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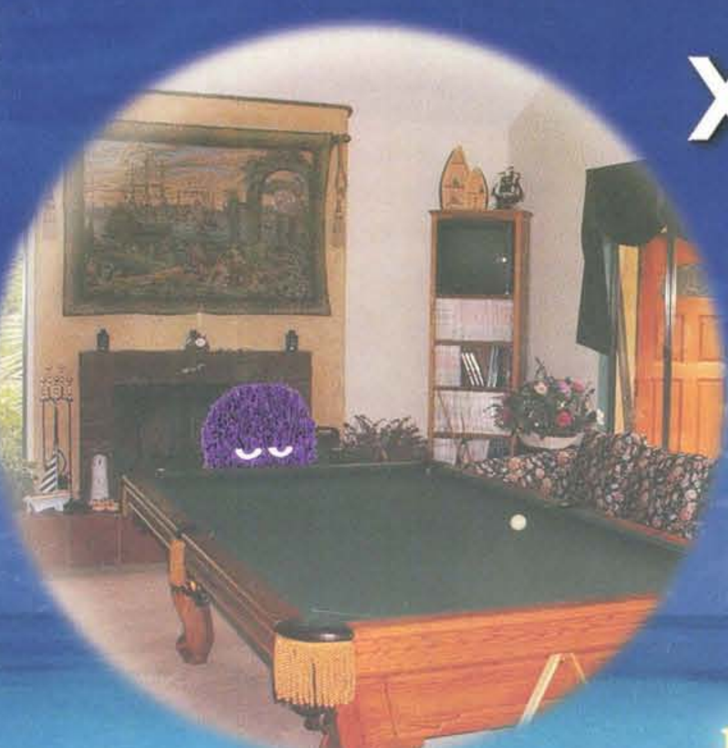

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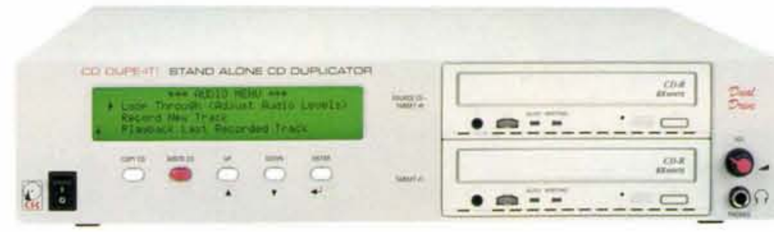

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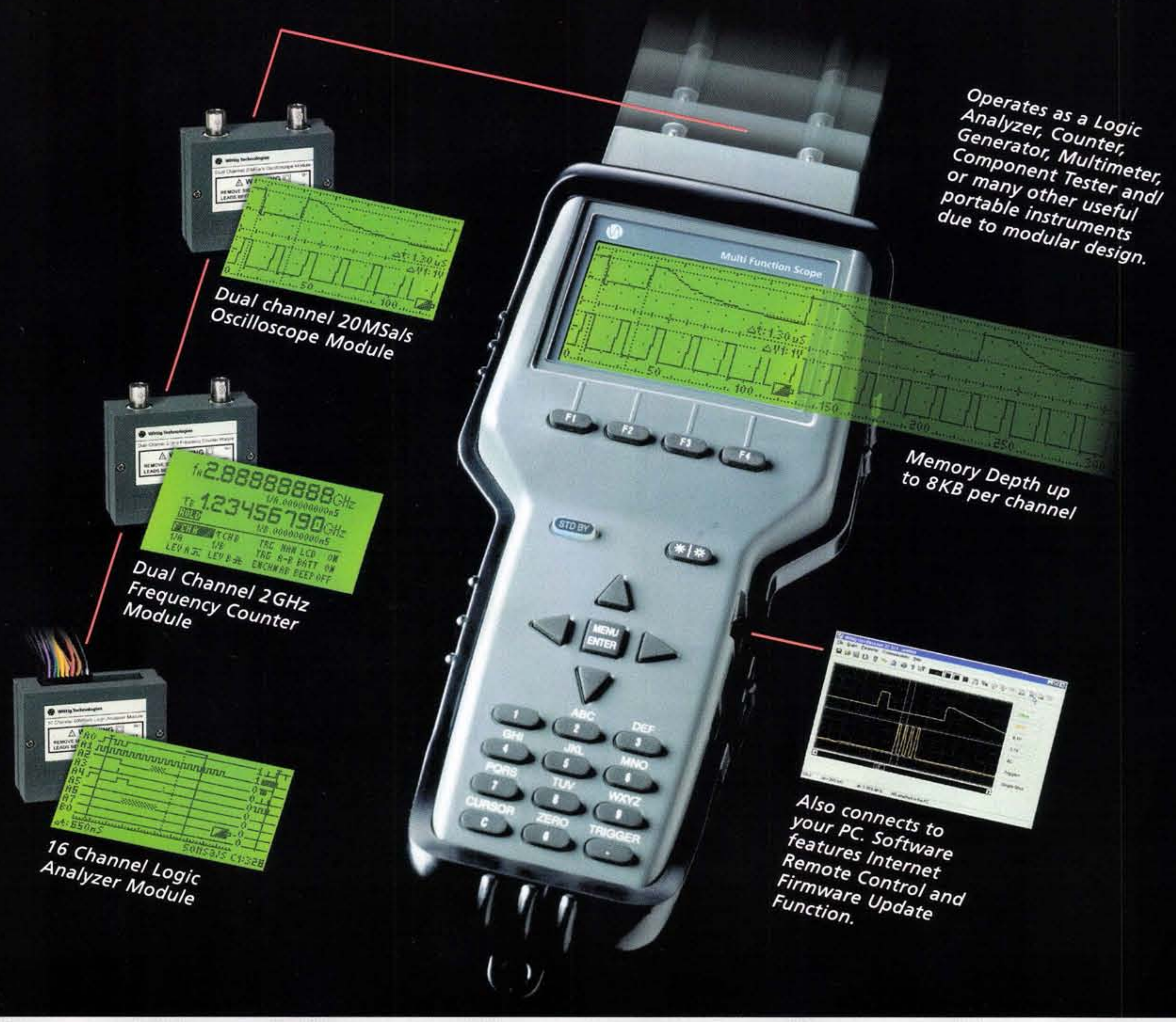

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A Homebrew Multiplexer and Color Sensor for the RCX

by Michael Gasperi

INTRODUCTION

In the fall of 1998, Lego introduced the extraordinary Mindstorms Robotic Invention System. It features a computer brick called the RCX. The RCX enables the construction of robots, vehicles, and other interesting inventions that have a mind of their own.

One serious shortcoming of the RCX is that it only has three inputs. Anyone who has experimented with the RCX, for any length of time, has run into the limitation.

There are a few simple ways to work around the problem. For example, you can connect several touch sensors to the same input, but they will all trigger exactly the same event. A more flexible solution to the problem is to build a sensor multiplexer to increase the number of inputs.

A multiplexer works by connecting multiple sensors to a single input one at a time. Most computers employ a multiplexer in their analog-to-digital conversion hardware to save space and money. In fact, the RCX has a multiplexer, but only three inputs are available for the user. The RCX uses one of the other channels internally to read its own battery voltage.

The design of a multiplexer for the RCX is tricky. Some obvious schemes use motor outputs with relays to select multiple sensors. However, because the RCX only has three outputs, these methods do not seem very acceptable. Something is needed that can sense that the RCX program wants to change to a different sensor without wasting one of the precious outputs.

In order to design an acceptable multiplexer, you need to understand how the RCX reads its sensor inputs. The RCX has two sensor modes: passive and powered. Examples of passive types are touch and temperature sensors, while powered types include the light and rotation sensors.

In the passive mode, the RCX measures a voltage on the input. To make reading resistive sensors or switches easier, there is a 10K-ohm resistor trying to pull the input up to 5V. In powered mode, the RCX applies about 8V to the input for 3mS and then reads the input just like a passive type during a short 0.1mS period.

By quickly toggling an input from powered mode to passive and back, a multiplexer circuit could detect that the RCX program wanted to change to another sensor. The selection of whether an input is in passive or powered mode can be changed on-the-fly from within programming languages like Not Quite C or Visual Basic. Unfortunately, RCX Code and Lego's P-brick Script language does not allow this flexibility.

Limiting the type of multiplexed sensors to passive achieves a great simplification in the multiplexer design. It means that only the sensor signals are switched and not the power to operate them. Passive light sensing with Cadmium Sulfide (CdS) photocells works about as well as the Lego light sensor, anyway.

CIRCUIT DESCRIPTION

Figure 1 is the schematic of the sensor multiplexer. It allows the three resistive sensors (S1, S2, and S3) to share a single RCX input. Good examples of resistive sensors are photocells, thermistors, and potentiometers. Switches can also be used since they are just extreme examples of resistive sensors.

Diodes D1 through D4 and capacitor C2 form the power supply. The fullwave bridge arrangement allows the power connector attachment to the RCX to be in any orientation. Make sure you observe the polarity of C2. CMOS integrated circuits U1 and U2 have their power supply connections shown in tables next to VCC and GND. VCC should measure at least 6V during normal operation with good batteries.

Integrated circuit U2 is a digital counter that sequences from zero to three and then resets.

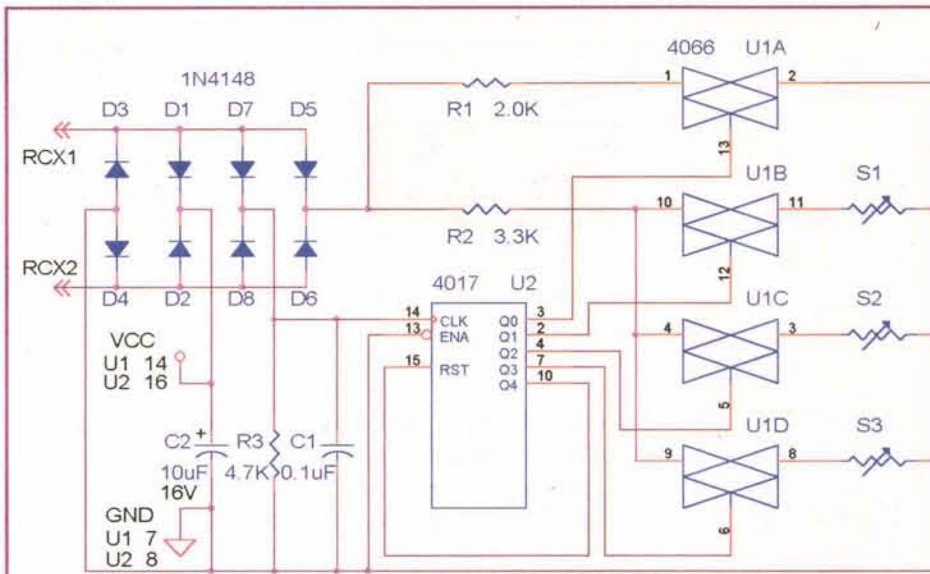


FIGURE 1: Circuit Diagram

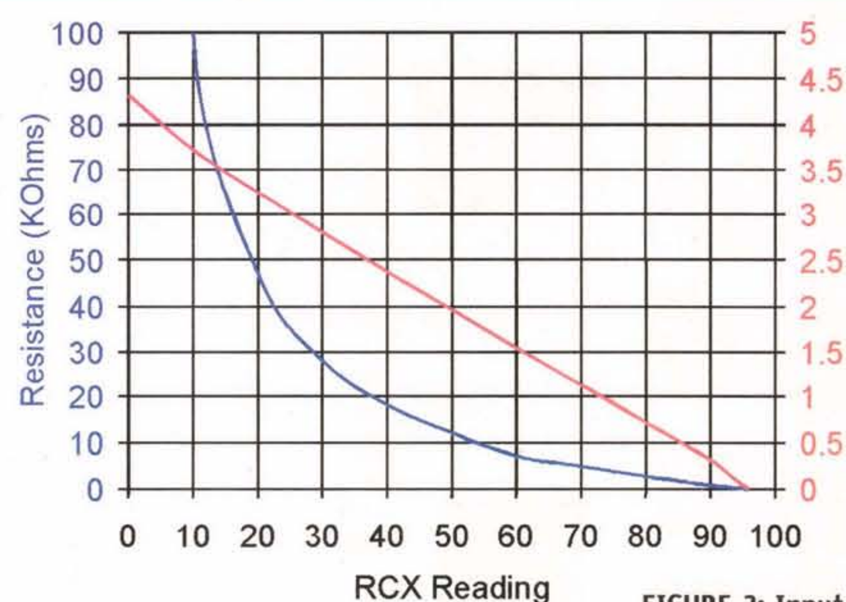


FIGURE 2: Input Plot

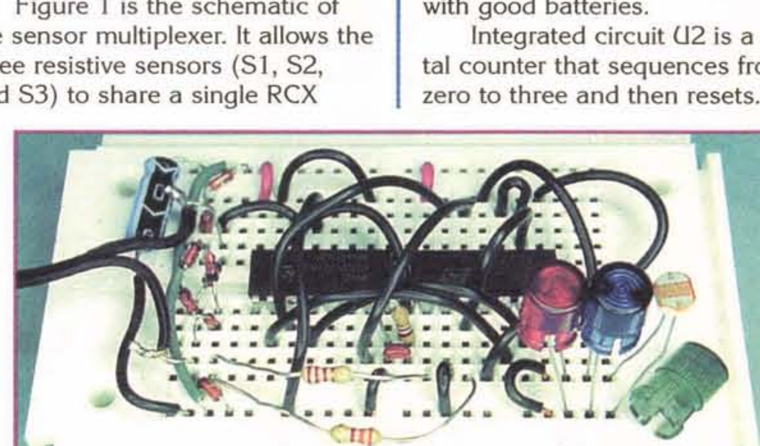


FIGURE 3: Multiplexer Built On Breadboard

Diodes D7 and D8, along with resistor R3 and capacitor C1, create the clock for U2. The voltage on the clock input stays high during the normal powered mode reading of the sensor by the RCX, but drops low during the much longer time when the sensor input changes to passive. When the sensor input toggles back to powered mode, the circuit creates the rising edge needed to clock U2.

Integrated circuit U1 contains the analog switches used to connect one sensor to the RCX at a time. U1A provides feedback to the RCX for synchronization. Otherwise, you could not tell which sensor was connected. Analog switch U1A closes when U2 counts zero and this connects the RCX through diode D5 or D6, and R1 to ground. The reading created on the RCX under this condition is always 100. The three sensors connect through R2, which is sized so that their maximum reading will never quite reach 100.

Figure 2 shows a range of inputs and the resulting reading on the RCX. Either resistive sensors or voltages can be applied to the inputs. The readings are backwards from what you might expect. Zero volts results in a reading near 95, while about 4.3V is 0. Zero resistance results in a reading near 95, while very high resistance reads 0.

CONSTRUCTION

The parts needed to build the circuit are very common and available from most electronic suppliers. Readers familiar with my *Extreme Mindstorms* book should recognize the construction method illustrated in Figures 3 and 4.

First, you build and test the circuit on an electronic breadboard and then transfer the parts to the related prototype PC board. Although the method works well, the results are not very compact and there is a chance of wiring mistakes. For this reason, I have prepared a small through-hole type PC board to make building and housing the circuit easier.

Figure 5 shows the populated PC board with three CdS photocells for sensors. The particular photocells used (Mouser #338-54C348) are small enough to fit into the little recessed area around the holes in Lego Technic beams.

Short pieces of insulated tubing slid over the ungrounded lead of the photocells prevent shorting during operation. All three photocells must be fed through the beam before soldering to the PC board. A Tictac® candy box provides a simple enclosure for the completed project as shown in Figure 6. Connection to the RCX is made by cutting a Lego #5111 9V motor wire in half.

Alternatively, the PC board is small enough for the project to be housed in a #5391 Lego 9V battery box. This is a handy enclosure with a connector built right into the top. It is easier to connect the sensors to a short piece of four-conductor wire when using this box as illustrated in Figure 7. A tie wrap secured around U2 provides strain relief for the wire. Short wires soldered to the posts where the 9V battery would have attached couples the circuit to the Lego connector on the top of the box.

COLOR SENSOR

Color sensing depends on measuring the intensity of light at different wavelengths. A spectrometer does this by splitting the light with a prism or diffraction grating into its component wavelengths. However, spectrometers are complex and too difficult to build. Another approach measures the light intensity in three primary color bands — red, green, and blue — then calculates the color or hue of the light in software.

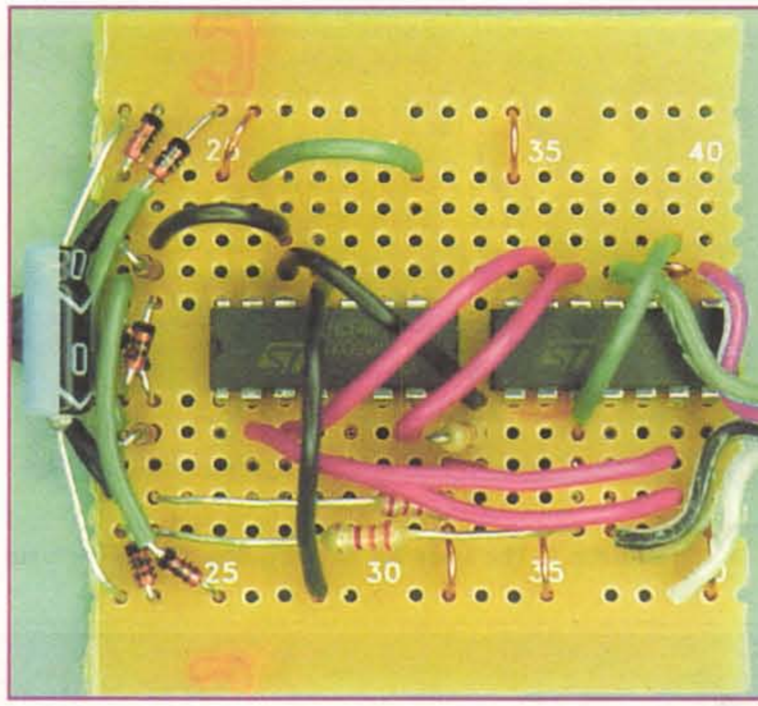
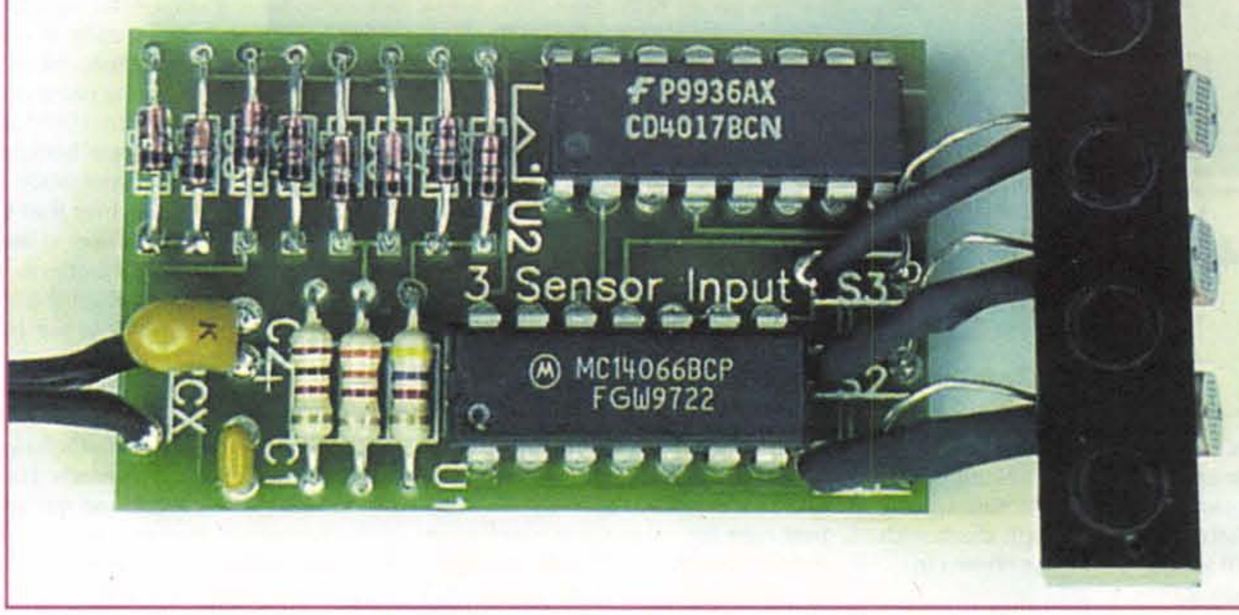


FIGURE 4: Multiplexer Built On Prototype Board

FIGURE 5: Multiplexer Built On PC Board



Hue is a single number that describes the overall color of a light. It ranges from 0 to 360, much like the degrees of angle around a circle. In the case of hue: 0 is red, 120 is green, 240 is blue, and 360 is back around to red again. Intermediate colors have hues like 60 for yellow, 180 for cyan, and 300 for magenta. The calculation of hue from red, green, and blue values is a simple algorithm described later.

My first approach was to use colored LED lenses for filters. You can see them in Figure 3. They turned out to be too pale and off color for accurate measurements. Then, I investigated using transparent Lego plates.

They are available in red, green, and blue in the Lego #5316 transparent accessories kit. They plug perfectly into holes of Technic beams to form filters for the CdS sensors shown in Figure 6.

After substantial experimentation, I found that the blue and green plates were too pale for use individually. Stacking two green and three blue plates created enough filter density for good

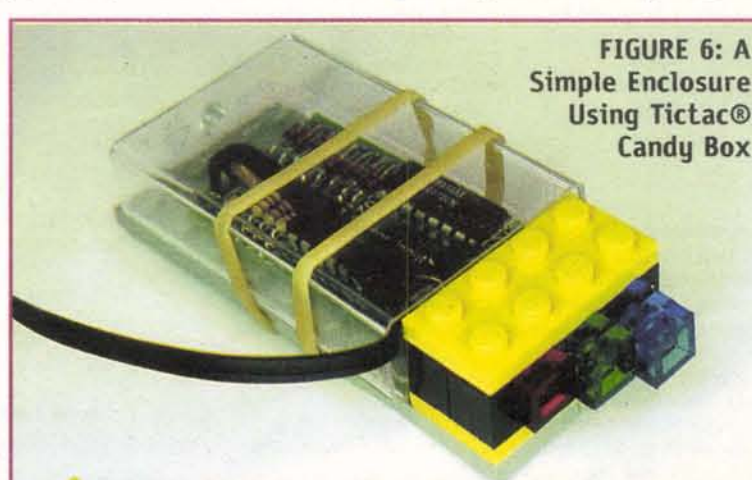


FIGURE 6: A Simple Enclosure Using Tictac® Candy Box

A Homebrew Multiplexer and Color Sensor for the RCX

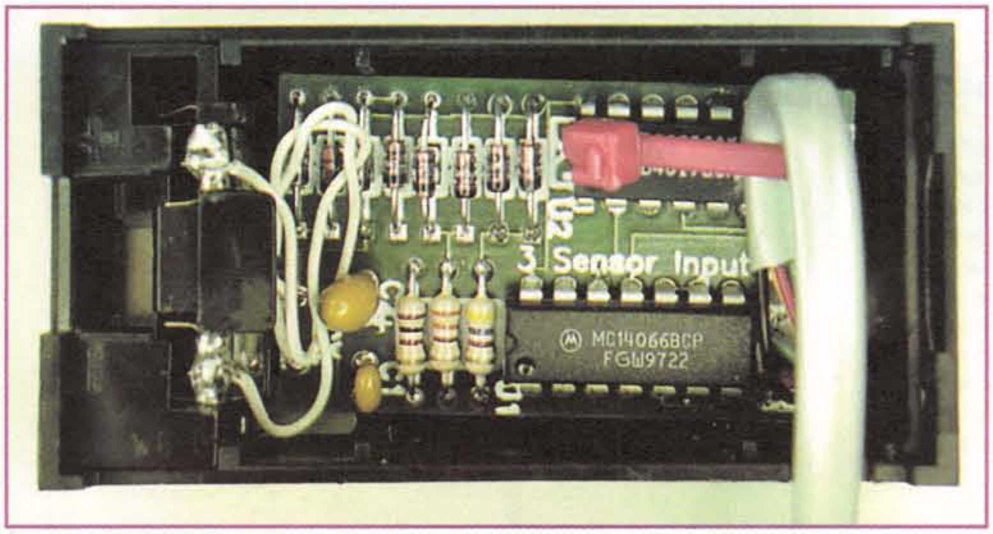


FIGURE 7: The Lego 9V Battery Box As An Enclosure

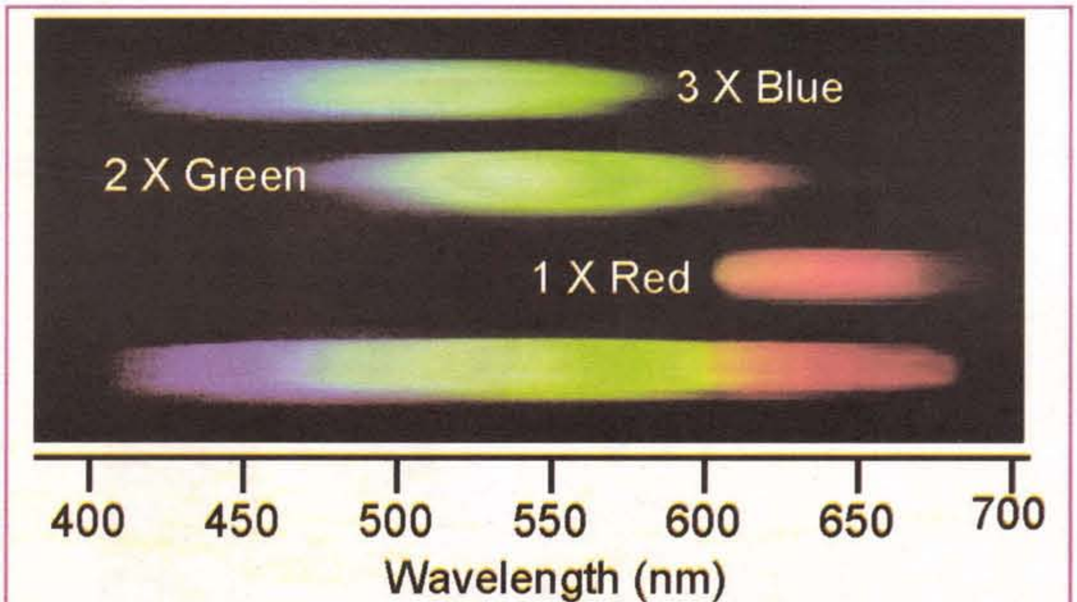


FIGURE 8: Transmission Spectrum For Transparent Lego Plates

color measurement. The actual color spectrum of the resulting filters can be seen by photographing sunlight shining through them with a diffraction grating as shown in Figure 8.

The spectral sensitivity of the photocell is another important factor in determining the color measurement accuracy. Not all CdS photocells are alike in this regard. The best type for color discrimination is called Type 5. It has peak sensitivity at about 560nm in the green part of the spectrum. Most other photocell types tend to be too red or even infrared-sensitive. I have experimented with photocells from several sources and found the Mouser #338-54C348 has the best spectral response, as well as the desirable geometry for mounting previously mentioned.

PROGRAM DESCRIPTION

Listing 1 is a Not Quite C program that controls the multiplexer and converts the red, green, and blue intensities into a hue value. It turns the RCX into a simple colorimeter by continuously displaying the hue on its LCD. Using the sensor to build a robotic Lego brick sorter would be a more useful application of the sensor.

After variable declaration and initialization, there is a "while color not equal to 100" loop. This loop handles synchronization to make sure that the multiplexer is on the right count. Only when the counter in the multiplexer is zero will the reading be 100. The program keeps toggling the power and clocking the multiplexer until it reads 100.

There is a PlaySound call at the bottom of the loop that makes a buzz sound. This signals that synchronization is taking place. After the first time through, the program should not need to go into this loop again. If the RCX keeps making the buzz sound for more than a few seconds, there is something wrong with the multiplexer.

The next program steps toggle the power and read the red, green, and blue values. Because the RCX only has integer math, the values need to be scaled up by 100 for later arithmetic. In integer math, 1 divided by 4 results in 0 not 0.25 since there is no fractional part. By scaling the denominator by 100 before the division, the result becomes 25. An additional toggle of the power after reading blue sets the multiplexer to start the process over again.

Hue calculation requires first determining which color had the maximum value and which color had the minimum value. After that, the difference between the maximum and minimum is calculated. Then dividing by the difference normalizes the color intensities.

Ordinarily, you would need to be concerned about the unlikely event that the difference equaled zero, but the RCX makes the result of division by zero simply zero. The hue is computed using the color with the maximum value. If the hue is negative, adding 360 fixes the result.

RESULTS

Figure 9 shows how well the color sensor works. The chart compares the hue of nearly 100 different light sources to the RCX reading. Transmission values were obtained by shining broad-spectrum fluorescent light through transparent filters manufactured by Rosco Laboratories Ltd., and available from Edmund Scientific as catalog number CR30394-17. A Rosco engineer sent me the equivalent red, green, and blue values of the filters, which were used to calculate the expected hue. Emission values were taken by holding the sensor against a solid color window on the screen of a computer monitor. A simple Visual Basic program allowed control of the red, green, and blue color components for the color of the window. The reflected values were measured by reflecting light off the color samples of a test pattern in a Kodak Professional Photoguide.

It looks like the hue measurement is accurate within ±60. That means, for example, you might not be able to discriminate between green and cyan, but you certainly can tell green from blue. The color and type of light source has a significant effect on the accuracy, too. If you use the color sensor to sort bricks, you need to calibrate the hue reading for the

BILL OF MATERIALS

Electronic Parts:

Part	Type	Description
D1 - D8	1N4148	Small Signal Diode
R1	2.0K 1/4W	Resistor
R2	3.3K 1/4W	Resistor
R3	4.7K 1/4W	Resistor
C1	0.1uF 50V	Monolithic Ceramic Capacitor
C2	10uF 16V	Tantalum or Electrolytic Capacitor
U1	4066	CMOS Quad Analog Switch
U2	4017	CMOS Decade Counter
S1 - S3	CdS	Photocell (See Text)
Misc.		Insulated tubing, tie wrap, 1ft. four-conductor wire, and PC board.

Note: A complete set of all parts listed above plus a high-quality two-sided, through-hole, PC board can be purchased from the author for $15.00 plus $2.00 shipping and handling. Please contact the author by email for more information about how to purchase: gasperi@alynk.com

Lego Parts:

Number	Description
5111	9V Motor Wire
5391	9V Battery Box
5316	Transparent Accessories

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Suppliers:

RadioShack:	www.radioshack.com
Mouser:	www.mouser.com
Jameco:	www.jameco.com
Digi-Key:	www.digikey.com
Lego Shop at Home:	www.lego.com

Information:

Lego Mindstorms:	www.legomindstorms.com
Extreme Mindstorms Book:	www.apress.com
RCX Sensor Input Page:	www.plazaearth.com/usr/gasperi/lego.htm
Online Lego Community:	www.lugnet.com
Not Quite C:	www.enteract.com/~dbaum/nqc
Edmund Scientific:	www.scientificsonline.com
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A Homebrew Multiplexer and Color Sensor for the RCX

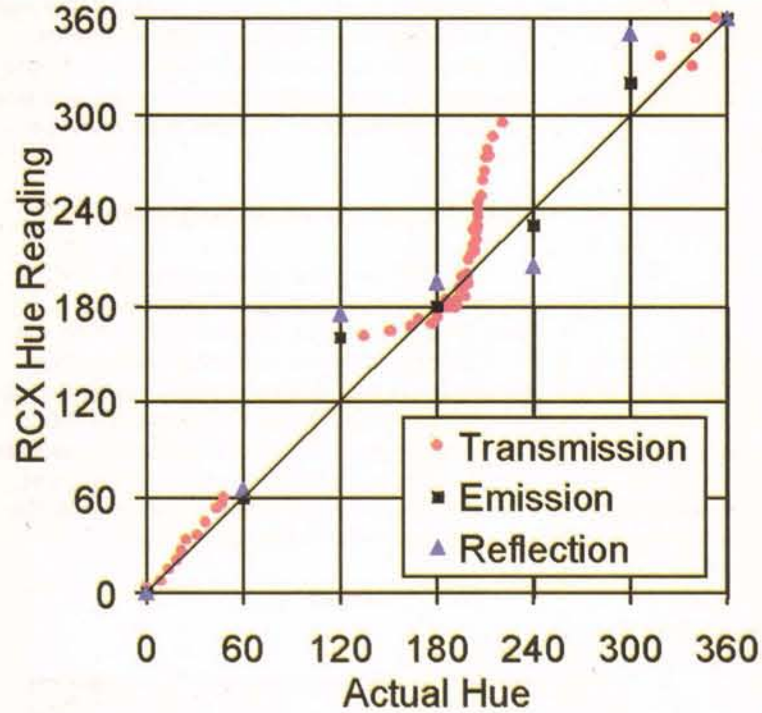


FIGURE 9: Hue Comparison Plot

```
// Color Sensor Demonstration Program
// by Michael Gasperi
#define COLOR SENSOR_1               //color sensor on sensor port 1
#define SHORT_WAIT 2                 //short wait for value to stabilize
int hue;                             //hue as a global
task main()
{
  int r,g,b,max,min,d,rd,gd,bd,h;    //declare all other variables
  SetUserDisplay (hue,0);            //set display to show hue value
  SetSensor(COLOR, SENSOR_LIGHT);  //power on sensor by making it light type
  while (true)                       /loop forever
  {
    while (COLOR != 100)             /only mux channel 0 will read 100
    {
      SetSensor(COLOR, SENSOR_TOUCH);//power off sensor by making touch
      SetSensor(COLOR, SENSOR_LIGHT);//reapply power to toggle channel
      Wait(SHORT_WAIT);           //wait for reading to stabilize
      PlaySound(SOUND_LOW_BEEP);  //alarm sound
    }
    SetSensor(COLOR, SENSOR_TOUCH); //toggle power to change to channel 1
    SetSensor(COLOR, SENSOR_LIGHT);
    Wait(SHORT_WAIT);
    r = COLOR*100;                  //read the red and scale by 100
    SetSensor(COLOR, SENSOR_TOUCH); //toggle power to change to channel 2
    SetSensor(COLOR, SENSOR_LIGHT);
    Wait(SHORT_WAIT);
    g = COLOR*100;                  //read the green and scale by 100
    SetSensor(COLOR, SENSOR_TOUCH); //toggle power to change to channel 3
    SetSensor(COLOR, SENSOR_LIGHT);
    Wait(SHORT_WAIT);
    b = COLOR*100;                  //read the blue color scale by 100
    SetSensor(COLOR, SENSOR_TOUCH); //toggle power to change to channel 0
    SetSensor(COLOR, SENSOR_LIGHT);
    if(r>g){max = r;}else{max = g;}   //find the color with max intensity
    if(b>max){max=b;}
    if(r<g){min = r;}else{min = g;}   //find the color with min intensity
    if(b<min){min=b;}
    d = ((max-min)/60);               //diff of max and min also scale
    rd = (max - r)/d;                 //normalize color intensity
    gd = (max - g)/d;
    bd = (max - b)/d;
    if(b==max){h = 240 + gd - rd;}    //compute hue based on max color
    if(g==max){h = 120 + rd - bd;}
    if(r==max){h = bd - gd;}
    if(h<0){h = h + 360;}             //if hue is negative add 360
    hue = h;
  }
}
```

LISTING 1: Color Sensor Program

bricks you want to sort with a controlled light source.

SUMMARY

The sensor multiplexer allows you to connect three passive sensors to a single input of the RCX. This potentially triples the total number of sensors connected to an RCX. The example color sensor shows acceptable color discrimination performance, but is only a starting point. Other resistive sensors could be substituted for the photocells. They might be used together to make a single "smart sensor" like the color sensor, or independently to control different parts of the same robot. **NV**

ACKNOWLEDGMENTS

A virtual community sprung up on the web to share ideas on how to use and improve the RCX. Several people have contributed to the design of this multiplexer that I would like to thank. Sven Hortman first proposed the idea of toggling the sensor mode for clocking the multiplexer. Paul Haas suggested the special value channel for synchronization, and my good friend Dave Baum developed the alternative language Not Quite C used to write the RCX interface program.

Michael Gasperi works as a principal engineer with the Advanced Technology division of Rockwell Automation and is an expert in building custom sensors for Lego Mindstorms. He is a co-author of the new book *Extreme Mindstorms: An Advanced Guide to LEGO Mindstorms*. His Web page www.plazaearth.com/usr/gasperi/lego.htm is the central depository for homebrew RCX sensor information.

Building a Flash Programmer for PIC Microcontrollers

by Ron Russ

Have you ever wanted to experiment with microcontrollers but didn't want to invest a lot of money in programming or development tools? Or do you want a low-cost development system that is simple and works the first time? This article details a simple and inexpensive microcontroller programmer that uses the parallel port on the PC to program a PIC16F87x flash microcontroller.

One of the best things about the PIC16F87x family of flash microcontrollers from MicroChip® is the low-voltage programming mode. Using the low-voltage programming mode, a very inexpensive in-circuit programmer can be made with a few components and a little bit of time. In this article, I'll show you how you can build the low-cost 2BIT programmer for programming the MicroChip PIC16F87x series of microcontrollers. Add a C or Basic compiler and you have a powerful embedded software development environment.

Background

Microcontrollers are the small self-contained chips used in embedded systems everywhere. These micros contain program and data memories, as well as an assortment of peripherals in one chip with a minimal amount of support components needed. In order to program the device, it is placed in a special programmer that supplies the correct signals in the correct manner to program the micro. If the micro was an OTP (one-time-programmable) device, you only got one chance to program it. If it was a windowed device, you got a chance to reprogram it many times by erasing it first with an ultraviolet light. Typical erase times can be anywhere from 10 to 20 minutes and even longer. This process required the device to be removed each time a new program was tested.

With the advent of flash technology, the microcontroller can be erased and reprogrammed in a matter of seconds, and can be reprogrammed in-circuit.

For years, MicroChip produced the PIC16F84 which is an 18-pin device with 1K of flash memory. This handy device had the traditional programming algorithm requiring a higher programming voltage to be applied to MCLR to program the device. There are numerous programmers available on the Internet for programming the 16F84. But the higher voltage requires additional circuitry.

Along comes the PIC16F87x family of microcontrollers. This family contains flash technology micros in package sizes from 28 to 44 pins, with program memory sizes from 2Kx14 to 8Kx14. I prefer the 28-pin 8Kx14 16F876 device and will refer to this device generically. In addition to the traditional high-voltage MCLR programming method, a low-voltage programming mode is available. This low-voltage programming mode makes the 2BIT programmer possible.

Circuit

The schematic in Figure 1 shows the 2BIT programmer. Connector J1 is a DB25 male connector that connects to the parallel port on a PC. The signal RB7 is the bi-directional data line used to send and receive commands and data to the micro. The data out signal from the PC parallel port uses D0 on pin 2 and the data in signal uses *ACK on pin 10. Resistor R1 and Q1 isolates pin 2 from pin 10 keeping the input from fighting the output.

Signal RB6 is the clock signal generated from the PC as an output on D1 pin 3. RB3 is used to enable the low-voltage programming mode on the PIC16F876 and is an output from the PC on pin 5. MCLR releases the micro from reset and is the remaining output on pin 6. The last important connection is to make sure a common ground from the PC on pins 18 through 25 is connected to the emitter of transistor Q1 and also to the micro.

