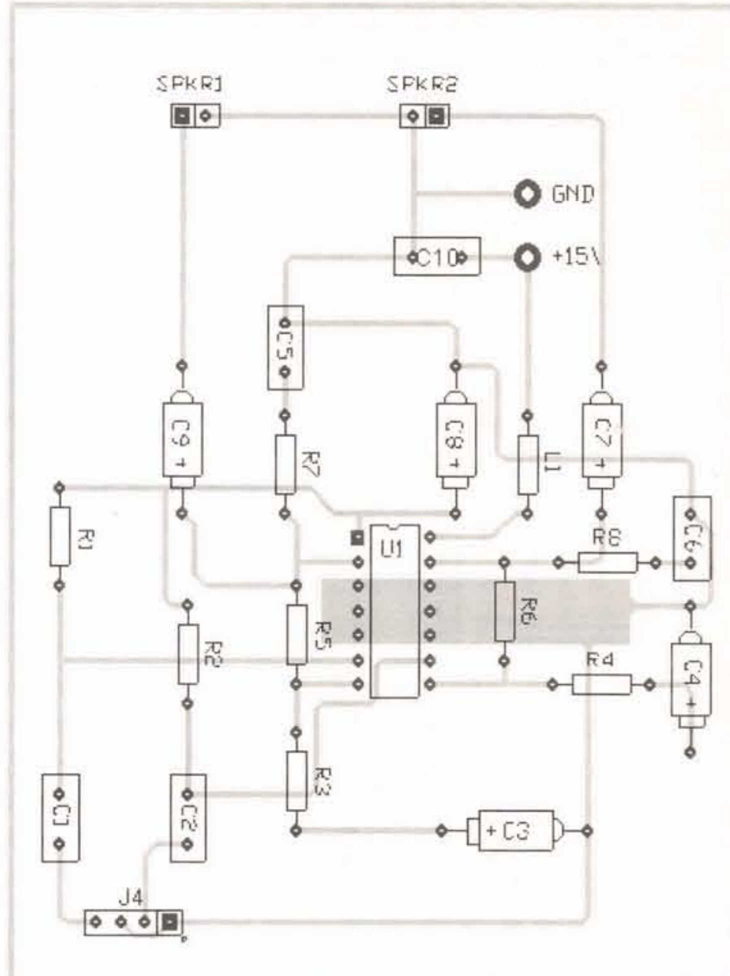


Figure 8. Foil pattern and parts layout for the LM1877 stereo power amplifier.

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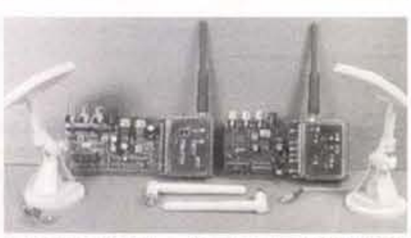

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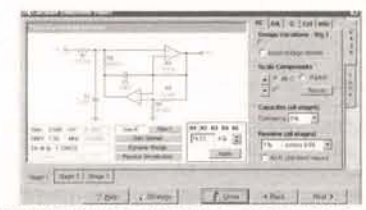

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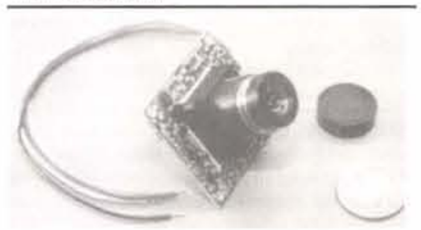

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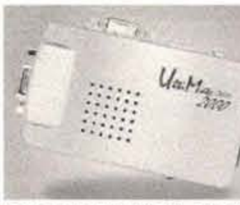

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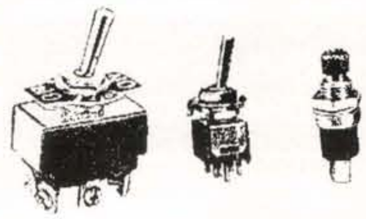

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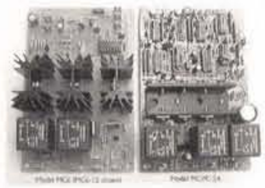

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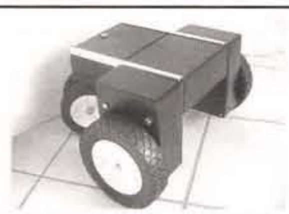

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10. Ham Gear	125. Microcontrollers
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80. Test Equipment	150. Plans/Kits/Schematics
85. Security	155. Manuals/Schematics Wanted
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95. Military Surplus Electronics	170. Misc. Electronics Wanted
100. Audio/Video/Lasers	175. BBS & Online Services
110. Cable TV	180. Education
115. Telephone/Fax	190. Business Opportunities
120. Components	200. Repairs/Service

Stamp listing continued from page 49

```
Calc_Direction:
  FOR idx = 0 TO 3                              ' convert readings to word
    direction.LowNib(idx) = romData(idx * 2 + 1) / 90
  NEXT

  ' convert word to 1 of 16

  dFlag = 99                                    ' preset for error inidcation
  LOOKDOWN direction, [$2220,$1220,$1222,$1122,$2122,$2112,$2212,$2211], dFlag
  IF (dFlag < 8) THEN Show_Direction            ' found in first table

  LOOKDOWN direction, [$2221,$0221,$0222,$0022,$2022,$2002,$2202,$2200], dFlag
  dFlag = dFlag + 8                             ' adjust for second table

Show_Direction:
  DEBUG MoveTo, 19, 8
  eeAddr = BadDir
  IF (dFlag < 16) THEN Good_Dir                 ' found in either table?
  GOTO Dir_To_Screen

Good_Dir:
  eeAddr = WindDir + (6 * dFlag)                ' address of direction string

Dir_To_Screen:
  GOSUB Print_String
  GOTO Main2


' ******************************
' Print a right-justified number
' ******************************
'
RJ_Print:
  rjSign = rjNum.Bit15
  rjNum = ABS(rjNum)
  digits = width
  LOOKDOWN rjNum,<[0,10,100,1000,65535],digits
  DEBUG REP " "\(width-digits-1), 13 * rjSign + " ", DEC rjNum
  RETURN


' **************************************
' Print string at current cursor position
' -- point to string with eeAddr
' -- string is zero-terminated
' **************************************
'
Print_String:
  READ eeAddr, char                             ' get character from EEPROM
  IF (char = 0) THEN Print_String_Done          ' if 0, string is done
  DEBUG char                                    ' print it
  eeAddr = eeAddr + 1                                 ' point to next character
  GOTO Print_String

Print_String_Done:
  RETURN
```

AMATEUR ROBOTICS

Wiring and Testing the PDM Chassis

By Robert Nansel

This month and next, I'll show you how to wire and test the Power Drive Module (PDM) chassis. The PDM chassis holds the chopper board, the power supply, fans, and assorted connectors, switches, fuse holders, and indicators. It's not a complicated job, but if you've never done chassis wiring, there are an awful lot of individual wires to keep track of — over 50. I'll show you ways to keep it all from turning into a tangled ball of wire, as well as techniques to reduce EM/RF interference in the process.

As promised, this month I also have the winner of the Third Lonely Gearhead Contest: Congratulations to Eric Daine of Haddock, GA. Send me an e-mail telling me where you would like your Solarbotics BEAM experimenter board shipped.

I got a terrific response to this contest, particularly regarding the list of robotics clubs. In fact, I got so many new listings for robotics clubs, that I don't have enough room for them this issue. Instead, I'll give the list of individuals looking for clubs this time and the club list next time. Thanks to all who sent in their information. (Even with splitting the lists up, I still had to edit down the thoughtful notes many of you sent to get them to fit; if your comments shown here aren't quite what you remember sending, that's why.)

Let's get down to wiring.

Figures 1 and 2 and the wiring table give road maps for all the chassis wiring. Figure 1 covers the DC power supply circuitry, and Figure 2 gives details of power distribution and chopper board wiring. Photocopy the figures and the wiring table, and as you wire the chassis, use a highlighter to mark each connection you make.

For clarity, the LED indicators have been omitted from Figure 2. All components — with the exception of the LEDs — are wired so they may be removed from the chassis without unsoldering or cutting wires. This makes it much easier to troubleshoot and maintain the unit. The LEDs will be the last items to be wired in the chassis, after everything has checked out.

Mounting the Transformers

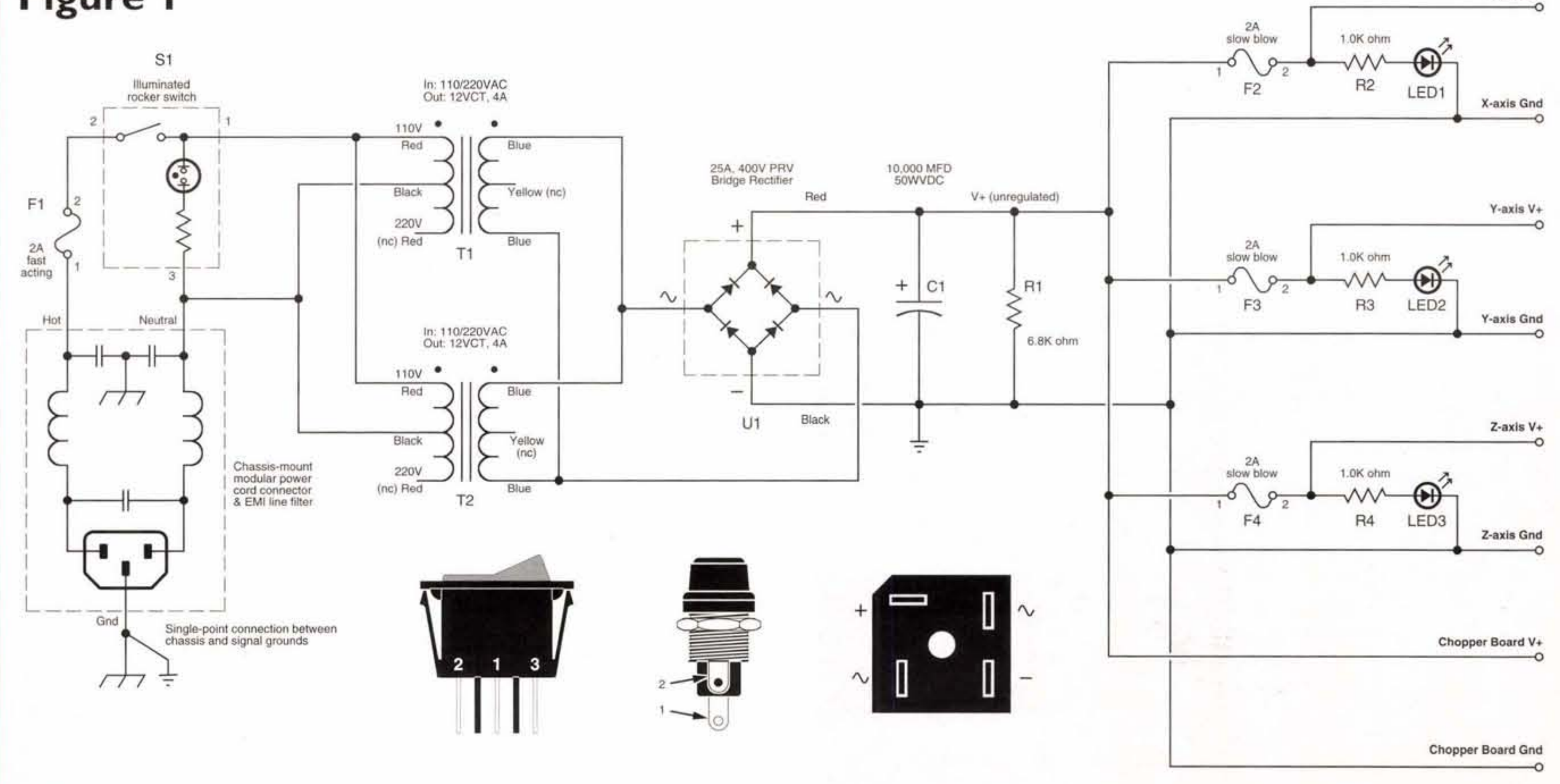
First, prepare the two transformers by either trimming or folding the unused leads as shown in Photo 1. The ends of these lead must be insulated to prevent short circuits and shock hazards since 110 and 220VAC will be present on the high-voltage side of both transformers. There are two unused leads on each transformer. The unused lead on the primary side is the "top" red lead — the 220V tap as shown on the label on the transformer, and on the secondary side, the middle yellow lead is unused. Crimp .35" closed-end nylon crimp connectors on the unused lead ends. If you intend to fold the lines rather than cut them short, be sure to secure them with nylon cable ties.