Construction

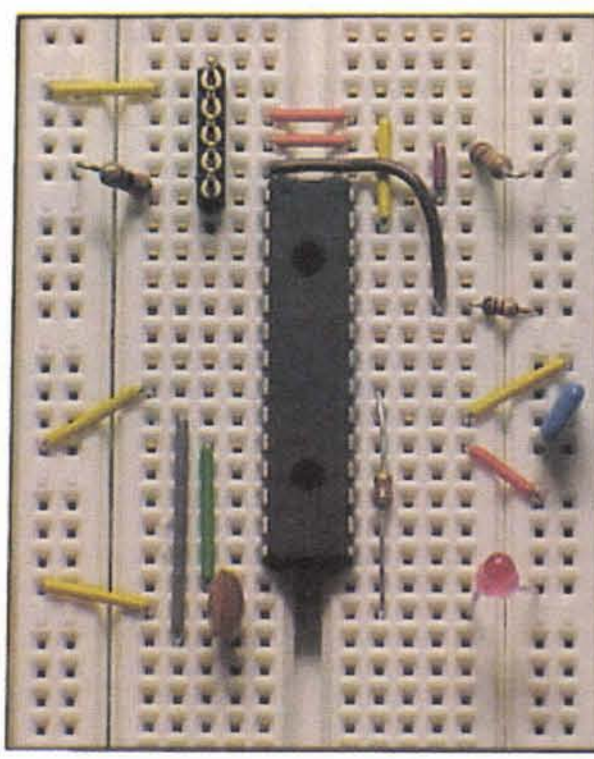
The 2BIT programmer is easily constructed using a copperclad prototype board. The DB25 connector contains the solder cup pins that were soldered to the edge of the copper board. Transistor Q1 and resistors were soldered down and connected between the output pin 2 on the DB25 connector and pin 3 of the right-angle header used as the output connector. The remaining circuits were completed using prototyping wire.

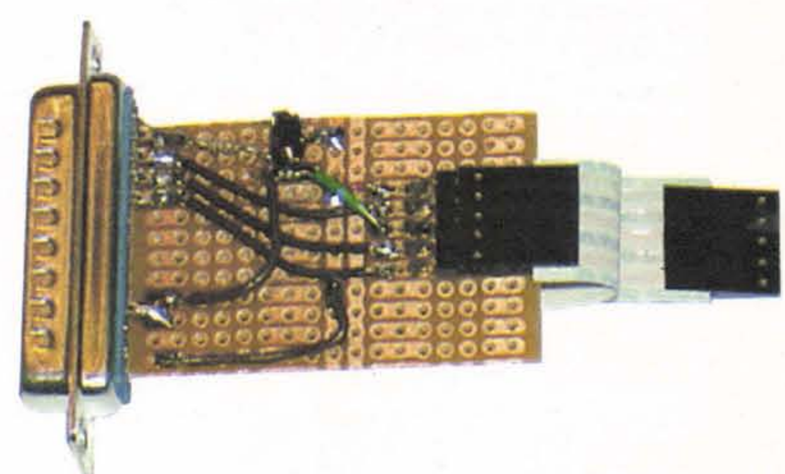
The cable connecting the 2BIT programmer to the PIC micro can be anything from prototype wire to a ribbon cable to a flat cable like the one shown. This cable is part #A9BBG-0505F-ND available from Digi-Key (www.digikey.com) and has connectors on both ends that makes it quick and easy to plug into header pins. A complete and tested 2BIT programmer is available from www.emicros.com.

2BIT Programming Software

The 2BIT program used to program the PIC16F876 is a DOS program available at www.emicros.com. The program is based on the PIC16F84 programming software available from numerous sources on the net. 2BIT reads the program from the .hex file and programs the PIC using the parallel port. Various options are available for setting the parallel port address, delay times, and operating modes, and are explained with the software. At the DOS prompt type in:

```
2bit filename.hex
```





Low-Cost Development System

It's now time for the embedded (fun) stuff. The schematic in Figure 2 shows a simple embedded development system to get you started.

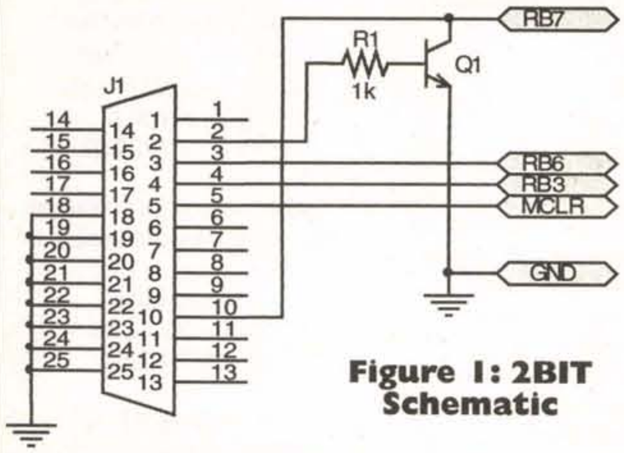


Figure 1: 2BIT Schematic

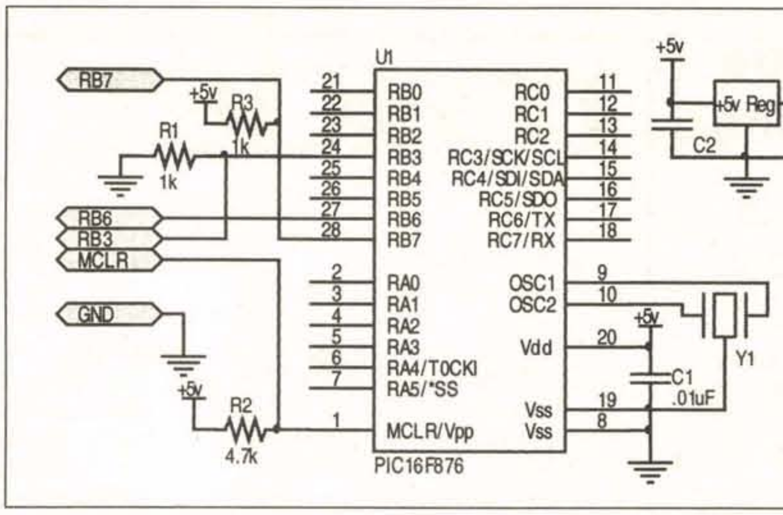


Figure 2: Low-Cost Development System Schematic

```
// To compile:
// pcm –c led.c

#include <16f876.h>
void main()
{
  for( ;; )
  {
output_high( PIN_A0 );
delay_ms( 500 );
output_low( PIN_A0 );
delay_ms( 500 );
  }
}

' To compile:
' pbc –p16f876 led.bas

loop:
  high 0
  pause 500
  low 0
  pause 500
  goto loop
  end
```

At the heart of the system is a PIC16F876 flash micro. The PIC is a 28-pin DIP device featuring 8K by 14 of flash program memory, 368 by 8 RAM, and 256 by 8 EEPROM. There are 22 pins for I/O and various peripherals including SCI, SPI, I2C, A/D, TIMERS, and PWMs. Refer to the online data sheet on the Microchip web site www.microchip.com for complete information.

There is +5 volt power supplied by a 78L05 regulator feed from either a nine-volt battery or comparable supply. Pin 20 connects to +5 volts and pins 8 and 19 are grounded. C1 is the bypass capacitor for the micro and should be placed close to the device. Y1 is a three-pin 8MHz ceramic resonator connected to pins 9 and 10 on the micro.

Make sure to connect the center lead of the resonator to ground. Pulling up pin 1 — MCLR — to +5 volts through a 4.7K resistor provides the reset. Any value from 1K to 10K is acceptable.

Pulling down RB3, pin 24, through a 1K resistor enables the low-voltage programming mode. A pull-up resistor to +5 volts on RB7 is needed for the open-collector transistor on the 2BIT module. The 2BIT programmer is connected to RB3, RB6, RB7, MCLR, and ground as shown.

Check-Out Software

A simple way to check out the 2BIT programmer and the development system is to write a simple program to blink an LED.

The first program is written in C and compiled using the CCS PCM C Compiler. The second program is written in Basic using the PicBasic Compiler from microEngineering Labs. Both are compiled under DOS.

Closing Remarks

The 2BIT programmer presented here is a simple way to program the flash microcontrollers from Microchip. A low-cost development system can be built with the 2BIT programmer, PIC16F876 microcontroller, prototype board, compiler (C or Basic), and a handful of discrete components.

Be sure to check the www.emicros.com web site for more information and to get the programming software. **NV**

reader FeedBack

Dear Nuts & Volts:

Just a quick note of thanks to both Netcom and *Nuts & Volts* for the three-volume set of the *IC MASTER* I received from the monthly drawing. I have already put them to good use, just like every issue of *Nuts & Volts* that I grab from my mail box each month for the last 10 years!

Nuts & Volts not only has great articles, but is also a great resource for parts, ideas, and solutions from your advertisers, as well.

Doug Dodge
via Internet

Dear Nuts & Volts:

Regarding (April 2001), "Arcade Machine" by Kerry Barlow. This is an interesting piece, Mr. Barlow has captured the essence of an arcade machine in his home-made unit.

As a 27-year veteran of the coin-operated amusement industry, I offer a couple comments.

An easy way to mount the marquee Plexi is to use two strips of plastic angle stock top and bottom. This material is sold in home stores and hardwares as drywall corner protector (keeps chair backs from breaking up corners in drywall). You don't need to bevel the Plexi then. Also, a good place to mount the speakers is on the panel under the marquee and right over the screen. This way, the sound comes out at the players head. A couple small speaker grilles from the automotive department dresses up the hole.

A professional touch is to put a piece of clear Plexi covering the control panel. Make holes to correspond to those in the wood. Do bevel its edges here. You can then print nice colorful labels for the controls and they will not wear out under the Plexi.

A good article.

Douglas McCallum
Lansing, MI

Dear Nuts & Volts:

I find ML Shannon's defense of hackers to be, actually, somewhat offensive.

How about a scenario where I take lock picks and go to his house and let myself in, look into every scrap of information I can find. I go through his desk, scrapbooks, diaries, check out his medicine cabinet to see what prescription drugs he might be taking, go through his phone bills to see who he's calling, check his checkbook register to see how he spends his money, check all his personal files to see if he has anything that might relate to lawsuits or other legal items, go through his computer and library to see if he's into pornography or something; in short, anything I can find.

I would take nothing away except a tremendous amount of knowledge about his tastes, finances, love life, and other personal information I could carry in my head.

By his definition of what is acceptable snooping, he should not be offended, or mind at all, that I had just pried into every facet of his personal life.

Analog Systems Engineer
Yahoo! Dallas

Dear Nuts & Volts:

After enjoying all of Mr. Shannon's articles *in Nuts & Volts* so far, I personally am finding his articles highly informative. The only drawback on his part is naïveté when it comes to our so-called benign government. The idea of all of us rushing to a single web site for example, to gain some sort of anonymity, only helps make the DOJ's job a little easier by allowing that so-called safe site to now be monitored easily by them (they read, too) and look for those who wish to be anonymous.

Considering their mentality, everyone who has something to hide must be guilty of something or other? For those of you who have never bumped heads with our finest (?), if you want to be anonymous, that's reason enough to be guilty in their minds and if you have something to hide, it must be illegal?

By routing some of the people to these web sites, it's like lambs to the slaughter? The only way this helps is if a flood of truly innocent people frequent the site so often that it makes it harder for our government to monitor with mostly false hits, but with computers doing even this job, they still gain the upper hand. If they can already monitor the entire phone system of this country looking for key words such as bombs, drugs, explosives etc, then these web sites are a piece of cake for them, especially if it is reduced to sites that are intended for extra security. Back in the crowd quickly becomes safer.

As to Mr. Burch's comments (May), I read the article three more times and fail to see even one mention of his complaint. Mr. Shannon's job of mentioning some

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News Bytes

KEEP A VIGILANT EYE ON ALL INCOMING E-MAIL WITH "MAPINOTIFY: SHADOW OF POWER!" E-MAIL MONITOR

Silmaril Software announces "MAPInotify: Shadow of Power!" version 2.60, an advanced skinnable e-mail checking utility that can monitor an unlimited number of mailboxes, IMAP4, and Microsoft Exchange folders, and then notify you in a variety of ways. The product is great for office and home workers or others who want to monitor more than one e-mail account while they are connected to a LAN or on-line, without the need to have multiple e-mail clients running continuously.

"MAPInotify: Shadow of Power!" is compatible with Exchange, Outlook 97 or higher, Microsoft Mail, and other Microsoft Exchange Server supported e-mail clients. It also support Internet related POP3 and IMAP4 protocols and can work in common with any of POP3/IMAP4 compatible e-mail client programs like Outlook Express or Eudora.

A friendly wizard walks you through the configuration set-up for each mailbox that you want to monitor. Profile configuration in the product identifies the type of e-mail account, server connection (local or remote), notification method(s), checking interval, and associated application. You can monitor profiles individually or all at the same time, preview the message headers, and delete the messages. If you choose the CDO or IMAP4 option, you can also check the contents of public or private folders, as well as your mailbox.

"MAPInotify: Shadow of Power!" can check remote mailboxes, as well. If you don't have a dedicated Internet connection, there's an option to check for mail only when there's an active connection. This program also contains anti-SPAM and anti-Trojan features that allow you to protect your mailbox from intruders. The latest version of the program also has a special compatible mode with Microsoft Outlook E-Mail Security Path and Microsoft Office 2000 Service Pack 2. "MAPInotify: Shadow of Power!" version 2.60 successfully passed compatibility tests on Microsoft's latest software products like Microsoft Exchange Server 2000 and Microsoft Office XP.

"MAPInotify: Shadow of Power!" also works well for organizations using Exchange Server. The product is very useful for team workers such as Technical Support staff who may be monitoring a group mailbox, a public folder, and their own personal mailbox all at the same time.

"MAPInotify: Shadow of Power!" can be downloaded freely from http://www.MAPInotify.com (3Mb only). Single-user licenses are $15.00 (US). "MAPInotify: Shadow of Power!" can be ordered by mail, phone, fax, or secure online from ShareIt!, Inc., P.O. Box 844, Greensburg, PA 15601-0844; Tel. 724-850-8186; Fax 724-850-8187; E-Mail: register@shareit.com.

WORLD TIME CLOCK, ANALOG TASKBAR CLOCK, QUICK-SET TIMERS AND ALARMS, AUTOMATIC ACTIVITY TRACKING, PROJECT TIME TRACKING

Cobasoft Clock 3.0 for Windows is a compact time management tool. It can show multiple digital or analog clock control panels, and it has a sharp analog clock in the Windows taskbar. Timers and alarms can be set with only two mouse clicks. The Cobasoft Clock keeps an automatic activity log, supports simple project billing, and shows the moon phase.

The Cobasoft Clock is fully world-time enabled. It can show analog or digital clocks for different time zones, with customizable name and daylight time saving options. Alarms and timers can be set relative to the time zone of one clock; this can be handy when travelling or when calling relatives in other time zones.

The Cobasoft Clock is used by self-employed and home-office workers to track their working time automatically. It runs in the background and writes a report of the currently open window and the time spent in it. Additionally, one can choose a current project manually. This is also logged in the report and its times are accumulated. The automatic tracking can be turned off. The Clock can also be switched to Private mode, making it invisible for other users of the computer.

The Cobasoft Clock is distinguished by the fast and easy way to set alarms or timers – one just takes a marker and drags it to a time. The alarms and timers can also launch programs and play sound and video files. They can be limited to certain days of the week.

The moon phase icon is shown in the task bar, too, and has a tooltip that shows the exact moon age and time of the next full or new moon.

Cobasoft Clock 3.0 for Windows costs $9.95 (US) for a single-user license. There are discounts for volume licensing. For details go to: http://www.cobasoft.com/eng/csclock/order.htm.

E-MAIL WITH IRON-CLAD SECURITY

RITLABS has released AuthenticBat! and SecureBat!, Windows e-mail clients that take the security worries out of communicating over the Internet.

Based upon RITLABS' powerful, highly configurable e-mail client, The Bat!, AuthenticBat! provides secure authentication using iKey hardware tokens from Rainbow Technologies. Every user has an iKey which plugs into their computer and identifies them. With its processor, RAM, and USB interface, the iKey token eliminates the problems of passwords being

Continued on page 71

Reader Feedback continued ...

of the Zealots in this world was anything but specific or pointed at any group of citizens unless you consider the heading alone of "Christian Solders" to be somehow demeaning? I doubt most honest Christians want to be labeled a solder anyway and thus aren't offended by this generic cliché or title. Not all Christians are alike, or even want to be!

I hope Mr. Shannon has more articles to come because he has enlightened us as to how the web works and has given us valuable tools to work with. I look forward to any and all future articles that he may write.

Chris Smith
Beiber, CA

Editor's Note:

In last month's Stamp Applications column, on page 15, lower left column, part of a sentence was inadvertently left out.

The sentence should read:

What you'll see is that *the greater the ratio toward the last reading, the slower the filter will respond.*

Murphy strikes again!

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
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430 Princeland Ct.,
Corona, CA 92879.

What's Up:

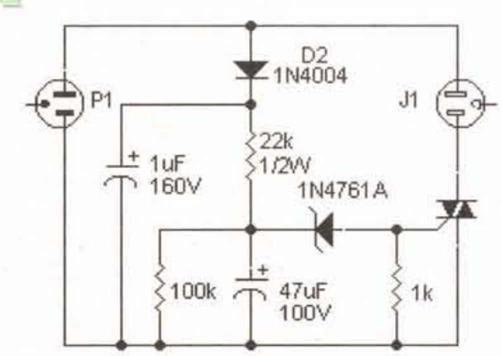
This time, we look at power control, everything from timers to special switches. I also take a close look at the 555 family and their related design rules. Finally, a reader hacks a previous project to prefection.

Good-bye, Thumper

Q. I have a receiver and a sub-woofer amp that are connected to a switched 110VAC outlet. However, when I flip the switch, the sub-woofer makes a loud thump. I've noticed that if the sub-amp is switched on a short while after the receiver, I get no thump. Which leads me to believe that what I need is a timer with a 10-second delay so that the receiver has time to settle down before power is applied to the sub-amp. I have found a bunch of timer circuits, but they all run from 9 or 12 volts to control a relay, which means more components. Any suggestions for a simple timer to hold back the 110VAC from the sub-woofer amp for about 10 seconds?

Grumpy, the Third Dwarf
(Dave Johnson)
via Internet

A. This circuit will easily fit in a power strip.



Circuit operation couldn't be simpler. Flip the "on" switch and the rectified DC line voltage charges the 47uF capacitor through the 22k resistor. When the voltage across the cap exceeds 77 volts — the added voltage of the zener diode and triac gate — the triac turns on the sub-woofer amp outlet. When the power is removed, the cap discharges through the 100k resistor and resets the circuit for the next time you power up the system. The 1uF capacitor isn't absolutely necessary, but it does stabilize the circuit and keep it from "seeking" during the triac's switch from off to on, so don't throw it away unless you absolutely can't make it fit in the space allocated.

Hello, Remote Sub-Woofer

Q. I built a sub-woofer amp and enclosure about two years ago and liked it well enough to make it part of my primary listening system. I would like to add an "automatic on/off" feature as provided in many commercially-available units so that my unit will come on when the main audio system is energized. However, the sub-woofer is located some distance from the audio system's power strip, and therefore I need a circuit that will switch the AC power to the sub-woofer using the speaker wires as a sense input. Can you help?

Len Kastner
Moneta, VA

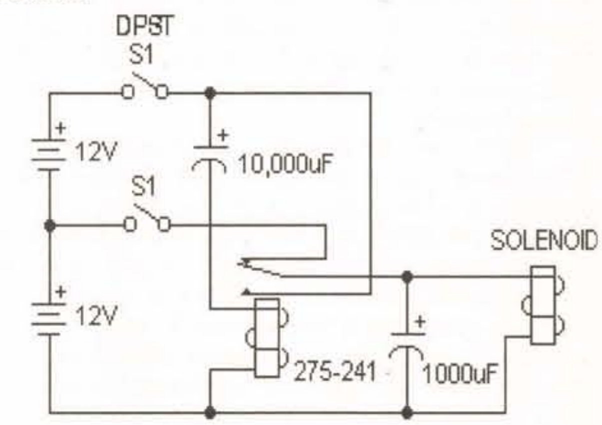
A. Instead of trying to separate a control signal from the sub-woofer signal over the speaker wires, I'd buy an X10 controller (MC460, $12.99) and remote appliance module (AM466, $13.99) to control power to the sub-woofer. As a bonus, the controller has eight channels total, which leaves seven channels free for other chores, like dimming the lights in the listening area. If you want to get really fancy, there's an X10 module (VK59A-M1) that lets you eliminate the speaker wire, too. Contact **X10** at **800-675-3044; www.x10.com**.

EV Solenoid Switch

Q. I would like a circuit for powering up a solenoid in a battery-powered vehicle. The solenoids are 24 volts, 0.75 amp, and require the full 24 volts to pull in — but will hold with 12 volts. Can you help me find an FET or similar type driver that would allow the solenoid to pull in with 24 volts and, after a short period of time, drop down to 12 volts or so? The solenoids I'm using are continuous duty, but they sure generate a lot of heat that could be put to better use.

Roger Roberts
Vail, AZ

A. I assume this is an EV with two 12-volt lead-acid batteries. In which case, a semiconductor is not a first choice; a single relay is a better and simpler solution.



When S1 is closed, the 10,000 uF capacitor charges through the relay, which pulls in and bangs the solenoid with a full 24 volts. After the capacitor nears fully charged — about five seconds — the relay drops out and switches the solenoid over to a 12-volt operation. The 1,000 uF capacitor prevents the solenoid from disengaging during the transfer process.

PIC Frequency Counter, Anyone?

Q. Do you know if there is a project or schematic in the *Nuts & Volts* archive for a frequency counter utilizing a PIC processor that is accurate to three significant digits? I need to count a squarewave signal, approximately one-volt peak-to-peak, and display it on a liquid crystal display of some sort.

Derek Casari
via Internet

A. Sorry, our archive doesn't have such a circuit, but you can find several PIC-based frequency counter kits and schematics on the Internet. Here are two of the more popular designs.

PIC-FC1 Frequency Counter
www3.justnet.ne.jp/~32lab/products/measure/PIC-FC1/doc_e.htm

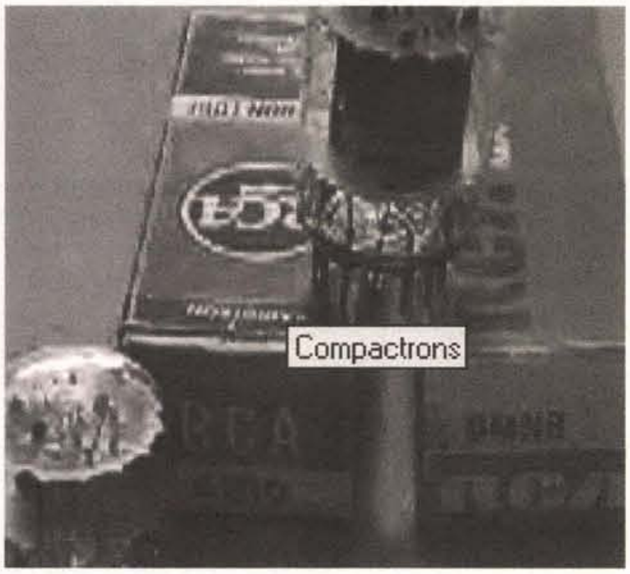
Weeder Technologies
www.piclist.com/techref/piclist/weedfreq.htm.
(See their ad on page 88.)

Compactron Tube Sockets, Anyone?

Q. Over the past several months, I've acquired some vacuum tubes with 12 pins on the bottom. Does anyone have any idea where I can get 12-pin sockets for these tubes? I've looked at various places on the Internet, but didn't find much to choose from.

Wayne C. Green, Jr.
via Internet

A What you have is called a compactron, a stop-gap method for prolonging the life of the vanishing vacuum tube. Essentially, they placed three tubes in one envelope to reduce board space and inventory. Tube World at 920-208-0353; www.tubeworld.com/sockets.html has a good inventory of odd tube sockets, including the 12-pin compactron type.

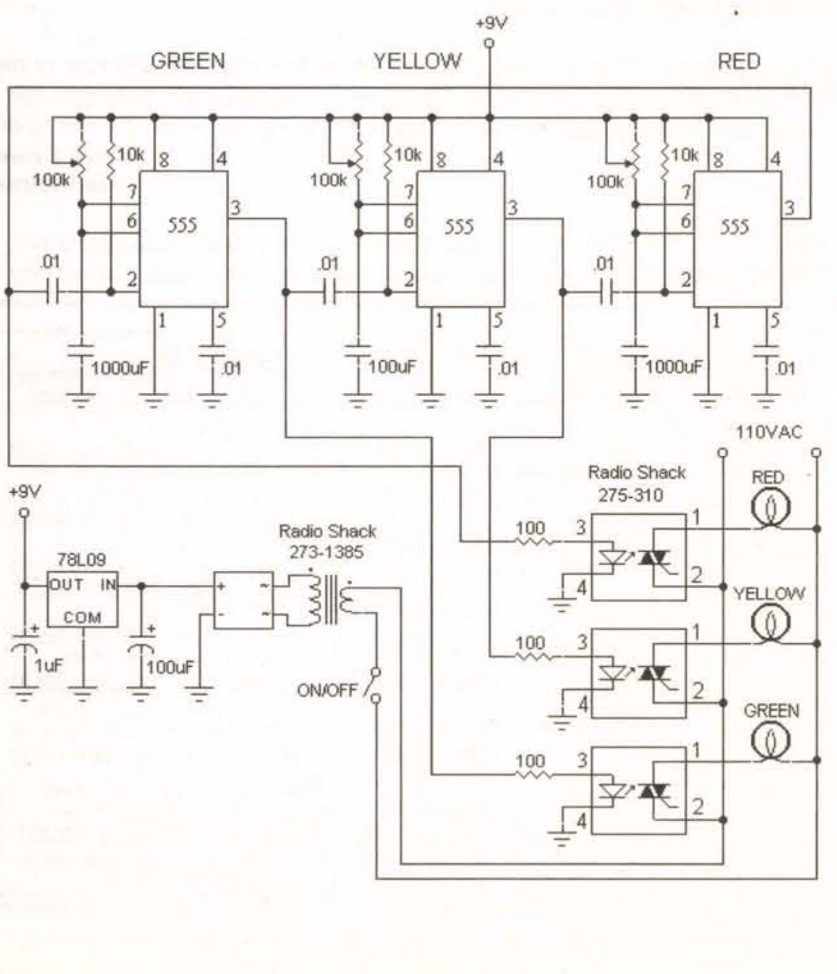


Follow That Light!

Q In the March 2001 issue, you showed a circuit that lights lamps up to 300 watts instead of driving LEDs. This is exactly what I've been looking for except for the fact that all three lights stay on for the same period. I'm trying to find a circuit that will work just like a stop light, in that the green is on for, say, 30 seconds, the yellow for four or five seconds, and then the red for 75 seconds. My question is, can this circuit be modified in some way to accomplish this?

Raymond Geiger
via Internet

A You and several other readers who are less than thrilled by the fixed timing sequence of the original circuit. Adding variable timing to each step isn't a major engineering chore, but it changes the design concept completely. Instead of a lamp chaser circuit like the one in the March issue, what this circuit cries for is a sequential timer. Simply put, a sequential timer provides multiple outputs which are activated in a linear sequence. In this circuit, three 555 timers are cascaded and tapped to drive three solid-state relays (SSR), which, in turn, activate the signal lights. The ON time of each light is set by its respective 100k pot.

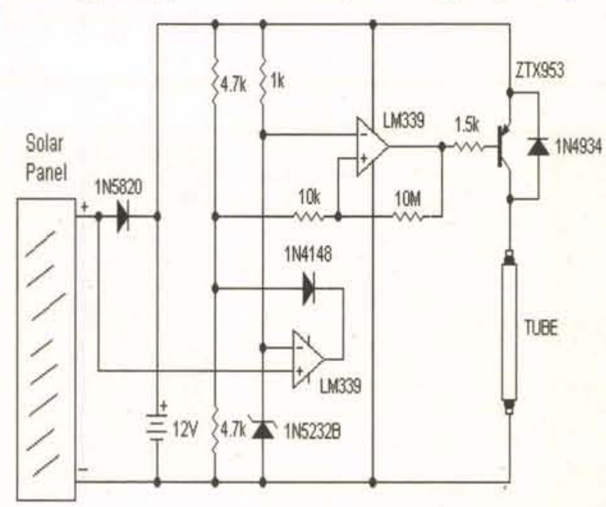


Solar Lamp Monitor

Q I have a small solar panel (12V @ 1.5A) and a relatively small battery bank for it (12V @ 20 AH). I have it hooked up to a single fluorescent lamp (22 watts). I'm looking for a low-loss circuit that will turn the lamp on at dusk, and leave the lamp on until the voltage on the battery drops to a predetermined point, and then shuts off until the next evening.

Keith Beckmann
via Internet

A That's no small solar panel, it's rated 21 watts! Still, to take best advantage of every drop of power your solar panel has to offer, I've used low-power solid-state devices throughout this controller. Total power consumption is less than 20 mA, yet it can switch up to 3.5 amps. All parts are available from **Digi-Key (800-344-4539; www.digikey.com)**.



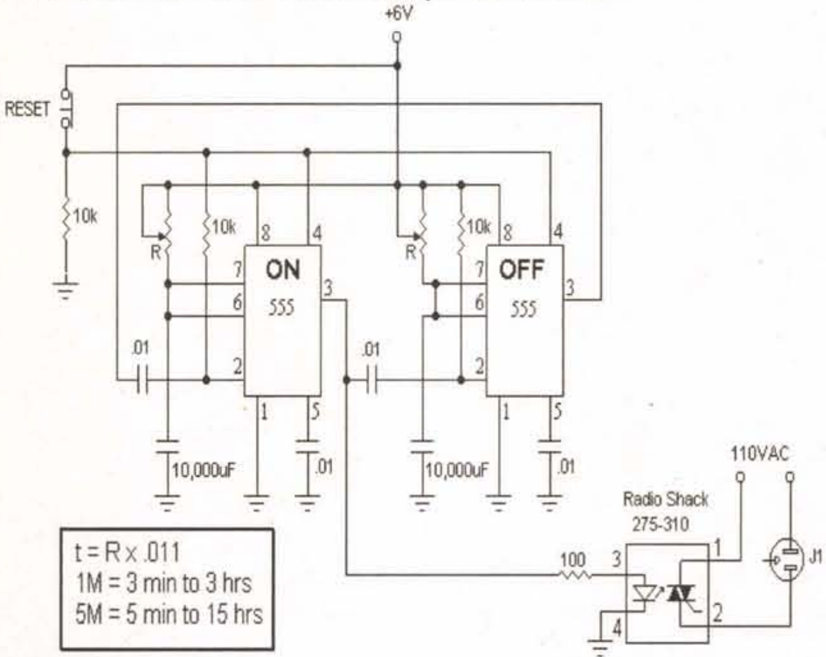
The controlling elements are a pair of LM339 comparators. The lower comparator monitors the light level on the solar panel and the upper comparator monitors the battery's charge level. When the output voltage of the solar panel is above 5.6 volts, its comparator output is low, which effectively shorts the monitoring voltage of the battery to ground. This prevents the battery monitor from reacting to changes in the battery voltage. After the sun sets and the solar panel's comparator goes high, this line is unclamped, which allows the voltage monitor comparator to track and react to battery voltage. With the values shown, the monitor will turn off the fluorescent lamp at 11.2 volts — the proper trip point for a lead-acid gel-cell.

Solid-State Appliance Timer

Q. I need a more reliable continuous on/off appliance timer than the common motor driven ones. Could you suggest a solid-state device or circuit that would give the same functions? Perhaps two NE555s in series or a NE556 with potentiometers for variable on/off time settings to control a solid-state relay?

Tom Wahl
via Internet

A. You can use the circuit above ("Follow That Light!") with minor modifications. First, drop one of the ring stages, then increase the times to be more in line with those found on motorized timers — something in the range of five minutes to several hours. Here's your timer circuit.



The ON and OFF times are determined by the setting of the R pots, which charge a 10,000 uF capacitor. When one timer times out, it starts the second timer running. The ICs are labeled as to which 555 chip controls the ON time and which controls the OFF time. The approximate times for 1 meg and 5 meg pots are three hours and 15 hours, respectively. For best performance, use a CMOS chip, like National Semiconductor LM555 or NE555. This timer is good for small appliances and lamps up to 300 watts. For larger loads, like a refrigerator, the current rating of the solid-state relay must be increased accordingly — e.g., 15 amps for 1,500 watts. The amperage of the relay can be calculated using the formula: Amps = Watts/110.

Solid-State Interval Timer

Q. I need a controller that will run a compressor at a timed interval of 5 to 60 minutes, then off for the same interval. The compressor has a surge of 10 amps starting and 5 amps running. The device needs to do this constantly.

Dean Freeland
via Internet

Cool Web Sites

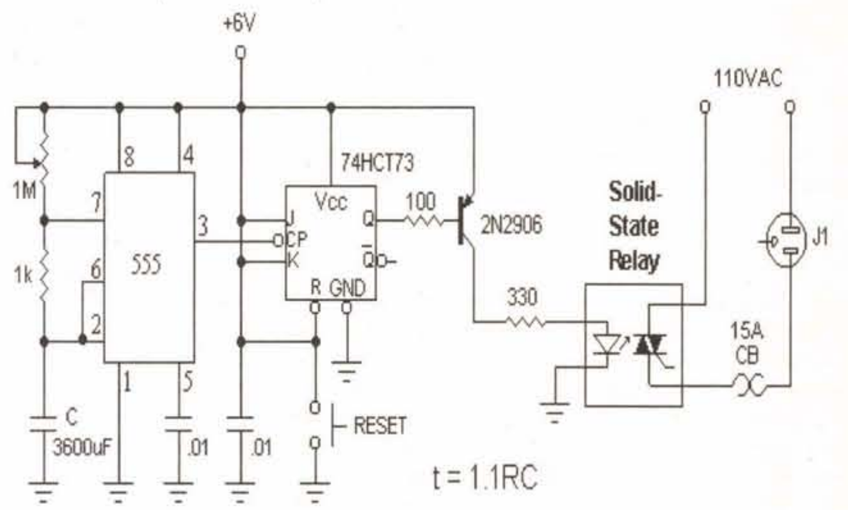
Have questions? These web sites have answers.

GeoHistory Animated History Maps
www.geoportals.com/demos/maps/
Condensed animated historical review of the American Revolution and The American Civil War.

Shareware
http://tmworld.com/sftw_files/shareware.htm#Files
Software programs and utilities from Test & Measurement World

3BP.com
www.3bp.com/
The only, if not, the largest collection of funny and odd headlines, photos, and video-clips.

A. The best circuit for this application is a pulse triggered flip-flop. The pulse is generated by a 555 chip which has a timer range of about three minutes to 60 minutes. Each time the flip-flop is triggered, it changes state, which either turns on or off the solid-state relay. The relay has to be rated for the load involved — in this case, the relay should be 280 VAC at 10 amps or better, like a CC1028-ND from Digi-Key. Don't forget the circuit breaker, it's a vital safety device. For readers with lighter loads, the RadioShack 275-310 solid-state relay will handle up to 300 watts.

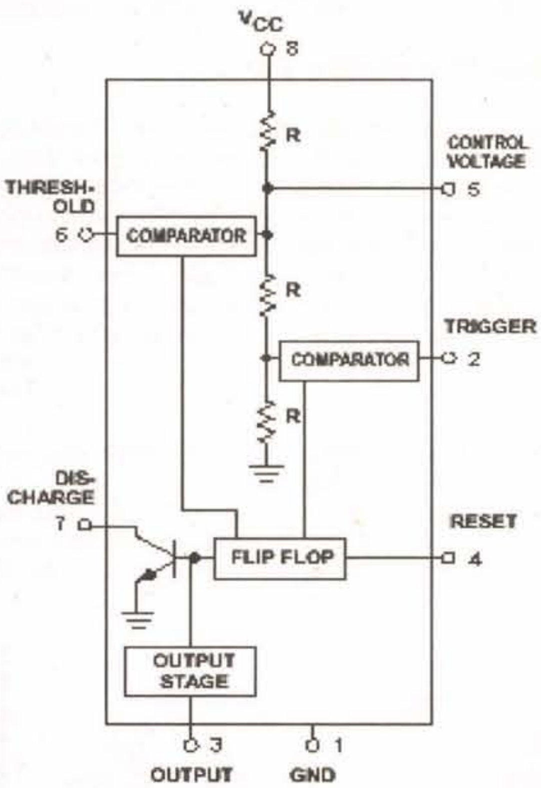


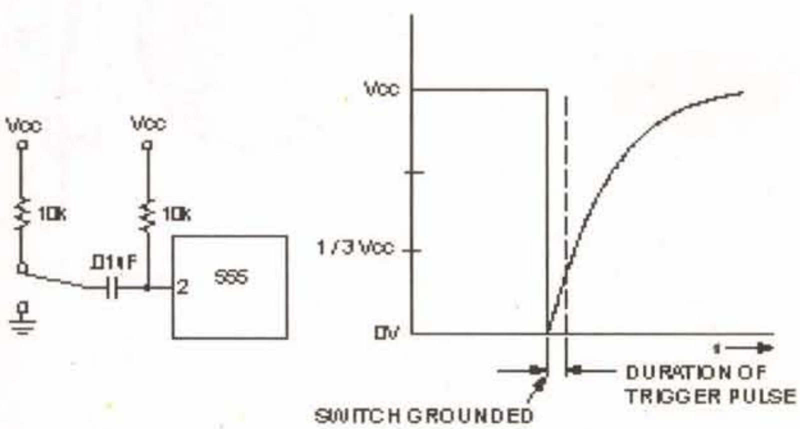
Re: Floating 555 Input

Q. On page 80 of the Feb. 2000 issue, you described the ugly side of the 555. What did you mean by "You need to tie pin 2 high through a 10k resistor ..."? Can you elaborate a bit? Does the 10k go from pin 2 to ground?

Derek Casari
via Internet

A. Pin 2 of the 555 is the trigger input that, when pulled low, starts the 555. This input goes to a high-impedance comparator with a sensitivity of 10 nA. That's why stray radiation and static will cause the 555 to operate erratically if pin 2 is left dangling (unconnected). To prevent this from happening, pin 2 is tied to Vcc (power supply positive), as shown below.





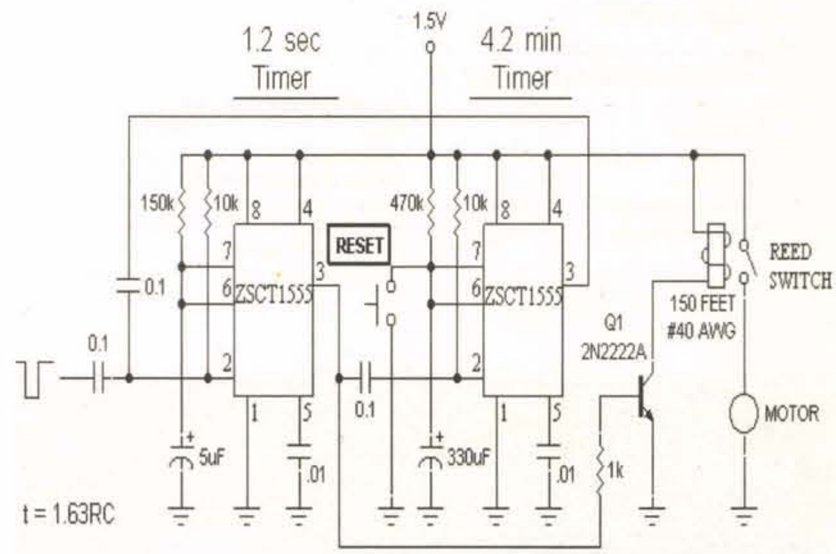
Due to the nature of the trigger circuitry, it's necessary that pin 2 be returned high before the flip-flop times out. This is usually done by AC coupling the trigger input through a capacitor. By AC coupling the trigger, a short negative-going pulse is generated as the input capacitor charges. Once charged, the pull-up resistor holds the trigger high until the next pulse arrives.

Shake It Baby

Q. I'm looking for a circuit that will operate a 1.3-volt pager motor for about one second, then wait for four to five minutes before jolting the motor again for one second. In essence, I want to give the pager wearer a second chance to respond.

Ron Kidney
via Internet

A. Ordinarily, I'd say this is easily accomplished using a plain ol' 555 timer chip, but not this time. The standard 555 has an operating voltage of 4.5 to 18 volts, too high for single-cell operation, which has a working voltage of 1.5 volts when fresh and 0.9 volts at the end of its life. Fortunately, Zetex of UK has a fresh solution — the ZSCT1555, which has guaranteed operation down to 0.9 volts, better than any CMOS alternatives, and just 75 µA of standby current at 1.5V. Moreover, it has the same pin-out as the original 555. The ZSCT1555 is available from Digi-Key for $3.09 each at the time of this writing.



For this design, I'd go with a pair of ZSCT1555 timers arranged in a ring counter configuration. When a pulse is applied to the trigger input (pin 2) of the first timer, its output goes high. Unlike the original 555, which can drive your motor directly from its output, the ZSCT1555's source current is a paltry 100 uA, far too low to operate the motor directly. Instead, the source current is used to turn on Q1, which pulls in the reed relay and starts the motor. After one second, the output goes low, Q1 turns off, the motor stops, and the four-minute timer is started. When this timer times out, it feeds a pulse back to the one-second timer, and the cycle starts all over again, and will continue 'til the twelfth of never or the battery goes dead, whichever happens first — unless you put a stop to it by pressing the "Reset" button. (The button has to be pressed during the four-minute cycle and held down for longer than one second.) Because of the low voltage, the relay isn't an off-the-shelf device. Instead, you make it yourself by winding 150 feet of #40 AWG magnet wire on a 1/2" long by 1/4" diameter coil form, and sliding the coil over a reed switch (Hamlin MDSR-7 10-20, or equivalent).

Sink Or Source

Q. What is the significance between a current source and a current sink? Why would I want to use one rather than the other, especially in regard to their use with photosensors in an industrial environment?

Bill Tipton W4TAL/CET
via Internet

A. A source is an emitter of electrons and a sink is a collector of electrons, or a receptacle. To understand the concept, look no further than your kitchen. The kitchen faucet is a supplier of water, and therefore is a source. The sink is, well ... a sink, a place where the water goes. Faucets cannot accept water and sinks can't emit water — unless the garbage disposal goes crazy, but that's another story for another time.

As a rule, a current source comes from the high side (positive) of the circuit, and a current sink is on the low side (negative) — usually ground. The amount of current either can handle is determined by circuit design and the properties of the chips involved. Take the example of the ZSCT1555 timer above, and compare it to the LM555 specifications.

ZSCT1555

ABSOLUTE MAXIMUM RATINGS

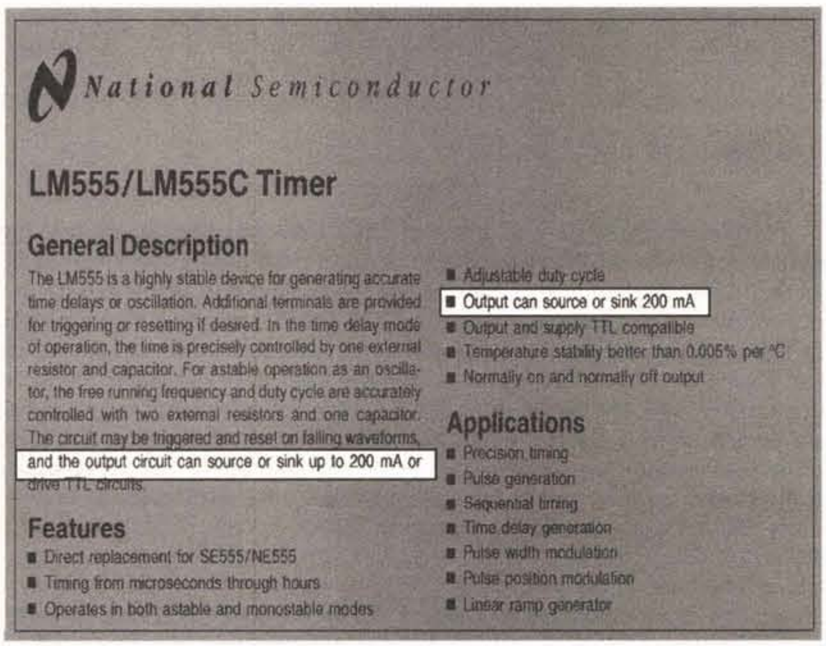
Supply Voltage	9V
Input Voltages (Cont, Reset, Thres, Trig)	9V
Output Current	100mA
Operating Temperature	-20 to 100°C
Storage Temperature	-55 to 150°C

Power Dissipation (T_{amb}=25°C)

DIL8	625mW
SO8	625mW

Recommended Operating Conditions

Supply Voltage	0.9V(min)	6V(max)
Input Voltages (Cont, Reset, Thres, Trig)		6V(max)
Output Current	Sink	100mA(max)
	Source	150μA(max)


National Semiconductor

LM555/LM555C Timer

General Description

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200 mA or drive TTL circuits.

Features

- Direct replacement for SE555/NE555
- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C
- Normally on and normally off output

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

One can source a full 200 mA, while the other is hard pressed to source .00015 mA — yet both are capable of sinking 100 mA. You'll find this kind of variation between sink and source often, and you need to pay attention to it when working with new designs, as I had to in the "Shake It Baby" circuit above.

As to which is best for use with photosensors, it depends on how the sensor fits with the rest of the circuit. Do you want to reference your sensor to ground? Then you want a good current sink. Floating ground applications, where the sensor is tied to Vcc or its equivalent, a stable current source is in order. For differential inputs, the two sources should be matched and tracking.

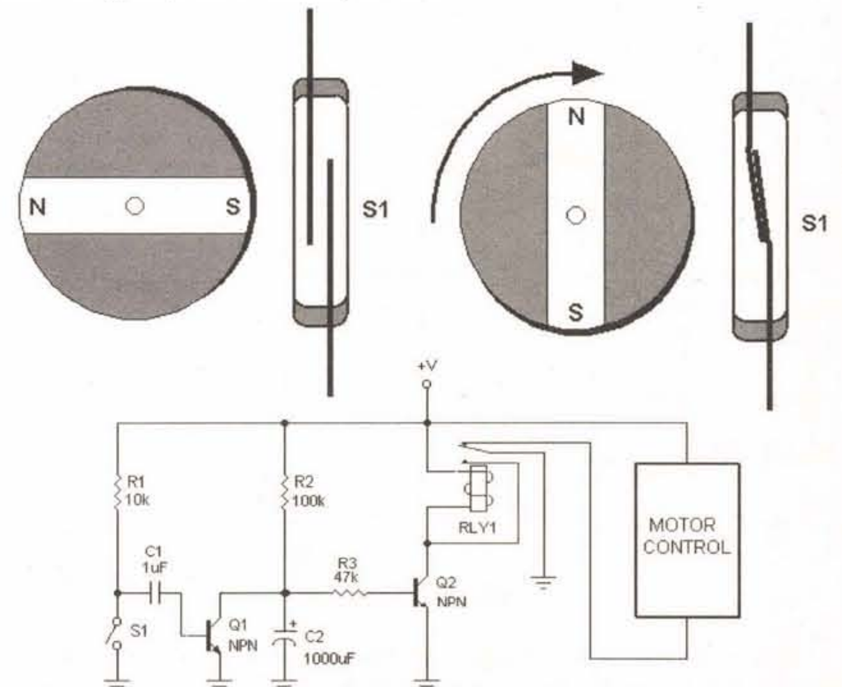
A Magnet Makes The Motor Go

Q. I have an old cassette tape deck, a Pioneer CT-4141 made some 30 years ago, that keeps activating the auto shut off (end of tape). This happens in all functions, including play, rewind, and fast forward. I originally assumed that a circuit monitors the motor drive current and activates the trip solenoid when the stall current is too high. However, removing the drive belt made no difference. From this, I presume the problem is not caused by binding or excessive friction in the drive mechanism, but some other sensor device. I have no schematic, so I am not sure how the trip circuit works. Can you help?

Ed Schmidt
via Internet

A. This cassette deck uses a rotating magnet and reed switch to sense when the take-up spindle is rotating.

This is the sensor mechanism. As the magnet rotates, S1 alternately opens and closes in step with the magnetic field. There are many forms the circuit can take to monitor the switch's closures. The circuit shown in the drawing below is typical, but not the only solution.



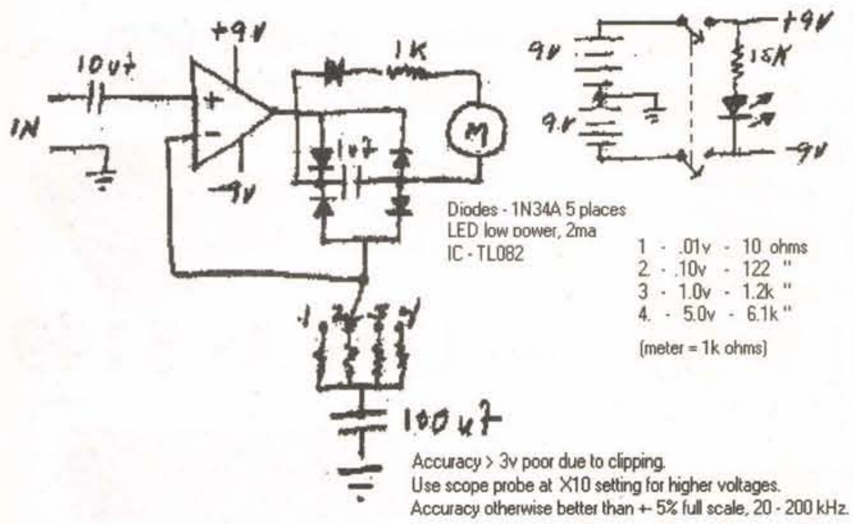
Let's assume the switch starts out closed, in which case, Q1 is turned off and C2 charges through R2. As the magnet rotates, S1 will open and start charging C1, which now turns on and discharges C2. Another 90 degree-twist again closes S1, turning off Q1, and C2 starts to recharge. If the magnet quits rotating, Q1 quits switching and C2 is allowed to charge unhampered. When the voltage across C2 exceeds about 1/2 +V, Q2 turns on and pulls in relay RL1. This causes the relay to latch in place and remove the power to the motor controller. Like I said, the actual circuitry may vary, but it's the making and breaking of S1 that determines whether the spindle is rotating or not (end of tape).

MAILBAG

Dear TJ:

I tried to build the "Sensitive AC Voltmeter" in the Dec. 2000, issue but was having little luck getting it to work until you pointed out that the 100 uF cap is drawn wrong in the diagram. As I suspected, it should connect to the junction of the three nearby resistors. While that got the meter working, I was less than impressed with the meter's performance. Basically, it wasn't linear.

I had no explanation as to why the scales weren't linear. Maybe some stray AC was affecting the instrument. Not one to give up, I hacked away at the design to improve its performance, and would like to share my findings with your readers. How I got to this final design was by using a breadboard, oscilloscope, a DMM, and lots of trial and error.



The TL082 clips inputs over three volts which destroys accuracy. I spent a lot of time trying to make it work at five volts without success before I figured this out. To solve the problem, I added a five-volt scale to the meter face for the top range with press-on letters. I suppose I could have added a voltage divider for a 10-volt range, but that would have required a more complicated range switch.

I never did get much success trying to use a single supply. Fortunately, the TL082 uses very little current, (about 5 mA) so battery power worked well. I think good results could be obtained using a 741, but I suspect it would not have as high an input impedance or as low a battery drain. I also noticed that higher voltages allow higher input without clipping. A plug in supply of ±15V would raise the high-range accuracy some.

The 1 uF cap is needed across the meter to damp out oscillations that also affect accuracy a lot. I figured this out pretty quick after allowing for the clipping. The original diagram showed a diode in parallel with the meter. My meter is 1k ohms, and needs one volt for full scale, so I eliminated the diode. I put an extra 1k resistor in the meter circuit because the datasheet for the IC suggested that it wanted 10k output impedance for frequency accuracy, and 2k was twice as good as the 1k of the meter. Not very scientific, but it worked.

The values of the feedback resistors are very critical to accuracy. I gave up and used trimmers. The original diagram suggested a 2,000 uF cap in the feedback circuit. It took an annoyingly long time to charge when I changed ranges, and I found that using 100 uF had no adverse affect that I could tell.

I used a 5 1/4" x 2 1/8" x 2 7/8" aluminum box. I trimmed about 1/4" off the "U" clamp that secures the meter. I attached the circuit board to the back of the meter clamp. This leaves plenty of room for the batteries. I secured them to the bottom section of the box with a "U" shaped piece of aluminum.

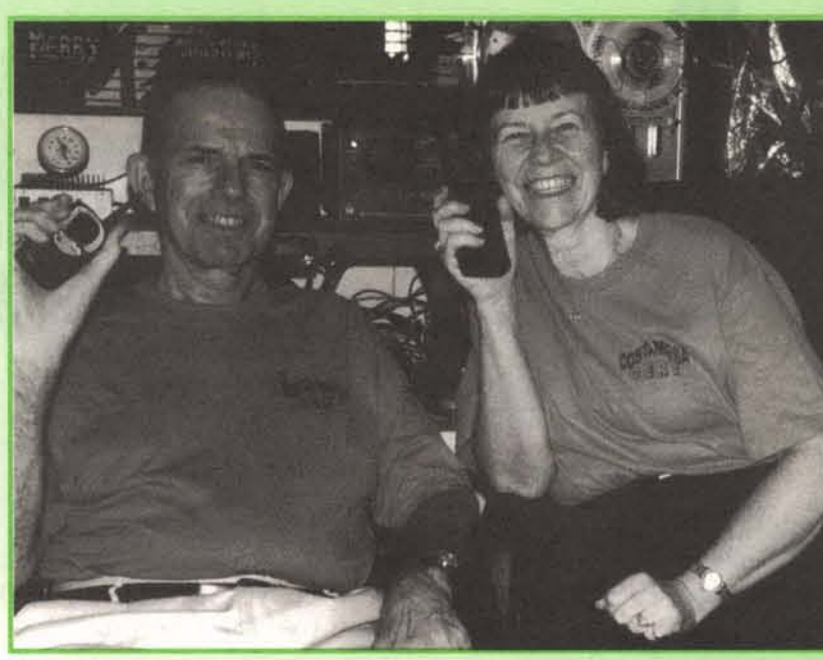
As best as I can tell, my meter project is accurate to better than ±5% of full scale, which is as good as the meter. Thanks for starting me on this project. I had fun and learned a lot.

Alan May
Houston

RESPONSE TEAMS USE FRS RADIOS

by Gordon West

The Family Radio Service (FRS) with FCC-authorized 14 UHF channels of operation is now four years old. FRS walkie-talkie-type radios continue to be hot retail sellers among electronic giants like Motorola, Cobra, Midland, and RadioShack.



Two happy CERT (Citizen Emergency Response Team) members operate over longer distances using more powerful GMRS equipment.

"We find the Family Radio Service market a stable sales opportunity throughout the year," comments Jim Bazat, President and Chief Executive Officer of Cobra Electronics.

"Unlike some electronics that sell at big numbers during specific seasons, FRS radios are always in demand," adds Bazat, speaking about Cobra's recent acquisition of marine electronic manufacturer Lowrance Electronics.

"With marine electronics, the marine business is quite seasonal and there are some flat periods when our huge manufacturing facility could run at full speed," says Darrell Lowrance, co-founder, President, and Chief Executive Officer of the Tulsa, OK company.

"This acquisition secures a leading position for Cobra in the marine and recreational GPS and sonar business, and we are excited to see all of the possibilities of Family Radio Service communications," adds Lowrance.

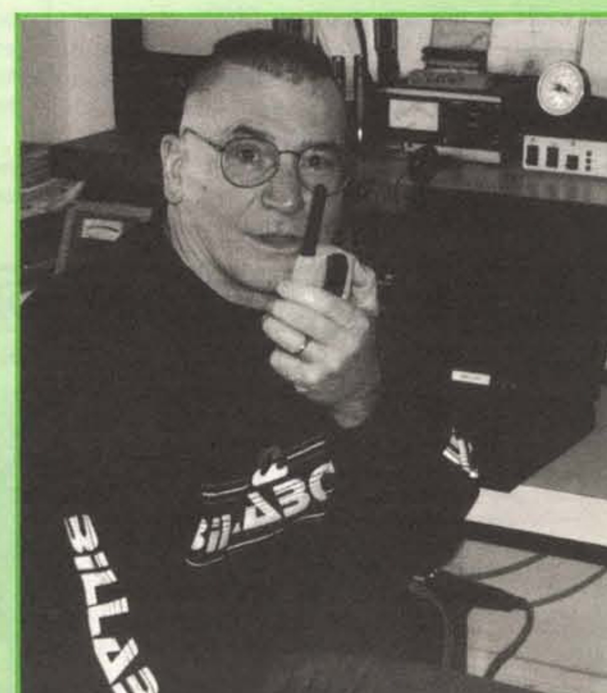
Last year, marine electronics global positioning system manufacturer Garmin announced it was considering some sort of short-range positioning system using Garmin GPS receiver modules built into an FRS transceiver. There were some issues about the transfer of data over FRS frequencies, and dealing with the FCC may sometimes be an exasperating experience.

FRS equipment operates on 14 "splinter channel" simplex UHF frequencies, interstitial to present duplex GMRS channels. FRS transceivers shall not exceed half-watt effective radiated power output, nor may they transmit with a deviation greater than 2.5 kHz with an audio frequency response of 3.125 kHz.

FRS Channels 1 through 7 fall in between GMRS (General Mobile Radio Service) repeater output frequencies, and GMRS simplex talk-around channels. FRS Channels 8 through 14 are interstitial to GMRS repeater input frequencies. And although there was some initial GMRS user group concerns that the little FRS radios might interfere with FCC-licensed GMRS repeater input frequencies, the little half-watt FRS equipment doesn't seem to be a problem throughout the United States.

FRS operation on any one of the 14 channels using FRS equipment is license-free. But to operate on the more powerful GMRS equipment on GMRS channels does require an FCC license.

"The GMRS is a radio service intended primarily for use by people communicating with their family and friends during recreational activities, such as fishing, camping, and boating," explains Ken Collier, sales manager for Pryme Radio Products, a company well-known for commercial and GMRS heavy-duty radios at lightweight commercial radio pricing. In their GMRS radios, they give easy steps on filing for



FRS "Block Captain" who also operates GMRS.

The Pryme 99 channel GMRS/FRS UHF handheld (left) and FRS radio (right) in use by CERT teams.

Chan.	Frequency	Mode	CTCSS
CALL	462.675* MHz	Repeater	141.3
1	462.5625 MHz	Talk Around	FRS 1
2	462.5875 MHz	Talk Around	FRS 2
3	462.6125 MHz	Talk Around	FRS 3
4	462.6375 MHz	Talk Around	FRS 4
5	462.6625 MHz	Talk Around	FRS 5
6	462.6875 MHz	Talk Around	FRS 6
7	462.7125 MHz	Talk Around	FRS 7
8	462.550 MHz	Talk Around	
9	462.550 MHz	Repeater	
10	462.575 MHz	Talk Around	
11	462.575 MHz	Repeater	
12	462.600 MHz	Talk Around	
13	462.600 MHz	Repeater	
14	462.625 MHz	Talk Around	
15	462.625 MHz	Repeater	
16	462.650 MHz	Talk Around	
17	462.650 MHz	Repeater	
18	462.675* MHz	Talk Around	
19	462.675* MHz	Repeater	
20	462.700 MHz	Talk Around	
21	462.700 MHz	Repeater	
22	462.725 MHz	Talk Around	
23	462.725 MHz	Repeater	

*462.675 is the designated emergency and traveler's assistance channel. Many repeaters are available nationwide for the sole purpose of providing help to people in need. In addition, the Personal Radio Steering Group suggests the 141.3 CTCSS code for this use.

The Pryme FRS/GMRS works on these 23 channels — 99 max!

a GMRS license through the Internet, or filing on the new FCC Form 605. Just use your FAX machine to call 202-418-0177 and request Form 000605.

"The Pryme Micro-Connect radios provide four watts of power output on GMRS channels, and with the GMRS license, you may also transmit four watts of power on FRS Channels 1 through 7," adds Collier. This may explain why some FRS stations sound so much louder than others when operating on FRS Channels 1 through 7.

"GMRS-licensed operators are indeed allowed to communicate on FRS Channels 1 through 7 directly to FRS unlicensed operators," adds Collier. This little known loophole — backed up with FCC rule interpretation — could allow the more powerful GMRS radio to operate on any one of the first seven FRS channels and become an extra loud voice to anyone in the area working the less expensive, half-watt, UHF, FRS walkie-talkies. And why would any GMRS licensee find this to their advantage?

Take Chuck Northcutt W7SRZ, an amateur radio operator, GMRS licensee, and emergency radio operator in the Seattle suburbs.

"When the 6.8 quake hit, many of our local community watch groups all came up on their local FRS channel to exchange information and possible damage reports. They could do this independent of the cellular phone system which immediately became jammed moments after the quake," adds Northcutt, explaining that several citizen groups in the Seattle area use FRS in their community watch programs.

Throughout the United States, many cities and communities are forming Community Emergency Response Teams (CERT) through support from the Federal Emergency Management Agency (FEMA). These CERT pro-

PR-460 SportConnect: 8-Channel GMRS Radio

PR-460 ClearConnect: 23-Channel GMRS Radio with repeater capability!

Everyone these days knows about Family Radios, right? These low power, short distance handhelds are popping up everywhere from amusement parks to shopping malls. FRS is a great way for families to keep in touch, but there is one terrible limitation: lack of range. FRS range is usually less than one mile.

When you need long range personal communications, you need to go beyond family radio. The new SportConnect and ClearConnect GMRS (General Mobile Radio Service) radios offer family style communications with a range of up to 25 miles* or more!

Staying in touch with your family and friends on the go has never been easier. The new SportConnect and ClearConnect portable two-way radios by PREMIER Communications usher in a new era in personal communications. These powerful two-way radios use frequencies within GMRS to provide unparalleled communications range. The ClearConnect and SportConnect make great travelling companions for outdoor activities, whether you are hiking, camping, skiing, or playing sports, because both radios feature one-touch access to the 462.675 MHz emergency and motorist assistance channel. Having a GMRS radio means that help is not far away. Whether you're hiking in the backwoods, or sending your children outside to play, staying in touch can also mean staying safe.

Unlike Family Radio, which is limited to a fraction of a mile in range, the new ClearConnect and SportConnect provide reliable, long-range communications. Both radios have a powerful four-watts output power, compared to half-watt or less for most Family Radio Service radios.

The eight-channel SportConnect model offers radio-to-radio communications of up to five miles* over clear terrain. The ClearConnect model is a 23-channel unit that has the same radio-to-radio capability as the SportConnect, but also ads the capability of using GMRS repeaters, which can increase your reliable range to up to 25 miles* or more! Access to a GMRS repeater may require a monthly subscription fee.

Family Radio users upgrading to GMRS because of its longer range need not worry about losing communications with their existing FRS radios, because Channels 1-7 in both the ClearConnect and SportConnect are the same as Family Radio Channels 1-7, so you can use your MicroConnect portables to intercommunicate with any FRS radios in your group!

Connect With Features!

Powerful four-watt output power for talk range of up to five miles, radio-to-radio!* User selectable lower power settings help to conserve battery life! ClearConnect model adds repeater capability for a communications range of 25 miles or more!* Includes 38 CTCSS Interference Eliminator Codes for increased privacy, decreased interference, and selective calling! Uses UHF frequencies for superior range, especially inside buildings, around obstructions, and through heavy foliage! For recreational use!

Both radios feature one-touch access to the 462.675 emergency channel. A speaker/microphone jack allows your portable radio to be used with an external microphone, headset, earphone, or other audio accessory! Removable antenna with BNC connector! Squelch monitor key for receiving weak signals! Up to eight hours of use with the supplied rechargeable NiCd battery pack! LCD Display on the front of the radio shows the radio's current status!

Signal strength meter (S-Meter) gives you a visual indication of the strength of received signals. Channel scan, dual watch, and priority scan modes to help locate activity! Low Battery Warning Time Out Timer! One Year Warranty! Channels 1-7 correspond to Family Radio Service (FRS) channels 1-7, allowing you to communicate with any FRS radios that you may already have! Operates on the GMRS. An FCC issued license is required.

An FCC license is required for GMRS use. Instructions for licensing are included with the radio, and the license application can be filed electronically using the Internet. One GMRS license covers you and your immediate family, including spouse, children, siblings, parents, grandparents, and more!

* Effective range may vary due to nearby terrain, elevation, battery condition, channel usage, and other factors. Communications range of five miles or more may only be accomplished through subscribing to repeater use. There may be a fee for such a subscription.

Pryme technician programming a new handheld with the portable programmer.

grams are aimed specifically to train citizens and their neighbors to become self-sufficient in the event of a catastrophic disaster. Just like in the Seattle earthquake, emergency service personnel may not be available to help everyone out immediately, and CERT-trained citizens can make a difference by using their training to save lives and protect their property.

The FEMA CERT training program is divided into seven sessions covering the following topics:

Topic 1: Disaster Preparedness
Topic 2: Disaster Fire Suppression
Topic 3: Disaster Medical Operations — Part 1
Topic 4: Disaster Medical Operations — Part 2
Topic 5: Light Search and Rescue Operations
Topic 6: Disaster Psychology and Team Organization
Topic 7: Course Review and Disaster Simulation

"The goal of the training continues to be preparing people to help people," comments FEMA. "CERT teams can assist with saving lives and protecting property in the event of a major disaster," adds FEMA. Each city may use the FEMA handbook — 100 pages long, #SM-137 — as their guideline for setting up a CERT training class.

CERT classes are offered by local city fire departments, police departments, or a city disaster preparedness agency. In Southern California, free CERT classes are offered by the City of Costa Mesa fire prevention specialist Ms. Teri Durnall, ham radio call sign KF6VDC. She is first to point out that Family Radio Service and ham radio communications play an important part in keeping city CERT-trained members in immediate radio contact during a major earthquake, fire, or flood.

"The City of Costa Mesa CERT program became so popular that local ham operators saw a need for developing block communicators and school communicators who might use another radio system to transmit and receive localized radio reports," adds Durnall, describing the once-a-week radio net on FRS Channel 4 conducted by ham operators who possess their own GMRS license and operate higher powered equipment with elevated antennas to increase the range of their weekly net news and information service.

"When the hams come on with their powerful weekly net messages, everyone in our city with a tiny FRS radio hears them loud and clear," adds Durnall. But hearing the half-watt FRS signal by the City's volunteer ham radio net coordinator gets mighty tough, especially when repeater outputs are on the air that straddle the interstitial half-watt FRS 2.5 kHz incoming signal. Here is where CERT-trained block communicators play an important role in taking reports from FRS within a block or two of their station, and then going to their GMRS license and higher power to relay those reports back to net control.

A very special FRS and GMRS operator for the City of Costa Mesa's CERT group, which we will call 44 Diane, makes this communication possible with Diane and her husband having one of the largest FRS teams in the country. Once a week on FRS Channel 4, they take check-ins from within their neighborhood, and then relay them to net control with their more powerful GMRS radio equipment. Recent sonic booms from the Space Shuttle and some minor earthquakes in Southern California has had "44 Diane" and her husband immediately on the air, taking incoming radio reports from their neighborhood up to three or four blocks away.

"On a line-of-sight basis, our net control can hear half-watt FRS sets several miles away," comments Julian Frost N3JF, one of the CERT trainers for the City of Costa Mesa. "But if the FRS operator is inside the house, with a big tree in between their house and our net control station only five blocks away, we can barely hear a thing," adds Frost, pointing out that the UHF half-watt signals are quickly attenuated by buildings and vegetation. This calls for "44 Diane" to faithfully relay the outgoing traffic.

Since FRS and GMRS radio compatibility is limited only to FRS Channels 1 through 7, the

FREQUENCY CHART FRS

CH	Freq. (MHz)	CH	Freq. (MHz)
1	462.5625	6	462.6875
2	462.5875	7	462.7125
3	462.6125	8	467.5625
4	462.6375	9	467.5875
5	462.6625	10	467.6125

CH	Freq. (MHz)
11	467.6375
12	467.6625
13	467.6875
14	467.7125

FRS Channels

Red Cross communicators also use FRS for local communications at the scene.

next question is whether or not there should be a nationwide emergency channel just for CERT communications for training, disaster preparation, and the "real thing" disaster reports. Or should each city within a tight geographic area adopt their own unique channel, leaving a single channel only for bonafide emergency calls?

REACT International, a strong voice when it comes to the volunteer monitoring of 27 MHz CB Channel 9; GMRS Channel 6, 462.675 MHz; and the provider of safety and emergency communications for countless public service events — all on a volunteer basis — suggests that FRS Channel 1, 462.5626 MHz, be used as a call channel, with privacy code (CTCSS sub-audible tone) disabled. You can see their thoughts by going to their web site at www.reactintl.org.

"There are thousands of these FRS units being used in the USA," comments REACT's Bob Leef (949-770-9501). "As we have seen, certain conditions will allow a much greater distance than a couple of miles maximum, but even within that advertised range, contact on FRS might be made, if necessary, when there is a recognized call channel," adds Leef. "REACT suggests that it is now time to realize the changing face of FRS and take advantage of the safety aspects of the product, as well as the designed concept of convenience," finalizes Leef, who I know personally and can attest to the thousands of hours he has put in for REACT, and using his CB and ham radios to provide motorists safety communications. If ever there is a dedicated man for highway radio safety, Leef holds my vote!

Most recently, a web site was established to further the FRS Channel 1 national call channel consideration. Look up www.f-r-s.org. "We are a grassroots effort attempting to draw attention to F-R-S Channel 1 by designating it as a national call channel for help and emergency assistance," explains the web site Channel 1 proponent.

Possibly an emergency calling channel might have brought help faster to two injured climbers using FRS radios to reach out to a seven-year-old to handle their call for help. But not everyone agrees that a single call channel on FRS is wise for this unlicensed radio service.

"The REACT proposal to use Channel 1 for emergencies should produce an increase in the number of potential listeners," comments Paul Folmsbee, ham call sign K5PF. "In other words, besides those using FRS for personal activities, there hopefully would be additional individuals who are listening simply from a desire to help others," adds Folmsbee.

But Paul raises the same issue that REACT volunteers were faced with while trying to listen to CB radio 27 MHz Channel 9, "... Are you willing to listen to chatter, whistlers, call tones, and kids playing on a dedicated channel ... if a national emergency protocol is established, the public should not be lulled into a false sense of security," cautions Folmsbee, to which I heartily agree. The range of a little half-watt FRS radio is many times not in miles that the advertising indicates, but rather in the hundreds of yards.

"Don't have an unrealistic expectation for FRS as an emergency tool," adds Folmsbee, again a statement absolutely true. He points out that dedicating a channel for calling/emergencies results in a seven percent reduction in the allocation for personal communications on FRS.

He also worries about a GMRS five-watt radio station using the seven channels designed for half-watt, limited-range transceivers, possibly creating "alligator stations" which can talk farther than they can hear. While he is absolutely correct, this is indeed the way we send out our news to local citizens of the City of Costa Mesa, and then let the local "44 Dianes" do relays from their individual neighborhoods back to net control.

So take it from Seattle FRS operators who stayed on the air quite nicely after the big quake. Exchanging block-by-block reports, FRS to relay stations, and then onto a central net control station works in connection with CERT preprograms for local citizens.

Also keep in mind that many GMRS transceivers may be computer programmed to add the seven FRS interstitial channels, and some of the slickest programming capabilities come from a little portable keypad programmer from Pryme (www.pryme.com).

The Pryme UHF, 99-channel, programmable radio is one of the hottest GMRS/FRS capable radios on the market. The programmer is a portable keypadder that simply plugs in and lets you take full control of the internal microprocessor. **NV**

USING SEVEN-SEGMENT DISPLAYS

PART 2

by Ray Marston

Ray Marston looks at practical seven-segment decoder/driver ICs in this concluding part of this special feature article.

Last month's opening episode of this special feature explained the basic operating and usage principles of seven-segment alphanumeric displays.

This month's concluding episode deals with practical seven-segment decoder/driver ICs.

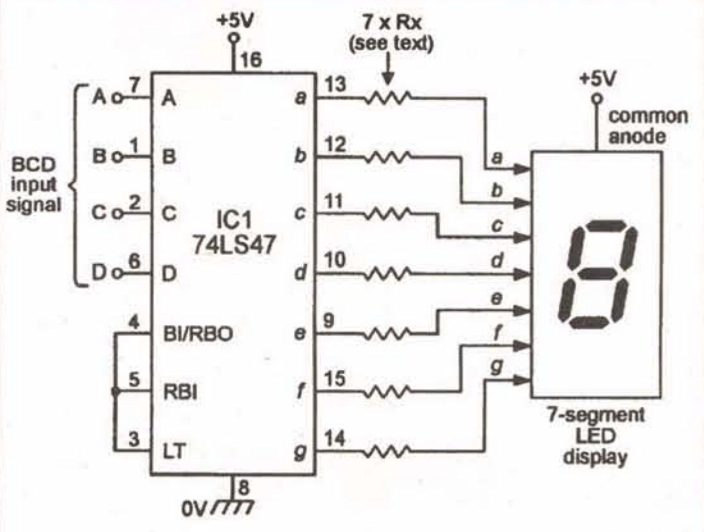


Figure 2. **Basic way of using a 74LS47 IC to drive a common-anode LED display.**

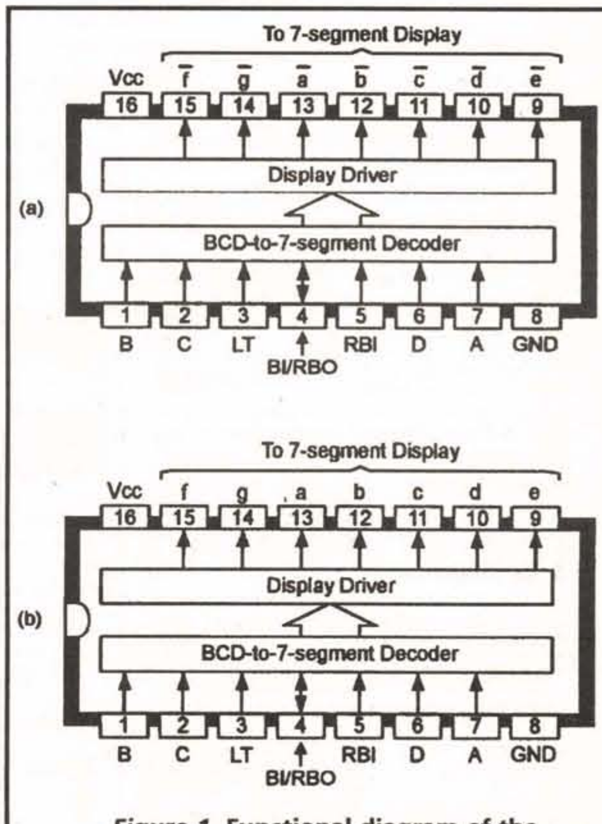


Figure 1. **Functional diagram of the (a) 74LS47 and (b) 74LS48 BCD-to-seven-segment decoder/driver ICs.**

PRACTICAL DECODER/ DRIVER ICs

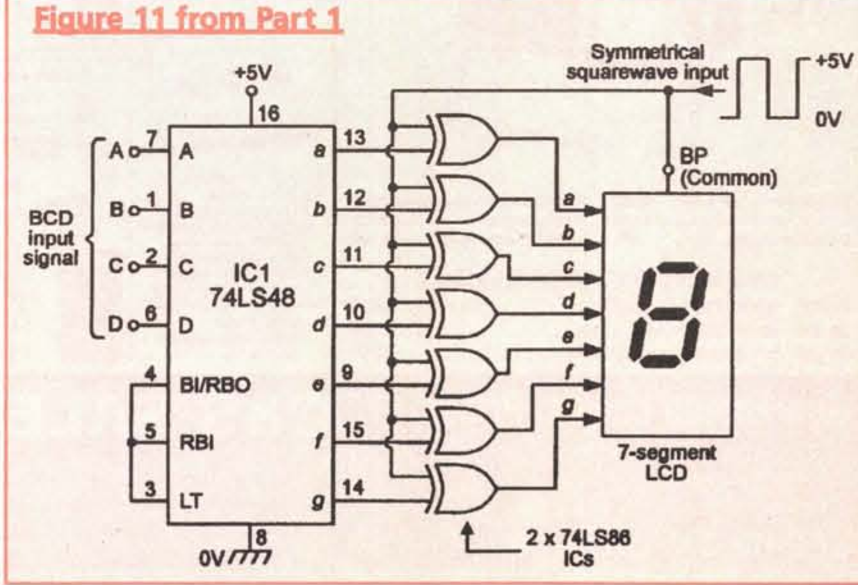
Decoder/driver ICs are available in both TTL and CMOS forms. Some of these devices have integral ripple-blanking facilities, others have built-in data latches, and a few even have built-in decade counter stages, etc. The rest of this article describes a few of the most popular of these devices.

The 74LS47 and 74LS48

These seven-segment decoder/driver ICs are members of the LS TTL family. They have integral ripple-blanking facilities, but do not incorporate data latches. *Figure 1* shows the functional diagrams and pin designations of these devices, each of which is housed in a 16-pin DIL package.

The 74LS47 has active-low outputs designed for driving a common-anode LED display via external current-limiting resistors (Rx), as shown in *Figure 2*. The 74LS48 has active-high outputs designed for driving a common-cathode LED display in a manner similar to that of *Figure 2*, but with the display's common terminal taken to ground. The Rx resistors must limit the segment currents to less than 24mA in the 74LS47, and

Figure 11 from Part 1



less than 6mA in the 74LS48. The 74LS48 can be used to drive a seven-segment LCD display by using the connections already shown in last month's *Figure 11*.

Note from *Figure 1* that each of these ICs has three input 'control' terminals, these being designated LT (Lamp Test), BI/RBO, and RBI. The LT terminal drives all display outputs on when the terminal is driven to logic 0 with the RBO terminal open or at logic 1.

When the BI/RBO terminal is pulled low, all outputs are blanked; this pin also functions as a ripple-blanking output terminal. *Figure 3* shows how to connect the ripple-blanking terminals to give leading zero suppression on the first three digits of a four-digit display.