Next, sand to bare metal both surfaces of what will be the upper mounting tab of one of the transformers. This tab will serve as the chassis safety grounding point and must make good electrical contact with both the chassis on one side and the ground strap on the other.

To make the ground strap, crimp a #10 stud ring-tongue terminal on the stripped end of a 3" length of 18 AWG stranded wire; this end will attach to the bare metal of the mounting tab. Crimp a 1/4" female quick disconnect terminal to the other end of the wire; this end will attach to the safety ground tab of the power entry module.

Each transformer mounts sideways in the chassis with its label side up (Photo 2). The transformer with the sanded tab mounts on the right side of the case (left in the photo). You can either use #10 machine screws or 3/16" pop rivets, but if you intend to paint the chassis, use screws for the time

Figure 1



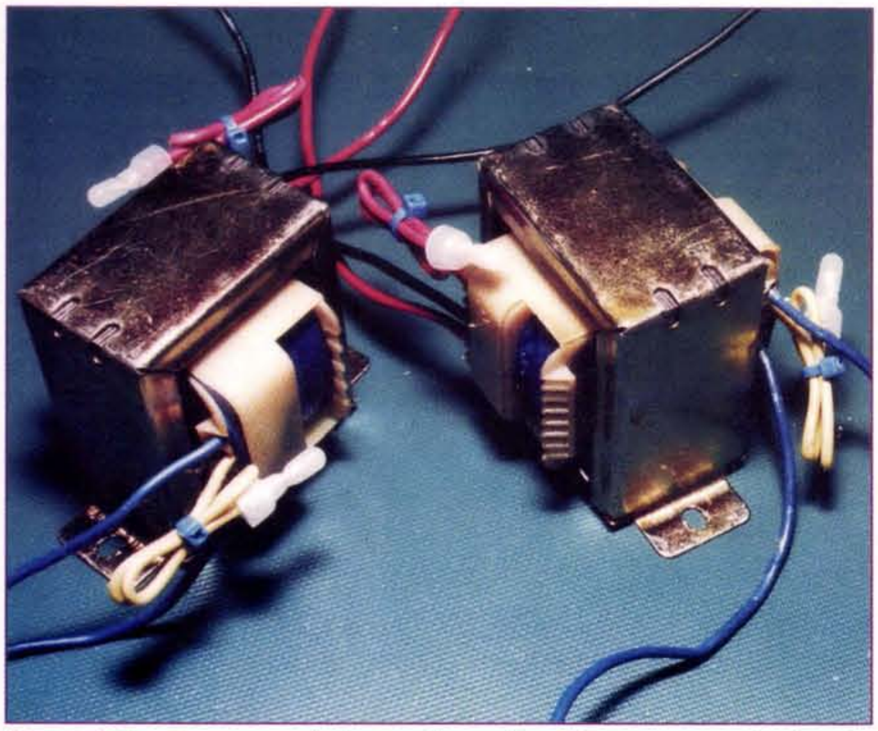


Photo 1. Transformers ready for installation. Unused wires are insulated with closed-end crimp connectors, then neatly bundled and tied with nylon cable ties.

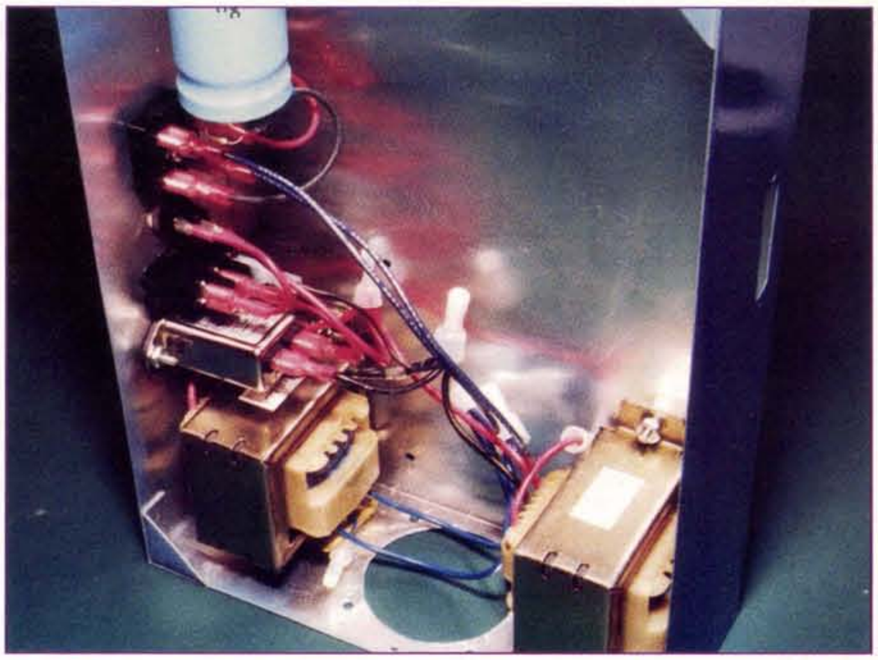


Photo 2. Power supply components installed in chassis. All connections to the transformers are made with closed-end crimp connectors, but all connections to the power entry module, switch, and rectifier bridge are made with insulated 1/4" quick disconnects. This way, all components can be changed out from the chassis without unsoldering or cutting any wires.

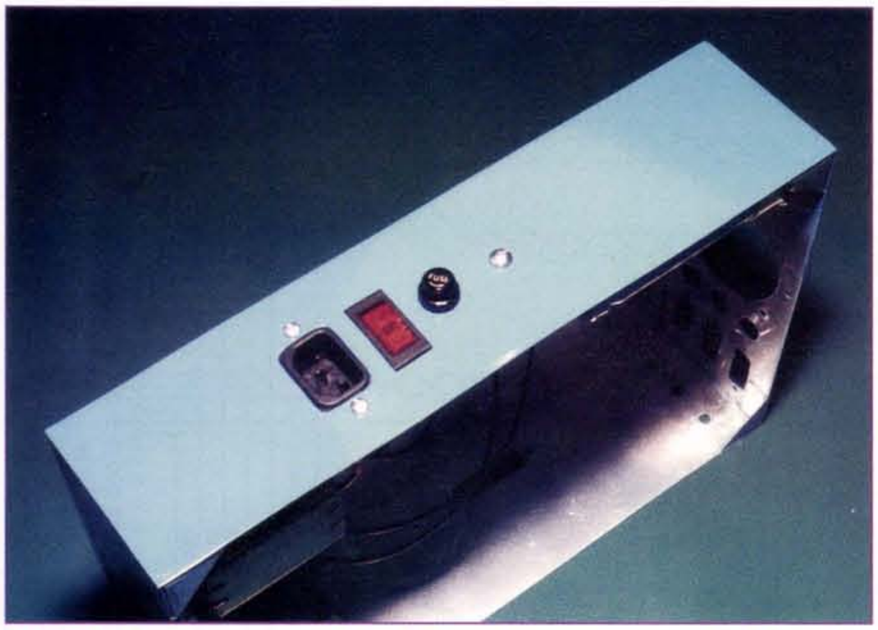


Photo 3. Chassis exterior, right side, showing power entry module, lighted power switch, and main fuse. The chassis has undergone many hours of sanding, multiple primer and paint coats, with yet more sanding between coats. After the power supply, chopper board, and all connectors are wired and installed, I'll temporarily remove everything and label the chassis.

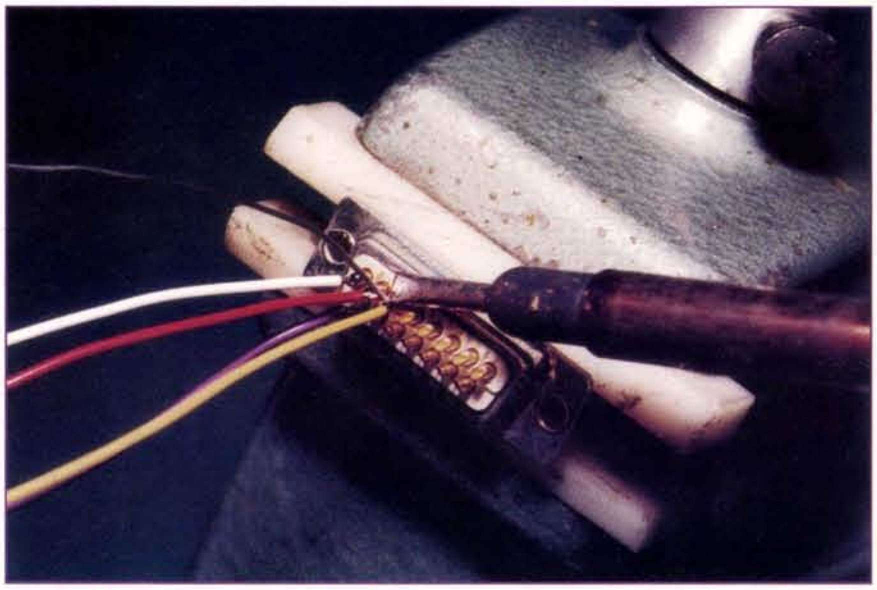


Photo 4. Wiring up one of the 15-pin axis connectors. I use solid wire for the stepper motor phases and stranded wire for the limit and home switches.

being. In the photos, I've already painted my chassis but haven't yet done the labeling, so I use screws. If I were doing it over, I would delay painting until all of the wiring was done and all of the chassis components were removed. (More on paint next time.)