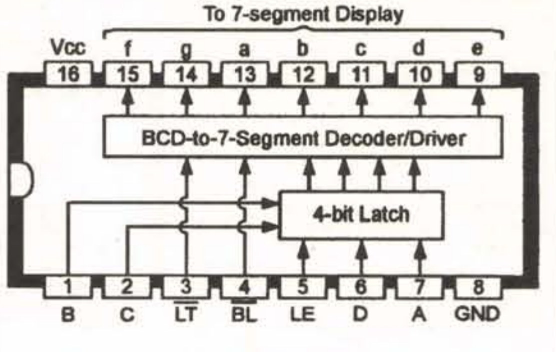


***Figure 4.* Functional diagram and pin notations of the 4511B seven-segment latch/decoder/LED-driver IC.**

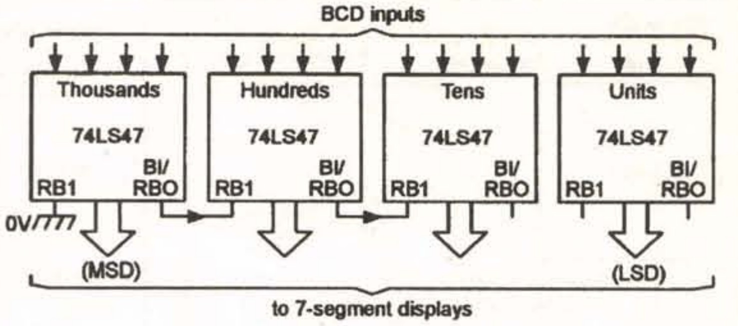


***Figure 3.* Method of applying leading-zero suppression to the first three digits of a four-digit display using 74LS47 ICs.**

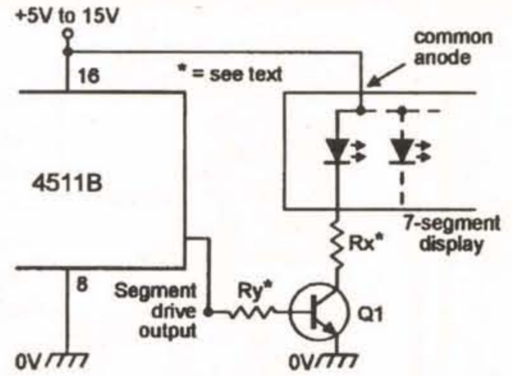


***Figure 6.* Driving a common-anode LED display.**

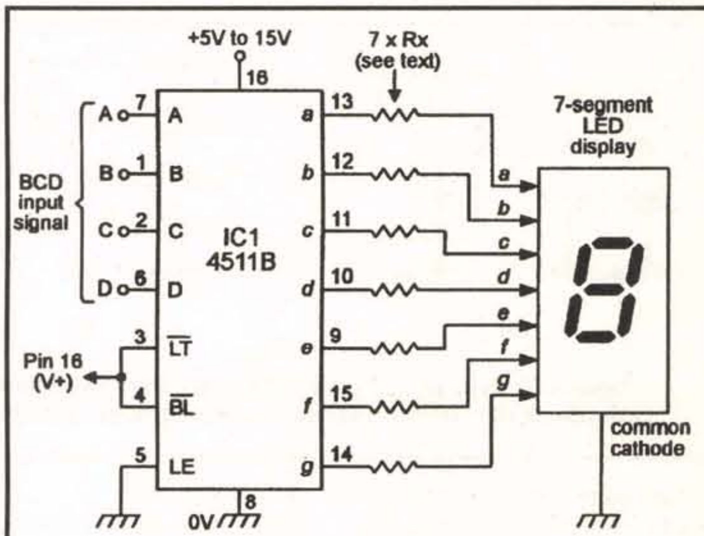


***Figure 5.* Basic way of using the 4511B to drive a seven-segment common-cathode LED display.**

The 4511B

The most popular CMOS 4000B-series BCD-to-seven-segment LED-driving IC is the 4511B (also available as the 74HC4511), which has an integral four-bit data latch, but has no built-in ripple-blanking facilities.

Figure 4 shows the functional diagram and pin notations of the device, which can use any power source in the 5V to 15V range. The IC is ideally suited to driving common cathode LED displays, and uses NPN bipolar output transistor stages that can each source up to 25mA.

The 4511B is very easy to use, and has only three input control terminals; of these, the not-LT (pin 3) pin is normally tied high, but turns on all seven segments of the display when pulled low.

The not-BL (pin 4) terminal is also normally tied high, but blanks (turns off) all seven segments when pulled low.

Finally, the LE (latch enable) terminal (pin 5) enables the IC to give either direct or latched decoding operation. When LE is low, the IC gives direct decoding operation, but when LE is taken high, it freezes the display.

The 4511B can be used to drive most popular types of seven-segment displays. *Figure 5* shows the basic connections for driving a common-cathode LED display.

A current-limiting resistor (Rx) must be wired in series with each display segment and must have its value chosen to limit the segment current below 25mA.

Figures 6, 7, and *8* show how to modify the above circuit to drive LED common-anode displays, gas discharge displays, and low-brightness fluorescent displays, respectively. Note in the cases of *Figures 6* and *7* that an NPN buffer transistor must be interposed between each output drive segment and the input segment of the display.

In each case, Rx determines the operating segment current of the display, and Ry determines the base current of the transistor.

The 4511B can also be used to drive seven-segment liquid-crystal displays by using an external squarewave 'phase' signal and a set of EX-OR gates in a configuration similar to that of last month's *Figure 11*. In practice, however, it is far better to use a 4543B IC for this particular application.

The 4543B

The most popular 4000B-series BCD-to-seven-segment LCD-driving IC is the 4543B (also available as the 74HC4543), which has a built-

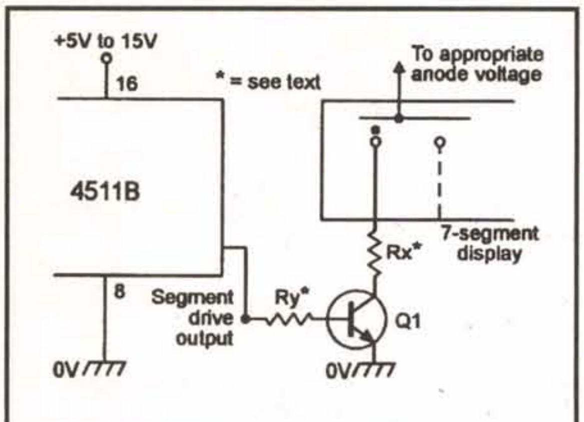


Figure 7. **Driving a gas discharge readout.**

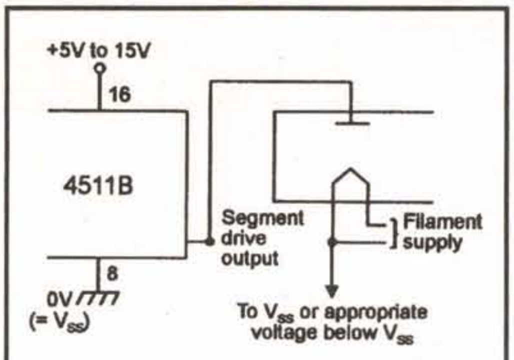


Figure 8. **Driving a low-brightness fluorescent readout.**

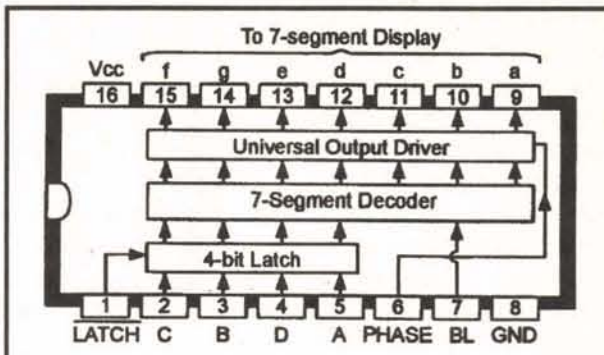


Figure 9. **Functional diagram and pin notations of the 4543B universal seven-segment latch/decoder/driver IC.**

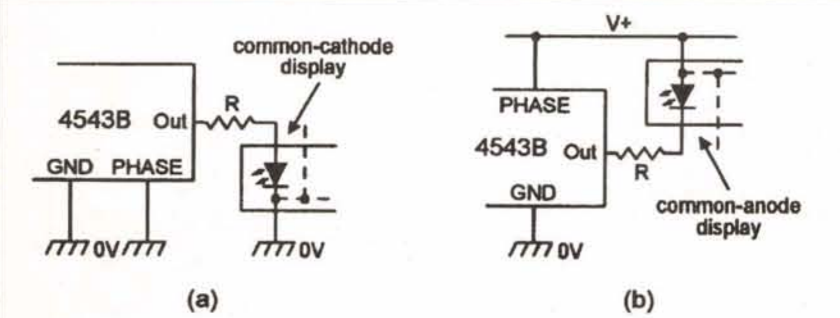


Figure 10. **Way of using the 4543B to drive (a) common-cathode or (b) common-anode seven-segment LED displays.**

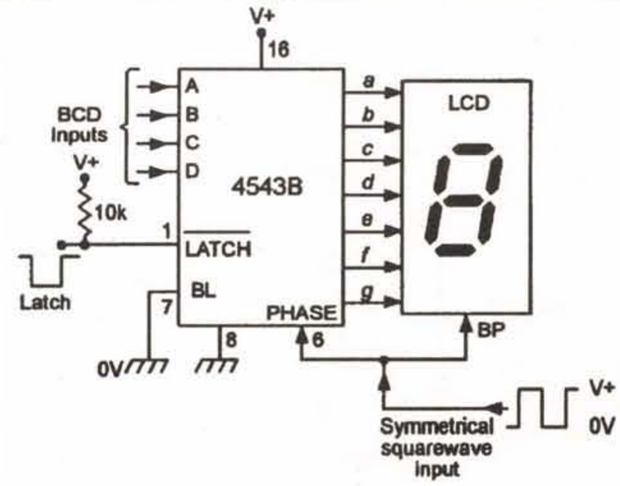


Figure 11. **Way of using the 4543B to drive a seven-segment LCD.**

in data latch. *Figure 9* shows the IC's functional diagram and pin notations. The device incorporates an EX-OR array (of the type shown in last month's *Figure 11*) in its output driver network, which can source or sink several milliamps of output current. This feature enables the IC to act as a universal unit that can drive common-cathode or common-anode LED or liquid-crystal seven-segment displays with equal ease, as shown in *Figures 10* to *13*.

The 4543B has three input control terminals, these being designated not-LATCH, PHASE, and BL (BLANK). In normal use, the not-LATCH terminal is biased high and the BL terminal is tied low. The state of the PHASE terminal depends on the type of display that is being driven. For driving LCD readouts, a squarewave (roughly 50Hz, swinging fully between the GND and Vcc values) must be applied to the PHASE terminal. For driving common-cathode LED displays, PHASE must be grounded. For driving common-anode displays, PHASE must be tied to logic high.

The display can be blanked at any time by driving the BL terminal to the logic-1 level. When the not-LATCH terminal is in its normal high (logic-1) state, BCD inputs are decoded and fed directly to the seven-segment output terminals of the IC. When the not-LATCH terminal is pulled low, the BCD input signals that are present at the moment of transition are latched into memory and fed (in decoded form) to the seven-segment outputs until the not-LATCH pin returns to the high state.

Figure 10 shows basic ways of using the 4543B to drive common-cathode and common-anode seven-segment LED displays; the 'R' resistance value must limit the output drive current to below 10mA per segment. *Figure 11* shows the basic way of using the 4543B to drive a seven-segment LCD, and *Figures 12* and *13* show it used to drive other types of seven-segment displays. In *Figure 12,* Rx sets the segment current of the display and Ry sets the base current of the transistor (10mA maximum).

The 4026B

The 4026B IC is a complete decade counter with integral decoder/driver circuitry that can directly drive a seven-segment common-cathode LED display. The segment output currents are internally limited to about 5mA at 10V or 10mA at 15V. Enabling the display can be connected directly to the outputs of the IC without the use of external current-limiting resistors. The IC does not incorporate a

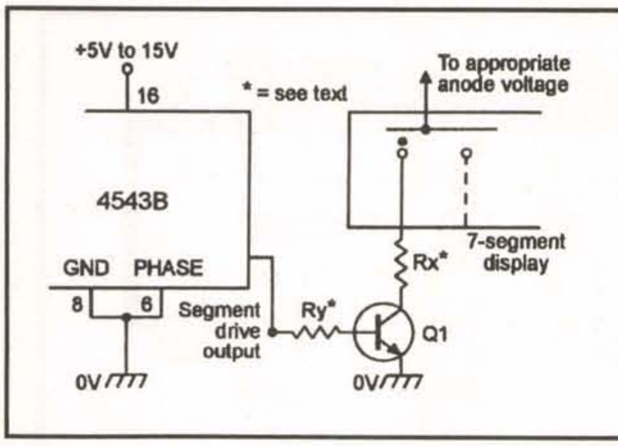


Figure 12. **Driving a gas discharge readout with a 4543B.**

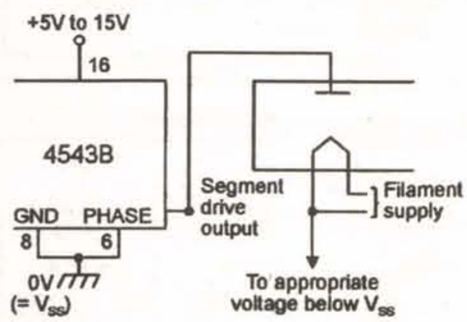


Figure 13. **Driving a fluorescent readout with a 4543B.**

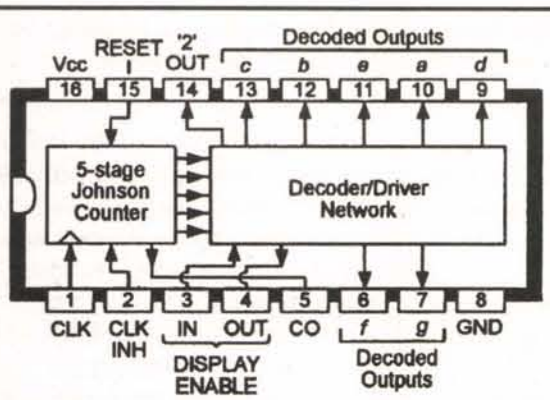


Figure 14. **Functional diagram and pin notations of the 4026B decade counter with seven-segment display driver.**

data latch and has no facility for ripple blanking. *Figure 14* shows the functional diagram and pin notations of the 4026B.

The 4026B has four input control terminals, and three auxiliary output terminals. The input terminals are designated CLK (CLOCK), CLK INH (CLOCK INHIBIT), RESET, and DISPLAY ENABLE IN. The IC incorporates a Schmitt Trigger on its CLK input line, and clock signals do not have to be pre-shaped. The counter is reset to zero by driving the RESET terminal high.

The CLK INH terminal must be grounded to allow normal counting operation. When CLK INH is high, the counters are inhibited. The display is blanked when the DISPLAY ENABLE IN terminal is grounded. The DISPLAY ENABLE IN terminal must be high for normal operation. Thus, in normal operation, the RESET and CLK INH terminals are grounded and the DISPLAY ENABLE IN terminal is held positive, as shown in *Figure 15*.

The three auxiliary output terminals of the 4026B are designated DISPLAY ENABLE OUT, CO (CARRY OUT), and '2' OUT. The DISPLAY ENABLE OUT signal is a slightly delayed copy of the DIS-

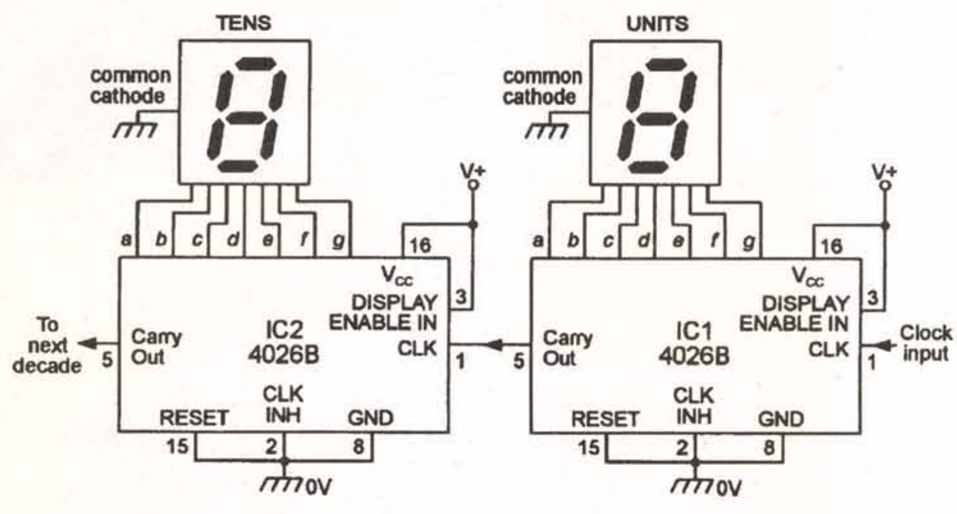


Figure 15. **Basic method of cascading 4026B ICs.**

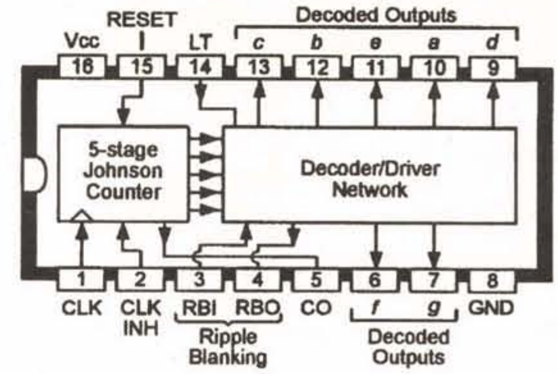


Figure 16. **Functional diagram and pin notations of the 4033B decade counter with seven-segment display driver.**

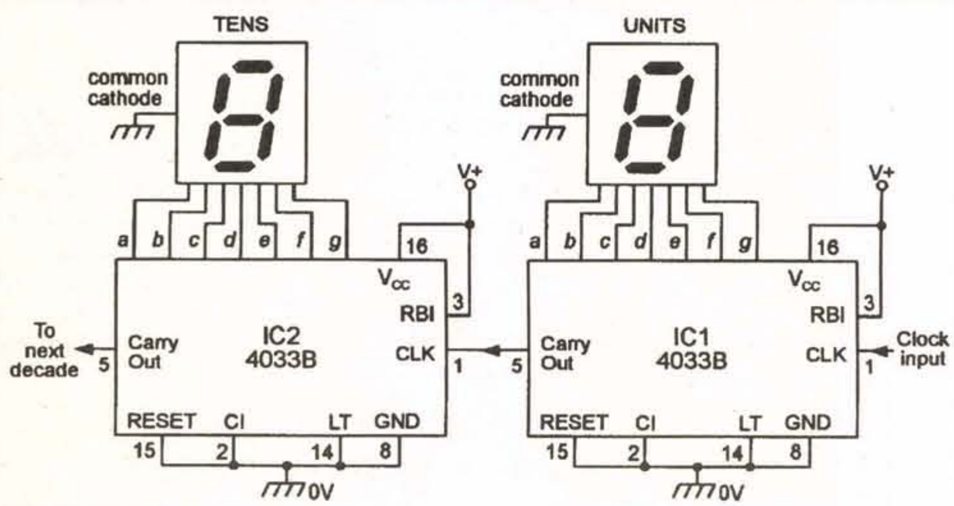


Figure 17. Basic method of cascading 4033B ICs (without zero suppression).

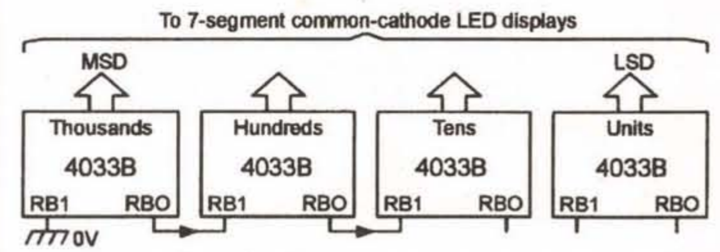


Figure 18. **Method of modifying the *Figure 17* circuit to give automatic leading-zero suppression.**

PLAY ENABLE IN input signal. The CO signal is a symmetrical square-wave at one-tenth of the CLK input frequency, and is useful in cascading 4026B counters. The '2' OUT terminal goes low only on a count of 2. *Figure 15* shows the basic circuit connections to be used when cascading stages.

The 4033B

This device (see *Figure 16*) can be regarded as a modified version of the 4026B, with the DISPLAY ENABLE IN and DISPLAY ENABLE OUT terminals eliminated and replaced by ripple blanking input (RBI) and output (RBO) terminals, and with the '2' OUT terminal replaced with a LT (LAMP TEST) terminal which activates all output segments when biased high.

In normal use, the RESET, CLK INH, and LT terminals are all grounded and the RBI terminal is made positive, as shown in *Figure 17*. This configuration does not provide blanking of unwanted leading and/or trailing zeros.

If cascaded 4033B ICs are required to give automatic leading-zero suppression, the basic *Figure 17* circuit must be modified as shown in *Figure 18* to provide ripple-blanking operation. Here, the RBI terminal of the most significant digit (MSD) is grounded, and its RBO terminal is connected to the RBI terminal of the next least-significant stage.

This procedure is repeated on all except the LSD, which does not require zero suppression. If trailing-zero suppression is required, the direction of ripple-blanking feedback must be reversed with the RBI terminal of the LSD grounded and its RBO terminal wired to the RBI terminal of the next least-significant stage, and so on. **NV**

Check out Peter Crowcroft and Frank Crivelli's article on Page 67. They utilize BCD-to-seven-segment drivers in their projects.

ANOTHER SUPER EXPERIMENTERS SPECIAL, RAYTHEON, LON TALK TERMINAL, Communicates over the AC Line. Using the Industry std. "LONWORKS" System.

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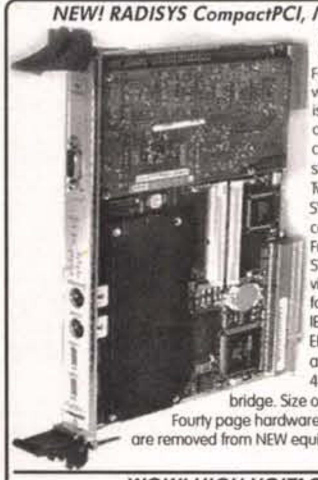

For those of you knoweldgeable in the cPCI world and using a Compact PCI chassis this is a golden opportunity. We were fortunate to obtain these unused units. Each board is capable of driving seven cPCI expansion slots. Front panel I/O and indicators include: Two USB ports, Keyboard port, mouse port & SVGA port. Panel ports are standard PC style connectors. Six LED's show system status. Front panel reset switch. A RadiSys, PMC SVGA II. 2 Meg. mezzanine card provides video up to 1280 x 1024 x 256. Floppy header for debug. Dual 16550C RS-232 ports, one IEEE-1284 bidirectional parallel port, primary EIDE interface and a 10/100Mbs Ethernet LAN all via the J5 backplane connector. Intel 443BX / PIIX4E chipset. Digital 21150 PCI-PCI bridge. Size only 0.8" Wide. Requires one 6U system slot. Fourty page hardware spec. included. Don't miss this one. Units are removed from NEW equipment. Ltd. Qty. Regular price > $1650 **RADISYS-PII....$399**

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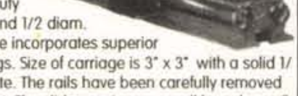
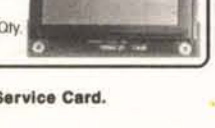
The 11 pound, black anodized base of this superb unit is 13.75"L x 6"W x 2.4"H, The interesting thing is that it machined from a solid Aluminum block which must have weighed in at close to 20lbs. before being hollowed out for the precision IKO recirculating ball slide with hardened steel rail. The carriage is motivated up to 11" by an 8mm diam., 10TPI, lead screw drive coupled to a roller bearing nut on the solid 1" thick alum. carriage. Oh and the lead screw is supported at each end by a ball bearing. On one end of the lead screw is a 15mm diam. toothed belt drive pulley and a 6" matching belt. Optical end of travel sensors on both end complete the package. A stepper motor mounted off the slide drives the belt. We give you the stepper too! This is a rare find. It was destined to be part of a wafer handling machine but now it's yours. Ltd.qty. **WAFERSLIDE-1.............$89ea.**

LINEAR SLIDE, for compact motion. Very high quality, Techno-Isel, series one, German made.



This is the slide you have been looking for! Overall length: 19.5" with an effective travel of 18". Very sturdy, based on a heavy duty 1.5" wide, extruded aluminum and 1/2 diam. steel, dual rail. The slide carriage incorporates superior quality, recirculating ball bearings. Size of carriage is 3" x 3" with a solid 1/2" thick aluminum mounting plate. The rails have been carefully removed from precision optical equipment. The slider carriages are all brand new & unused. Each rail includes one slide carriage. A few extras are available. **ISEL-19........$99ea. EXCAR-1, addtl. carriage only,.......$69ea.**

LCD, 128X64, GRAPHIC DISPLAYS from Varitronix



Type MGLS12864T-G-HT-HV, 128 x 64 pixel module. Standard Toshiba T6963 driver with 8 bit parallel interface. Module size: 78mmW x 70mmH x 10mmD, Viewing area: 62mmW x 44mm H. Dot size: 0.39mm x 0.55mm, Dot pitch: 0.44mm x 0.60mm. with data. An excellent display. Removed from new equipment. Ltd. Qty. **LCD-MGLS128..$24ea. or 3/69**

SPECIAL, PRICE BUSTER, PANASONIC, M-A100-PJ, COLOR, CCD CAMERA, ALL ACCESSORIES SUPPLIED!

Originally destined as the video camera, in a major brand conferencing system. Now available for a fraction of its' original price. Great looking styling. Camera has a very stable, manually adjustable pan and tilt base. Front panel LED power indicator. Excellent video performance packaged in a sturdy 2.9"W x 2.9"H x 4.8"L, 11 oz. package. Simply connect camera to any "Video Input." with the RCA cable supplied. Camera has 5.6mm lens with fixed focus from 18" to infinity. No adjustment required! Power is 12VDC from power adapter also included. 1/3" CCD, 330Lines resolution 37% better than standard VHS! Auto white balance. Externally adjustable sensitivity. Perfect for any general purpose video application. Brand new, in original sealed boxes. Don't miss out.

NEW COLOR CAMERA, 100PJ-CCD.......$59ea. 3 for $149

NEW & IMPROVED, 0.003Lux,UNDERWATER B&W CAMERA, 16X MORE SENSITIVE. Now with 12 INTERNAL, INFRA-RED LEDs!

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF down to 60feet. Adjustable mount included. Specs: 1/3" CCD, 400 Lines res.,super 0.003 Lux sensitivity, AGC, Auto Shutter. 12VDC @200mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area, pipe or ductwork inspection camera. Excellent for general outdoor use as well. **GM-300KX-12..$179**

NEW and IMPROVED, COLOR (down to 60 ft.) UNDERWATER. now with 12, Built-in WHITE LIGHT LED'S,

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustable mount incl. Specs: 1/4" CCD, 350 Lines res., 0.5 Lux sensitivity, AGC, Auto Shutter. 12VDC @200mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area inspection camera. TWELVE, super white LED'S! **GM-400K-12LED.....$229ea.**

DAYLIGHT/LOW LIGHT MINI CAM & A/I LENS,

For dawn 'till dusk applications. Rugged alum. housing, dual mtg. sockets. 1/3" CCD, 420 lines res., 0.1 Lux sens., AGC, 12VDC @120mA. Take full advantage of camera sensitivity with super, 4mm, f1.4, 78° FOV Auto Iris lens included. BNC video out. 50mm sq. X 65mmL. With pwr. adapt. **GM-510A/I...$179 or 2/$349**

B&W QUAD PROCESOR, The GM4-BQ is an unbeatable value. Four camera inputs with loop through. Full screen image, REAL TIME display, high resolution: 960 x480, brightness adj. for each chan. Alarm time (1-20 sec.) 4 alarm inputs. Auto Sequencing mode with adj. dwell:1-4 sec. Quality video processing. Specs: •4 video inputs. •1 monitor out and VCR in/out, •4 alarm inputs •Buzzer •2 Alarm Out •Dim: 239 x166 x55 mm. **GM4-BQ QUAD..........$179**

ULTRA RESOLUTION & HIGH SENSITIVITY, SCIENTIFIC QUALITY for demanding applications. Type GM-6000, offers 410K pixels, 570 Lines resolution, < 0.1 LUX sensitivity. >45db S/N with AGC off. Access all operating parameters, outside the camera! C or CS mount. Adjustable shutter speed from 1/60 to 1/100,000sec, BLC on/off, AGC on/off, gain auto/off, Auto iris selectable, DC/Video with level control, external/internal sync. 24VAC powered, adapter included. Video out on BNC. Industrial quality metal housing.Just the thing for scientific or low light. **SPECIAL, GM6000......$199ea.**

Circle #122 on the Reader Service Card.

Events CALENDAR

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

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

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

All listing information should be sent to:
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Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

JUNE 2001

June 1-2

MS - PASCAGOULA - Hamfest. Jackson County Fairgrounds. Fri: 5-9pm, Sat: 8am-2pm. VE testing. Talkin: 144.510/145.110. Jackson County ARC, Ira Groff NN5AF, 228-826-5095. Email: nn5af@arrl.net

June 1-2-3

NY - ROCHESTER - Atlantic Division Convention. Monroe County Fairgrounds, Rt. 15A. Fri: 6am-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Rochester ARA, Harold Smith K2HC, 716-424-7184. Email: harold@rochesterhamfest.org Web: http://www.rochesterhamfest.org
OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. SEA-PAC, Randy Stimson KZ7T, 503-297-1175. Web: www.seapac.org

June 2

CO - MONUMENT - Hamfest. Lewis-Palmer High School, 1300 Higby Rd. 8am-2pm. VE testing. Talkin: 146.970 or 146.520 simplex. Pikes Peak RA Assn., Inc., Bob Ryals KI0GF, 719-265-9950. Email: rryals@pcisys.net
GA - MARIETTA - Convention. Jim Miller Park. 9am-4pm. License Exams. Talkin: 146.82-. Atlanta RC, Gwinnett ARS, & Paulding ARC, John Talipsky, Jr. KA4VQH, 770-995-6446. Email: johnka4vqh@aol.com Web: http://www.saf.com/arc/atlfest.htm
IL - SPRINGFIELD - Hamfest. IL State Fairgrounds, Cooperative Extension Bldg. AR exams. Talkin: 146.685. Sangamon Valley RC, Edmund Gaffney KA9ETP, 217-628-3697. Email: egaffney@family-net.net Web: http://www.w9dua.net
MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. VE exams. Talkin: 147.16. IRA, Kathy KB8KZH, 616-698-6627 between 4-7pm EST. Web: www.iserv.net/~w8hvg
NJ - HACKENSACK - Hamfest. Bergen ARA, James Joyce K2ZO, 201-664-6725. Email: jjjoyce@cybernex.net Web: http://www.bara.org

June 3

CT - NEWINGTON - Hamfest. Newington AR League, Tom Ponte WB1CZX 860-666-4539. Email: wb1czx@arrl.net
IL - PRINCETON - Hamfest. Bureau County Fairgrounds. Talkin: 146.955 -600 PL 103.5. Starved Rock RC, Jerry Hagemann N9ZJK, 815-538-6932. Email: w9mkshamfest@hotmail.com Web: http://www.qsl.net/w9mks
MI - CHELSEA - Hamfest. Talkin: 145.450-. Chelsea ARC, Inc., Bill Altenberndt WB8HSN, 19501 Bush Rd. Email: wd8lel@hotmail.com
NY - QUEENS - Hamfest. Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. VE exams. Talkin: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Inc., Steve Greenbaum WB2KDG, 718-898-5599 eves only. Email: WB2KDG@Bigfoot.com or Andy Borrok N2TZX, 718-291-2561, email: N2TZX@webspan.net
PA - BUTLER (PITTSBURGH) - Hamfest. Breezeshooters ARC, H. Rey Whanger W3BIS, 412-826-8006. Email: w3bis.sat@juno.com Web: http://www.breezeshooters.net
VA - MANASSAS - Hamfest. Prince William County Fairgrounds. VE testing. Talkin: 146.97-, 224.660-, 442.200+. Ole Virginia Hams ARC, Mary Lu Blasdell KB4EFB, 703-369-2877. Email: mblasd1638@aol.com Web: http://www.qsl.net/olevahams

June 8-9

IN - GREENFIELD - Spring Festival. Hancock County 4-H Fairgrounds. IN Historical Radio Society, Glenn Fitch 765-565-6911. Email: glenn.fitch@cnz.com. Herman Gross, 765-459-8308. Email: w9itt@mindspring.com

June 8-9-10

TX - ARLINGTON - Convention. Ham-Com, Maury Guzick W5BGP, 214-361-7574. Email: chairman@hamcom.org Web: http://www.hamcom.org
WA - DRYDEN - Hamfest. Wenatchee Hamfest, John Lathrop N7RHY, Email: n7rhy@gte.net

June 9

FL - FT. MCCOY - Hamfest. Ft. McCoy ARC, Tom Bench W4BTB, 352-546-2448. Email: w4btb@arrl.net Web: http://www.qsl.net/w4frc
GA - ALBANY - Hamfest. Albany ARC, Bob Smith K4PHE, 229-883-9633. Email: k4phe@isoa.net
ID - RATHDRUM - Hamfest. Kootenai ARS, 208-667-4915. Email: jmonroe@dmi.net
MA - FALMOUTH - Hamfest. Falmouth ARA, Ralph Swenson N1YHS, 508-548-6405. Email: DEPSHER911@AOL.COM Web: http://www.falara.org
ME - HERMON - Hamfest. Pine State ARC, Edward Richardson K1DTW, 207-825-4417. Email: edandglo@earthlink.net
MO - MACON - Hamfest. Macon County, Tri-County, Nemo, & Schuyler County ARCs, Dale Bagley K0KY, 660-385-3629. Email: n0pr@arrl.net Web: http://www.istmacon.net/~kfoster/hamfest.htm
NC - WINSTON-SALEM - Hamfest. Forsyth ARC, Henry Heidtmann N4VHK, 336-761-8223. Email: info@w4nc.org Web: http://www.w4nc.org
PA - BLOOMSBURG - Eastern PA Section Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.bafn.org/~cmarc
TN - KNOXVILLE - Hamfest. The National Guard Armory, 3330 Sutherland Ave. Sat: 9am-4pm. Talkin: 147.300, 224.500, 444.575. Radio Amateur Club of Knoxville, David Bower K4PZT, 865-670-1503. Email: d.bower@ieee.org Web: http://www.korrnet.org/rack
VA - BAYSE - Auction. Massive antique radio, ham, audio, and NASA space auction. Orkney Springs Fire Dept., 10 mi. W. I-81 exit 273 on St. Rd. 263. Preview 8am-11am, auction 11am. Details at http://oak.cats.ohiou.edu/~postr/MRT/
VA - FRANKLIN - Hamfest. Franklin AR Repeater Assn., G. Stewart Tyler WA4JUO, 757-934-2115 or 757-934-5127. Email: stu.tyler@juno.com
WI - EAU CLAIRE - Hamfest. Eau Claire ARC, Jim Staatz KG9RA, 715-838-9108. Email: w9eau@ecarc.org Web: http://www.ecarc.org

June 10

IL - WHEATON - Hamfest. DuPage County Fairgrounds, 2015 Manchester Rd. VE testing. Talkin: K9ONA 146.52; K9ONA/R 146.37/97 (107.2). Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. Email: wa9rij@mc.net Web: http://www.cyber connect.com/orion/smcc.html
IN - WABASH - Hamfest. Wabash County 4-H Fairgrounds, State Rd. 13N. Talkin: 147.03/147.63 -442.325/447.325. Wabash County ARC, Ralph Frank KB9PLV, 219-563-8487. Email: wia1@netusal.net
KY - INDEPENDENCE - Hamfest. Northern KY ARC, Robert Blocher N8JMV, 513-797-7252. Email: nkarc@juno.com Web: http://home.fuse.net/dom/
NY - BETHPAGE - Hamfest. Briarcliffe College, 1055 Stewart Ave. Talkin: 146.850 (PL 136.5). Long Island Mobile ARC, Ed Muro KC2AYC, 516-520-9311. Email: hamfest@limarc.org Web: http://www.limarc.org
OH - SUFFIELD (AKRON) - Hamfest. Wingfoot Lake Park. 8am-3pm. Talkin: 146.985- or 146.520. Goodyear ARC, Rich Kuster N8ZDQ, 330-796-3951. Email: rich.kuster@goodyear.com

June 14-15-16

MD - BELTSVILLE - Flea Market. Sheraton College Park Hotel, 4095 Powder Mill Rd. MAARC, Brian Belanger, 301-258-0708. Email: bcbelanger@aol.com

June 15-16

NE - SOUTH SIOUX CITY - Convention. 3900 Club, Tom Brosamle WB0YNX, 712-252-4107. Email: tands@pionet.net Web: http://www.3900club.com

June 16

AL - RUSSELLVILLE - Hamfest. Franklin County ARC, Christopher Arthur NV4B, 256-332-2889. Email: nv4b@mindspring.com Web: http://www.qsl.net/fcarc
MI - MIDLAND - Hamfest. Midland ARC, Eldon Hall N8STF, 517-643-5101. Email: marc-swap@juno.com Web: http://www.qsl.net/w8kea/
MO - HOUSTON - Hamfest. Ozark Mountain Repeater Group, Blanche White N0FLR, 417-967-3000
NJ - DUNELLEN - Hamfest. Columbia Park. 7am-2pm. Talkin: 146.025/625, 447.250/442.250, PL 141.3 146.520 simplex. Raritan Valley Radio Assn., Doug Benner W2NJH, 732-469-9009. Email: wb2njh@aol.com Web: http://www.w2qw.com
NY - CORTLAND - Hamfest. Skyline ARC, Andrew Slaugh KB2LUV, 607-753-0597. Email: kb2luv@arrl.net
OH - MILFORD - Hamfest. Milford ARC, Chris Reinfelder KB8SNH, 513-753-5066. Email: kb8snh@cs.com
TN - NASHVILLE - Hamfest. Nashville ARC, Bob Malone WB5ZDS, 615-865-6225

June 17

IN - CROWN POINT - Hamfest. Lake County Fairgrounds. VE testing. Talkin: 147.00 repeater, 146.520 simplex. Lake County ARC, Lee Raue, 6401 Kentucky St., Merrillville, IN 46410. Email: leeraue@msn.com
MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., Steve Finberg W1GSL, email: w1gsl@mit.edu (Nick Altenbernd KA1MQX, 617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest .html
MD - FREDERICK - Hamfest. Frederick

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ComputerShow
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Web: http://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

County Fairgrounds, 797 E. Patrick St. 8am-3pm. VE testing. Talkin: 147.060+, 146.640-, 146.520 simplex. Frederick ARC, Carolyn Moroney N3VOK, 301-831-5060. Email: n3vok@erols.com Web: http://www.qsl.net/k3erm
MI - MONROE - Hamfest. Monroe County Fairgrounds, 2 mi. West on M-50. 7:30am-1pm. Talkin: 146.72. Monroe County Radio Communications Assn., Fred VanDaele KA8EBI, 734-587-2250 days or 734-242-9487 eves. Email: ka8ebi@arrl.net

June 23-24

CA - FERNDALE - State Convention. Humboldt ARC, Redwood ARC, Farwest Repeater Assn., & Southern Humboldt ARC, Marci Campbell K36IAU, marcidon@quik.com Web: http://www.geocities.com/clem95501

JULY 2001

July 1

PA - WILKES-BARRE (LEHMAN) - Hamfest. Luzerne County Fairgrounds, Rt. 118. FCC exams. Talkin: 146.61 (PL 82.5). Murgas ARC, Bob Michael N3FA, 570-288-3532. Email: wb3faa@aol.com

July 4

PA - BRESSLER - Hamfest. Emerick Cibort Park. 8am-3pm. VE testing. Talkin: 146.16/76. W3UU Harrisburg RAC, Pete deVolpi K3PD, 717-705-1370 weekdays. 717-938-8249 eves 6-9pm & weekends. Email: w3uu@aol.com Web: http://members.aol.com/w3uu/

July 6-7

MI - LANSING - Swapmeet. Holiday Inn South. 6am-3pm. MI Antique RC, Mark Oppat, 734-455-4169. Email: moppat@flash.net

July 7

CT - GOSHEN - Hamfest. Southern Berkshire ARC, Lee Collins K1LEE, 860-435-0051. Email: lee@leecollins.com
IN - INDIANAPOLIS - Central Division Convention. Indianapolis Hamfest Assn., Rick Ogan N9LRR, 317-257-4050. Email: oganr@in.net Web: http://www.indyhamfest.com
MI - PETOSKEY - Hamfest. Central Elementary School, 410 State St. 8am-12pm. VE testing. Talkin: 146.68-. Straits AREA ARC, Tom Sorrick W8IZS, 231-539-8459
NC - SALISBURY - Hamfest. Rowan ARS, Ralph Brown WB4AQK, 704-636-5902. Email: rbrown@salisbury.net Web: http://www.qsl.net/w4exu/
WI - OAK CREEK - Hamfest. American Legion Post #434, 9327 S. Shepard Ave. 6am-8pm. Talkin: 146.52 simplex. The South Milwaukee Amateur Club, POB 222, South Milwaukee, WI 53172-0102

July 8

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, John "Chip" Moore K9IOC, 815-933-1323. Email: karsfest@yahoo.com Web: http://www.w9az.com
OH - BOWLING GREEN - Hamfest. Wood County ARC, Bob Boughton N1RB, 419-354-1811. Email: hamfest@wcarc.bgsu.edu Web: http://wcarc.bgsu.edu/flyer.html
PA - PITTSBURGH - Hamfest. North Hills ARC, Milton Moratis W3XX, 412-364-0399. Email: mmoratis@juno.com Web: http://nharc.pgh.pa.us

July 12-13-14

MA - WORCESTER - 10-10 Int'l Convention. Ed Emco W1KT, 508-853-3333. Email: w1kt@aol.com Web: http://www.qsl.net/kc1fv/convent.html

July 13-14-15

UT - BRYCE CANYON - Convention. Ruby's Inn. Utah Hamfest Committee, Kathy Rudnicki N7JSH, 801-547-9218. Web: http://www.utahhamfest.org

July 14

CO - LOVELAND - Hamfest. Larimer County Fairgrounds. VEC exams. Talkin: 145.115. NCARC, Rod Cerkoney N0RC, 970-225-0117. Email: n0rc@arrl.net Web: http://www.qsl.net/n0rc/hamfest
GA - GAINESVILLE - Hamfest. Lanierland ARC, Terry Jones W4TL, 770-967-6364. Email: w4tl@arrl.net Web: http://www.mindspring.com/~w4tl/hamfest.htm
TX - TEXAS CITY - Hamfest. Tidelands ARS, Joe Wileman AA5OP, 409-945-6794. Email: aa5op@aol.com Web: http://www.tidelands.org

July 15

MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., Steve Finberg W1GSL, email: w1gsl@mit.edu (Nick Altenbernd KA1MQX, 617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html
MO - WASHINGTON - Hamfest. Zero Beaters ARC, Keith Wilson K0ZH, 636-629-2264. Email: w0bob@arrl.net Web: http://www.hyti.net/~w0bob/zbarc
NY - BATAVIA - Hamfest. Genesee Radio Amateurs, Randy Boyle K2RLB, 716-948-9679. Email: racboyle@iinc.com
PA - KIMBERTON - Hamfest. Fire Co. Fairgrounds, Rt. 113. Talkin: 146.835-, 443.80+ CTCSS 131.8. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. Email: gem@op.net Web: http://www.marc.org/hamfest.html

July 20-21

FL - MILTON - Hamfest. Milton ARC, Walter Yarbrough WA4TFR, 850-994-7335. Email: wa4tfr@worldnet.att.net

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HP 11971K WR42 Harmonic Mixer, for HP 8569B $800.00
HP 70620B Preamplifier, 1.0-26.5 GHz, for 70000 series $3,900.00
HP 8559A/853A-001 Spectrum An., $3,500.00
0.01-21 GHz, 1 kHz res.,w/rackmount frame
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300 kHz-2.9 GHz, for HP 8560 series
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HP 8569B Spectrum Analyzer, $5,500.00
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FLUKE 6060B/AK Synthesized $1,900.00
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2-8 GHz, 1 MHz res.,GPIB
GIGATRONICS GT9000-opt.26A $6,000.00
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HP 8656A-001 Signal Generator, $1,600.00
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HP 8657A-002 Signal Generator, $2,750.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8660C/86602A/86632B Synth. $2,500.00
Sig. Gen., 1-1300 MHz, AM / FM
HP 8660C/86603A/86632B $3,250.00
Synthesizer, 1-2600 MHz, 1 Hz res., AM / FM
HP 8672A Synthesized Signal $4,500.00
Generator, 2-18 GHz, +3 dBm output
HP 8684B Signal Generator, $3,000.00
5.4-12.5 GHz, AM/ WBFM/ Pulse

SWEEP GENERATORS

HP 8340B Synthesized Sweep $20,000.00
Generator, 10 MHz-26.5 GHz, AM, FM
HP 8350B/83522A Sweep Oscillator, $3,900.00
10-2400 MHz, +13 dBm levelled
HP 8350B/83540A-002,004 Sweep $3,900.00
Oscillator, 2.0-8.4 GHz, 70 dB step attenuator
HP 8350B/83545A-002 Sweep $3,900.00
Oscillator, 5.9-12.4 GHz, 70 dB step attenuator
HP 8601A Generator/Sweeper, $400.00
0.1-110 MHz, +20 dBm levelled
HP 8620C Sweep Oscillator Frame $550.00
HP 86222B-E69/8620C Sweep $1,500.00
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HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $375.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86260A-H04 RF Plug-in, $500.00
10.0-15.0 GHz, +10 dBm unlevelled
HP 86290C RF Plug-in, $1,850.00
2.0-18.6 GHz, +13 dBm levelled output
WAVETEK 962 Sweep Generator, $950.00
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HP 435B/8482H Power Meter, $900.00
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HP 436A-022/8484A Power Meter, $1,200.00
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HP 437B/8481D Power Meter, $2,200.00
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HP Q8486A Power Sensor, $1,200.00
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HP R8486A WR28 Power $1,500.00
Sensor, 26.5-40 GHz, for HP 435/6/7/8

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AMPLIFIER RESEARCH MHz $950.00
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HP 415E SWR Meter $200.00
HP 8406A Comb Generator, $500.00
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HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $750.00
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HP 8901B-1,2,3 Modulation An., $2,000.00
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HUGHES 1177H01F000 TWT $1,750.00
Amplifier, >30 dB gain, 2-4 GHz, 10 Watts output
HUGHES 1177H10F000 TWT Amplifier, $2,500.00
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BIRD 8251 1 kW Oil Dielectric Load, DC-2.4 GHz, N(f) $500.00
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FXR/MICROLAB SL-03N Stub Stretcher, $75.00
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GR 874-LTL Constant Impedance $400.00
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HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33321K Programmable Step $475.00
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HP 33327L-006 Programmable $1,000.00
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HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D-011 Dual Dir. Coupler, $450.00
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HP 8431A 2-4 GHz Band Pass Filter, N(m/f) $150.00
HP 8494G-002 Programmable $350.00
Step Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8495H-001 Programmable $400.00
Step Attenuator, 0-70 dB, DC-18 GHz, N
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA $375.00
HP 8497K-004 Programmable $750.00
Step Attenuator, 0-90 dB, DC-26.5 GHz
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $300.00
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HP R382A WR28 Direct Reading $2,250.00
Attenuator, 0-50 dB, 26.5-40 GHz
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
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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 $1,000.00
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HUGHES 45722H-1000 WR22 $1,000.00
Direct Reading Attenuator, 0-50 dB, 33-50 GHz
HUGHES 45724H-1000 WR15 $1,000.00
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HUGHES 45732H-1200 WR22 $250.00
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HUGHES 45773H-1100 WR19 $650.00
Thermistor Mount, -20 to +10 dBm, 40-60 GHz
HUGHES 45774H-1100 WR15 $750.00
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HUGHES 47316H-1111 WR10 $600.00
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HUGHES 47741H-2310 WR28 $2,000.00
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HUGHES 47742H-1210 WR22 $2,750.00
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KRYTAR 201020010 Directional $200.00
Detector, 1-20 GHz, SMA(f/f)/SMC
KRYTAR 2616S Directional $200.00
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NARDA 4247-20 Directional Coupler, $200.00
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NARDA 4247B-10 Directional Coupler, $200.00
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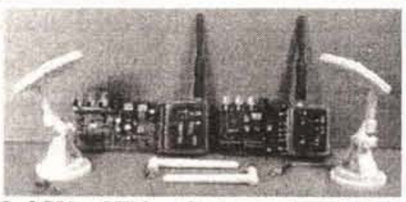

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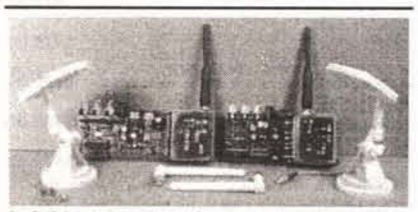

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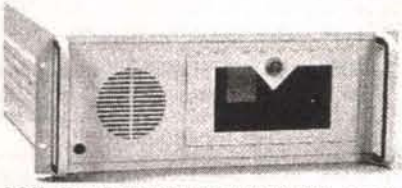

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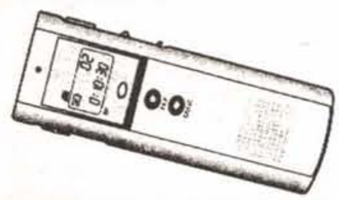

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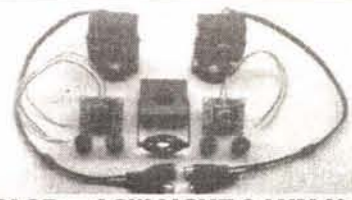

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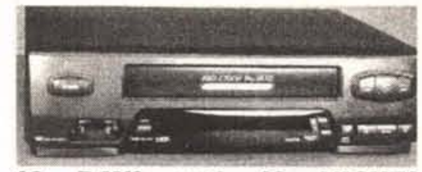

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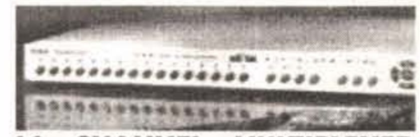

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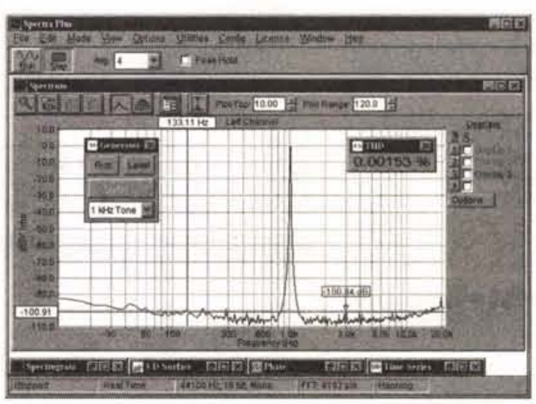

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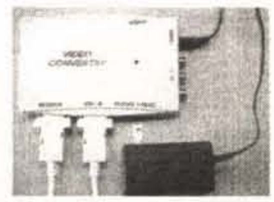

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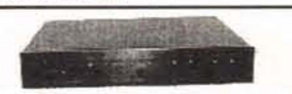

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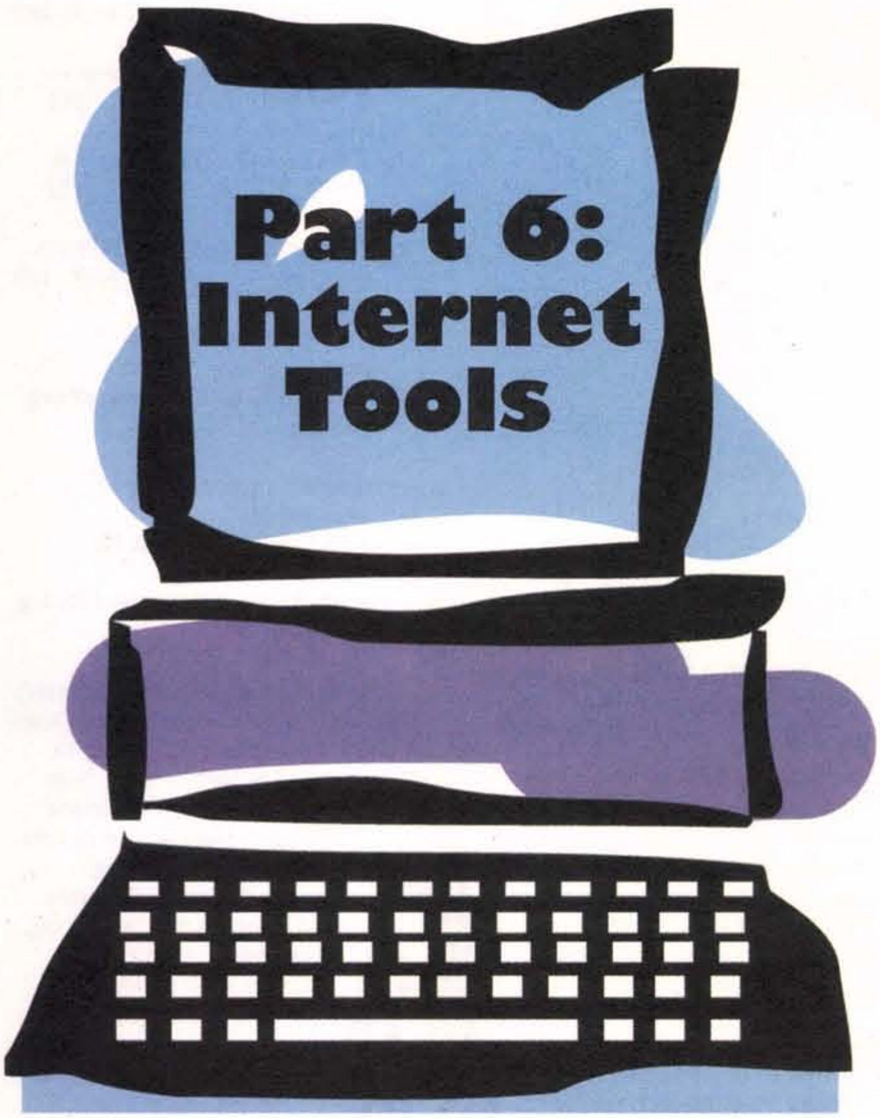
Continued on page 55

Circle #79 on the Reader Service Card.

Cyber-Street Survival

by ML Shannon



Welcome — once again — back to Cyber-Street

In Part 5, we read a little about "Hackers," viruses (virii?), the basics of encryption, and SuperScan — an excellent port scanner. A security and diagnostic tool that, while it can be abused, is a legitimate and necessary application for those who want to learn about IP technology.

In this article, the last in the series, we will rehash a few things from the previous articles, have a short review of NeoWatch (an automated firewall), and details of the exercise where someone in Australia hacked my notebook computer.

The rest of the article is devoted to Network Information tools: programs which you can use for trying to trace spammers, find out more about a company you saw advertised in a banner ad or found through a web search, verify an Email address, and other things.

Some of these tools are built into Windows. They run under DOS, and can be a little confusing — DOS has never been called user-friendly. There are other individual tools that are better, available from various download sites, but the most efficient way is to use a 'suite' — a program that contains most or all of these tools.

Net Demon

The one I use is Net Demon, the new version 3.0 which was released just a couple months ago (April 2001). It has a few things that none of the others do and it costs only $20.00, which is a lot less than it is worth. You can download it at www.netdemon.net (the filename is nd_inst.exe), and install it the same as any other program. Start it and you see the opening screen.

Now, in the last article, I mentioned that you will need the DNS — Name Servers — from your ISP.

Name Servers — as explained in Part 1 — work like this: When you type in the name (URL) of a web site into your web browser, such as www.fusionsites.com, and hit <ENTER>, your ISP uses a name server to convert fusionsites to its IP address; 208.128.203.195.

The IP tool is used to convert addresses back and forth. Click the IP button. In the window type www.nutsvolts.com and click OK. You'll see the screen in Figure 1.

Net Demon has found the numeric IP address for the *Nuts & Volts* site.

Now, do it in reverse, typing in 63.141.52.118 and hit OK.

Net Demon did the lookup in reverse. Try some others if you like.

Configuring Net Demon

At the top left corner, click File and then Options.

Minimize to Tray Icon, if clicked, will place an icon on the system tray so you can open it from there. Start Minimized means that when you first start up Net Demon, you will see that icon rather than the opening screen.

In the window below, you can (but do not have to) enter an Email address. It doesn't have to be your real address; you can use one of the free accounts such as Hotmail or Bigfoot that you read about in Part 3.

Check all of the three little boxes below. Ignore, for now, the Name Server box. We will come back to it. Click OK

Across the top of the screen are a number of icons: The yellow hand is Finger, then Whois, DNS, Traceroute, Ping, a funny face which is Stupid URL Tricks, an envelope which is Email Verify, WWW, Info, and IP as in the above example.

Ping

The icon with the yellow dot and red lines is Ping, which works something like the Sonar systems used in submarines. The sub sends out the signal we have all heard in movies, to see if it returns (bounces off something). Such as an enemy sub or Charlie Tuna. Your computer does the same thing — sends out a signal to an IP address you specify and waits to see if it echoes, bounces back. If it does, there is something at that address. If it does not return, there may still be a computer there, but it is probably in Stealth mode.

Remember Stealth from Part 1? Stealth means that the computer hears the ping, but just ignores it; does not respond. If not, you can go back to Gibson Research at www.grc.com to read about it.

In this example, I will ping the Electronic Frontier Foundation, www.eff.org.

— pinging 204.253.162.11, please wait...
— sending to 204.253.162.11 [204.253.162.11],

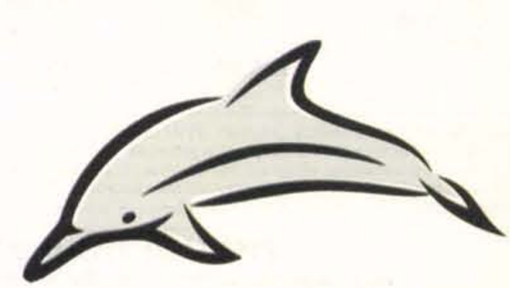
reply from [204.253.162.11] 311 ms
reply from [204.253.162.11] 194 ms
reply from [204.253.162.11] 196 ms
reply from [204.253.162.11] 238 ms
reply from [204.253.162.11] 188 ms

— ping statistics for 204.253.162.11
Five packets transmitted, five received round-trip time (ms) min 188, avg 225, max 311

Since the pings returned, something is there. Incidentally, some Ping programs will have 'TTL' in the report. This stands for Time To Live. The Pings you send only last for so many thousandths of a second. As they go along their path to the desti-

An interesting trick:

You can also use Finger on an IP address, not just Email. When you do a Traceroute, look at the next to the last listing. It will sometimes include the word Gateway. Now copy the IP of this next to last hop and do a Finger on it. You may see, before your startled eyes, a list of everyone who is logged on to the site. Sometimes a very long list.



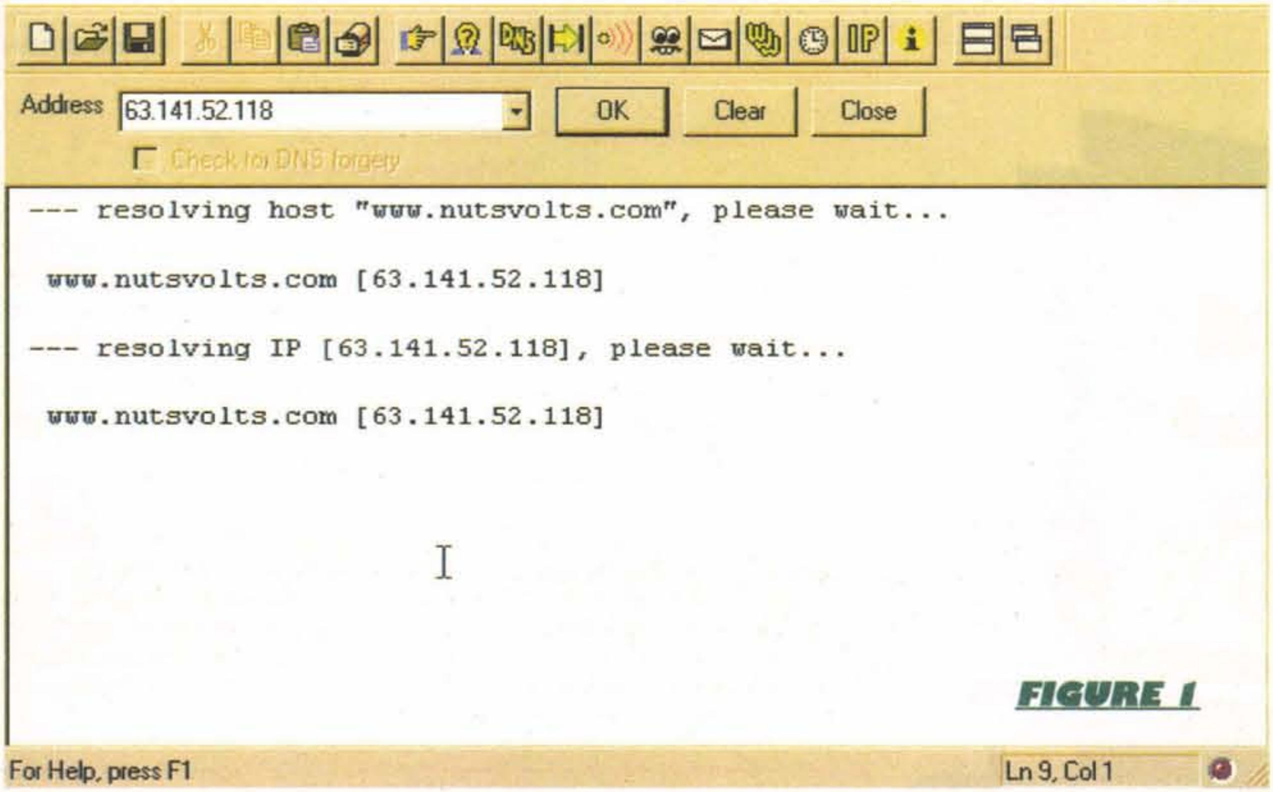


FIGURE 1

nation, they lose some of that life and eventually 'decay' and end.

Traceroute

Remember Hippety Hippety Hop from Part 3? How Email bounces around on its way to the destination? Traceroute will trace this path, showing where each of these hops are. At least in theory, since it doesn't always show all of the hops.

Right! You got it: Stealth!

Click the right-pointing arrow and enter a target, using either the numeric IP or the Domain name.

An example: I will do a trace from the computer used to write this, to a Tecra notebook computer which is also here on my desk. But first, I need the IP. So, using the Tecra, I use IP Agent (from www.grc.com), and get the Tecra's IP which is 208.128.xxx.xxx. Type this into the Net Demon window and hit OK, and it displays:

— looking up host 208.128.203.197
— traceroute to 208.128.203.197 [208.128.203.197],
30 hops max, 18 byte packets

1 [208.128.203.195] halfdome.istep.com 123 ms
2 [208.128.203.197] dial01.istep.com 283 ms

— traceroute statistics for 208.128.203.197
Two packets transmitted, two received round-trip time (ms) min 123, avg 203, max 283

The numbers after the names — 123 and 283 are the time, in milliseconds, it took for the trace.

What it did was send a Ping from one computer to the other through my ISP which is istep.com, so there are only two hops. The Tecra (208.128.xxx.xxx) and my ISP (208.128.203.195). Istep is in San Francisco, only about four miles from here.

As another example, I will use the path from this computer to www.eff.org, the Electronic Frontier Foundation. It is also located here in San Francisco, less than three miles away, so the result should be about the same, right?

I type www.eff.org in the window, hit OK and get:

— looking up host www.eff.org
— traceroute to www.eff.org [204.253.162.11],
30 hops max, 18 byte packets

1 [208.128.203.195] halfdome.istep.com 130 ms
2 [208.128.203.193] router.istep.com 136 ms
3 [204.153.194.149] bordercore1-istep-sf.isp.net 135 ms
4 [205.171.37.237] 205.171.37.237 132 ms
5 [205.171.18.2] sfo-core-02.inet.qwest.net 135 ms
6 [205.171.5.113] jfk-core-02.inet.qwest.net 182 ms
7 [205.171.30.1] jfk-core-01.inet.qwest.net 179 ms
8 [205.171.5.235] wdc-core-02.inet.qwest.net 188 ms
9 [205.171.24.1] wdc-core-01.inet.qwest.net 190 ms
10 [205.171.24.38] wdc-brdr-03.inet.qwest.net 191 ms
11 [205.171.4.70] 205.171.4.70 184 ms
12 [146.188.162.214] 129.at-0-1-0.XR2.DCA8.ALTER.NET 184 ms
13 [152.63.35.249] 152.63.35.249 182 ms
14 [152.63.3.246] 115.at-6-1-0.TR4.SCL1.ALTER.NET 243 ms
15 [152.63.48.137] 499.at-1-0-0.XR4.SCL1.ALTER.NET 183 ms
16 [152.63.48.169] 294.ATM10-0-0.GW2.SCL1.ALTER.NET 181 ms
17 [204.253.162.1] gateway.eff.org 197 ms
18 [204.253.162.11] www.eff.org 198 ms

— traceroute statistics for www.eff.org
18 packets transmitted, 18 received
round-trip time (ms) min 130, avg 175, max 243

What happened here? Eighteen hops to go three miles? Look at lines 4 to 11. All of these IPs belong to Qwest which is sort of like a huge ISP. They have their own fiberoptic cables, and many individual ISPs have their traffic passing through (in and out) Qwest. And, because they are so big, they need a number of routers, each of which has its own IP address. So, my pings bounced around at Qwest, going through different routers until it found the right one.

Explanation: Each router takes the incoming IP address and compares it with its list of tables. If not found, the router says "Hey, this IP isn't one of mine" and it goes to the next router until it is found. "Ah, this IP is one of mine; it belongs here so I'm not sending it on" the router says to itself. Otherwise, then off to the next hop.

WHOIS (Who Is?)

With Whois, you can do things such as find the owner of a web site. Click the icon with the question mark. Type in www.nuts volts.com and you'll see this:

Registrant:

Nuts & Volts Magazine (NUTS-VOLTS-DOM)
430 Princeland Court
Corona, CA 92879

Domain Name: NUTSVOLTS.COM
Administrative Contact, Billing Contact:
Lemieux, Larry (LL347)
larry@NUTSVOLTS.COM
T & L Publications, Inc. 430 Princeland Court

Domain servers in listed order:
NS1.WEBHOSTING2U.NET
63.140.75.240
NS2.WEBHOSTING2U.NET
63.140.75.241
— connection closed

The rest of the information is deleted to save space. Most of the above is self explanatory. Larry Lemieux, the editor of *Nuts & Volts*, owns the Domain name www.nutsvolts.com. Greg Jacobs is at IMAGE-2020.com which is the Internet service provider for the *N & V* web site and also the producers of the new *N & V* site. The Domain servers are the DNS you already read about; they convert from names to numbers and back so you can get connected to the site you want. There are other things you can do with Whois.

You can look up a partial address or a name to track down spammers. This is well explained at http://www.netdemon.net/tutorials/whois.txt which was written by Matt Schneider, the programmer who produced Net Demon. Unfortunately, there isn't enough space here to reproduce the files.

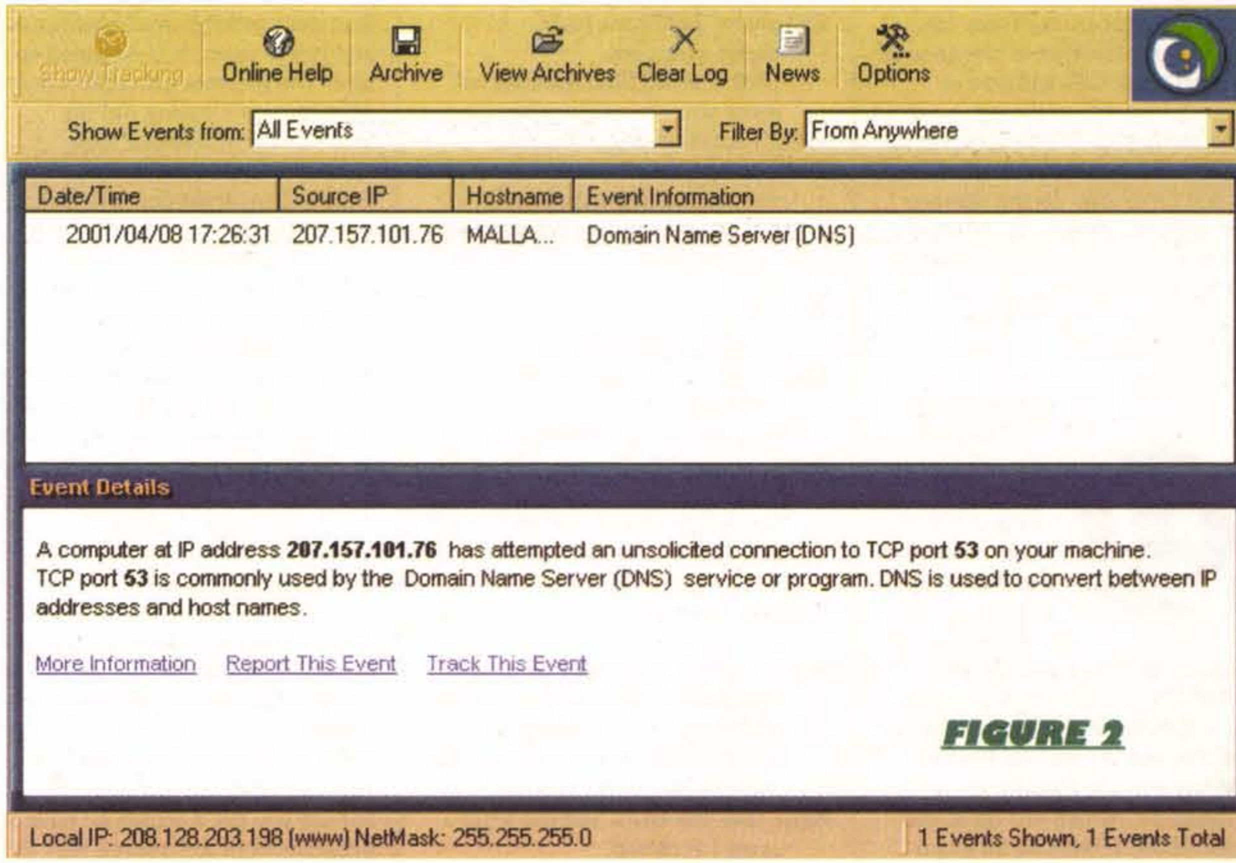


FIGURE 2

Stupid URL Tricks

Spammers sometimes try to disguise their IP address so you can't trace them. But with this tool, you can sort through the gibberish and find the real IP.

One example from the Help file is http://0321.0314.0341.036/768.html. Doesn't look like the IP addresses you are familiar with, does it? Click the icon with the strange face, type it in, and hit OK. Aha! The real IP is 209.204.225.30. To see some more examples, go to http://www.netdemon.net/help/urltricks.html.

Visual Route

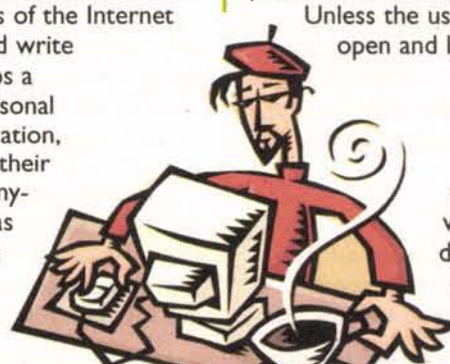
Visual Route is another program that shows the list of hops, and displays this on a map.

You can do an online demonstration at http://www.visualware.com/visualroute/index.html by typing in the URL of the site you want to trace. Or you can download a trial version.

Finger

Finger is a tool used to find information about someone. It was set up in the early days of the Internet when people would write up a profile; perhaps a resume, maybe personal and contact information, that was placed at their UNIX server for anyone to see. This was called a "Plan." But it doesn't seem to be used much anymore. Some ISPs block Finger requests and advise you to contact them directly for more information. Most of the time, however, you will get 'Connection Refused.'

One exception is the publisher of *2600 Magazine*, Emmanuel Goldstein. Click the icon with the hand and type in emmanuel@2600.com to give Emmanuel the Finger, and you will see when he was logged on and if he has unread Email waiting. Try it with some friend's addresses. You never know what you might find.



WWW

This tool is used to connect to an IP that you think is a web site, and want to find out. Just enter the IP and see. If it is, and it is not blocked, you will see the source code of that site — the HTML used for building web sites. Then, you can use your browser to log on. In many cases, you will see 'connection refused' which could mean any of several things. You might be trying to connect to someone's personal computer, rather than a site or a server.

Unless the user has port 80 open and listening, you'll get connection refused. Remember that because you can use port 80 to view a web site, does not mean that port 80 is open, or 'listening.' In the above example of URL Tricks, we resolved to the IP 209.204.225.30. Type this in and you'll see an example of the HTML code. Now, open your browser and enter the same IP and you'll be taken to a school that teaches martial arts. Interesting, no?

Information

The icon with the yellow letter 'i' displays information about your computer. Winsock Version: Winsock, ('Windows Socket') is what Windows uses to make the Internet connection. The version you are using is shown here.

Highest Version: The latest version available.
Description: Description of the winsock
System Status: On Win95.
Max Sockets: 32767
Max UDP Datagram: 65467
Socket Types: Stream, UDP, RAW
Nameserver: ns.internic.net

Local Host: mycomputername, the name you used when Windows was installed.

IP Address: You know what that is.
Resolved Host: Your Internet conection at the ISP.

Back to Configuring Net Demon

If you try to use the DNS tool you may get an error message, 'Host not found.' To make it work, you need to tell Net Demon the IP addresses of the Name Server(s) that your ISP uses. Now that you have tried out Whois, you know how to find them. Click the Whois icon and enter the name of your ISP, such as www.myserver.com and click OK. At the bottom of the window, you will see something like this example:

Domain servers in listed order:
NS1.ISTEP.COM 216.200.201.12
NS2.ISTEP.COM 208.128.203.208
— connection closed
Write down the IP addresses.

Then click File and Options to get the Configuration screen. Check 'Specify' and in the window to the right, enter the first IP address, where in this example, it is

216.200.201.12. You would enter the actual IP you got from Whois. Hit <Enter> and then type in the second IP address, click OK, and you're done.

To verify that it was done right, close Net Demon and restart it. Click the DNS icon. In the window to the right of Server, you will see the first IP that you typed in; the one you got from Whois.

Email Verify

Some of the addresses you find in spam are forged. This tool is used to see if an Email address is valid. To use it, type in the suspected Email address and click OK. The result may be a little confusing, many lines of text with terms that may as well be Greek.

What you are looking for is "Recipient ok" which will be at the bottom of the screen. As an example, I will use the same Email address as in Finger, the publisher of 2600 Magazine. Here is the result:

— 10/09/00 03:17:37 Pacific Daylight Time
— verify e-mail "emmanuel@2600.com"
— looking up mailexchange for 2600.com
— contacting nameserver 216.200.201.12 (216.200.201.12)
— found mailexchange "phalse.2600.com"
— contacting host phalse.2600.com [216.66.24.2]

220 phalse.2600.com ESMTP Sendmail 8.8.8/8.8.8; Mon, 9 Oct 2000 06:13:26 -0400 (EDT)
> HELO istep.com
250 phalse.2600.com Hello dial04.istep.com [208.128.203.200], pleased to meet you
> VRFY emmanuel@2600.com
250 Emmanuel Goldstein <emmanuel@phalse.2600.com>
> MAIL FROM: <mdavis@istep.com>
250 <mdavis@istep.com>... Sender ok
> RCPT TO: <emmanuel@2600.com>
250 <emmanuel@2600.com>... Recipient ok
> EXPN emmanuel@2600.com
250 Emmanuel Goldstein <"|IFS=' ';exec /usr/pkg/bin/procmail"@phalse.2600.com>

— verify completed

Again: It is not necessary to understand all of this stuff. Just ignore it. What you are looking for is Recipient ok which tells you that this is a real Email address.

Now, take the Email address from a spam I received:

michelle_4025292@worldnet.att.net and see what happens.
550 Invalid recipient: <Michelle_4025292@worldnet.att.net>
— verify completed
Not a valid Email address.

This is only part of what you can do with Net Demon. Download a trial copy and see for yourself; a fascinating application. And remember that the help files are very good.

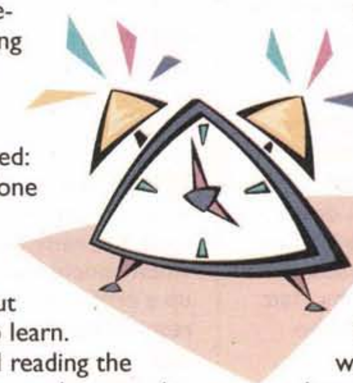
NeoWatch

NeoWatch is described as "The Next Generation Personal Firewall." NeoWatch is a unique personal firewall with intrusion detection designed for small businesses and home users. It is intended to offer the greatest protection possible for users having dial-up Internet service and/or high-speed Internet connections like DSL and cable modems. Check out Figure 2.

Once installed, it detects attempts to access your computer and pops up this screen. You have several options including Trace which automatically runs Traceroute and displays a map with the place of origin and a list of hops, as in the above example with Net Demon.

A very nice program, and there is a 30 day demo available from www.neoworx.com.

By now, you probably have Zone Alarm, which is a different type of Firewall (application specific) so you might like to know that there is no reason why you can not run both of them at the same time. But if you run only one, use Zone Alarm. Should you get a Trojan, or have any program from any source that has been 'modified' to act as a Trojan, Zone Alarm will prevent it from accessing the Internet. Or, as someone who knows a great deal more than I do stated: "Never ever take Zone Alarm down."



Okay, troops, this covers the basics of IP Tools, but there is still a lot to learn. Again, I recommend reading the tutorials at www.samspade.org and www.netdemon.org and the many articles at Gibson Research, and there are lots of web sites that have useful information with which you can increase your expertise.

Looking Back

Now, a short review of some of what was covered in the last five parts.

The Internet started out as the Department of Defense Advanced Research Projects net and evolved into the Internet. Some years later, the government decided that we should have an Information SuperHighway; "A communications infrastructure that will place voice, data, and video information at consumers fingertips," and suggested a budget of half a billion dollars to set it up. Then someone happened to tell them that such an infrastructure already existed, and it wasn't necessary to spend all that taxpayer money.

What started out as a good thing became both better and worse. While the 'new' Internet has become the greatest source of information in the world, big business has made it into a massive mechanism for gathering personal information about consumers. Income, shopping habits, and

HACKED BY INVITATION

On one of the Usenet newsgroups, I hooked up (hacked up?) with a guy in Australia and arranged for him to access one of my computers; a Toshiba Tecra portable. This machine had nothing important on it; I had deleted almost everything getting ready to install Linux.

I wrote to him:
mls at fusionsites dot com wrote:
>On Wed, 13 Dec 2000 01:39:47 -0800, "xxxW" <xxx@xxxxxx.com>
>And how, specifically, will you do this? What ap will you use?

Answer:
>I pull out of my bag'o'stuff a Trojan and put it onto your drive

Application? None, Windows is a fine tool to use to access another Windows system with F&P sharing enabled ... :)

In effect, I connect to your system as if I was on your network, that is, I establish a connection to that drive via NET VIEW \\[ip address] to get the list of shares and NET USE [virtual drive letter]: \\[ip address]\[sharename]
ie: NET VIEW \\127.0.0.1
NET USE Z: \\127.0.0.1\MyShare

This allows me to map your shared drive to a drive letter and affords me all the priviledges I'm allowed i.e., if it's read/write, I can access it as read/write. I've now mapped your share to a network drive on my system and can access it as such.

(In other words, drive C on my Tecra will become another logical drive on the computer he is using.)

Then I sent this:
OK, the Toshiba is online 11:22 AM Pacific time. IP is 208.XXX.XXX.XXX

And he emailed back:
Have a look on the desktop of the laptop (greet.txt)
> At 01:23 AM 12/16/00 +1000, you wrote:
> >-----BEGIN PGP SIGNED MESSAGE-----
> >Hash: SHA1
> >

Greet.txt was a short message explaining that he had in fact accessed the Tecra and made a change in the autoexec.bat file so that the next time I restarted the Tecra, this text file, greet.txt would appear on the screen.