Wiring the Primaries

Twist the stripped ends of the remaining red transformer leads together with a 4" length of red 18 AWG stranded wire and crimp them together in a .44" closed-end nylon connector. Crimp a 1/4" fully-insulated quick disconnect terminal to the other end of the 4" wire. This terminal connects to the middle terminal of switch S1, labeled "1" on the switch.

The black transformer leads get twisted and crimped together with two 4" lengths of black 18 AWG stranded wire. Crimp 1/4" fully-insulated quick disconnects to the free ends of these wires. One wire connects to "neutral" on the power entry module and the other wire connects to terminal "3" of S1.

Install the power entry/EMI filter module next, oriented label-up (or safety-ground-down) and secure with two 6-32 x 3/8" panhead screws, lock washers, and nuts. Installed this way, the "hot" terminal is toward the front of the chassis, and "neutral" is toward the back.

Next, snap in the power switch with the terminal labeled "3" toward the front (use a small straight-blade screw driver to separate the mounting ears). Remember, the chassis front is the closed side, while the back is the open — or cover — side.

Now comes the main fuse holder. Note that in the preliminary schematic (September 2001 issue), the main fuse was shown connected between S1 and the transformers. For improved safety, I've since moved the fuse to between power entry "hot" and S1 terminal 2 so that S1 does not light when the fuse F1 is blown.

Prepare the fuse holder by soldering the stripped end of a 4" length of red 18 AWG stranded wire to terminal 1 and a 3" length of the same type wire to terminal 2 (see Figure 1). Slip 3/4" lengths of 3/16" diameter heat shrink tubing completely over the terminals and solder joints, and apply heat to shrink the insulation in place. Complete the fuse assembly by crimping 1/4" quick disconnects as above to the free ends of these wires.

Feed the wires and fuse holder through the panel mounting hole, slip the nut on, and tighten. The longer wire (terminal 1) connects to the "hot" terminal of the power entry module, and the short wire (terminal 2) connects to S1 terminal 2. Connect the rest of the primary circuit up per Figure 1 and the wiring table. Don't forget the safety ground lead.

Wiring the Secondaries

Before wiring the secondaries together, you should: **1)** Check continuity of all the wiring so far, highlighting all the connections on the schematic as you go (preferably with another highlighter color); **2)** Determine the phasing of the secondary windings. The latter step is a good idea even if you are using the exact transformers I specify because the consequence of wiring the secondaries backward — anti-parallel instead of parallel — is likely to be smoke.

With the transformers specified, the secondary wires are blue. For both transformers, temporarily connect with an alligator clip lead

Figure 2

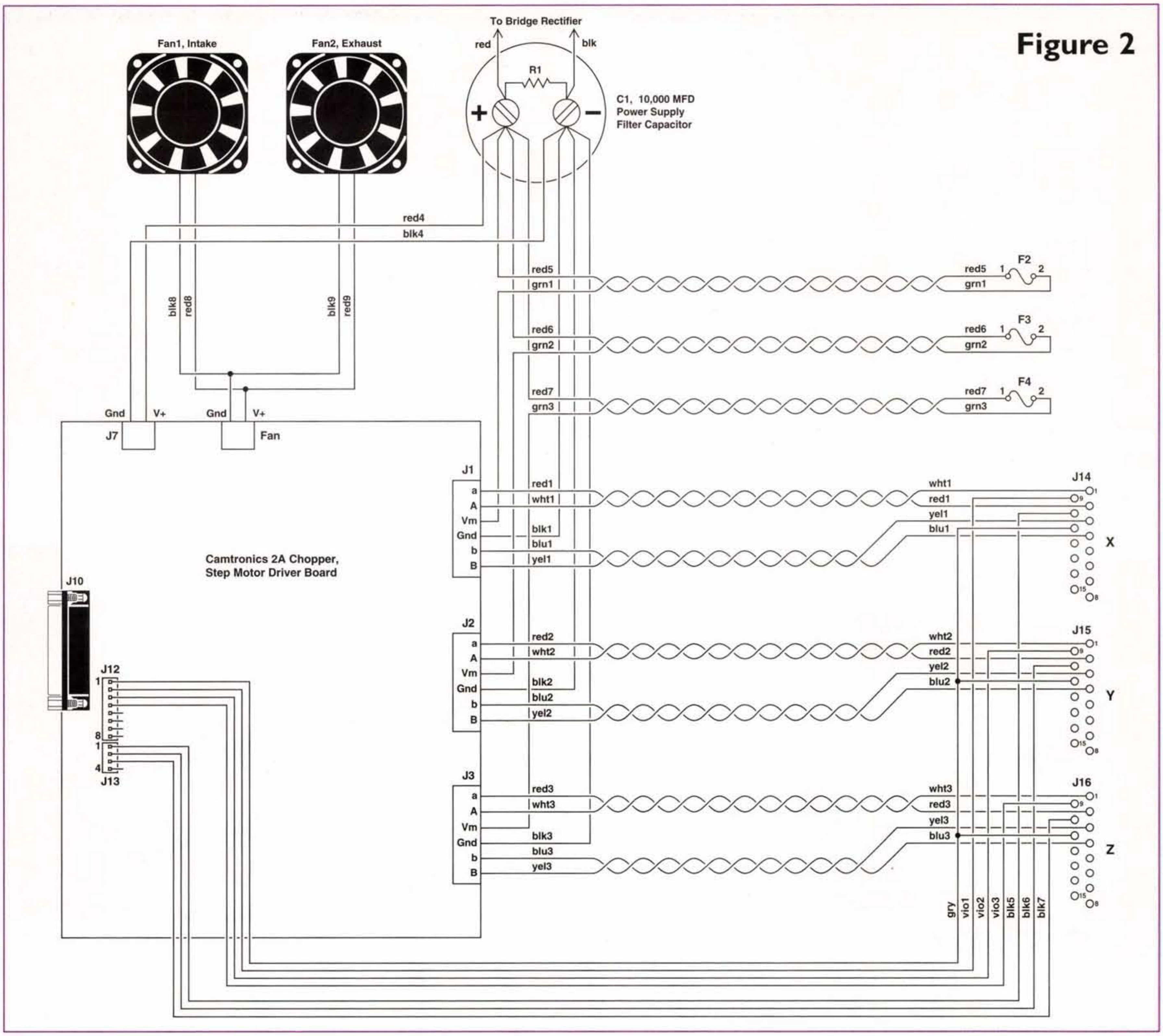


Photo 5. Each wire gets insulated with heat shrink tubing to prevent shorts and strengthen the connections.

the blue lead closest to the front of the chassis to the same lead of the other transformer. Leave the remaining leads unconnected except to the probes of a VOM or DVM set to measure AC voltage. Install F1, plug the modular cord set into the power entry module, and then plug the cord into an outlet of a switched-off power strip. Check everything one more time, then switch the power strip on. Everything okay? Now switch on S1.

If the secondaries are phased correctly, your meter should read zero volts across the two unconnected leads. If it reads zero volts, mark each lead connected by the clip lead with a black marker dot. If it reads somewhere around 26-28VAC, they are connected backwards, and you need to switch one of the leads.

(If the light of S1 fails to light, turn the power strip off and unplug the cord. Check the fuse and recheck your wiring.)

Assuming everything is working, apply power again, and this time measure AC voltage across the secondary of each transformer. Both should read about 14VAC. Power down, connect the last two wires together with another clip lead, and repeat the measurement process; it should still read about 14VAC.

Once you've achieved this, twist the stripped ends of each set of blue leads together with an 8" length of blue 18 AWG stranded wire and crimp together with one .44" closed-end nylon connector each. Crimp a 1/4" fully-insulated quick disconnect terminal to the other end of each 8" wire. These terminals connect to the AC input terminals of U1. Figure 1 shows the terminal layout of U1. Note that the AC inputs are diagonal from each other.

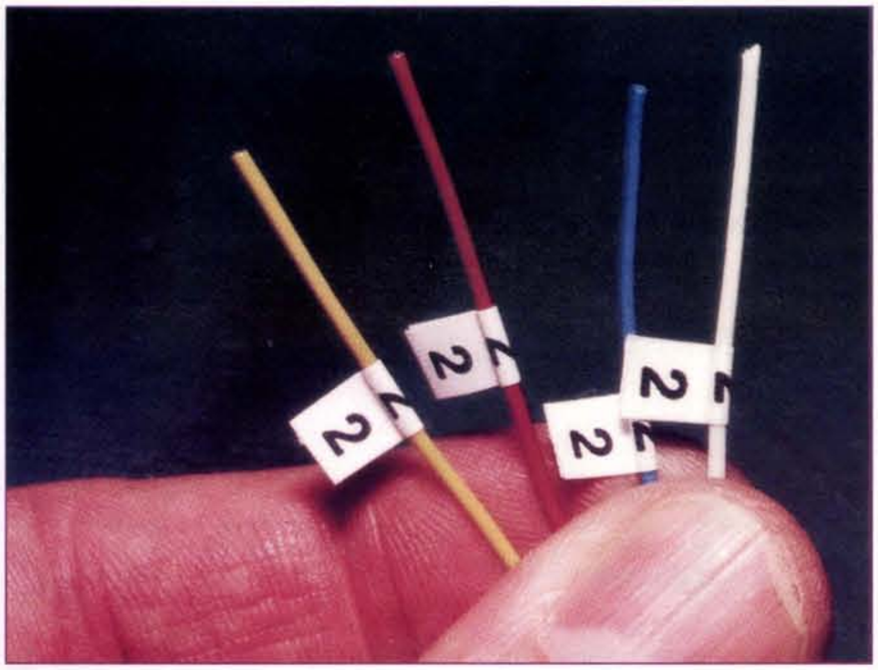


Photo 6. Since I use the same color combinations for each axis connector, I use numbered wire markers to identify the other end of each axis. These wires are the Y-axis phases.

Wiring the DC Section

Install the vertical capacitor mount with 6-32 x 1/4" screws, lock washers, and nuts, but don't install C1 yet. Cut and strip the ends of one 3" red and one 3" black wire, both 18 AWG stranded. On one end of each, crimp a quick disconnect terminal and on the other end crimp a snap-spade terminal.

The red wire connects the positive output terminal of U1 to the positive screw terminals of C1, and the black lead connects the negative terminals. Before you install C1, first form the leads of R1 to go around the screw terminals. R1 is there to safely drain all charge from C1 within a minute or so of power being removed. Without this bleeder resistor, C1 holds enough of a charge — even after hours — to melt a notch in the blade of a screwdriver (ask me how I know).