Which it did. Then the Trojan was installed so that he could access the Tecra anytime I was online. Which took him all of 10 minutes. And, if you have F&P Sharing enabled, he, or 10,000 others could do the same. They could even add a 'Butt Sniffer' type of code that would automatically Email them when you went online.

Now, it is true that I had selected a drive to be networked — shared — as well as having File and Printer Sharing enabled. This made it possible for the Australian hacker to access drive C. However, had I not, with F&P enabled, he would still have been able to get to it; to drive C or any of the other logical drives on the Tecra.

For more on how this works, look at http://happyhacker.org and their Guide to (Mostly) Harmless Hacking. But never forget for a second that if you try this on a machine where you are not authorized, and if you get caught, there is the very real possibility that the feds will raid you, take every piece of electronic equipment you have, and put you in jail where you might stay for a very long time.

all the other things you read about in Part 1. You know how to avoid becoming another number, now.

Government wasn't being totally altruistic in making this system available, either. They saw it, or more likely planned it, as a huge surveillance system; a way of compiling dossiers on the tens of millions of people who are online. But you can set up temporary anonymous Email accounts at any of dozens of web locations and use anonymous proxy servers to avoid leaving an electron trail behind you.

You have learned the basics of dealing with the problems that make the Streets of Cyber unsafe; the dark side of the Internet. How to avoid viruses by not opening Email attachments, and to make your computer more secure by using Netscape or Opera instead of Internet Explorer, and Eudora or Pegasus, rather than Outlook Express.

Spam. Just Say Delete is the easiest and least complicated way of dealing with UCE: Spam.

You now know how to see — and control — what information enters and leaves your computer by using CommView. How to — at least sometimes — trace Email and find out who owns a web site with the tools reviewed here in Part 6. Some ways to prevent stalking, but to deal with it should it happen to you. And, you know just a little bit about hacking.

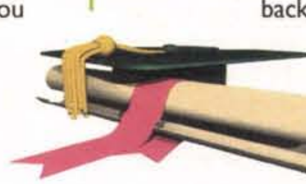
Move to the head of the class. You know more about privacy and security than 90 percent of the people on the Internet. Now: Where do you go from here?

If you want to learn more about Internet technology, a good place to start is to get a shell account and a Telnet program with which to access it. You will need to learn UNIX commands which are a bit cryptic, but once you have the basics, you will be able to connect to Internet locations that you cannot from a web browser. Some UNIX examples are in the Finger report above.

The Final Word: The Future of the Internet

It has been an interesting journey through the Streets of Cyber these past six months, and I hope you have found these articles useful. But what is the future of the Internet? It depends, in part, on people like you. People who read *Nuts & Volts* and similar publications. Who have some interest in what happens when you log on. Who care enough about privacy and security and free speech to do something about it.

Religious extremists tried to pass laws that would have virtually shut down the Internet. And, they will be back. Again and again, trying to force their beliefs on all of us.



The government tried, again and again, to make encryption unlawful except for the cipher (Skipjack) they tried to force us to use.

Laws that the government pass favor spammers with "Opt-Out." Big corporations are filing lawsuits against small web sites to control not only the content of their sites, but what other sites they can even mention or link to.

Carnivore exists. Echelon exists ...

Eventually, it could get to where a person who wants Internet access would have to apply to some federal agency for a permit. Given a numbered card ... Fingerprinted ... Photographed ...

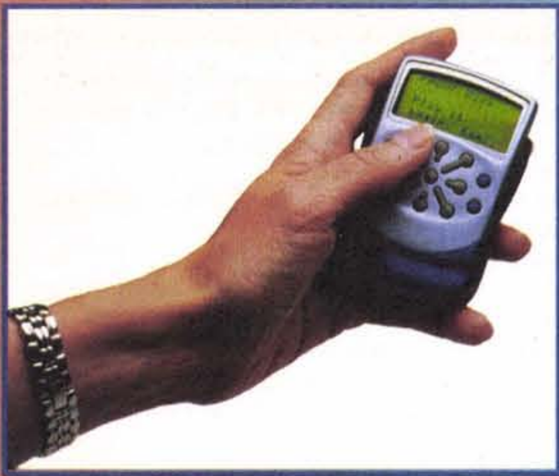
It could happen.

What stands between us and that? The Electronic Frontier Foundation, the ACLU, the Electronic Privacy Information Center, and other such organizations that are fighting to preserve what today most users take for granted.

You can help by joining these dedicated people. Make a contribution no matter how small, and add your name to the growing list of those who would keep the Internet free from total government control. Please, get involved. Volunteer if you have the time.

Defendit numerus; there is safety in numbers.

And the game goes on ... **NV**



Thumbscript™: More Alphanumeric Input, Less Hardware

by Jeffery Smith

In the Beginning

Before the Palm Pilot was invented, I was waiting impatiently for my wife to come out of the fitting room in a department store, just wishing I had a pocket-sized electronic gadget to write some notes. This started me thinking of ways to input text with one hand. I wanted something natural to use and fast, but I began to appreciate the difficulties and tradeoffs of text input with small devices.

I explored the idea of chorded keyboards, where different combinations of buttons represent characters. I built some models using plastic project boxes and miniature switches. I designed a plunger switch with four positions and tried to work out a simple scheme of combinations of buttons. The biggest problem was that the button combinations were hard to remember. Just when I thought I had the best scheme I could think of, I came upon an ad for the Twiddler. It was a good implementation of exactly what I had imagined, but at the same time, seeing the ad in a back page of *Byte Magazine*, it was clear that this was not a product for the mass market. (In fact, the Twiddler is alive and well, a cult favorite of wearable computer enthusiasts.)

I set aside my project boxes, but the idea didn't go away. It was several years later, that I was thinking again about the problem and suddenly saw it in a new way. The world's most common data input device is not the keyboard, but the keypad. Why not think of the nine number keys as a nine pixel drawing tablet? Obviously, the "A" would go from the 7 at the lower left to the 5 at the center and then to the 9 at the lower right corner. I began to draw letters on a nine dot grid. What unfolded was Thumbscript™, a visual keypad alphabet. The visual figures made for easy learning and the nine keys meant simple and inexpensive implementation.

The Inner Workings

All the letters consisted of two strokes, going from START at one of the eight outer keys, passing through the center of the keypad, then going to STOP at a different one of the outer keys. Since the center key was the same for each letter, you would only have to press the START and STOP keys to "write" a character. The center key was implied. The letter "E" was the first one where there wasn't any obvious figure to represent it, but it was a vowel and the next vowel, "I," should clearly be represented as a straight line from the 2 to the 8. Naturally, the vertical, diagonal, and horizontal, straight lines came to represent the vowels E, I, O, and U.

The phone keypad doesn't permit pressing two keys at once, so each letter had to START with one key and STOP with the other. A simple rule was to draw each letter from top to bottom, or if START and STOP were on the same row, from left to right. Mathematically, this meant that the number of the STOP key was always higher than the number of the START key.

Looking further into the math of sequential combinations of two numbers out of a set of eight (the eight outer keys), there are 64 in all. If we set aside the combinations that START and STOP on the same key, then we have 56 left. Dividing these into two groups, those that go from top-bottom/left-right, and those that go from bottom-top/right-left, each group consists of 28 combinations. That was just right for the 26 letters of the Roman alphabet.

The "backwards" combinations could represent symbols and punctuation using a visual resemblance wherever possible. The eight "double tap" combinations where START and STOP are on the same key were obviously right for functions like Space (8-8), Backspace (3-3), and Return (6-6). Numbers started on the number key and ended on the 5 key with the reverse of "o" used for zero. With some work, we were able to show the whole character set on one side of a wallet-sized plastic card (see www.thumbscript.com).

The story of obtaining a patent, forming a partnership with Smart Design — a product design firm — and finalizing the technology is beyond the scope of this article, but what Thumbscript Development, LLC, eventually introduced was a text input system that lent itself to short text message composition on a variety of hardware. Any device with eight electrical actuation points, either in a circle, or in a square with three points per side, could be used for text input. The software to interpret the two-key combinations was simple on any computing platform.

Real World Applications

The first working implementation was programmed on a Newton, using nine virtual keys and software that captured each pair of keystrokes, then looked them up in a 9x9 array variable. We began exploring other applications and designed the "starburst" tactile keys shown on the Prototype Communicator for blind input. We found that pen-based Thumbscript was even faster than the keypad version.

What made it fast was that when you put the pen down on one of nine points, dragged it to another, and lifted it off, you had generated not one, but a pair of distinct electrical events, one for pen-down (START) and one for pen-up (STOP). A Thumbscript letter could be represented by a single stroke that was faster than two key presses or even a complex Graffiti character. In addition to speed, recognition was positive as long as the stroke was placed reasonably accurately. In fact, by our texts, pen-based Thumbscript was 25% faster than Palm's Graffiti.

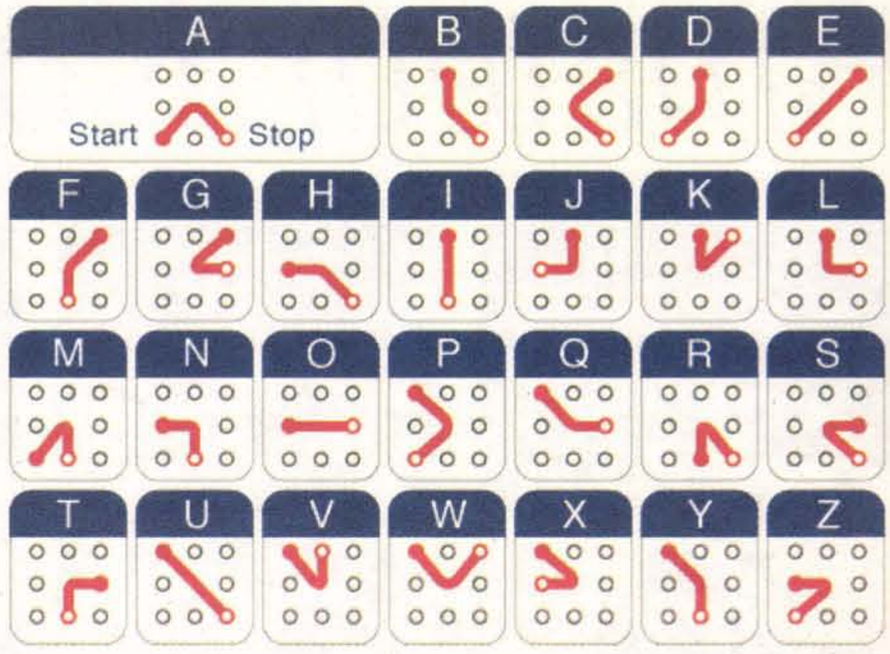
Not only was it faster, but this second-generation Thumbscript allowed full keyboard emulation in a one-half inch pen-sensitive area. Text input would be possible for a Watch computer.

The most recent software version for Palm devices — including Visor and Clie — is Go-Thumbscript, a freeware program that enables Thumbscript input and includes a real-time WPM (words per minute) speedometer to monitor improvement with practice. Twenty words per minute has not been hard to achieve. The software is available for free download on at www.thumbscript.com. In addition, a telephone demo is available at 1-877-THUM. (In Thumbscript, that is 68 49 19 78 where the last digit is ignored.)

Thumbscript for Hobbyists and Experimenters

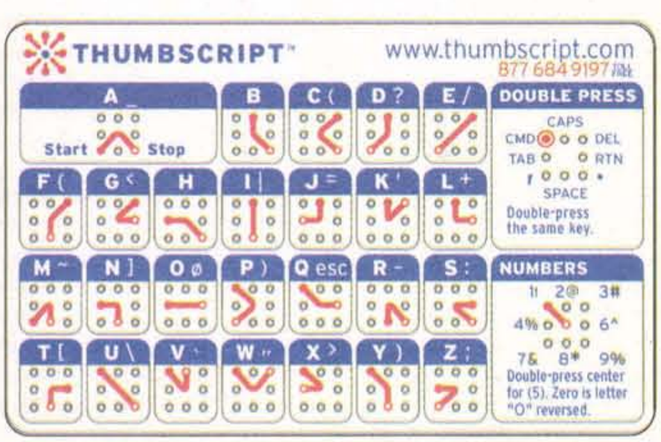
Thumbscript provides a means for inputting the full ASCII character set using no more hardware than a keypad. The software to translate the pairs of keystrokes is simple, even if one includes refinements such as CMD (1-1) + SHIFT (2-2) toggling a caps-lock state. Software simply captures the CMD combination, and sets a flag so that if the following character is SHIFT, then it is treated differently. The logic is within the capabilities of a BASIC Stamp or other microcontroller reading a keypad.

Translation can be performed at either end of a remote communication system. For example, an infrared remote could transmit nine distinct signals from its keypad and the translation could be performed at the receiving end. In another application, an inexpensive modem could recognize DTMF tones from a remote telephone, and feed the data to a computer where plain English commands could be parsed into remote home control codes.



The Basic Thumbscript Alphabet

Wallet-sized Plastic Card Sample



Some Other Project Ideas

- Use a small keypad attached to the steering wheel to input data for an automobile computer.
- Send plain English commands to a robot ... or a model railroad.
- Use servos to position semaphore flags to send visual text messages.
- Build a wireless two-way communicator with keypads and LCD screens.
- Build a scrabble-like word game by presenting random letters, and scoring the words that the player inputs.
- Build a 9x9 grid of touch-sensitive squares and use them for finger input.

Future Directions

The idea of the touchpad as ahandheld input device with both text and pointing functions is very attractive for applications where a keyboard is impractical, such as in harsh environments or applications for the disabled. In the consumer domain, couch potatoes could add text to the list of things their remotes can do.

Thumbscript for foreign alphabets is currently under development.

Another step towards the Thumbscript Cell Phone is a WAP site allowing Thumbscript to enter text email messages from WAP-enabled phones.

Several beta testers have suggested a version of Thumbscript that doesn't rely on a fixed grid, and doesn't require you to look while you write. Conceptually, this is possible and we are working on a prototype "floating grid" Thumbscript in which the START and STOP points of the stroke define the location of the virtual grid.

We are excited by the possibility of a single technology that can solve the text input bottleneck for mobile electronic devices and we are excited by the variety of applications that are possible with this inexpensive, simple, and flexible technology. Even more, we are excited by the thought of what new applications will come from the imagination and ingenuity of individual hobbyists and experimenters. **NV**

jssmith@thumbscript.com

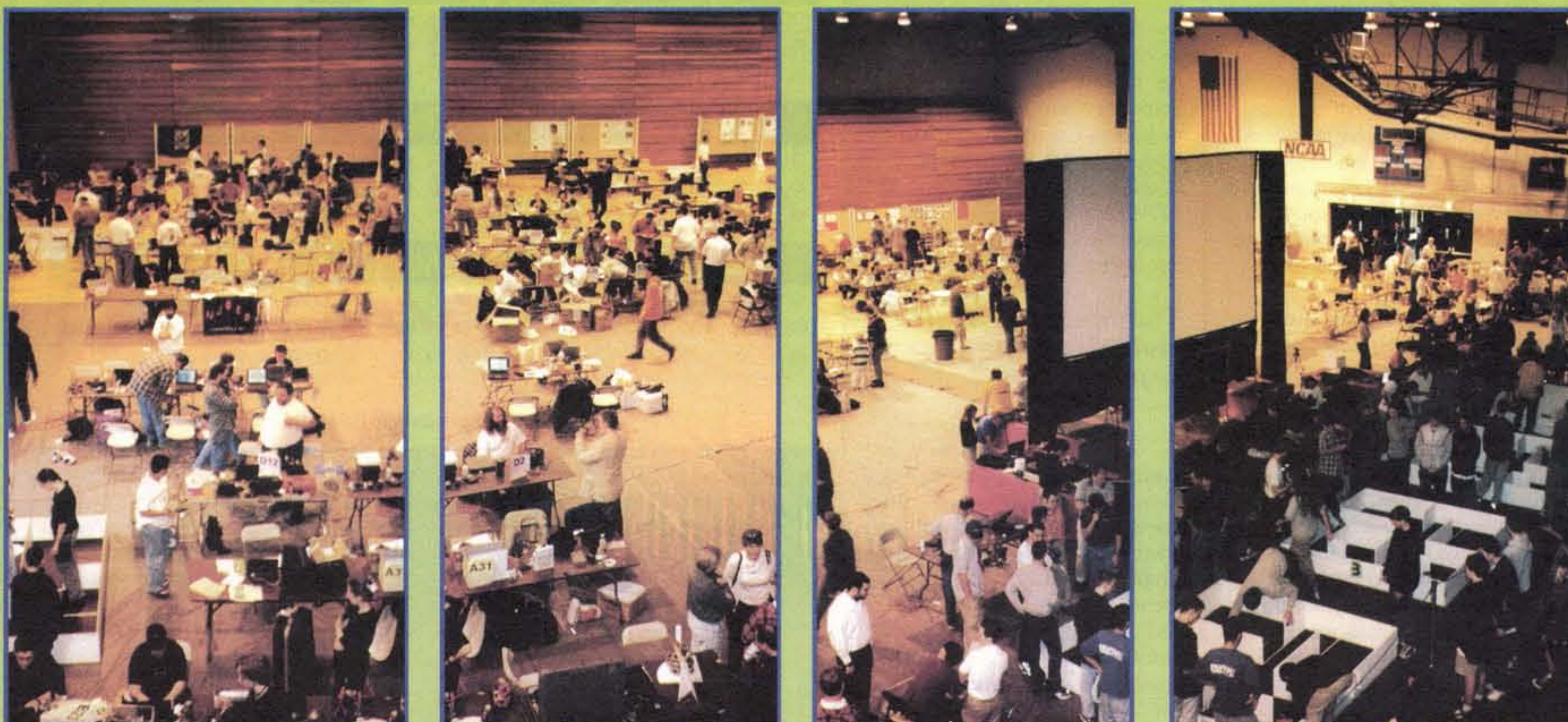
Licensing the Thumbscript Technology

As a patented technology, Thumbscript will come into the public domain in 2019. Prior to that, it is the property of Thumbscript Development, LLC. In order to encourage wide adoption of the technology, we are offering free personal licensing to expermenters and hobbyists. We simply require that you download the licensing agreement, from our website — www.thumbscript.com — give a brief description of your project, and return the signed document to us.

We are also offering easy licensing for small developers, including the possibility of help by marketing your product from our website. Developers should fill out the "Friends of Thumbscript" form on the website and indicate an interest in small developer licensing.

by Robert Nansel

Amateur Robotics



Panoramic view of the 8th Annual Trinity College Fire-Fighting Home Robot Contest site, Oosting Gym at Trinity in Hartford, CT. The four official mazes are lower right and a practice maze is on the left. Robot builders tinker with their machines out in the sea of fold-up tables surrounding the competition arena, and against the back wall are the posters of the poster session. For the 2001 contest, organizers shut off the sodium vapor lighting directly above the mazes; in past years, those sodium vapor lamps have played hob with robot sensors. The new set-up more closely approximates the lighting found in a typical home, but it's still a good idea to make your robot's sensors as immune to ambient lighting conditions as you can. You'll be doing the majority of your tweaking at the contest in the worktable areas which are still in full glare of the gym lighting.

This month, I have a special treat — a photo essay on the 8th Trinity College Fire-Fighting Home Robot Contest. Next month, I'll get back to serious hardware on the Heavy Iron project, but for this month, settle back and relax, y'all, we're going to talk fire-fighting 'bots.

I've now gone to Hartford, CT for the Trinity competition five years in a row. This year's competition — held April 21-22, 2001 — was the biggest and best yet. Over 133 robots were present from 23 states and seven countries; 107 of the robots entered qualified to compete. Last year, there were 130 robots present, but only 81 qualified.

The object of the contest is for the robot to navigate a known maze (simulating a house floor plan) and put out a candle placed at random in one of the rooms of the maze. The robot fire-fighter must fit within a 12.25-inch cube; moreover, it must never extend beyond the 12.25-inch dimension in any direction during operation. The only exception to the latter rule is that use of an external power and/or control tether is allowable as long as the link serves only as a tether to a remote desktop computer. The key is that the robot must be autonomous.

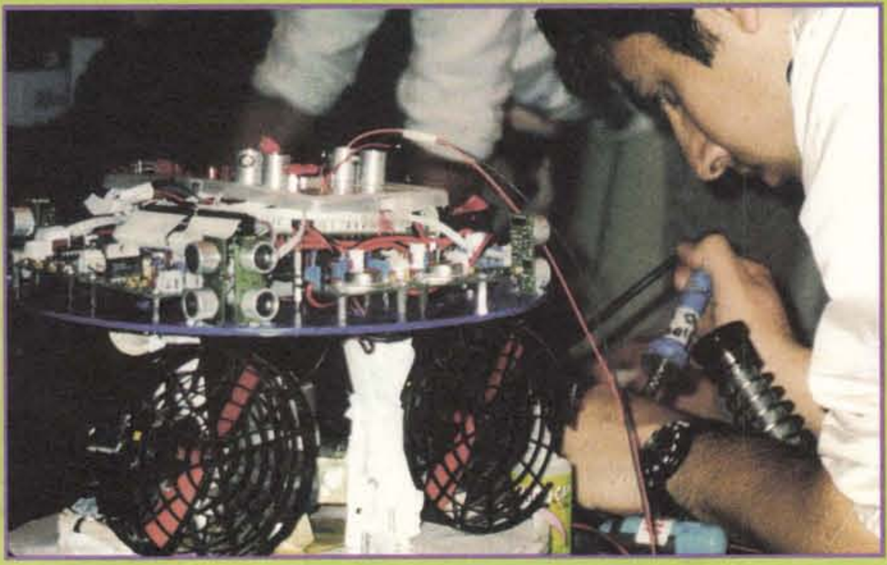
Fire-fighters run on painted plywood and, in some operating modes, must contend with fiberglass "speed bump" ramps in the hallways; ramps are optional, but they get you better scores if your robot deals well with them. A fire-fighter is penalized for ever touching a wall or (worse) the candle. In all but the Expert Division, fire-fighters must recognize white stripes on a dark background because entrances to individual rooms in the maze are marked by such stripes, as are the start and candle positions.

There were a couple changes to the rules this year. The most important change was a rearrangement of the competition divisions. Up until this year, there had always been just two divisions: Junior and Senior. The Junior division included kids up through high school, while the Senior division was for everyone

Text continued on page 86
Photo essay shown on pages 51-53.

Robotics

An Israeli high school student performs the delicate debug cable dance in stocking feet while her robot navigates its way through a practice maze. When something goes wrong during a test run, she has debug information captured at her laptop for analysis.

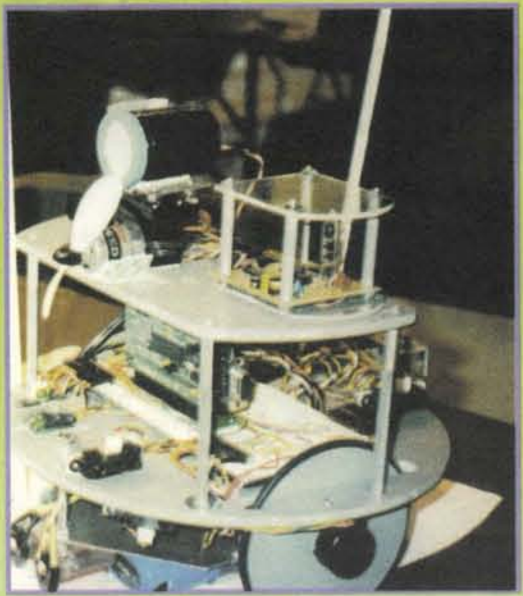


Last minute repairs and rebuilds are the norm during competition. Here, an Israeli student works on his Hovercraft Robot. This machine won the "Spirit of an Inventor" award given to the most unique Robot that does not win the contest, but which shows the greatest creativity and ingenuity. David Salame and Itamar Meridor from Blich High School teamed up to build this nifty 'bot. I heard it could actually hover, but I never saw this in person. The machine ultimately wasn't able to qualify, pointing out the cruel reality of this competition: cool, innovative robots usually don't stand a chance against simpler, but tried and true 'bots.

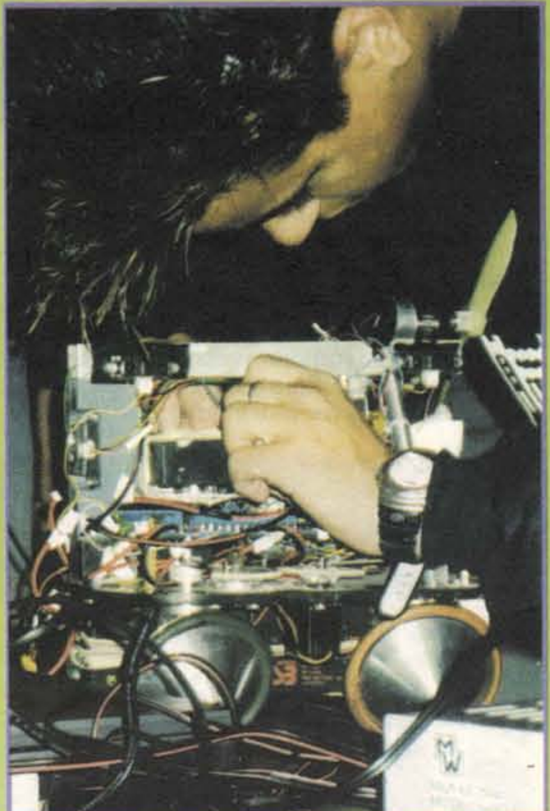
The team of Israeli students from Herzliya Hebrew Gymnasium give a well-earned cheer for their 2nd place finish in the High School Division.

"Nancy" scored 436.71, enough to take 3rd in the tough Expert Division. "Nancy" was built by Acroname engineer Mark R. Whitney of Colorado. Mark is no stranger to the Trinity competition; in both '99 and '00 he brought highly original bipedal walkers to the competition; first "Stampy" and then "Mrs. Stampy."

When you go to Trinity there are plenty of reasons to smile, not least of which is rubbing elbows and sharing tips and techniques with several hundred like-minded gearheads from around the world.



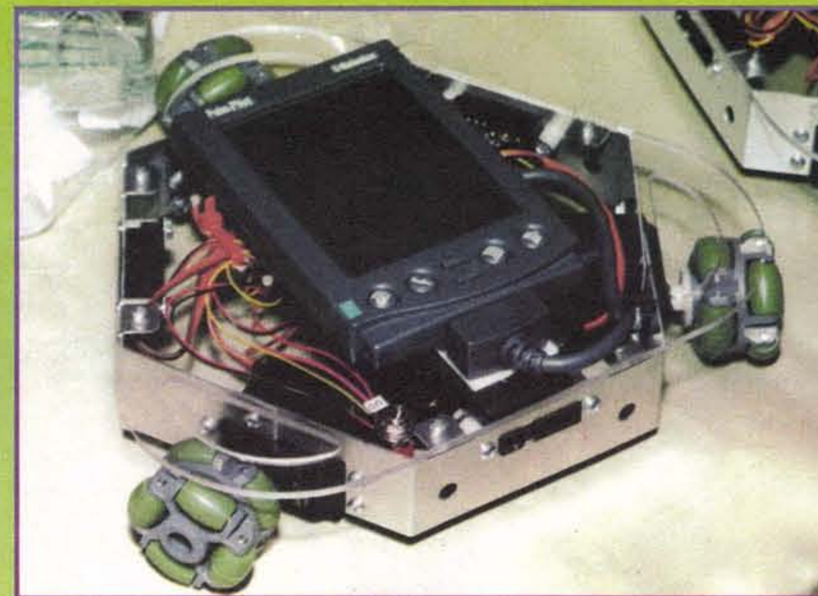
"Snuffy the Shamfire Slayer," built by Alex Brown of California, placed 1st in Senior Division with a blazing score of 2.01. Alex is a member of the Robotics Society of Southern California. Note the use of toothbrush heads as casters.



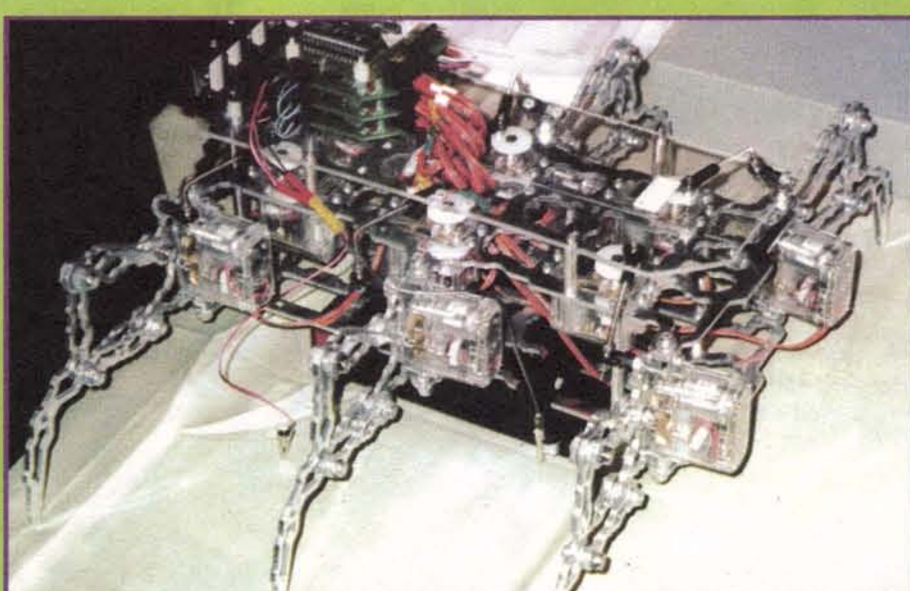
Sometimes the last-minute tinkering pays off. This robot, named "Bentz," placed 2nd in the High School Division with a score of 8.56. It was built by a team of Israeli students from Herzliya Hebrew Gymnasium and featured a unique omnidirectional synchro-drive.

Robotics

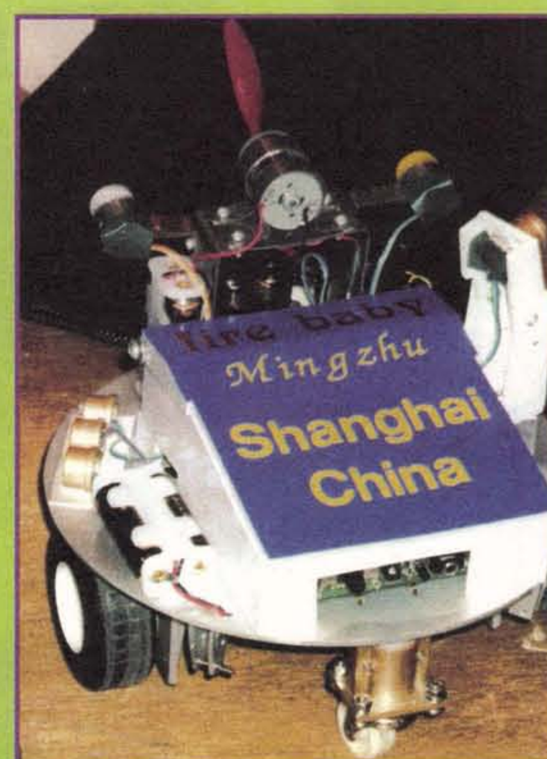
Nine-year-old Jessica A. Krawec, grade 4, received the Youngest Competitor Award which is given to the youngest competitor who actually builds their own Robot. Jessica's robot, "Smaug," tied for 8th place in the Junior Division. Jessica and her brothers Walter and Robert are home schoolers in New York. This was their second year competing at Trinity.



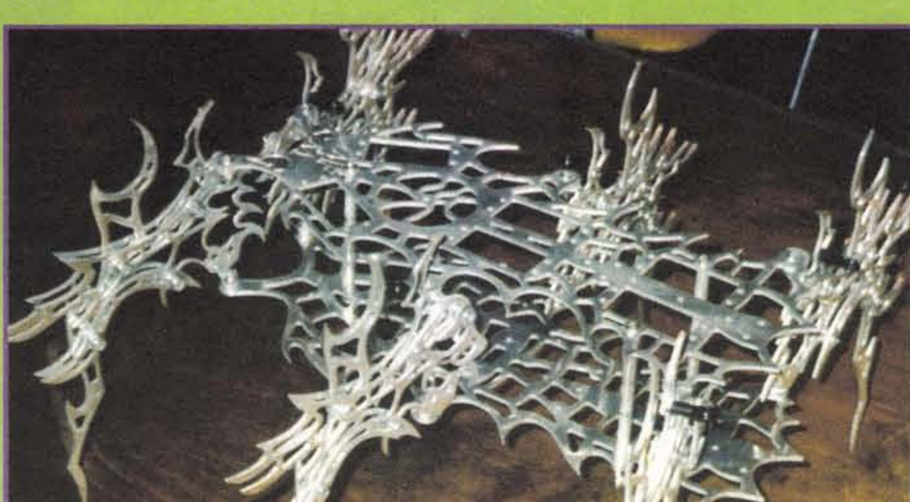
Steve Richards of Acroname brought assembled examples of their PPRK — Palm Pilot Robot Kit. This kit is based on a design by a Carnegie Mellon undergraduate, and uses a holonomic drive system. Steve brought lots of other robot parts and kits to sell to appreciative robot builders.



Another hexapod frame designed by Marcus Fink, though this one isn't so likely to cause lacerations as the Gothic. Here it's been fully tricked out by the folks at Acroname with transparent-case servos and Acroname's new Brainstem controllers (the three stacked circuit boards on top). Check out Acroname.com for more info.



Firebaby, 1st place winner in the Junior Division with a score of 25.56. Firebaby's builders are He Gang, Li Banruo and Zhou Miyuan of Mingzhu Middle School in Shanghai, China. This was China's first time sending teams to compete at Trinity, and they did very well indeed: other teams took 2nd in the Junior Division ("UFO," score: 95.62) and 1st in the High School Division ("Superstorm," score: 2.90).



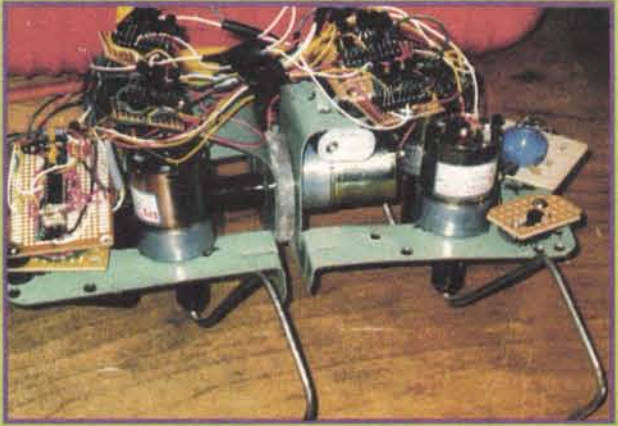
Looking like a Klingon's idea of a Furby, this is a "Gothic Hexapod" robot frame designed by Marcus Fink, a Hollywood animatronics engineer. Scott Savage of Savage Innovations brought this frame to Trinity for display (it's too large to compete in fire-fighting). Though no servo motors or OOPIC controllers are yet installed, I'd vote this 'bot as Most Likely to Draw Blood.

This is "UFO," 2nd place Junior Division with a score of 95.62. The builders are Gu Chengzhe and Shen Miao of Shanghai 2nd Middle School, China.

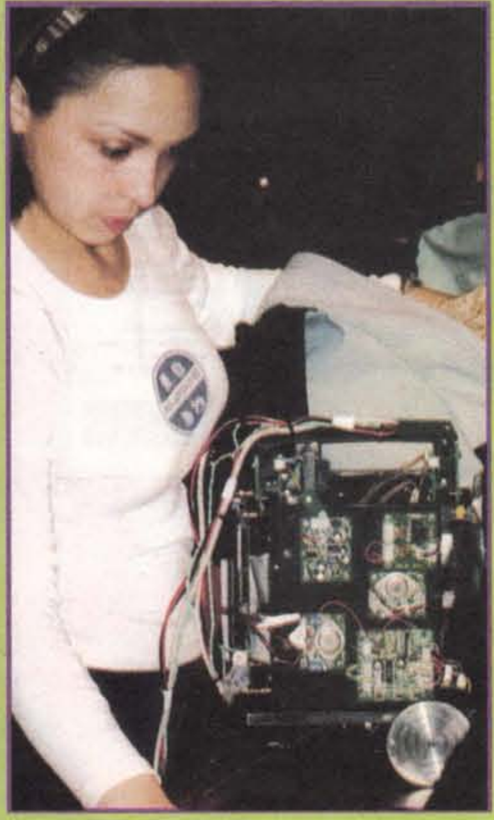
Jim Cannaliato with "Oculus," 1st place winner in the difficult Expert Division. Jim also received an award from Savage Innovations for the best use of an OOPIC in a robot. This was Jim's second year competing at Trinity. "Oculus" scored 4.57. To give some perspective, the 2nd place finisher "Mini-Bob" scored 401.75, a ratio of about 88 to 1.

Rex Marling and his robot "MicroRX" intended for the Senior Division. Rex went from having the messiest robot last year to one of the neatest this year. Though his 'bot didn't qualify this time around, I predict that Rex will build an even prettier robot next year. Rex is a pharmacist in Indiana.

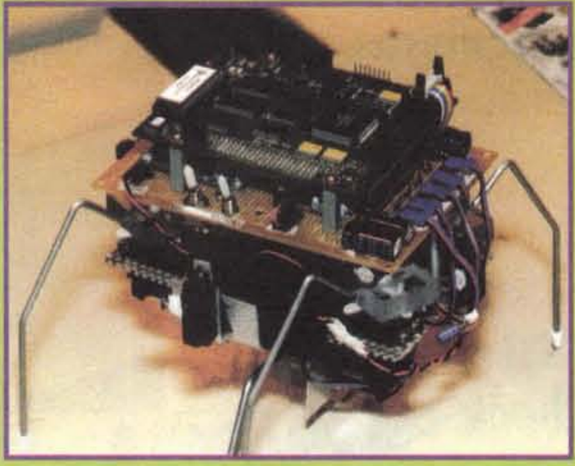
Another view of Jim Cannaliato's "Oculus." The small white cylinder at the top of the robot is a Dinsmore magnetic compass sensor used to help the robot make precise turns. Jim had some problems during his runs because the compass sensor readings deviated significantly when the robot was near the thick steel tubes being used to simulate furniture in the rooms. His design was robust — and lucky — enough to recover from this, but anyone planning on using magnetic compass headings in future competitions would do well to devise some way to dynamically compensate for local magnetic distortions caused by the steel "furniture." Maybe an array of widely separated compass sensors would do the trick.



A five-motor BEAM-style quadruped robot with four leg motors and one "waist" motor. I estimate this robot cost about $120.00 to build, most of that for the motors (those cost $19.95 each at Jameco.com). A single 74HC14 hex Schmitt Trigger operating as a "Microcore" controls all five motors, with discrete-transistor H-bridges on small perfboards at the top of the robot providing power drive. The legs are made from steel croquet wickets and the two body frame segments are, as the builder told me, made from "off-the-shelf components" (that's right, they are modified steel bookends). This 'bot was actually intended to enter the competition, but wasn't finished soon enough, so all the fire sensing and suppression gear was removed for sake of appearance. Too bad. I'd love to see a BEAM robot enter and win this competition some day.



When you design a robot to compete at Trinity, design it with debugging in mind from the beginning. This Israeli high school student's robot uses a serial communication umbilical to capture debug information during live test runs. Heavy-gauge power wires are taped to the serial cable to save battery charge during lengthy debugging sessions. If it were me, though, I'd also put some opto-isolation in between that umbilical and the laptop. Things get hectic and confused during competition, and it's just too easy to make a mistake that releases blue smoke from your machine; this is bad enough if the smoke comes from your robot, but it's devastating if the smoke comes from your laptop.