Install C1 and tighten the mounting clamp. Photos 2 and 3 show how everything should look when you're done. When you power up the circuit, you should read about 18VDC across the screw terminals of C1, and when you remove power, that voltage should decay to zero within a minute.

Wiring the Rest

I don't have room to go into detail this time on the rest of the wiring. With Figure 2, the wiring table, and Photos 4 through 6, you should get a pretty good idea of what's involved. I'll make a few points, though.

First, I used solid 22 AWG wire for all connections from C1 to the chopper board, F2-F4, and J14-

CHASSIS PARTS LIST

Part	Description	Vendor	Vendor part #
C1	10,000 MFD, 50WVDC electrolytic capacitor	Mouser	539-CGS50V10000
F1	Miniature fuse (5mm x 20mm), 2A, fast-acting	Mouser	5765-35002
F2-F4	Miniature fuse (5mm x 20mm), 2A, slow-blow	Mouser	5765-39002
Fan1, Fan2	2-3/8" sq. x 9/16" 12VDC box fan	MPJA	12716-FN
J14-J16	DB15 15-pin female connector, solder cup, tin	Digi-Key	1115F-ND
J17-J19	DB15 15-pin male connector, solder cup, tin	Digi-Key	1115M-ND
J20	2-pin right-angle friction lock male header	Digi-Key	WM4300-ND
J21	2-pin center crimp terminal housing	Digi-Key	WM2000-ND
J22, J24	2-pin pocket header, "G" version	Digi-Key	WM2900-ND
J23, J25	2-pin pocket header, "A" version	Digi-Key	WM2533-ND
LED1-LED3	Red, diffused T-1 (3mm), panel-mount LED	Mouser	35CA001
R1	6.8K-ohm, 1/4W, 5% carbon film resistor	Digi-Key	6.8KQBK-ND
R2-R4	1.0K-ohm, 1/4W, 5% carbon film resistor	Digi-Key	1.0KQBK-ND
S1	Illuminated rocker switch, SPST 15A, 125VAC w. amber neon lamp & internal resistor	Mouser	10DS322
T1, T2	Transformer, 110/220VAC input, 12VAC output	MPJA	7840-TR
U1	25A, 400V PRV bridge rectifier	Mouser	625-GBPC2504
Misc:			
1 ea.	3-axis 2A Chopper/Step Motor Driver kit	Camtronics	
1 ea.	Vertical capacitor mounting hardware	Mouser	539-VR3
4 ea.	Panel-mount miniature fuse holder	Mouser	441-R3-12
2 ea.	Fan guard for 2-3/8" fan	MPJA	8660-FN
1 ea.	6-ft 3-wire IEC cord set	Mouser	173-63101
1 ea.	IEC connector/line filter, 6A 250VAC 50-60Hz	Mouser	562-857-06/27
1 ea.	8"W x 12"D x 3"H aluminum enclosure	Mouser	537-8123
1 ea.	8" x 12" aluminum enclosure cover	Mouser	537-8123C
3 ea.	DB-15 conn. backshell, shielded plastic	Digi-Key	915CA-ND
6 ea.	4-40 female hex screwlock conn. hardware	Digi-Key	160-10F-ND
4 ea.	Hex threaded standoff, alum. 6/32, .25" x .375"	Digi-Key	2209K-ND
2 ea.	Crimp terminals for J21	Digi-Key	WM2200-ND
4 ea	Box crimp terminals, female, for J22, J24	Digi-Key	WM2510-ND
4 ea	Box crimp terminals, male, for J23, J25	Digi-Key	WM2517-ND
10 ea.	1/4" fully-insulated quick disconnect, female, crimp	Digi-Key	WM18237-ND
10 ea.	Snap-spade crimp terminals, #10 stud, insulated	Digi-Key	WM18317-ND
4 ea.	Nylon-insulated, closed-end crimp connector, .35"	Digi-Key	WM18394-ND
4 ea.	Nylon-insulated, closed-end crimp connector, .44"	Digi-Key	WM18395-ND

J16. These wires, once routed around the chassis, will only rarely need to be moved, and all of the connections made to the chopper board are made with screw terminal blocks, which work best with solid wire.

Second, twist together the wires carrying chopped current to each stepper phase. This keeps down the electrical hash these lines would otherwise radiate.

Third, cut way more wire for the 15-pin connectors than you think you will use. I cut 18" lengths of each color needed for each connector so I would be sure to have enough once the wires were routed to their destinations.

Forth, I'm a belt and suspenders kind of guy when it comes to wiring. I soldered wires to the connectors (Photo 4), checked for shorts and continuity from pin to wire end, then insulated each connection with 1/8" heat shrink tubing (Photo 5), and checked for shorts and continuity again.

Finally, even before I trimmed wires to final length, I marked each line with wire label tape (Photo 6). After trimming, I mark them again so it's easy to tell which wire is what. And that is all the space for this month.

See you next time! **NV**

WIRE SIZES AND CONNECTIONS

Wire	Gauge	Connections	Description
BLK1	22 AWG, solid	C1- to J1.Gnd	X-axis ground
BLK2	22 AWG, solid	C1- to J2.Gnd	Y-axis ground
BLK3	22 AWG, solid	C1- to J3.Gnd	Z-axis ground
BLK4	22 AWG, solid	C1- to J7.Gnd	Chopper board ground
BLK5	22 AWG, stranded	J14.10 to J13.1	X-axis Limit/Home sw. ground
BLK6	22 AWG, stranded	J15.10 to J13.2	Y-axis Limit/Home sw. ground
BLK7	22 AWG, stranded	J16.10 to J13.3	Z-axis Limit/Home sw. ground
BLK8	24 AWG, stranded	Fan1- to Fan-	Intake fan ground
BLK9	24 AWG, stranded	Fan2- to Fan-	Exhaust fan ground
BLU1	22 AWG, solid	J14.4 to J1.b	X-axis step motor b-wire
BLU2	22 AWG, solid	J15.4 to J2.b	Y-axis step motor b-wire
BLU3	22 AWG, solid	J16.4 to J3.b	Z-axis step motor b-wire
GRN1	22 AWG, solid	F2.2 to J1.Vm	X-axis motor voltage, fused
GRN2	22 AWG, solid	F3.2 to J2.Vm	Y-axis motor voltage, fused
GRN3	22 AWG, solid	F4.2 to J3.Vm	Z-axis motor voltage, fused
GRY	22 AWG, stranded	J14.11, J15.11, & J16.11 to J12.1	Limit/Overtravel sw. sense
RED1	22 AWG, solid	J14.2 to J1.a	X-axis step motor a-wire
RED2	22 AWG, solid	J15.2 to J2.a	Y-axis step motor a-wire
RED3	22 AWG, solid	J16.2 to J3.a	Z-axis step motor a-wire
RED4	22 AWG, solid	C1+ to J7.V+	Chopper board V+
RED5	22 AWG, solid	C1+ to F2.1	X-axis motor voltage
RED6	22 AWG, solid	C1+ to F3.1	Y-axis motor voltage
RED7	22 AWG, solid	C1+ to F4.1	Z-axis motor voltage
RED8	24 AWG, stranded	Fan1+ to Fan+	Intake fan V+
RED9	24 AWG, stranded	Fan2+ to Fan+	Exhaust fan V+
WHT1	22 AWG, solid	J14.1 to J1.A	X-axis step motor A-wire
WHT2	22 AWG, solid	J15.1 to J2.A	Y-axis step motor A-wire
WHT3	22 AWG, solid	J16.1 to J3.A	Z-axis step motor A-wire
VIO1	22 AWG, stranded	J14.9 to J12.2	X-axis Home sw. sense
VIO2	22 AWG, stranded	J15.9 to J12.3	Y-axis Home sw. sense
VIO3	22 AWG, stranded	J16.9 to J12.4	Z-axis Home sw. sense
YEL1	22 AWG, solid	J14.3 to J1.B	X-axis step motor B-wire
YEL2	22 AWG, solid	J15.3 to J2.B	Y-axis step motor B-wire
YEL3	22 AWG, solid	J16.3 to J3.B	Z-axis step motor B-wire

Does anybody know of a robotics interest group in South Africa?

Andrew C. Smith
CSIR B43, PO Box 395, 0001 Pretoria
South Africa; www.icomtek.co.za

I live in Kearney, NE which is located in about the middle of the state. Thanks for trying to get people hooked up with one another. I'm looking for a local club or other gearheads in the area.

Scott Willson, boweeble@nebi.com
Kearney, NE

I've been trying to break into robotics for about 10 years now, Being on my own, it's hard to get and stay motivated. Hopefully, you can help me find some interested people (or better yet, a club) in my area, and we can get together and motivate!

Patrick Innes, Frederick, MD
Robotics@tinkersfolly.com

My name is Mark Sobanek and I am a lonely gear head from Shawnee, KS, a suburb of Kansas City. Not exactly the technology hub of America, but it could be worse. My schedule and budget are kind of tight with a wife, three kids, another on the way (due early February), and a dog. Needless to say, I would rather join an existing club, but if I have to I would be willing to start one.

Mark Sobanek
Kenabos@aol.com

I hope to find others in the Cincinnati-Dayton area who are interested in robotics.

Mark Aulfinger
5678 Yamassee Dr., Hamiltion, OH 45011
(513) 425-3776 (day phone)
mark_aulfinger@aksteel.com

I'm very interested in joining a local club and organizing events/contests/conferences/shows/exhibits "geared" (no pun intended) toward the amateur robotics enthusiast.

William T. Jahnke
will@lulu.com; Lulu Holdings: www.lulu.com
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I live in Beckley, WV. I am a retired physician and also a senior EE student at West Va Univ Tech. We have entered the IEEE Region 3 robot competition several times in the past few years and have won it every time we've entered. We're so small a school that people from the bigger schools wonder just who we are!

Jim Wills; TopDocJim@aol.com
Beckley, WV

If you know of any robotics club in the Nashville, or middle, Tennessee area, please let me know.

Steve Ghertner
steveghertner@mindspring.com

Hi. I am either looking for or starting a robotics club in the Central New Jersey or Eastern Pennsylvania area. Please include my email address in your February column. If there is enough interest, I will start one.

Mike Adams
Cnjrobots@aol.com

Please add me to your list of people in the Southeast Florida area who want to join a local robot club. My home is in a suburb of Ft. Lauderdale, FL.