"Hexabob," another hexapod walker, this one designed by a team of Trinity College students, won 2nd place in the National Collegiate Inventors & Innovators Alliance Award (www.nciia.org). This award is given to students in American universities and colleges for innovative designs and unique concepts. Like the BEAM walker, it is a five-motor walker intended to compete in the Fire-fighting competition (only it wasn't finished in time). Unlike the BEAM robot, this one cost considerably more to build than the $250.00 prize money it garnered. For instance, it uses a 32-bit single-board computer with a Motorola 68332 CPU. That board alone cost more than the entire BEAM walker. How can a hexapod work with only five motors? If you look closely at the photo you'll see the two center legs are shorter and lower than the others. Actually, they are really one leg with two feet. Rather than a waist motor, this walker uses its specialized center leg to control the body roll of the robot.

Continued from page 42

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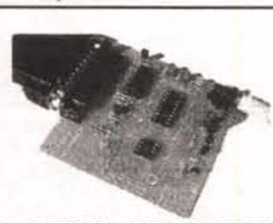

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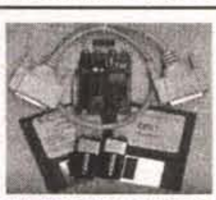

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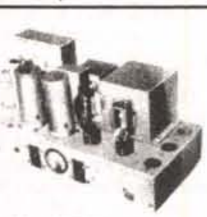

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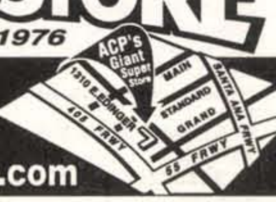

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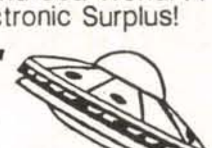

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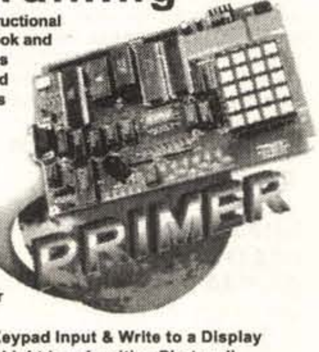

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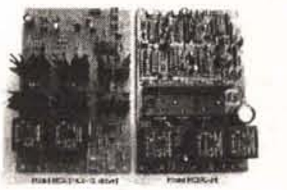

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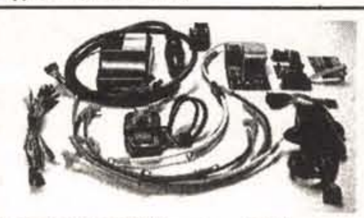

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ROBOTS WANTED: Dead or alive, whole or parts. Marvin (Iowa Precision), Gemini, RoPet, Hubot, RB5X, Newton SynPet, ComroTot, ELAMI, ITSABOX, HeathKit (HERO JR, 1, 2000, or Arm Trainer), Androbots (TOPO, BOB, Fred, and Androman), Rhino, Maxx Steele, Omnibots, etc. Also looking for robot prototypes, options, and literature, will pay cash. Please E-Mail rdoerr@bizserve.com Call 810-777-1313 or write to: Robert Doerr, 26308 Cubberness, St. Clair Shores, MI 48081.

3AMP STEPPER motor microstepper. 2-4 Axis, easy connection to parallel port. Under $200. WWW.Brewingtons.com

SERVO CONTROLLERS liquidation of inventory, 1,500 units, manually operated for robotics and R/C use, now taking offers on wholesale values. For details: www.sattronics.bigstep.com Email: zdtvguy@hotmail.com

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Features: Ventilating holes. Self-adhesive feet and screws included. Front and rear panels: 0.05" (1.3mm) aluminum alodine (painted white). Top and bottom covers: 0.04"(0.9mm) phosphated steel (painted black).

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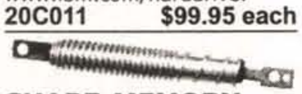
GC3119G 3.5"H x 8"W x 7"D **$15.00**
GC3119K 3.5"H x 17"H x 11"D **$26.00**

IBM LAPTOP HARD DRIVE
3.25GB ATA/IDE, 5VDC @ 500mA, 4200RPM. 6304 cylinders, 16 heads, 63 sectors C/T, 2.5" form factor commonly used in laptops. Label has setup info. 3.875"L x 2.75"W x 0.375"D. Model DBCA-203240, Part Number 21L9530. Info at www.ibm.com/harddrive.
20C011 $99.95 each



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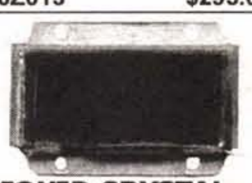
20Z013 $295.00



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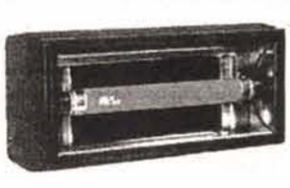
0.5" x 1.625" active area. 0% to 23% transmission. Switching rate up to 4 KHz. Specs included.
92L012 $9.95 each



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Avon "Derma-Spec" imager designed for skin evaluation, but ideal for many other applications. Plastic case contains a UV-B bulb and reflector. Auto turn-off after 50 seconds. Powered by 12VDC @ 500mA wall adapter (not included).
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HVCA Part No. HDB7.5. 7500 Volts, 1.3 Amps. Standard recovery. Docs available at our web site.
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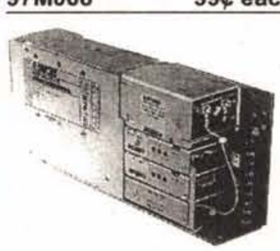
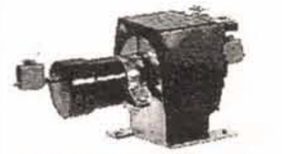
Auto light control, NTSC, 5V camera. Dimensions: 4 1/2" Long x 2 1/2" Wide. Cables, (keyboard plug power adapter for use with PCs and video capture card) included. Runs on 5VDC @ 100mA. To use independently of PC (CCTV, VCR, etc.), order our 99E006 power supply ($7.95).
99V006S $49.95

FUJI BIPOLAR STEPPER MOTOR
Four-wire bipolar stepper motor, 15°/step, 13V, 38 Ohms, approx 300 mA.
Fuji Part #SM35-2006.
97M008 99¢ each



SWITCHING POWER SUPPLY
Input 105-250VAC, 50-60Hz. Outputs 24VDC @ 15A, 5VDC @ 8A, and 24VDC @ 4A. Size: 5" x 2½" x 12". Weight 4.4 lbs.
20E023 $39.95



MERCURY RELAY
Contacts: N.O.,35A, 480VAC. Coil: 240VAC. SPST. Magnacraft P/N WM35A-240A.
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T1¾ ultrabright white, 5600 mcd. This will stun your eyes!
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HARD-TO-find parts: big screen screens, keypads, picture tubes, flybacks, tuners, CRT sockets, & modules for all TVs. Service manuals. 478-272-6561. Scarborough TV, 1422 Old River Road, East Dublin, GA 31027. scarboroughstv@pcnow.net

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ISOLATION TRANSFORMER: 200-240 input, 1200 @ 13A output, 1,600 watts. Go to www.surplusvalues.com/trans.jpg for pictures. Well marked terminals. Great for machine shops! 12 available @ $40 each plus shipping. Shipping weight 40 lbs. each. VISA/MC. Call Roger at GS&E, 716-338-7001.

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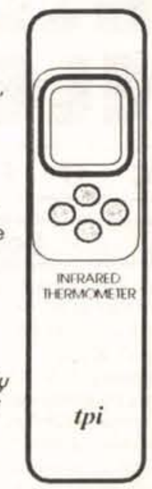
Top 10 Favorite Gateway Gizmos and Gadgets

VOICE CHANGER KIT $49.50
Change your voice with this really cool kit! Using DSP (Digital Signal Processing), you can make a man sound like a woman, make a woman sound like a man, create scary monster sounds, and have lots of fun. Use the special echo and vibrato modes for additional special effects. Kit features clip-on electret mic, removable speaker with case, sound effects selector switch, adjustable volume control, up/down pitch shifts, and step-by-step instructions. 3.5mm jacks for the microphone and speaker make it easy to connect to other audio equipment. Requires 4 AA batteries (not included.)



Infrared Non-Contact Laser Thermometer *introductory price* **$149.95**
This is such a cool thing, you gotta get one! No more climbing ladders or going down manholes trying to find temperatures. Are the rafters hot? How hot is that car? Point this little gizmo at almost anything and it will give you the temperature! Uses a laser sighting to help confirm target, and features an easy-to read large LCD. Fahrenheit or Celsius selectable. Features a 0.95 emissivity, 8:1 distance to spot ratio, 0.1 resolution, and a temperature range of 14 to 950 degrees Fahrenheit. Manufacturer's 3-year limited warranty.
*shipping this item requires insurance, please add an additional $0.50

Lightwave 2000 Flashlight $29.95
Four super-bright white LEDs replace the bulb you'd find in a traditional flashlight, providing a long-lasting high-intensity light. LED lights mean your flashlight will last about 14 times longer than a regular flashlight, and these flashlights are waterproof and shockproof. Ideal for short-range use in cars, planes, etc.
Flashlight requires 3 AA batteries (included). Manufacturer's limited lifetime warranty even includes the LED lights!

Spectrum LED A Rainbow of Light ! $5.95
Imagine an LED capable of producing all three primary colors in the same package! The entire spectrum, including near-white, can be created! Imagination becomes reality with this T 1-3/4 multi-color LED. Here's the technology: a red chip, a green chip, and two blue chips encased in a diffused T1-3/4 package. Using various current combinations, you can produce red, orange, yellow, green, aqua, blue, violet or white light! Detailed spec sheet included. What can you do with these (beyond the obvious amaze your friends!)? Create a single indicator system, designate various controls by color, make a multi-color bargraph, make your project something out of the ordinary with multicolor LEDs!

Lighted Screwdriver Supertool! $9.95
At first glance, this appears to be an ordinary screwdriver, but press a button on the base and two lights illuminate the area you are working on. Nifty, huh? But wait, there's more! The seven interchangeable bits are stored right there at the base of the screwdriver (6 storage slots) for easy access. No handles to unscrew or tool boxes to dig through. Hey, you ain't seen nothin' yet...remove the bit and the magnetic retrieval tool telescopes from the screwdriver shaft! Incredible!!! Of course, the comfort grip handle and rugged construction are icing on the cake! Definitely a 'gotta have it' tool!

The Photon Microlight II
A super bright keychain LED flashlight, push to light or switch on for continuous bright illumination. available in a variety of colors. Blue, Green, White, Turquoise, Red, Yellow, or Orange $15.95 (please specify)

AMAZING MINI MICRO FM RADIO! $7.50
Much lighter than a heavy jam box with really good sound! This tiny radio (1.5"x1.06"x0.38") has a seek button, reset control, and an on/off switch. Personal listening has never sounded better! Ideal for ballgames, beaches, and workouts. Battery and nugget style earphones included.

Geophone vibration sensing kit *Detect a fly stomping across the desk!*
Well maybe not that sensitive, but almost. These vibration sensors made by Geosource® were used in oil exploration to determine geological statistics. They are made with a magnet suspended in a coil and are very sensitive to vibration. Compact size, the unit measures approx. 1.6" high and 1.2" dia.
The kit includes a geophone vibration sensor along with parts to build a basic detector that will light an LED. In addition we include a schematic that will show you how to operate a relay. The sensitivity is adjustable, so you can set it to detect elephants and other small creatures. Similar units were used by our armed forces to detect enemy troop movements...the perfect device to alert you to the pitter patter of little Leroy's feet! Unit sensitivity can be set high enough to detect a business card dropped on a table, and we've made it work with vibrations up to 40 feet away! Earthquake or Aunt Agatha...you decide! It's a fun gadget with many uses.
COMPLETE GEOSENSOR KIT....$ 9.95 GEOSENSOR UNIT ONLY....$7.95

RF LINEAR POWER BOOSTER AMPLIFIER KIT $39.95
A quick and simple boost for signal generators, transmitters, and other low power devices, this kit can boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz. Operates on 12 to 15 vdc @ 250 mA, via a 2.1mm male power jack. 38 dB gain at 10 MHz, 10dB at 1000 MHz. Optional case $14.95

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Tired of lugging the VCR to another room to see a movie while Aunt Martha watches reruns of the Julia Child special on PBS? Sick of stringing wires through the house so Junior can watch the latest Power Ranger movie in the comfort of his room? Never fear, we've got the solution! This kit allows you to send any audio and video source, like a VCR or TV camera, to any TV set for up to 300 feet. With this little kit, you're the producer and the programming director of your own TV station. Tunable to any TV chahnnel 2-6, runs on 12 VDC, and accepts standard audio and video signals. Optional matching case set, $14.95

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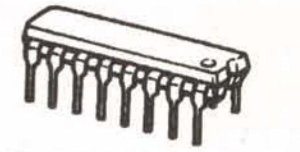

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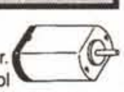
Miniature DC Motor



Mabuchi # FF-N20PN
Miniature 1.5 to 3 Volt DC motor. Ideal for modelsand radio control applications where small size is important. No load rating: 15,800 RPM @ 2.4 V, 96 mA. Length (excluding shaft), 0.654" long x 0.47" x 0.39". 0.039"(1mm) dia. x 0.13" long shaft. Solder-loop terminals. Large quantity available.

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Daewoo # 16216L-5-VSO
5 x 7 dot format. 2.56" x 0.54" viewing area. 3.15" x 1.41" module size. LED backlight. Includes hook-up/spec sheet.

CAT # LCD-53
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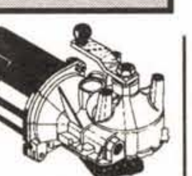
Eveready # NH22. Nickel Metal Hydride rechargeable battery. Replaces 9 Volt batteries in many applications. Actual voltage 7.2 Volts. Can be charged in most Nickel-cadmium chargers.

CAT# NMH-9 **$3.50 each**

Two Speed Worm Gear Motor



Powerful windshield wiper motor for 2000-2001 Saturn L series automobiles. Two speeds; high speed is 106 RPM at 12 Vdc, 4 Amps. Low speed is 41 RPM at 12 Vdc, 0.91 Amps. 3/8" threaded drive shaft with nut. A 2.25" lever with a universal joint, attached to the shaft, is easily removable. 7" overall length x 3.5" x 4".

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Lotus ScreenCam - Multimedia
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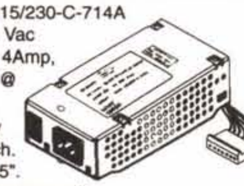
Requires Windows 95/98/NT4 and a CD-ROM drive.

CAT# LSS-1 **$10.00 each**

47 Watt Enclosed Supply



Astec # RPS4-115/230-C-714A
Input: 85 – 264 Vac
Outputs: 5V @ 4Amp, 12V @ 2A, -5V @ 0.7A. Compact enclosed supply with on-off switch. 6.5" x 3.2" x 1.45". White molex-type connector on 3.5" leads for output. Requires IEC-type power cord for input voltage (not included). These units were removed from new equipment in good condition.

CAT # PS-540 **$8.50 each**

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Class 2, direct plug-in AC-DC adaptor. Coax power plug, 2.1mm i.d., center positive. Individually boxed. UL, CSA.

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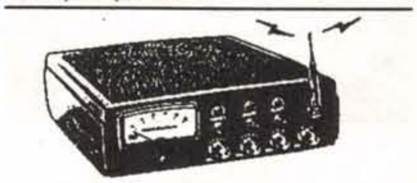

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Small Logic Gates Spawn Big Dreams — Part 2

Binary math for dummies: Discover how binary adders and shift registers can turn simple logic gates into cool calculators.

by TJ Byers

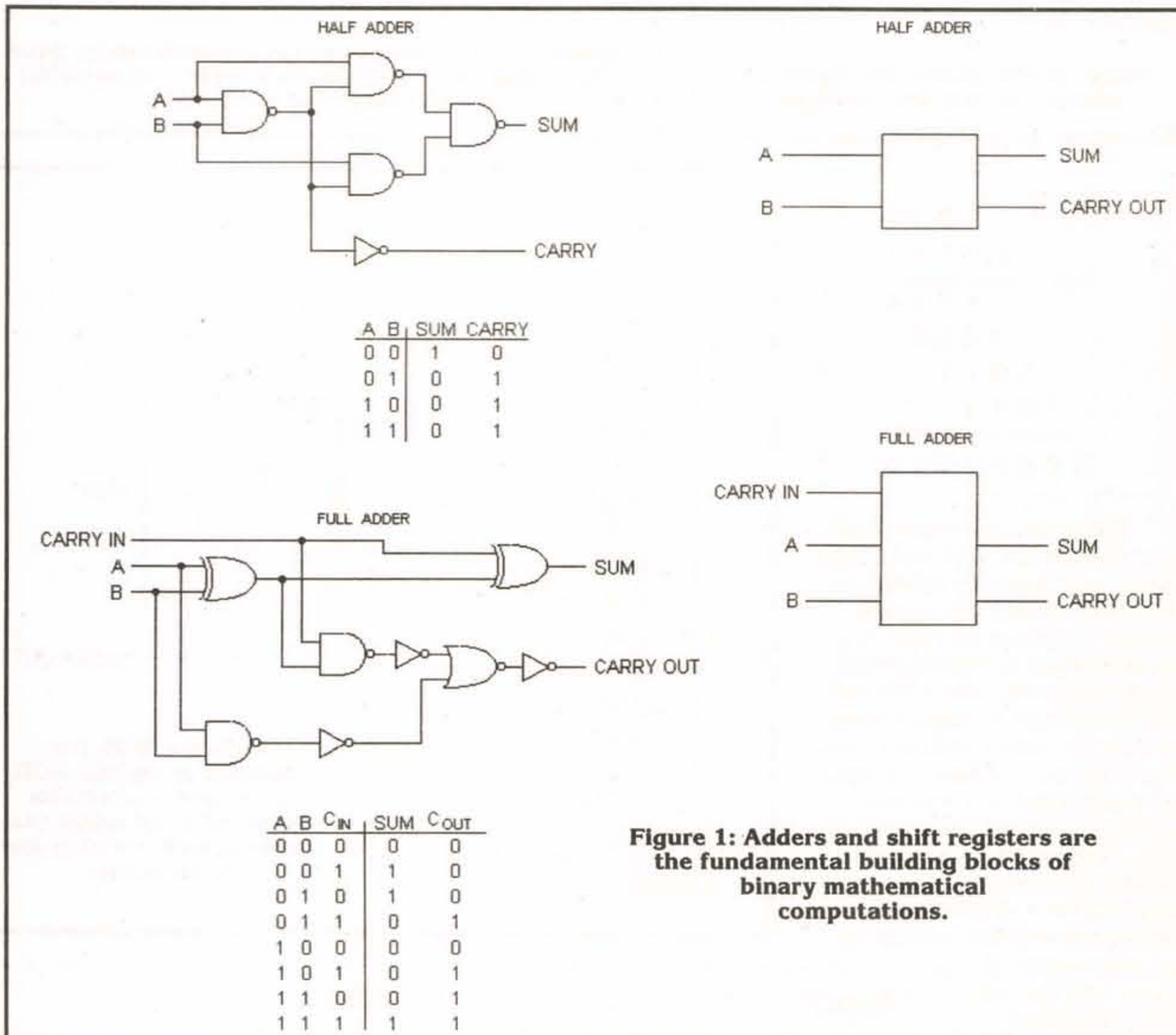


Figure 1: Adders and shift registers are the fundamental building blocks of binary mathematical computations.

Table 1

1 1 1 1	Carry Out
1 1 0 1 1 0 1	A
+ 1 0 1	B
1 1 1 0 0 1 0	Sum

Table 2

12	1 0 1 1
x 3	x 1
36	1 0 1 1

Now that you have a handle on binary logic, and how to make simple gate substitutions to solve your custom IC or obsolete part replacement problems ("Small Logic Gates Spawn Big Dreams — Part 1"), the next step is to put these gates to work for you. You know, the mundane tasks of add, subtract, multiply, and divide. The stuff we learned in elementary school and promptly forgot the moment we pocketed our first calculator.

Unlike "human" math, which is based on the number 10 (a result of having five fingers on each hand), computer math is based on the number 2 — which has the values of 0 and 1. So how do you do math using just nothing and something? The same way it's done using the numbers 0 through 9. The only difference is in the way the 1s and 0s are moved around to fill the needs of borrow and carry.

All binary math operations are built around just two basic circuits: the binary adder and the shift register. While both circuits are made up of several more elementary logic gates, the focus will be on how these two functions perform as a unit. I won't take a microscopic tour of each electron's movement. Instead, I'm going to tell you how to wire the functions together and just what to expect when you flip the switch.

Binary Addition

Basic to all math operations is the binary adder, which comes in two flavors: a half adder and a full adder (Figure 1). The half adder simply tallies two binary bits and outputs a sum. For example:

0 + 0 = 0
1 + 0 = 1
0 + 1 = 1

Nothing surprising here. But what happens when you add 1 + 1? Exactly the same thing that happens when you add 9 + 1 — you get 10. Like decimal addition, binary addition carries over the next most significant digit when the total exceeds the base number. For logic circuits, that's when the sum exceeds 1, whereupon the most-significant digit (MSB) is shifted left one position and a place holder (0) fills the least-most significant (LSB) position. Consequently, the sum of 1 + 1 = 10.

When adding numbers larger than two, a full adder is needed to deal with the overflow, which is called a Carry Out bit. Take the example shown in Table 1 of 1101101 + 101, which has a result of 1110010.

This operation requires an eight-bit adder, which is easily made using a pair of four-bit full adders, like the 74LS83 shown in Figure 2.

Binary Subtraction

Binary subtraction is interest-

Table 3

123	1 0 1 1
x 11	x 1 1
123	1 0 1 1
123	1 0 1 1
1353	1 0 0 0 0 1

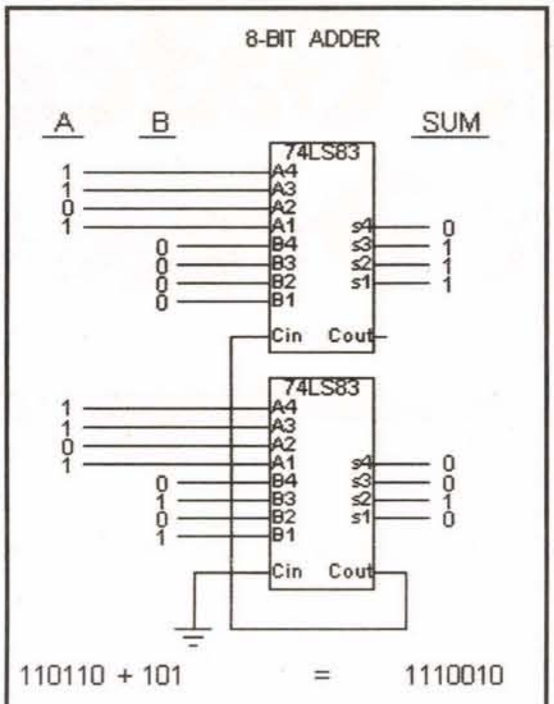
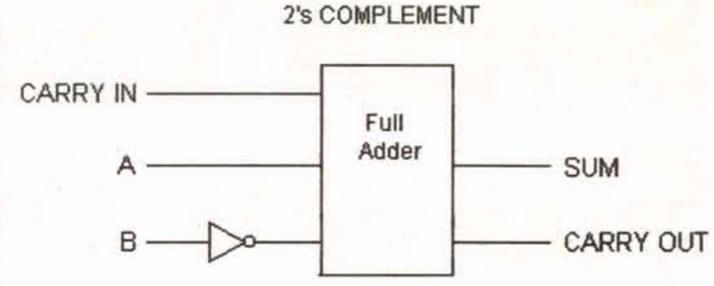


Figure 2: Full adders are stacked to process the required word size.



A	B	C_{IN}	SUM	C_{OUT}
0	0	0	not allowed	
0	1	0	not allowed	
1	0	0	not allowed	
1	1	0	not allowed	
0	0	1	0	0
0	1	1	1	0
1	0	1	1	0
1	1	1	0	0

Figure 3: A 2's complement conversion can be done by adding an inverter in the B input and applying a 1 to Carry In of a full adder.

ing in that it uses negative numbers to arrive at a result. For example, if you start with 7 and subtract 5, it's the same thing as adding 7 to -5.

7 - 5 = 2

is the same thing as:

7 + (-5) = 2

It's just a different way of skinning a cat, and a concept that wasn't available until the zero was fully understood. In fact, it wasn't until 1657 that a mathematician (John Hudde) used a single variable to represent either a positive or a negative number. For all those years until 1657, positive and negative numbers were handled as separate special cases. The reason is because we couldn't conceive of there being less than nothing.

Table 4

	1011
x	1101
	1011
	0000
	1011
	1011
	10001111

Computers and logical math are a lot like our ancestors. They don't understand the concept of less than nothing. For a math circuit to perform an operation, it has to have something tangible to work with. That's why subtraction is such an alien concept. In the computer's eyes, you can't have less than nothing — it doesn't exist (which is true; it only exists in our minds and mortgage ledgers). Boolean algebra solves this dilemma by assigning every number a value — even if that value is negative. In essence, you have a stack of apples, let's say, that need to be added and another stack of imaginary (negative) apples to be subtracted. The second stack doesn't exist in reality, they are merely items to be shuffled about. By matching the apples from the positive stack to those of the negative stack — that is, each time a negative apple mates with a positive apple, both are removed from the total — we arrive at an answer.

Still with me? Let's say we have four apples and we need two apples for another project. The computerese way to do this is to give two of the apples a negative value (-2 apples), while leaving the whole (4 apples) a positive value. These two numbers are now entered into a full adder circuit, which spits out the result of 2.

4 apples + (-2) apples = 2 apples

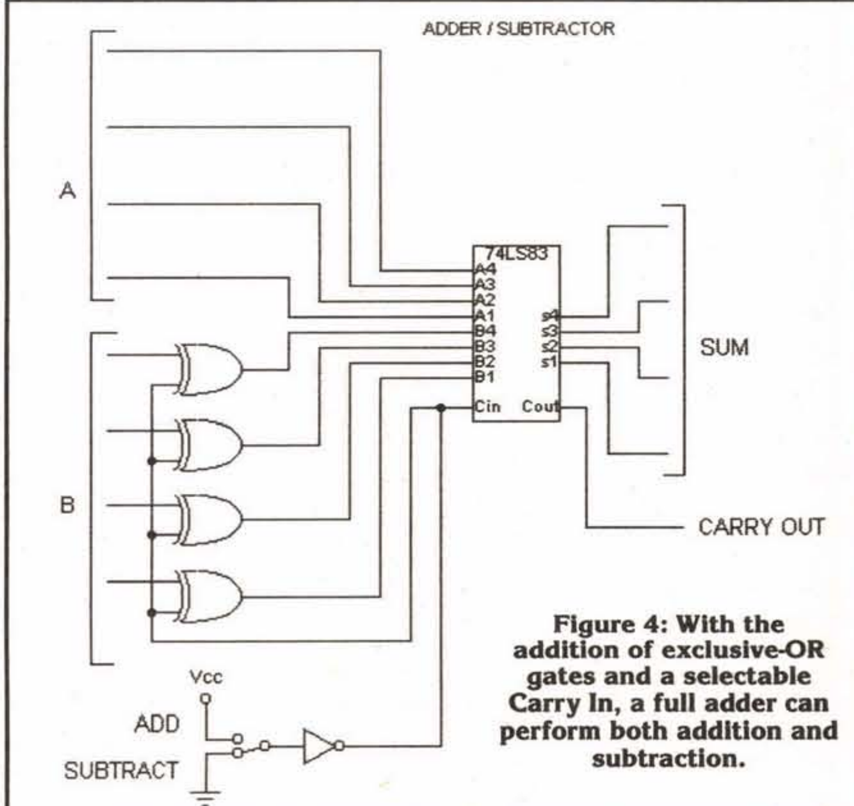


Figure 4: With the addition of exclusive-OR gates and a selectable Carry In, a full adder can perform both addition and subtraction.

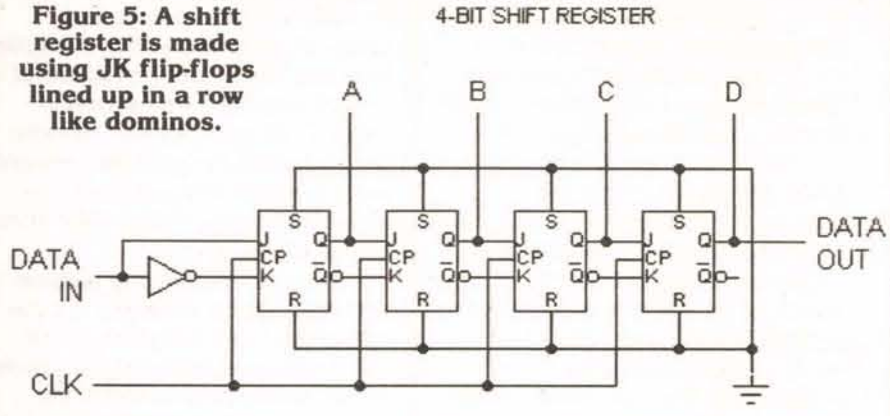
Table 5

1011	Multiplicand
x 1101	Multiplier
1011	First Product
1011	Shift 2 places
110111	Subtotal
1011	Next Product
10001111	Result

Table 6

100011	Dividend
1001	Divisor
11010	<> Check; Iter 1
1001	Divisor
010001	<> Check; Iter 2
1001	Divisor
001000	<> Check; Stop
Result	
11	Divisions
1000	Remainder

Figure 5: A shift register is made using JK flip-flops lined up in a row like dominos.



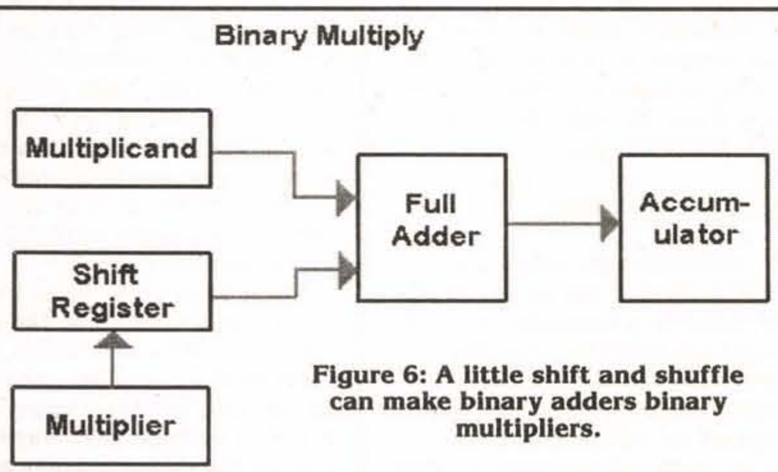


Figure 6: A little shift and shuffle can make binary adders binary multipliers.

Table 8

01110	00000	Dividend
	10001	Divisor
	01111	2's Complement
01110	00000	Dividend
11100	0000	Shift Dividend Left
01111		Add 2's
01011		Result #1
		<>=1; Q =00001
10110		Shift #1 Left
01111		Add 2's
00101		Result #2
		<>=1; Q =00011
01010		Shift #2 Left
01111		Add 2's
11001		Result #3
		<>=0; Q =00110
10001		Add Divisor
01010		Result #4
10100		Shift #4 Left
01111		Add 2's
00011		Result #5
		<>=1; Q =01101
00110		Shift #5 Left
01111		Add 2's
10101		Result #6
		<>=0; Q =11010
10001		Add Divisor
00110		Result #7
		Stop
11010		Quotient
00110		Remainder

Simple enough sure, but confusing for a logic gate. Fortunately, there's a binary shortcut that makes the task even easier. It's

Table 7

```
     28 r6
17 / 448
     34
     108
     102
       6
```

called 2's complement. If you do a little math here (I'll spare you the details), you'll discover that binary subtraction is identical to adding the A integer to the 2's complement of the B integer. The 2's complement of a number is equal to its NOT (inverted) value plus 1. To find the 2's complement of binary 3, for example, invert 0011 into 1100, then add a 1 (0011 +1) to give 0100 (-3). That's all there is to it. Here's a short list that should give you a grasp of the concept.

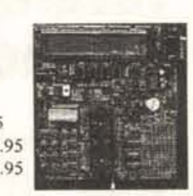
Binary 2's Complement

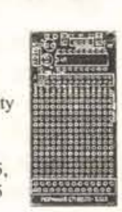
Decimal Number	Binary Number	2's Complement (NOT + 1)
0	0000	0001
1	0001	0010
2	0010	0011
3	0011	0100
4	0100	0101
5	0101	0110
6	0110	0111

Why add a 1 to the inversion, you may ask? For the same reason the new Millennium started at 2001 and not 2000. Logic circuits can't deal with the number zero when doing calculations, just like the calendar can't deal with the gap between 1BC and 1AD — that is, there was either a Christ or there wasn't. One AD represents his presence and 1BC is before his birth. There was never a time in-between. Computer logic is the same way. There is never a time when a number in neither positive or negative — it has to be one or the other. Adding a 1 shifts the inverted number back into the realm of computer comprehension.

The 2's complement conversion can be done at the hardware level using an inverter in series with the B input and applying a 1 to the Carry In line of a full adder (Figure 3). This input is then processed by the full adder to arrive at the difference between the two numbers (A and the 2's complement of B).

Since the subtractor just described is based on a full adder, it's possible to construct a multipurpose adder/subtractor circuit which performs either addition or subtraction, depending on the presence or absence of a 1 on the exclusive-OR/Carry In line. When Carry In is logic 1, the circuit behaves as a subtractor. Pulling Carry In low (logic 0) causes it to perform as an adder. (In our





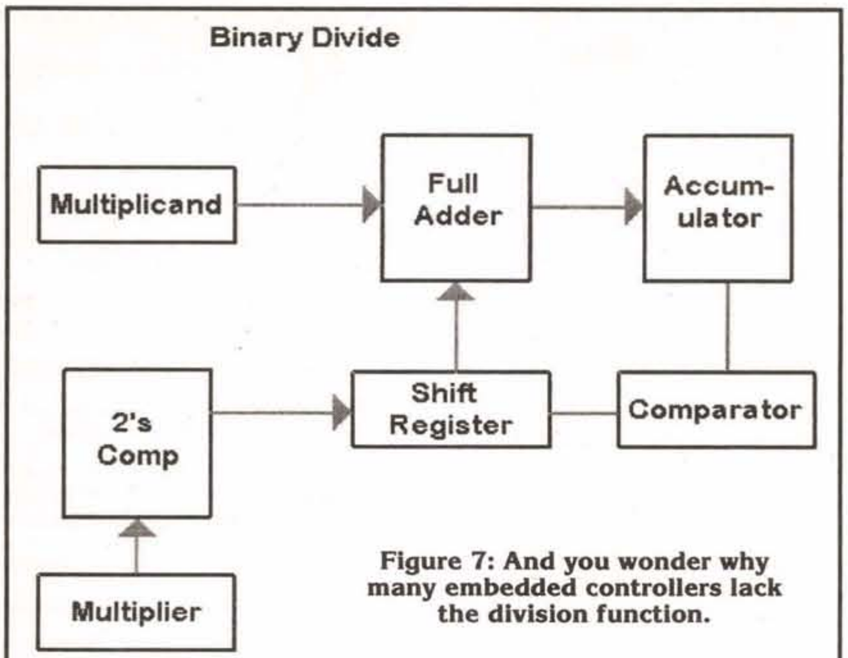


Figure 7: And you wonder why many embedded controllers lack the division function.

example of Figure 4, please note that the ADD/SUBTRACT switch goes through an inverter; don't let this NOT hardware gate confuse you when following the above discussion.)

Binary Multiplication

Any school kid knows that multiplication is simply a series of additions done a specified number of times. For example, 3 x 4 is the same as adding 3 four times over, or 3 + 3 + 3 + 3. With binary multiplication we do the same thing — add up a number the required number of times and arrive at a result.

We also learned very early that there is simple multiplication, where one number is multiplied by a single digit, and compound multiplication, where numbers of two digits or more are multiplied together. Simple multiplication looks like what you see in Table 2, whereas compound multiplication looks like what you see in Table 3.

Notice the shift and add technique which is the signature pattern of compound multiplication. Also notice that it's used with both decimal and binary multiplication. Shifting the position of the line one space to the left is equivalent to multiplying by 2 (binary) or by 10 (decimal). Here's where the shift register, mentioned earlier, comes into play. A shift register is made using JK flip-flops all lined up in a row like dominos, as shown in Figure 5. Let's look at a typical binary multiplication and see where it takes us at. Check Table 4. This is a straightforward calculation using the rules we learned in PS3. The shift register is first loaded with the multiplicand. Then the number in the register is multiplied by the multiplier. After the first line is completed, the register shifts its contents one position to the left and the process is repeated. This continues until all digits of the multiplier are exhausted. Just like doing compound multiplication using decimal numbers, and this circuitry is simple and straightforward, as shown in Figure 6.

But if you look at it carefully, you'll see places where the process can be streamlined to better fit the computer community. To begin with, 0 times anything is always 0, so line 2 is superfluous and can be removed. And it's more efficient and faster to do subtotals as lines are added rather than crunch through a tall stack of numbers at the end, which results in the pattern shown in Table 5. As the numbers grow larger, this winnowing process becomes increasingly more efficient, saving both time and resources.

Binary Division

Of all the arithmetic operations, division is the most complicated and can consume the most resources. In many computer applications, division is less frequently used than addition, subtraction, or multiplication. As a result, some microprocessors that are designed for digital signal processing (DSP) or embedded processor applications do not have a divide instruction. When hardware division is needed, there are several methods to choose from, none of which are stand-outs.

The simplest is to start subtracting the divisor from the dividend until you run out of numbers to take away from. With this scheme, all you have to do is count the number of iterations — and that's it. For example, look at Table 6 to see how 35 divided by 9 looks in binary using this method. Or, you can do it the old-fashioned way using long division. That is, look at the problem, guess at an answer, test your guess, and respond accordingly. For example, let's take the decimal problem of 448 divided by 17 as shown in Table 7. As you can see, this can be a long-winded process because each iteration takes at least one tick of the clock. Fortunately, there are other options.

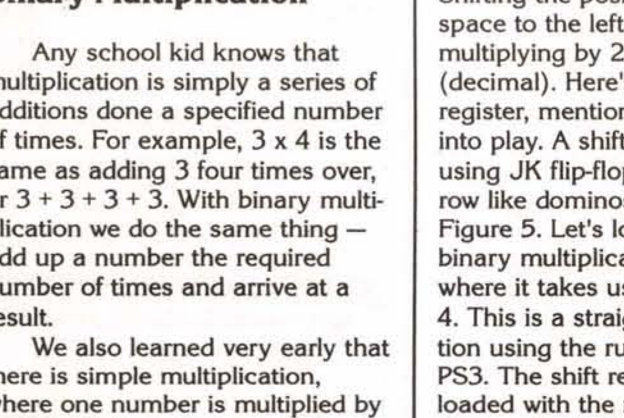
We can also do long division with logic gates. Basically, it's the opposite of multiplication, where the dividend is shifted right, instead of left, and subtracted from the divisor instead of added. While this seems great in theory, it can get rather cumbersome. A better way is to use 2's complements, and proceed just like before using straightforward multiplication — but with a twist. After each subtraction, a comparison has to be made to determine if the result of the last calculation is larger or smaller than the divisor. See Table 8.

Yes, the process looks more complicated — and it is! The circuitry, too, is more complex because of the compare and decide logic needed (Figure 7). But it's a lot faster than waiting for a count-down loop to arrive at an answer.