Wayne Tytell
3062 La Mirage Drive, Lauderhill, FL 33319-4246
wtytell@mediaone.net

I am a lonely gearhead living near Haddock, GA, which is close to Macon. We live pretty far out in the country on a little subsistence-type Permaculture farm community/eco village. I don't know anyone in this area who is into electronics. My interest is not robot building specifically, but I am interested in all things mechanical and electrical. I have recently been creating sculpture from electric discards and am interested in finding new ways to transform found objects into something new. I would love to find some folks around here to collaborate with on projects. www page in progress, but what little info there is: www.gypsyfarm.com/souly_solar

Eric Daine, Haddock, GA
ed@cerebral.org

Looking for a robotics club — ideally in St. Mary's or Kingsland, GA. Feasible travel would be Brunswick, GA, or maybe Savannah, GA — or Jacksonville, FL to the south. Not too practical would be north to Atlanta or south to Orlando. I will consider helping to start a robotics club with others in my area, and may consider doing so as far as Jacksonville to the south or Brunswick to the north. I'm also looking to correspond with other robot builders on robotics projects and mechanics and electronics. I will send my telephone number to those write.

Larry W. Finch
143 Cypress Lane, St. Marys, GA 31558

If you have suggestions, questions, or comments about amateur robotics topics, you can reach me at:

Robert Nansel
Box 228
Ambridge, PA 15003

E-Mail: **bnansel@nauticom.net**

Kronos Crawler Phase 2
The IR Connection

By Michael Simpson

Last month, we assembled the base and connected the Atom development board along with an SN754410 motor controller. I felt it was time for a few sensors.

Every time I have constructed a robot, I always wished I had a better way of testing the sensors as they were added. I decided to forgo the sensors and add an infrared remote control system that would make it easier to test and calibrate any sensors I might want to add.

I will be concentrating on the Vishay 1840 IR Module. This module operates at 40kHz and is well suited to our application. There are a great number of remotes available and protocols to match, but I will be concentrating on one in particular, the Sony® protocol.

- It is an easy protocol based on a pulse width bit stream which is very easy for microcontrollers to deal with.
- The remotes are readily available. You can pick up a universal remote for around $10.00.

The Protocol

I am not going to spend a great deal of time explaining the protocol in depth as it has been done many times. I will just go over a few important points regarding this protocol.

Let's start by diving into the Sony protocol. The IR module will output a pulse stream of bits with varying widths.

The widths are defined as follows.

Start Bit	2400ms
High State (1)	1200ms
Low State (0)	600ms

The world is not perfect and to compensate for the various manufacturers, we have expanded the specification as follows.

Start Bit	Any pulse greater than 2000ms wide.
High State (1)	Any pulse between 1000ms and 2000ms wide
Low State (0)	Any pulse less than 1000ms

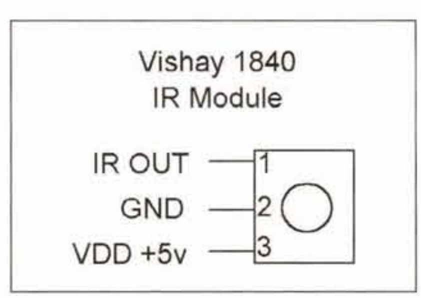
The actual bits sent consist of a starting bit followed by 12 data bits. The data bits can be further broken down into command and device bits as shown below.

S C C C C C C C D D D D D

These bits come with the least significant first and will be represented as the command byte and the device byte. We will get into this further when we look at the code.

The Modules

Let's look a little closer at the modules before we wire them up.

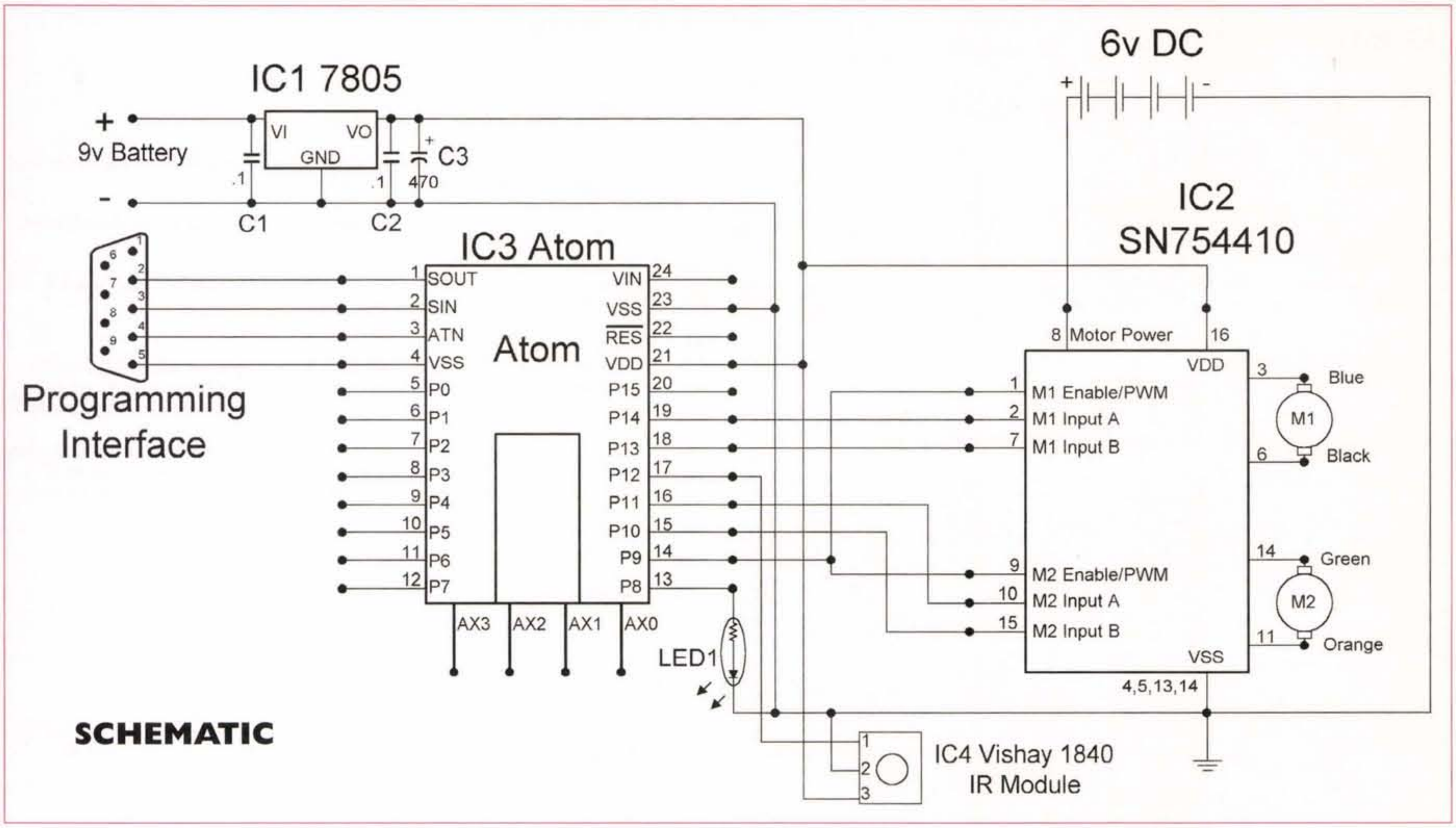


The end with the little round bump is the sensor side of the chip.

As far as the remote goes, you can use any Sony remote, as well as any universal remote that supports Sony. I use an RCA universal remote myself.

The Circuit

Wire up the circuit as shown in the schematic. Pay particular attention to



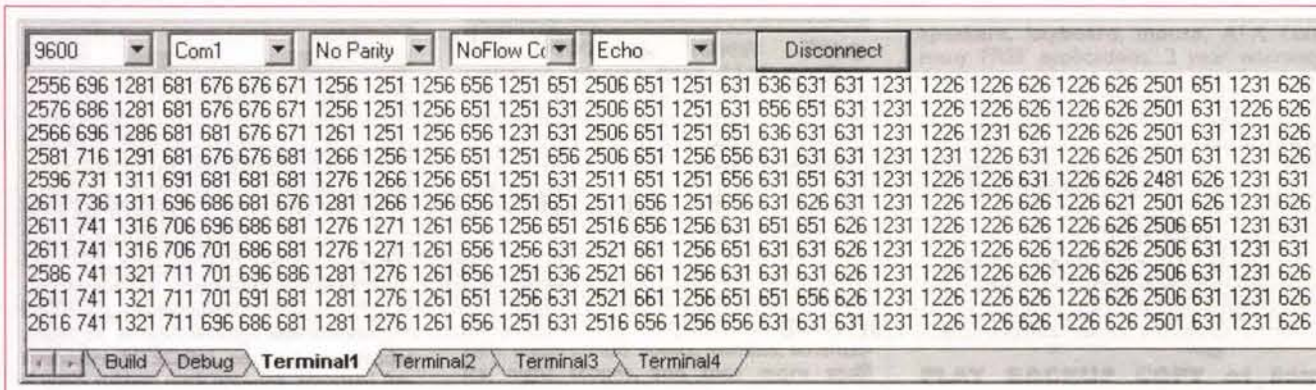
SCHEMATIC

C3. It must be at least 470uF. Locate it as close to the Atom and IR module as possible. If you are using an Atom development board, you still need to include C3 on the breadboard.

The Code

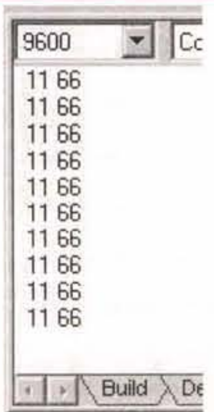
Program Listing 1 is just a simple program to demonstrate the actual pulse widths of the various bits. I wanted to include this program since I have never seen it done and feel that it helps demonstrate the Sony protocol better.

The first time I attempted to write this program was on a BASIC Stamp, but soon found there was not enough RAM available to hold the pulse data for 30 bits of data or even half that. This is one of the areas that the Atom really shines. The output should look something like this:



```
9600 | Com1 | No Parity | NoFlow Cc | Echo | Disconnect
2556 696 1281 681 676 676 671 1256 1251 1256 656 1251 651 2506 651 1251 631 636 631 631 1231 1226 1226 626 1226 626 2501 651 1231 626
2576 686 1281 681 676 676 671 1256 1251 1256 651 1251 631 2506 651 1251 631 656 651 631 1231 1226 1226 626 1226 626 2501 631 1226 626
2566 696 1286 681 681 676 671 1261 1251 1256 656 1231 631 2506 651 1251 651 636 631 631 1231 1226 1231 626 1226 626 2501 631 1231 626
2581 716 1291 681 676 676 681 1266 1256 1256 651 1251 656 2506 651 1256 656 631 631 631 1231 1231 1226 631 1226 626 2501 631 1231 626
2596 731 1311 691 681 681 681 1276 1266 1256 651 1251 631 2511 651 1251 656 631 651 631 1231 1226 1226 631 1226 626 2481 626 1231 631
2611 736 1311 696 686 681 676 1281 1266 1256 656 1251 651 2511 656 1251 656 631 626 631 1231 1226 1226 626 1226 621 2501 626 1231 626
2611 741 1316 706 696 686 681 1276 1271 1261 656 1256 651 2516 656 1256 631 651 651 626 1231 1226 1226 626 1226 626 2506 651 1231 631
2611 741 1316 706 701 686 681 1276 1271 1261 656 1256 631 2521 661 1256 651 631 631 626 1231 1226 1226 626 1226 626 2506 631 1231 631
2586 741 1321 711 701 696 686 1281 1276 1261 656 1251 636 2521 661 1256 631 631 631 626 1231 1226 1226 626 1226 626 2506 631 1231 626
2611 741 1321 711 701 691 681 1281 1276 1261 651 1256 631 2521 661 1256 651 651 656 626 1231 1226 1226 626 1226 626 2506 631 1231 626
2616 741 1321 711 696 686 681 1281 1276 1261 656 1251 631 2516 656 1256 656 631 631 631 1231 1226 1226 626 1226 626 2501 631 1231 626
Build | Debug | Terminal1 | Terminal2 | Terminal3 | Terminal4
```

In the Program Listing 2, we are going to get a bit fancier. We will analyze the widths and convert them to actual device code and command code values. The output should look something like this:



```
9600 | Cc
11 66
11 66
11 66
11 66
11 66
11 66
11 66
11 66
11 66
11 66
Build | De
```

The device code was 11 and the command code was 66.

Now we have the basics. Let's put it all together with last month's code. This will give you full control of the Kronos Crawler and the ability to add as many other functions as you wish. Check out Program Listing 3.

That's it. You should be able to control the Kronos Crawler with the remote control.

Use the following keys:

CH+	Move forward	2	Set low speed
CH-	Move backward	5	Set medium speed
Vol-	Spin to the left	8	Set high speed
Vol+	Spin to the right		

You can now experiment with sensors. Just place the code that tests the sensors at the beginning of the main loop.

Before I close, I want to say a few things about the Atom. I have been using it for a while and the power of this controller is unbelievable. For instance, the Program Listing 3 uses 46 bytes of RAM leaving over 350 bytes for future use. It uses 1377 bytes of program space leaving over 6800 bytes free for more software. Just think of all the sensors you can monitor with that kind of code space.

What's next

Maybe a few sensors or an encoder or two. We shall see.

Be sure to visit the Kronos Robotics web site at www.kronosrobotics.com for updates and enhancements. **NV**

Article continues on pages 70 and 71.

Side Bar

You will notice that I use the serout command instead of the debug command throughout the code examples.

Serout with the pin constant of S_OUT is the equivalency of the BASIC Stamp's debug command.

The Debug command on the Atom is a whole new ball game. The IDE software actually takes over the Atom and allows you to watch variables and single step through the code.

Since the IDE becomes integrated with the Atom there is a performance hit.

So if you want full speed debug just use the Serout command with the S_OUT pin option.

Program Listing 1

I define a few variables to hold the recorded pulse data.

```
'Define buffer to hold ir values
IRbits var word(30)
x var byte

bitcount var byte
bitvalue var word
```

This is the main loop. Before checking for pulses, I clear all variables.

```
main:
'Clear the Irbits
for bitcount = 0 to 29
   IRbits(bitcount)=0
 next
```

I then look at pin 12 and record the pulse width.

If it is less than 2000 I go back and look again.

```
 bitcount=0
getstartbits:
 bitvalue = 0:PuLSIN 12,0,bitvalue:IRbits(0)=bitvalue
 if bitvalue < 2000 then goto getstartbits
```

I now have the start bit.

Let me record the next 29 bits

```
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(1)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(2)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(3)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(4)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(5)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(6)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(7)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(8)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(9)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(10)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(11)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(12)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(13)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(14)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(15)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(16)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(17)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(18)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(19)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(20)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(21)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(22)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(23)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(24)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(25)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(26)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(27)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(28)=bitvalue
bitvalue = 0 : PuLSIN 12,0,bitvalue : IRbits(29)=bitvalue
```

In this section I display all 30 recorded bits.

I use the serout command. Use one of the terminal sessions and set it up as 9600 with No Parity.

```
displaybits:
 for bitcount = 0 to 29
   serout S_OUT,i9600,[dec IRbits(bitcount)," "]
 next

 serout S_OUT,i9600,[10,13]

 goto main
```

The Parts

Item	Qty	Description	Source
IC2	1	Atom	Kronos Robotics #ATM1
IC3	2	SN754410	Kronos Robotics #MDR1
IC4	1	Vishay IR Module	Kronos Robotics #IR2
	1	Atom development board	Kronos Robotics #ATM3
C3	1	470uF Capacitor	Kronos Robotics #C470-50
LED1	1	LED with integrated resistor	Kronos Robotics #LED5YR
	1	Dip Heatsink	Kronos Robotics #HSDIP
	1	9V Battery connector with power connector	Kronos Robotics #CO5
	1	4 cell C battery holder	Kronos Robotics #BH4C
	1	9V Battery holder clip	Kronos Robotics # BH9V
	1	Crawler Base	Kronos Robotics #RB1
	1	Crawler Platform	Kronos Robotics #RB2
	4	1/2" 4-40 machine screws	Kronos Robotics #HWPH6
	8	4-40 hex nuts	Kronos Robotics #HWHN3
	1	Sony Compatible Remote Control	Kronos Robotics #REM1

Sources

Kronos Robotics
www.kronosrobotics.com

Basic Micro
www.basicmicro.com

Program Listing 2

I define the two variables that the subroutine getsonycode is going to populate, devicecode and cmdcode.

A few working variables are also created, bitvalue and level1value.

```
devicecode var byte
cmdcode var byte

'Holds the pulse width of the current bit under test
bitvalue var word

'Holds the divisor for testing the width of each pulse
level1value var word

'In this case 1200ms or longer will be a level 1
level1value = 1200
```

The bitvalue variable will contain the pulse width of each bit I test in the bit stream.

Level1value is a width test variable. Bitvalue will be divided by lebel1valuew to determine if it is less than or greater than our high bit reference value.

```
'We will devide bitvalue by level1value to determine
' if bitvalue is less than 1200 (high state pulse
' width value). If it is then the bit is 0 other wise its 1.

' By using some simple integer math I can still scan
' each bit in time for the next. Had I used an IF
'  statement we would eat too much time between
' pulses in the  stream.
```

The main loop just calls the getsonycode subroutine over and over.

If both the devicecode and cmdcode contain valid values the results are displayed with the serout command.

```
main:

gosub getsonycode
if devicecode > 0 or cmdcode > 0 then
serout S_OUT,i9600,[" ",dec devicecode," ",dec_
  cmdcode,10,13]
endif

goto main
```

First thing I do is clear all the variables so I have a fresh start.

I then look at pin 12.

If there was no pulse, bitvalue will contain 0 and I will exit the subroutine.

If it contains a value and it is less than 2000ms I go back and get another pulse.

I keep doing this until I have a valid start bit.

```
GetSonyCode:

'Clear the Irbits
devicecode=0
cmdcode=0

getstartbits:
'We have to clear the variable used with the pulsing
' command as the Atom will not clear the variable if
' it times out.
bitvalue =0

Pulsin 12,0,bitvalue

'No spaghetti code here cause we have multi-line
'IF/Then's
if bitvalue = 0 then
  return
endif

if bitvalue < 2000 then getstartbits
```

Record the next 12 bits.

```
'At this point we are ready to get the command code

pulsin 12,0,bitvalue
cmdcode.bit0 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit1 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit2 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit3 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit4 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit5 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit6 = bitvalue/level1value

'Now lets get the device code
pulsin 12,0,bitvalue
devicecode.bit0 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit1 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit2 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit3 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit4 = bitvalue/level1value

return
```

Program Listing 3

I define the two variables that the subroutine getsonycode is going to populate, devicecode and 'cmdcode.

```
'IR Section
devicecode var byte
cmdcode var byte
```

A few working variables are also created, bitvalue and level1value.

```
'Holds the pulse width of the current bit under test
bitvalue var word

'Holds the divisor for testing the width of each
'pulse
level1value var word
```

The bitvalue variable will contain the pulse width of each bit I test in the bit stream.

```
'In this case 1200ms or longer will be a level 1
level1value = 1200

'We will devide bitvalue by level1value to
'determine if bitvalue is less than 1200 (high state
'pulse width value). If it is then the bit is 0
'otherwise its 1.
```

Level1value is a width test variable. Bitvalue will be divided by lebel1valuew to determine if it is less than or greater than our high bit reference value.

```
' By using some simple integer math I can still
'scan each bit in time for the next. Had I used an
'IF statement we would eat too much time
' between pulses in thestream.

'We use this as a form of IR indication
output 8
```

I now set up the ports used to control the SN754410.

```
'Motor Controller Section

'—— Sets up the constants for the motor
'controller
M2InputA Con 11
M2InputB Con 10

M1InputA Con 14
M1InputB Con 13

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

Output M2InputA
Output M2InputB
```

I also make a call to CrHigh which sets the PWM signal generator to output a nearly 100% duty cycle.This sets the fastest speed.

```
'—— Setup the initial speed
gosub CrHigh
```

In the main loop I call the getsonycode subroutine. This routine populates the cmdcode and devicecode variables.

We test to see if they are both 0. If they are I assume I had a time out and go stop the Crawler.

If I did get an IR code I turn the indicator light on and continue to test the command codes.

A small note. I am not using the device code for anything other than a test for valid codes. You could test it here and just go back to the main loop if it is not what you expect.

```
main:

 'Insert Sensor code here ....

 gosub getsonycode

 '— Time out (no key pressed)
  if devicecode = 0 and  cmdcode = 0 then
   gosub Crstop
   'Turn indicator off
   low 8
   goto main
  endif

'Turn indicator on
 high 8
```

In this section I test the cmdcode variable to determine the action to take.

In each case I call the appropriate Crawler command.

```
'— Reverse —  (CH -)
  if cmdcode = 17 then
   gosub Crrev
   endif

'— Forward  — (CH+)
if cmdcode = 16 then
   gosub Crfwd
   endif
'— spin left —  (Vol -)
  if cmdcode = 19 then
   gosub CrLspin
   endif

'— spin Right —  (Vol +)
  if cmdcode = 18 then
   gosub CrRspin
   endif

'Set Low Speed (2 Keypad)
if cmdcode = 1 then
   gosub Crlow
   endif

'Set Medium Speed (5 Keypad)
if cmdcode = 4 then
   gosub Crmed
   endif

'Set High Speed (8 Keypad)
if cmdcode = 7 then
   gosub Crhigh
   endif

Goto main
```

Motor speed routines

```
Crlow:
 HPWM 1,9890,7000 : Return '81% Duty cycle
 Return

CrMed:
 HPWM 1,9890,8000 : Return '90% Duty cycle
 Return

CrHigh
 HPWM 1,9890,9890 : Return '99% Duty cycle
 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

'————————
' This is the main IR routine
'  It populates cmdcode and
'  devicecode variables
'————————
```

First thing I do is clear all the variables so I have a fresh start.

```
GetSonyCode:

'Clear the Irbits
devicecode=0
cmdcode=0
```

I then look at pin 12.

If there was no pulse, bitvalue will contain 0 and I will exit the subroutine.

If it contains a value and it is less than 2000ms, I go back and get another pulse.

I keep doing this until I have a valid start bit.

```
getstartbits:

'We have to clear the variable used with the pulsing
'command as the Atom will not clear the variable if it
'times out.

bitvalue =0

Pulsin 12,0,bitvalue
if bitvalue = 0 then
  return
endif

if bitvalue < 2000 then getstartbits
```

Once I have a valid start bit I record the next 12 bits.

```
'At this point we are ready to get the command code
'(7 bits)
pulsin 12,0,bitvalue
cmdcode.bit0 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit1 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit2 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit3 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit4 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit5 = bitvalue/level1value
pulsin 12,0,bitvalue
cmdcode.bit6 = bitvalue/level1value

'Now lets get the device code (5 bits)
pulsin 12,0,bitvalue
devicecode.bit0 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit1 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit2 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit3 = bitvalue/level1value
pulsin 12,0,bitvalue
devicecode.bit4 = bitvalue/level1value

return
```

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No-License Handhelds

By Gordon West

If you are planning a ski trip or winter camping adventure, bring along handheld radios for safety and staying in touch with base camp. Cross-country skiers swear by them — these little portable radios could very well get you out of a jam when a white-out occurs. But not all handheld radios qualify for cold weather land adventures. Some may work better than others, yet the "ultimate" handheld radio might be totally illegal to use on the slopes.

"I'm a sailor during the summer, so I pulled my two VHF marine radios off the boat and was planning to use them up in the mountains," comments an FCC-busted boater.

"I bought these at a marine store that told me I didn't need a license to transmit and receive over marine VHF, so you can imagine my surprise when I got hit with a $5,000.00 fine for using them at my ski lodge."

Marine VHF handheld transceivers, operating on 55, 25-kHz-spaced channels at 156 MHz are permitted only for on-water radio service in strict accordance to channel assignments detailed in FCC Part 80.373. Although Federal Communications Commission maritime rules do not mandate a ship station license to operate this equipment, "no license" does not mean "no rules" on how these five-watt handheld marine radios work in the maritime FM marine radio service. Unfortunately, our boater-turned-ski-lodge operator arbitrarily picked a marine channel authorized only for the vessel traffic system service.

"No wonder they were telling me to get off of their channel!"

Handheld radios that don't require a FCC license may fall under FCC rules Part 15 and Part 95. Part 15 no-license handheld radios are the toy walkie-talkies sold to youngsters that typically transmit only for a couple hundred feet. These Part 15 FCC-defined "intentional radiators" may only transmit a few milliwatts of output power, and are usually limited by a field strength not to exceed 1,000 microvolts/meters at three meters. We see Part 15 toy walkie-talkies on higher frequencies as well, but their range is limited to usually less than a couple hundred yards — and because these little Part 15 handhelds are sold to kids, you can be assured that any RF output coming off the antenna is next to nothing for safety factors.

These toy walkie-talkies share the same range characteristics as 48 MHz/49 MHz cordless phone handsets. If you get a block of range, you're doing swell! Twenty-seven megahertz (27 MHz) CB handhelds do not require a license, and specific rules for their operation are found under Part 95, Subpart D. CB radio manufacturers like RadioShack, Cobra, Maxon, and Midland have done a nice job of packaging these medium-weight, medium-sized, 27 MHz handhelds. Gone are the long telescopic whips and big battery packs.

Now the 27 MHz handheld works into a very inefficient rubber-duck antenna, and at three or four watts output, their battery packs only last for a few hours. The switch from nickel cadmium batteries to nickel metal hydride have almost doubled their playing time, but 27 MHz CB handheld radios run at high power don't stay on the air for long between battery changes.

If you have a 40-channel CB in your vehicle already, the little CB 27 MHz handheld could make sense. Range is limited to about one mile between mobile and handheld, and about a half mile between two portable 27 MHz radios with their little rubber antennas when skip conditions are pounding in. In the dead of night, you might get one mile at best between two CB walkie-talkies.

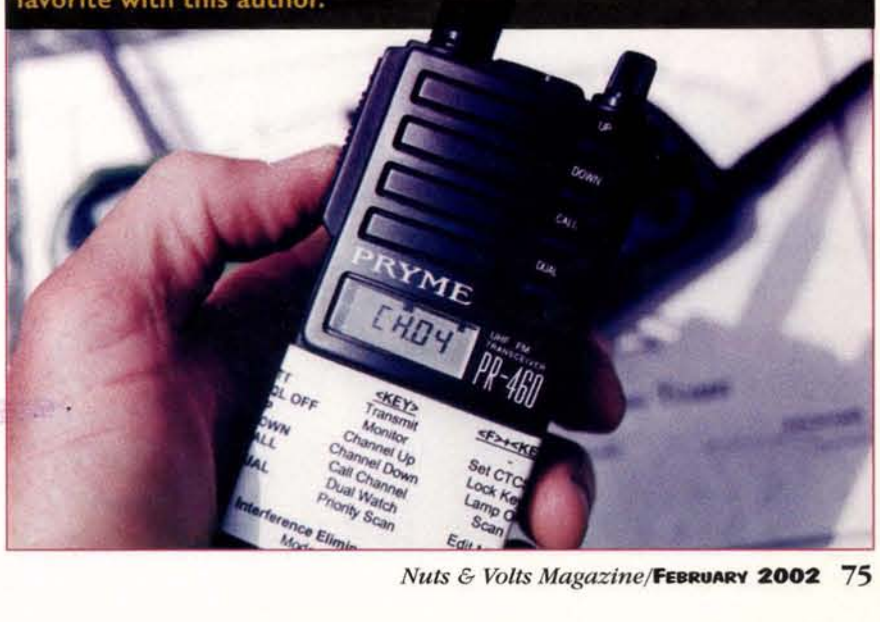
The FCC rules have been "plain languaged" for CB operation, preventing no more than four watts of AM carrier power, no linear amplifiers or radio contacts over 155.3 miles away, and no general chit-chat on CB Channel 9 used only for emergencies and traveler assistance. Other rules also prevent the CB 27 MHz radio from being hooked into the telephone system, and no deliberate jamming of other CB radio signals you hear on the air.

CB for traveling has merit in communicating with other motorists and truckers — listening into traffic conditions on CB Channel 19 is a good way to learn what is up ahead. For yakking back and forth between two handheld radios, 27 MHz CB will be noisy, frustrating, and battery power hungry.

Family Radio Service (FRS) is a BIG hit up on UHF with 14 channels. No license required, and only four FRS FCC rules dictate how this equipment is operated. Although the little FRS radio is only permitted a half-watt output on 14 UHF FM channels, their range is remarkable. Two FRS radios could span up to 10 miles distance from mountain top to mountain top, and easily cover several ski slopes if you pick one of the 14 channels not tied up with other operators on the same frequency. Up on the mountain slopes, FRS users have found Channels 8 through 14 relatively clear of general mobile radio service powerful repeater outputs situated on each side of FRS Channels 1 through 7. Channels 1 through 7 are also shared with more powerful GMRS handheld

This marine radio, with 25 watts output, may not be used at the ski lodge! On a boat, it is fine.

The very popular Pryme combo FRS and GMRS radio was a favorite with this author.



Boaters do not need a handheld license for local marine VHF radio calls.

A brand new MURS portable radio, ideal for both land and boat use.

radios sold to licensed GMRS operators, and these more powerful handheld radios will easily knock you off the air on the first seven channels.

There is a petition in front of the FCC to designate FRS Channel 1 as an emergency-only channel, or a call-only channel. There are so many people on the air, I really don't know if this is all that necessary because surely you should be able to reach someone else with similar equipment.

With that said, the exception are those operators using more expensive FRS equipment with scrambling turned on, or "privacy code" engaged. Scrambling indeed will make communications private, but the "privacy code" is nothing more than tone-coded squelch. Anything you say can and will be heard! Trying to break into a conversation that is scrambled or to another station on privacy code may be futile.

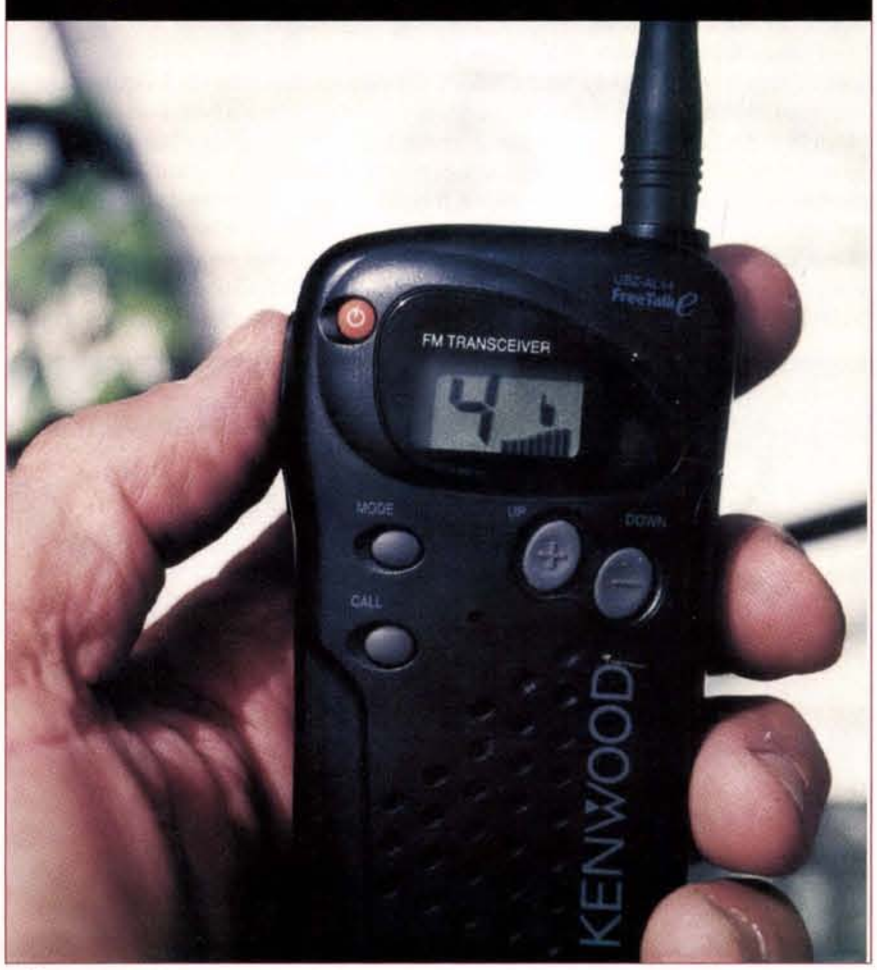
FRS radios have taken a nosedive in pricing. When they first came out, a good Kenwood FRS radio sold for over $100.00 apiece. Same thing with Motorola. Now you can buy Kenwood and Motorola FRS full-feature radios in PAIRS for under $79.00. You can buy pairs of inexpensive Cobra and Midland FRS radios for under $39.00! But I recommend staying in the $79.00 a pair bracket and enjoying such features as optional headset with voice-operated action, scrambling, privacy codes, and a tough exterior that will keep the snow out up on the slopes. The FRS radios cannot hook up to an external antenna, so the best way to get maximum range is to take the unit off of your belt, hold it up high, and place your call. The prices of FRS radios can only go lower.

The latest license-free radio service is called MURS (Multiple Use Radio Service). Five VHF channels became available on July 12, 2000, but actual radio equipment designed specifically for MURS has not appeared until just recently. One reason was the almost immediate negative reaction by licensed radio operators on five VHF channels they were presently operating on. In fact, these radio users put so much pressure on professional two-way radio dealers that sold them the "color dot" equipment that both Motorola and RadioShack back-peddled on their endorsement for this radio service.

The five channels allocated to MURS landed right on the popular "anything goes" commercial radio service at 151 and 154 MHz. These were channels used primarily by construction workers and traveling shows to carry communications ranging from church usher comms to cranes picking up mega-ton loads. The blue and green dot channels at 154 MHz were also in use by fast-food vehicle speaker phone circuits, and you can imagine trying to stay in touch on a MURS channel and ending up with a burger and order of fries at the pick-up window.

MURS was also clouded with some rather vague rules, such as no more than two watts of effective radiated power output. This could lead someone to develop a system around a four-watt transmitter, 3 dB loss in coax, going to a unity gain antenna up 100 feet, perfectly legal! There was also a con-

The tiny FRS radio transmits for about a mile in the mountains.



Fast chargers will replenish handheld batteries in less than an hour!

cern that the rules did not forbid tie-in to your home phone system, nor any rule that would prevent two MURS radios from acting as a portable repeater tied into an external VHF, high-band, exotic antenna system.

Motorola continues to ask the FCC to further examine logical restrictions on telephone interconnect and repeaters, and more clarification for sending data over these five channels. It is apparent that Motorola is hoping to convert its present "color dot" users over to a more sophisticated radio system, and get them onto other bands and other frequencies before unlicensed MURS radio signals begin to clog these VHF channels.

Corwin Moore, well known for his Personal Radio Steering Group (PRSG) in Ann Arbor, MI, points out there are probably over a million licensed radio users on the present MURS channels, and these users will soon find that their legitimate radio system is now clogged with unlicensed radio operators tied into their home phone for an exotic cordless phone system, or sending data from one business to another over the airwaves.

With MURS equipment capable of attaching to an outside antenna, it will be interesting to see how far two watts of effective radiated power may go between two MURS base stations. In the clear, I could see a range of over 40 miles, point to point. Between two MURS handhelds, I see a quadruple of distance now enjoyed by little FRS radios on UHF. After all, the MURS handheld is four times as powerful as the little FRS.

Finally, licensed radio users on the General Mobile Radio Service (GMRS) look on to see what might adversely affect their present simplex and repeater channels sandwiched in between FRS walkie-talkies. That same FRS skier on the top of a mountain next to a licensed GMRS could easily inadvertently create interference to that GMRS repeater when using FRS channels 8 through 14. Something else to think about when mountain-topping with a little FRS radio.

Luckily, handheld battery manufacturers have seen the opportunity for longer lasting AA and AAA batteries. The new Maha battery cells and quick battery chargers are flying off the shelf because of their popularity with these little radio systems. New battery chemistry like nickel metal hydride and lithium ion handle the cold weather elements better than traditional nickel cadmium cells. Something to think about when your handheld dips below freezing.

Stay tuned — FRS will continue to gain popularity and equipment will continue to drop in price, and MURS is just coming on the scene. **NV**

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Jungle Robot is an excellent beginner series robot. This battery-controlled robot kit can teach the basic principles of robotic sensing and locomotion. It features a pre-assembled printed circuit board, hardware, and mechanical drive system that can be handled by almost anyone from age 10 and up. Only basic hand tools are required for assembly.

Educators, science museums, and hobbyists will surely appreciate the durability, educational value, and endless hours of amusement for children and adults too!

Suggested selling price: $19.95 USD.

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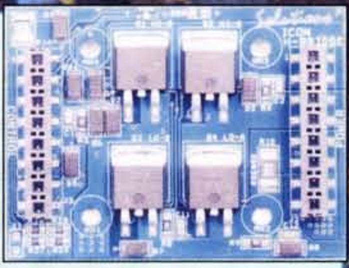

The ICON H-Bridge provides easy connectivity to a wide range of medium power brushed DC motors. An on-board microcontroller monitors current and temperature to provide protection if either trip point is exceeded. Various configuration registers may be monitored and programmed via the serial interface. These registers contain information such as the system load current, board temperature, over current trip point, over temperature trip point, and status information.

In serial mode, the H-bridge is enabled/disabled via a serial command set. In direct drive mode, the serial input line becomes the H-bridge enable control pin, while the serial output can be used to monitor the H-bridge status. In both operating modes each MOSFET in the H-bridge is controlled individually by a control input (four MOSFET control lines in all).

The ICON H-bridge is designed to operate with motor voltages up to 40V, and can carry continuous currents up to 12A with the active cooling solution available from Solutions Cubed. This robust H-bridge handles peak currents of 25A and can operate to 85°C.

Connectivity to the ICON H-bridge is simplified to two 1x8 0.156" receptacles capable of top or bottom insertion of 1x8 0.156" headers. With the small size (2.5" x 1.9" x 0.5") and versatile interface capabilities of the ICON H-bridge, it meets the requirements of many DC motor interface designs.

Pricing in single unit quantities is $100.00.

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The extremely versatile high-performance 200-ksps + 12-bit ADC can be configured and optimized to meet the unique needs of customer's applications. The eight-channel ADC comes with a built-in programmable sample and hold, an on-chip RC oscillator, a temperature sensor, low-battery detection, and an auto scan with a 16-word buffer that supports high-speed mixed-signal processing. With the auto scan, the MCU is no longer burdened with servicing the high-speed data conversion.

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The entire clock system is driven by a single 32kHz watch crystal, which saves cost and reduces high-frequency EMI, eliminating the need for a second high-speed crystal. Another key advantage of the MSP430 product line is the 16-bit RISC CPU resulting in the industry's leading C code efficiency.

Samples of TI's new family of MSP4F43x/F44x are available now, with volume production planned for March 2002. The devices are packaged in a 100-pin PZ quad flat pack (QFP). Suggested pricing for the MSP430F449 in quantities of 1,000 is $ $7.03. The Flash emulation tool, the MSP-FET430P440, is a complete integrated development environment available now for just $99.00.

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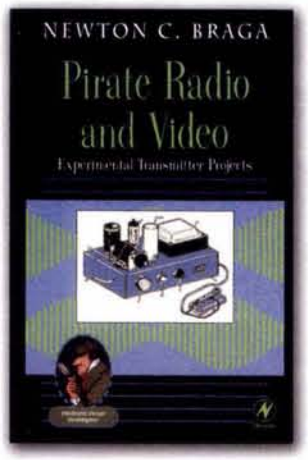

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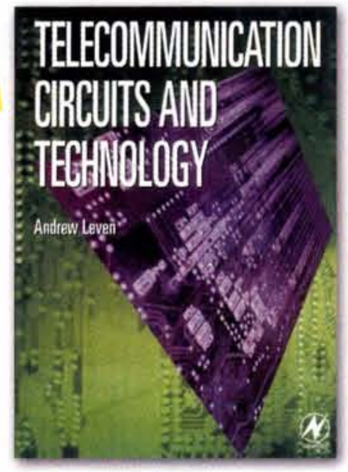
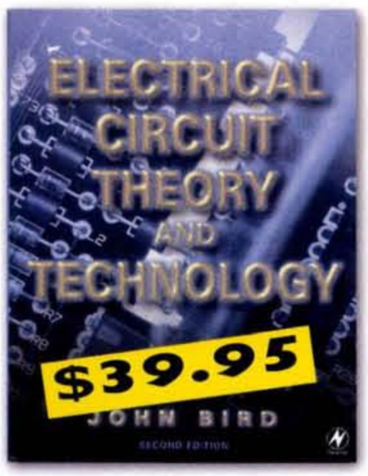


Telecommunication Circuits and Technology provides readers with a problem solving approach to understanding the fundamentals of telecommunications. The author covers the common telecommunication and data communication circuits that are currently taught at higher education level and also used in industry. Understanding is reinforced with frequent worked examples and problems for specific applications. Also includes industrial data sheets.



Electrical Circuit Theory and Technology **Second Edition** by John Bird

Electrical Circuit Theory and Technology is a fully comprehensive text for courses in electrical and electronic principles, circuit theory and electrical technology. The coverage takes students from the fundamentals of the subject, up to and including first degree level. Thus, this book is ideal for students studying engineering for the first time, and suitable for pre-degree vocational courses, especially where progression to higher levels of study is likely.

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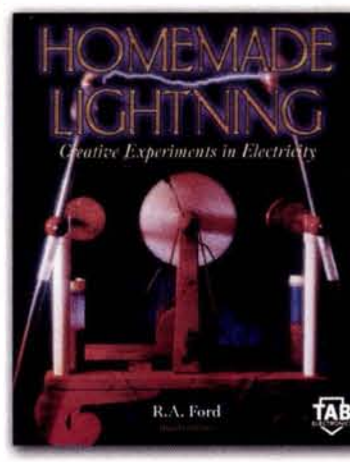

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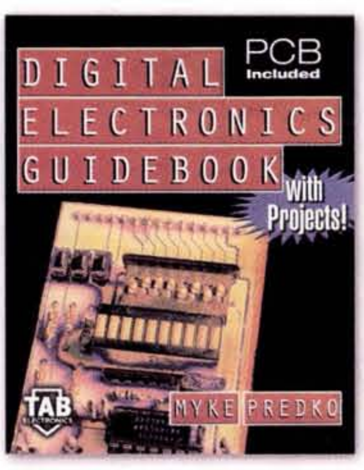

Digital Electronics Guidebook: With Projects!

$34.95 by Myke Predko

Perfect for electronics hobbyists and students — even complete beginners — who want to understand digital logic and build their own low-cost logic circuits. Featuring more than 20 projects with step-by-step directions for designing, constructing, and interfacing easy-to-do TTL (Transistor-Transistor Logic) circuits.

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