And The Numbers Are In

Now that you've taken the whole binary tour, I hope that I've touched on something that affects your electronics hobby needs, whether it be scarce part substitutions or basic design. Or, at least piqued an interest or exposed you to something new. Nonetheless, you have to agree that it's so amazing that even the most complex of digital designs are based on three lowly Boolean functions: AND, OR, and NOT. **NV**

Taking the Backache Out of Roadside Weed Spraying



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Hirsch Sales Corporation
219 California Dr.
Williamsville 14221
Tower Records/Video
105 Old Country Rd.
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO
Footsteps
4925 Jackman Rd. Store #58
Toledo 43613
Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952
Keyways, Inc.
204 S. 3rd St.
Miamisburg 45342
Leo's Book Shop
333 N. Superior St.
Toledo 43604

OKLAHOMA
Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102

OREGON
News & Smokes
1060 S.E. M St.
Grants Pass 97526
Norvac Electronics
7940 S.W. Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial N.E.
Salem 97303
Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA
Tower Books
425 South St.
Philadelphia 19147
Tower Records
340 W. Dekalb Pike
King of Prussia 19406
Tower Records
Land Title Bldg.
100 S. Broad St.
Philadelphia 19110

TENNESSEE
Tower Books
2404 W. End Ave.
Nashville 37203
Tower Records
504 Opry Mills Dr.
Nashville 37214

TEXAS
BDL News, Inc.
809 Pierce
Houston 77002
Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063
Mouser Electronics
958 N. Main St.
Mansfield 76063
Tanner Electronics
1301 W. Beltline #105
Carrollton 75006
Tower Records
2403 Guadalupe St.
Austin 78705

VIRGINIA
Tower Records/Video
6200 Little River Turnpike
Alexandria 22312

4110 W. Ox Rd. #12124
Fairfax 22033

1601 Willow Lawn Dr.
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

WASHINGTON
A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155
Supertronix
16550 W. Valley Hwy.
Seattle 98188
Tower Books
10635 N.E. 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN
Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223

WYOMING
Western Test Systems
2701 Westland Ct. #B
Cheyenne 82001

Laser Insight

NEW COLUMN!!

by Stanley York

I guess most people by now know something about lasers, and how they came into being. But how much do people really understand about them?

Well, the laser story is a very interesting one and, indeed, is really much older than the device itself. In "The War of the Worlds," H.G. Wells told a fanciful story of a chronologically older and far superior race from Mars that invaded and almost conquered the Earth. Their weapon of choice was something that very closely resembled what we now call a laser.

The weapon was a mysterious "... sword of heat ..." from which flickered "... a ghost of a beam of light ..." This weapon "... killed men in their tracks ... made metal run like water ... and flashed anything combustible into fire ..." Fortunately for us, the one thing the Martians never counted on was the climatic differences between our planets.

Real lasers are not used for weapons of war, however, even though the military continues to investigate the possibilities of using it as such. The laser in the real world has invaded our lives in many ways though, and in the first part of this column, we will take an in-depth look at one type of laser that can be found cheaply on the surplus market, and how they work. But first, let's recap what a laser is.

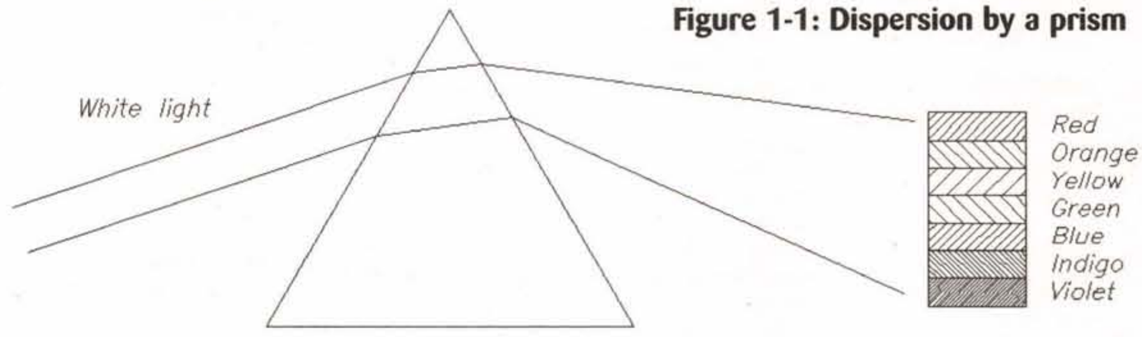


Figure 1-1: Dispersion by a prism

Laser Principles

Most of us are aware that the frequency of the note emitted by a church organ is determined by the length of the pipe. The pipe as we say, is 'resonant' at the frequency emitted.

In a similar way, the space between the mirrors in a laser system is resonant at the characteristic frequency (or color) of the lasing medium. In this case, however, the length of the laser resonator is not so important as the filtering characteristics of the end mirrors and the lasing medium. Also, like all electronic oscillators, the laser resonator must have a gain greater than unity, and positive feedback in order to sustain oscillation.

There are many types of laser in operation these days, but each type shares certain common characteristics. The first laser was described in 1958, but was not successfully demonstrated until the early 60s. The word 'laser' is an acronym coined soon after the first system was built. It stands for Light Amplification by Stimulated Emission of Radiation. Since it is an amplifier, it shares some common characteristics with other electronic amplifiers, but we'll get into that later.

Just as an electronic amplifier can be 'tuned,' a laser resonator (the space between the end mirrors) is, in effect, a tuned cavity. In this case, however, the frequency of oscillation is vastly higher than what we are accustomed to seeing in everyday electronics.

In order for the laser cavity to sustain oscillation, there must be enough gain to overcome the losses, just the same as in an electronic circuit.

In the laser, the electrical energy put into the lasing medium by an arc discharge (or any one of a number of excitation means) is sufficient to maintain a 'population inversion' as it is called.

In a population inversion, there are more lasing medium atoms in a metastable (higher-than-normal energy) state, than there are in the ground (or rest) state. This population inversion keeps the gain of the laser system high enough to sustain the regenerative action that causes the high-state electrons to emit photons as excess energy is released when they return to the ground state.

Because of the quantum nature of the lasing medium atoms, there can only be certain amounts (quanta) of energy given up for each electron returning to the ground state. These energy packets correspond to a particular wavelength, and give the laser its characteristic color.

Light – as we know – consists of electromagnetic waves (or particles, we haven't really decided yet since it exhibits properties of both) whose wavelength determines the color of the light. White light consists of a wide range of wavelengths that we can see when we use a prism to refract the light.

I suppose most of us have seen the classic demonstration first performed by Sir Isaac Newton before the fellows of the Royal Society in London. In this demonstration, old Sir Isaac showed the Society how a prism breaks up sunlight into a broad band of multi-colored light, that gradually changes from red to yellow to blue (Figure 1-1).

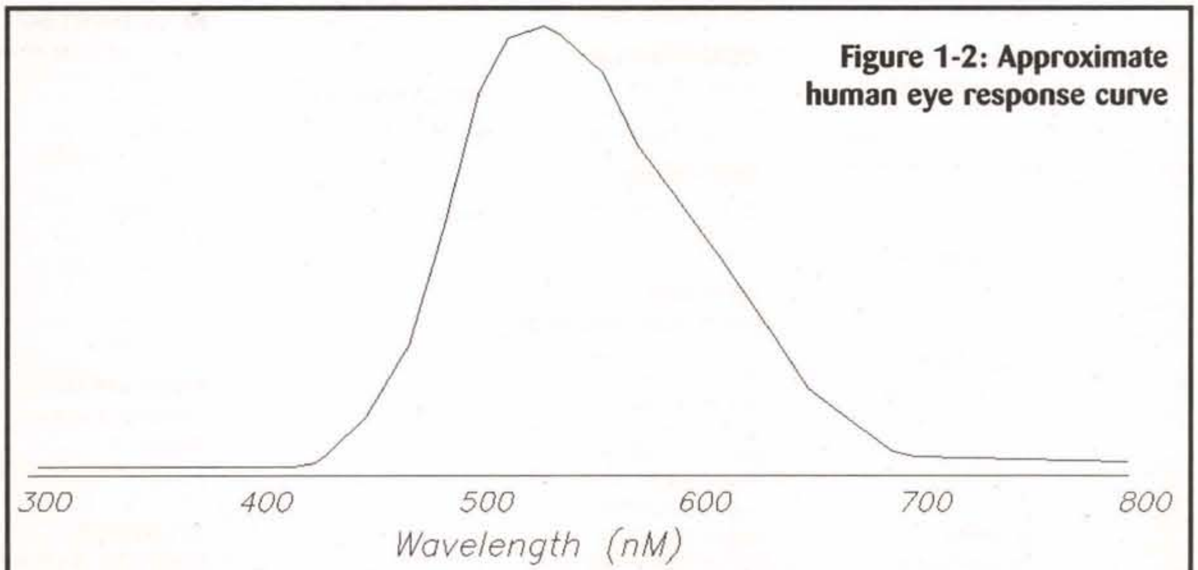


Figure 1-2: Approximate human eye response curve

White light from the sun consists of many wavelengths, and some of those wavelengths are detectable by the human eye (Figure 1-2).

Taken as a whole, the visible part of the electromagnetic spectrum is a very tiny part.

But old Sir Isaac was able to show that there were indeed wavelengths (and therefore energy) outside of the visible part of the spectrum. Those wavelengths existing beyond the red end of the spectrum became known as infrared, and those wavelengths beyond the blue end became known as ultraviolet.

Looking again at Figure 1-2, we see that the most sensitive part of the human eye's response lies in the range of 460-570nM (1nM = 1 x 10^{-9} meter), and corresponds to the yellow-green part of the spectrum.

A lot of laser light shows have laser systems whose predominant wavelength is in the green/blue part of the spectrum. Since the eye is most sensitive to some of these wavelengths, there is a danger that a beam from one of these lasers could do permanent and irrepairable damage to the eye, if there was a direct hit. I personally have worked on some of these lasers, and they put out a pretty hefty power level, far more than is safe for the eyes.

But more on the dangers of laser light in a later column. For now, we have to look at the laser in general, and see what makes it tick. The point of looking at the wavelengths, and particularly the wave nature of light, is important in understanding the properties of laser light, and how it behaves in different situations. But more on that later.

In white light, for example, sunlight or a flashlight or regular light bulb, the light emitted consists of many wavelengths, all emitted simultaneously in all directions, and in varying proportions depending on the gas filling, gas pressure, or the material from which any of the component parts are made. In the case of the sun, or other stars, the light comes from the energy released during the transmutation of helium into heavier particles, and as Sir Isaac showed us, it covers a very broad range of wavelengths.

Laser light is different. In many respects. Laser light usually consists of a single narrow band of color (although there are 'tunable' lasers, which we'll cover later) that corresponds to a particular wavelength. For the helium-neon laser – one of the most common lasers available to the average amateur – the characteristic wavelength is 632.8nM, and is derived from the excitation/relaxation constants shown in Figure 1-4. Typical laser output powers at this wavelength are usually on the order of 0.5mW up to about 10mW. Surplus-market lasers tend to fall into the lower power range, and are far more common than the higher power devices.

The Helium-Neon Laser

The helium-neon (HeNe) laser was invented in the early 1960s by a team of engineers at Bell Labs. It was the first successful CW (continuous wave) gas laser in operation. The first laser built was, in fact, a pulsed laser, using a synthetic ruby rod, which we'll cover in a later article. The characteristic wavelength of the HeNe is due to neon as a lasing medium as explained above and in the transition diagram (Figure 1-4).

Since the first laser was made, there have been many developments, and it is now possible to get HeNe lasers in many colors from the original red, through infrared, orange, yellow, and green.

The HeNe laser works like this: A gas mixture is introduced at partial pressure into a closed tube. Within the tube is a second glass tube called the capillary, which is a thick-walled tube with a fine hole running down its length (Figure 1-3). The gas mixture is predominantly helium with only a small amount (less than 15%) of neon.

An electrical discharge is started in the gas mixture, and is maintained through the narrow bore of the capillary. Typical discharge voltages for small HeNe tubes are in the range of 2,500-3,500 volts DC at about 2-4 mA. The high voltage discharge creates a plasma in the gas mix.

Excitation by collision with free electrons in the plasma causes some of the helium atoms to be trapped in the lowest metastable states (Figure 1-4). These are known as the 2^1S and 2^3S states, where one of the two helium electrons has been raised from the lowest energy 1S atomic orbital to the 2S orbital. In this case, they are referred to as electronically excited states.

The neon atom is a much larger, more complex atom than the helium, with 10 electrons in a $1S^2 2S^2 2P^4$ configuration in the $^1S_0$ ground state. The neon atom has many excited states, and the ones that most concern us here are shown in the energy level diagram (Figure 1-4). The multiple excited states arise from the number of different ways in which the motions of the 10 electrons can be aligned with each other.

Two sets of excited states of neon (2s and 3s) occur at excitation energies similar to the 2^3S and 2^1S states of helium, which are favorably populated by the laser discharge. Within the plasma, atomic collisions occur with other atoms, electrons, and the walls of the tube, causing some of the neon atoms to be excited to the 2s and 3s states. This colliding transfer of energy is a resonant process, with total energy conservation. Most of the neon laser wavelengths utilize the transitions into the 2p series of levels.

As an example, the familiar 632.8nM red output is produced by the $3s_2 \rightarrow 2p_4$ transition. (Data courtesy of Melles Griot, Inc.)

As the excited atoms relax to the ground state, they emit excess energy in the form of a photon of light. These light photons then travel randomly down the capillary. During the transition down the tube, the photons collide with other excited atoms, causing some of them to relax and emit photons (stimulated emission).

This chain reaction excitation-relaxation cycle continues as long as the plasma is sustained by the electrical discharge in the gas mixture. Upon reaching the end mirrors, some of the photons are reflected back into the capillary, where they further stimulate other excited atoms into the relaxed state and emit other photons.

It is interesting to note here that not all photons striking the mirror are returned down the capillary. Those photons hitting the mirror at an angle will collide with the wall of the capillary, and give up their energy in the form of heat into the glass wall.

This stimulating process continues very rapidly of course, with the

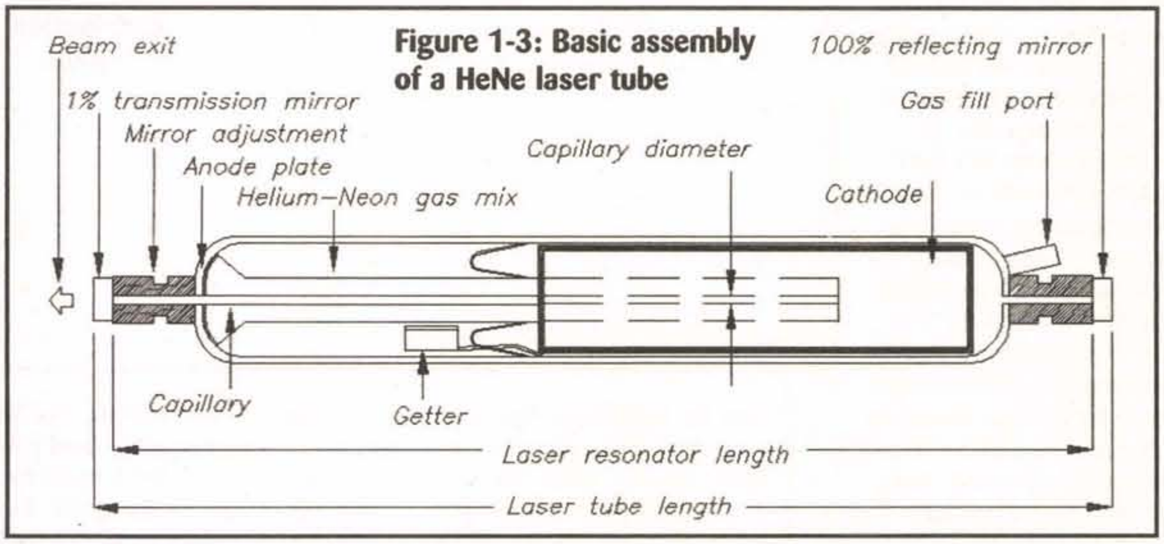


Figure 1-3: Basic assembly of a HeNe laser tube

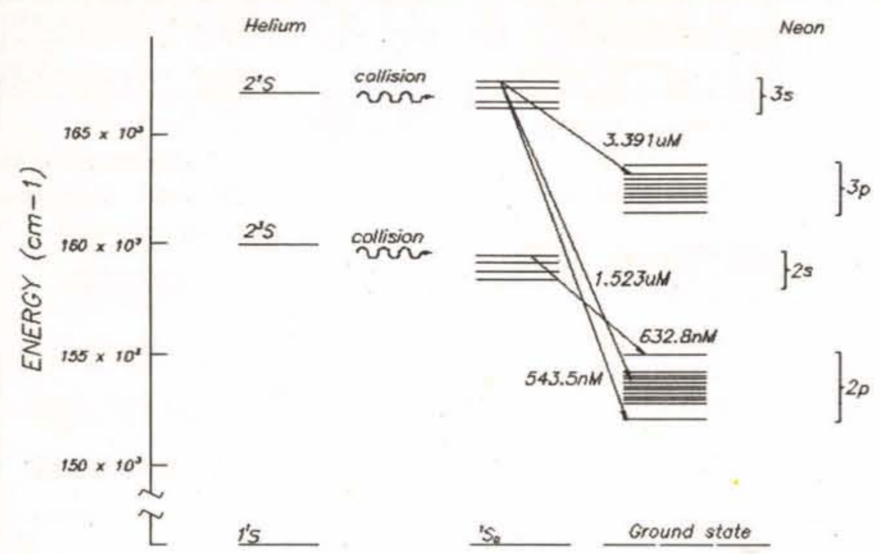


Figure 1-4: Helium-Neon transitions

photons making a round trip of the resonator in just a couple of nanoseconds (in this case, 1 nanosecond = about 11-3/8").

Each round trip of the resonator causes more and more photons of energy to be released, until equilibrium is reached and the power absorption/relaxation cycle of the excited atoms reaches a steady-state level.

The wave nature of light allows only those waves that are in step (in phase, or synchronized, if you like) to reinforce each other, and contribute to the laser beam.

Most of the HeNe laser wavelengths use the transitions into the 2p levels. As an example, the typical red HeNe, operating at 632.8nM, is produced by the transition from the $3s_2$ level to the $2p_4$ level.

Various combinations of laser cavity exist, and for the HeNe laser, the most common configuration is what is known as a hemispherical resonator.

In this design, the output mirror (1% transmission) is usually flat, and is placed so that it lies at the center of curvature, and parallel to the rear (99.9% reflecting) mirror.

This configuration is the easiest to set up, is the most stable, and is least prone to misalignment due to temperature variations within the tube. It also gives the most nearly Gaussian power distribution in the output beam (see explanation below), with a minimum of drift. There are other resonator configurations, but we'll not get into them just yet. One disadvantage with this resonator structure is that it does not use the full volume of the laser plasma, which makes it slightly less efficient.

The spacing of the laser mirrors is very important in this type of laser configuration. If the mirror spacing is not correct, the effects on the laser are instability, the beam can become widely divergent, or it may exhibit a bad beam profile. As I mentioned before, there are other configurations, using two flat mirrors in a plane parallel resonator (unstable resonator) and two curved mirrors (confocal cavity), but these types are rarely used for HeNe laser systems. Instead, they are used in other laser types for special applications, but more on those later.

In the HeNe laser, the bore of the capillary confines the light path to a narrowly defined channel in order to get the maximum gain from the resonator. The HeNe laser is really very inefficient as a gain medium.

Typical output power/total input power is very small. In order to achieve a high enough gain within the resonator (between the end mirrors), most of the laser light generated within the resonator stays there! The rear mirror is selected for the highest reflectivity at the laser wavelength, and is usually around 99.9%. The output coupler has to be carefully chosen to allow no more than about 1% of the available energy to leak through.

It follows from this that the energy within the laser resonator is more than 100 times the power coming out! But this is only true for a HeNe laser. A CO_2 laser on the other hand is the most efficient laser ever devised, with efficiencies around 10-20%. But again, we'll discuss other laser types in future columns.

If you could take a very thin knife, and slice up a beam coming from a HeNe laser, you would see that, as you approached the center of the beam, the energy of the beam would increase gradually, reach a peak at the center, and gradually fall again as you went further from the center. What we are examining here is the so-called mode structure of the laser beam.

The way the total energy is distributed within the laser beam is called the spatial profile of the beam. The spatial profile and mode structure of the beam tells us how good the beam is, and allows us to predict how the beam will behave under certain conditions. It also allows us to grade laser systems, and to select the best laser for a particular task. In a typical HeNe laser, the spatial profile of the beam closely resembles a Gaussian curve (Figure 1-5).

The mode structure of the beam and the spatial profile are used interchangeably, and you hear people talking of both, as though they were separate entities. There are some slight differences between mode structure and spatial profile, and won't be dealt with here. But mode structure of the beam defines more how the beam is constructed, not only of spatial modes, but also longitudinal modes, rather than how the energy is distributed within the beam. More on this later, but for now, let me share a horror story with you.

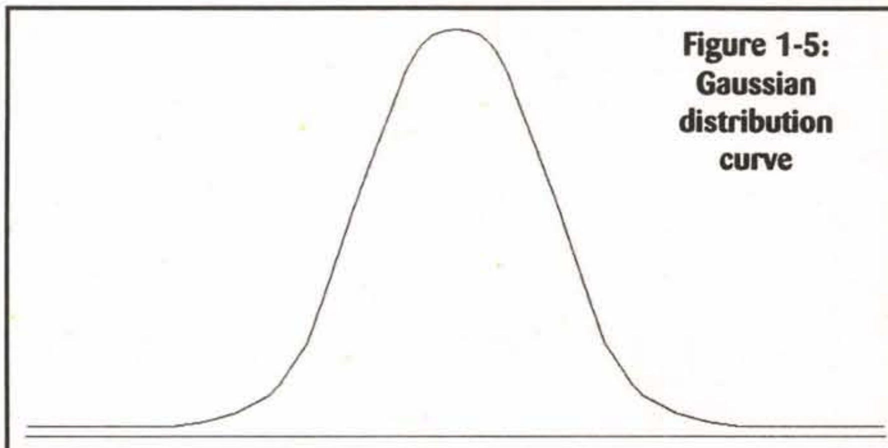


Figure 1-5: Gaussian distribution curve

When I first came to the US in the early 1980s, I worked with a group of people that had been in the laser industry for a while and knew the ropes, so to speak. I had to help develop and build a 2.5kW CO_2 laser for my new employer to experiment with, and to show them the applications for this type of laser.

The technician – Jack – that was running the lab where the laser was installed was a tall, lanky fellow who could easily reach over the machine to make adjustments, where I would have to walk around the machine or use steps (the laser resonator was 14 feet long, and folded in half, so a round trip for the light beam was 28 feet!).

The exit beam diameter on this machine was about 1-1/2".

Attached to the output coupler housing was a guard tube to prevent dust from settling on the output window, and to prevent the unwary from getting his fingers burned ... or at least, that was the idea.

One day, Jack noticed a loss of power from the laser and decided that he would clean the output coupler and try adjusting the mirror angle to maximize the output.

All went well with the mirror cleaning after he had removed the guard tube, but he decided to try the laser first, before trying to replace the awkward retaining screws in the tube.

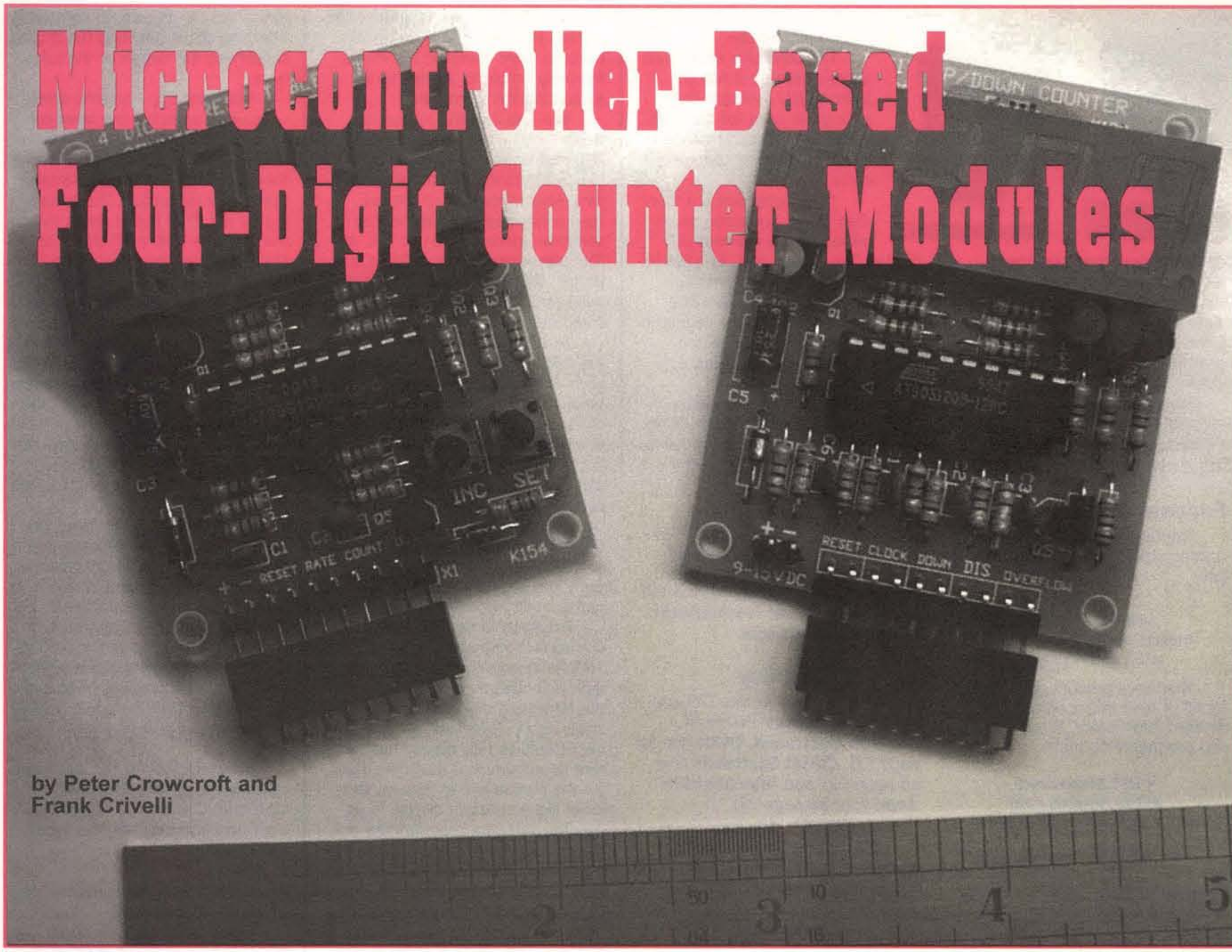
Well, as I said, Jack was tall, and he was reaching over to adjust the output window while watching the power meter, and ... well, you can probably guess what happened. Jack got his hand in direct line with the laser beam. He removed his hand quickly of course, but CO_2 lasers have a particular affinity for moisture, and at 2,000 watts output, that moisture gets real hot, real fast.

It burned Jack's hand really bad, and he was in the hospital for a couple of days for skin grafts. It was like he had put his hand on a cooking range element. So, let this be a lesson for all of us.

Let's try to learn by Jack's mistake, I know I did when I smelled the burning flesh that used to be his hand. Don't be complacent. Treat the laser as the dangerous tool that it is. Think carefully before you make adjustments. Think about where the beam will go when the safety shutter opens. And remember, *never, never, never, under any circumstances, look directly into a laser beam, or its reflections, however weak it appears to be.*

Next month, we'll take a closer look at laser beams, and how they're constructed. We'll also look at polarization, coherence, spatial profile, and so-called TEM modes. **NV**

Microcontroller-Based Four-Digit Counter Modules



by Peter Crowcroft and
Frank Crivelli

Introduction

Modern electronics is allowing products – consumer, industrial, scientific – to be produced with more features in smaller packages at less cost than ever before. Electronic Engineers must find new ways to meet these challenges.

Not too long ago, the controller for an appliance like a washing machine or microwave oven would be a mechanical timer or perhaps discreet components (switches, transistors, and 4000 series logic, etc). However, all these things take precious space and are difficult to design and update or reuse for different product models or revisions.

Today, these problems are neatly and cheaply solved with microcontrollers – single chip computers complete with I/O pins, RAM, Program Storage (ROM), and sometimes other useful features like ADCs, UARTS, and PWM drivers. One simply arranges for relevant inputs (switches and sensors) and outputs (motor drivers, LEDs, and displays) to be connected to the microcontroller, and writes some software to manage the lot.

The space-savings and cost-effectiveness of these small wonders are excuse enough to use them. But when you consider the flexibility they provide to adapt the control system to changes in the device or consumer demanded functionality, they are indispensable. It's simple, you change the software (which can often be done in circuit) and the same hardware will perform the new task.

There are very few fields left in electronic engineering where microcontrollers have not made their mark, so it is very important to engineers to understand how to apply them in their designs and how to develop and debug their software. Luckily, there are many sources on the Internet open to the engineer and hobbyist alike that provide free tools, examples, and designs.

The manufacturer of the microcontroller will have lots of details in the datasheet and application notes and so is a good place to start.

As an example of this great flexibility, this article presents two simple, low-cost, four-digit counter modules from DIY Electronics. One will count up or down and the other will count down in several user-defined ways from a preset value. The main difference between the modules is the software in the microcontroller.

The use of an ATMEL AVR microcontroller allows the circuit to be greatly simplified with no onboard crystal required, and a larger range of useful features to be provided than could be achieved with conventional logic circuits.

For instance, if we wanted to implement a simple counter with conventional logic, we would need a counter for each digit (say 74LS192, a BCD Decade Counter), and then we would need to drive a seven-segment LED display using a BCD to seven-segment driver (74LS47). (*Check out Ray Marston's article discussing seven-segment displays on page 26.*) Straight away, we have eight ICs (two per digit). Then, we'd need some glue logic to hang everything together. Then, we get a counter that can only count up. To fit this into a reasonable space, we'd have to use a double-sided board with plate-through holes because there are a large number of connections required between ICs, we might even need to go to surface-mount components to reduce the size. It begins to get very expensive and complex, not to mention tedious (if not, impossible) for the hobbyist to assemble.

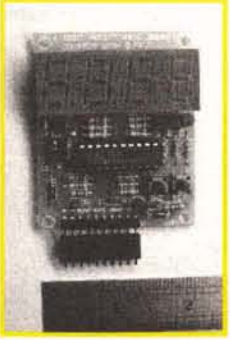
With the microcontroller solution presented here, this complexity is reduced to one IC only and a handful of discreet components to condition the input and output signals, all on a small cheap single-sided PCB. All the hardware complexity has vanished into the software where finding and fixing errors is easy. As we shall see, we also get the ability to change and add more useful features and modes of operation easily.

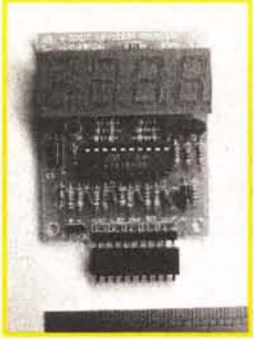
The Up/Down Counter (Kit 129) has an overflow output allowing multiple units to be chained together for greater counter range. The unit will count between 0000 and 9999, producing the overflow pulse when the count rolls over to 0000.

The Presettable Down Counter (Kit 154) allows the user to program a starting count and select one of four different operating modes which determine what happens when the count reaches 0000.

Circuit Description

Both modules are almost identi-





cal; the display driver, the power supply, and the output are identical. The differences are confined to the inputs and their "meaning" to the microcontroller. Let's start by looking at the identical parts of the modules.

The counter modules are designed around an AT90S1200 AVR microcontroller from ATMEL (http://www.atmel.com). A detailed product datasheet is available from their website.

This particular device was chosen because it has an internal R/C oscillator eliminating the need for an external crystal, simplifying the circuit and reducing component costs.

The display unit is a four-digit, common anode, multiplexed, seven-segment LED display. This means that the LEDs in a single digit share a common anode (positive) connection. The cathodes (negative) of the segments (a, b, c, ... g, dp) are connected across the four digits forming a matrix.

Multiplexing results in fewer connections and board space being devoted to the display, and reduces the number of outputs from the microcontroller required to drive the display. However, the drive signals become more complex, but this is relatively simple to achieve in the microcontroller's program.

Bits 1 to 7 of the microcontroller's Port B are connected via 270-ohm current limiting resistors (R1 to R7) to the shared segment pins. Four of the Port D bits are then connected to drive the four common anodes via Q1 to Q4, the PNP transistors. Resistors R8 to R11 protect the transistors from excessive base current which otherwise could destroy them.

To display the current count, the microcontroller cycles through each of the four digits one at a time, providing current to the anode of the digit by turning on the appropriate transistor (driving the base low). It then arranges for outputs connected to the segments it wishes to light to be driven low so that current can flow from the transistor, through the LEDs in the display, and to ground via the microcontroller port. The segments it wishes to remain unlit are driven high.

After approximately 1mS, the display is extinguished and another 1mS delay occurs, then the next digit is lit. This then continues for the remaining digits and the cycle starts again. Therefore, it takes about 8mS to fully display the current count, which is much too fast for the human eye to discern, so it looks like a constant display to us.

The software programmed into the microcontroller uses a timer that triggers an interrupt about every 1mS to achieve this. When the interrupt occurs, the next display is set up or the current display is extinguished. This allows it to be monitoring the inputs without constantly worrying about handling the display, simplifying the design of the software.

Transistor Q5 — an NPN device — provides an active low open collector output for the overflow signal in the up/down counter version and the output signal in the presettable down counter version. The remaining bit (Bit 0) of Port B drives this transistor via R18, a 1K-ohm resistor. Q5 is protected by zener diode Z1 that will break down and conduct if the voltage across Q5 exceeds 33V or it will conduct if a negative voltage is applied to the collector. This is needed when driving inductive loads like relays, as the back EMF generated by the collapsing magnetic field in the coil when the current is turned off can easily exceed the rating of the transistor and destroy it.

Power for the circuit is provided by an external 9 to 15 volt DC power supply and is regulated by IC2, C4, and C5 resulting in a five-volt supply. IC2 is a 78L05 low-current voltage regulator that needs about 2.2 volts of headroom to ensure regulation, so you must ensure that the voltage supplied to it doesn't drop below about eight volts. Diode D1 provides reverse-bias protection in case the power supply is connected the wrong way around.

Now let's look at the input circuits for the different modules. Up/Down Counter Kit 129 (the Up/Down counter) has four inputs and one output.

Reset: Reset the current value of the counter to 0000.

Clock: Increment (or decrement) the value of the counter. If the counter rolls over to 0000, an overflow pulse is generated. The clock input is debounced in software to prevent extraneous counts when mechanical switches are used. This is achieved by ensuring a high-to-low or low-to-high transition remains valid for more then 15mS. This means the maximum count rate is around 30 counts per second. The count is triggered on a high-to-low transition (falling edge)

Down: Controls the direction of the counter. When unconnected, the counter will increment; when driven low (grounded), it will decrement.

Disable: When grounded, the counter will not count even if the clock input is being pulsed.

Overflow: This is an open collector output. When the count rolls over to 0000, it is pulled to ground by the circuit for approximately 25mS. This may be connected to the Clock input of the next module to create a counter with a larger range, or used to drive a relay, indicator, or other circuit.

The four inputs are all pulled high by the 1K-ohm resistors and have a low pass filter formed by the

Further Information

The following may be good starting points to find more information:

• ATMEL
www.atmel.com
(makers of the microcontroller used in this project)

They have product datasheets for all of their microcontrollers with detailed information about using and programming them.

• DIY Electronics
http://kitsrus.com
(kit supplier for this project)

They also have an AVR Programmer kit (Kit 122) and BASCOM Basic Compiler that are useful for people wishing to experiment with AVR microcontrollers.

Questions or comments about the kits can be directed to **Peter Crowcroft, peter@kitsrus.com**. Technical questions may be directed to the kit's designer **Frank Crivelli, frank@ozitronics.com**.

Kit Availability

A kit of parts for Kits 129 and Kit 154 may be obtained from **Amazon Electronics, Qkits** *(see ad page 72)*, **Circuit Specialists** *(see ad page 93)*, and "**electronickits .com**" *(see ad page 73)*.

UK/European distribution is available through **Quasar Electronics Limited** (email simon@quasar electronics.com or www.quasarelec tronics.com/home.htm).

27K-ohm resistor and 1nF capacitor to filter out high frequency noise from the line to reduce the chance of false triggers. This filter's time constant is approximately 20uS and any pulses shorter than this won't make it to the microcontroller. A 20uS time constant equates to a frequency of 50KHz. The inputs are also debounced in software with the level in the input needing to be constant for 15mS before it is recognized as a valid input.

Presettable Down Counter

Kit 154 (the Presettable Down counter) is a little more complex. It has two push-button switches added to its inputs. These are used to program the preset value and operating mode. This module has three inputs and one output.

Reset: Reset the current value of the counter to the preset value.

Count: Decrement the value of the counter. If the counter rolls over to 0000, the current operating mode determines the output pulse and new count value. For more information, see "Using the Modules." The count is triggered on the high-to-low transition. Software debouncing is optionally applied to the count signal using the Rate input. If it is enabled, it is identical to the Up/Down counter.

Rate: Select if software debouncing is applied to the count input signal. If high (by default), debouncing is applied; if driven low (grounded), debouncing is not applied. This is useful if the count is derived from another logic circuit that doesn't exhibit extraneous pulses like a switch can do. If debouncing is disabled, the count input can be clocked a lot faster. Note that this input is not debounced at all as it is meant to be set permanently.

Output: This is an open collector output. When the count rolls over to 0000, the current operating mode determines what this output does.

Like the other module, the inputs are pulled high by 1K-ohm resistors. The Count and Reset inputs have the same low pass filtering applied with the 27K-ohm resistor and 1nF capacitors. The SET switch is connected directly to Port D, Bit 4 with a 1K-ohm pull-up resistor. There is no need for filtering on this input as the microcontroller will debounce it in software.

The INC switch is interesting as it is shared with the Count input. This is an example of making efficient use of the available inputs. This can be done because in set-up mode, no counting in done. This also means that the INC button can be used to decrement the counter when it is running.

Software

The software for the microcontroller is not supplied, however, this description is provided for those who are curious or want to have a go at creating their own.

The first thing the code does is set up all the inputs and outputs, and initializes all the internal states. It then sets the count to the default value (0000 or the preset, depending on the module) and starts the internal timer.

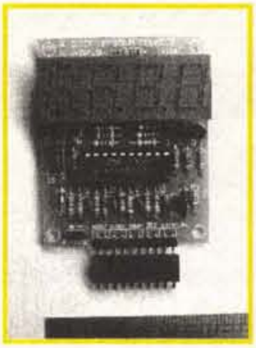
The timer is set to trigger an interrupt every 200uS (observant readers will notice I said 1mS earlier, I lied for simplicity). When the interrupt occurs, the handler routine updates various internal counters used for debouncing inputs, output pulse timing, and the display timer routines. If any of these counters reach zero, they need attention and are processed. For example, every 1mS the display routine is called to update the display.

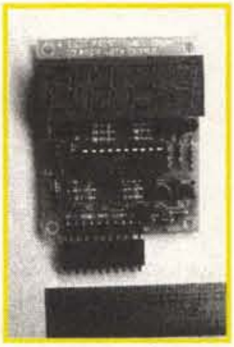
The main loop constantly monitors the inputs and sets up the debounce counters when they change. If a valid clock pulse is detected and the count isn't disabled, a routine to either count up or down is called.

The count is stored as four binary coded decimal (BCD) values, so constant conversion is not required in the display driver routine. This is updated by the count up or down routines, and if the value changes to 0000, the overflow output of Kit 129 is activated and a counter set up to turn it off in about 25mS. In Kit 154, the output is determined by the current operating mode.

The display update interrupt routine uses a BCD to seven-segment conversion routine to map the 0-9 value of the digit being displayed to the correct output for driving the segments in the display.

The Presettable Down Counter also has a set-up mode that is entered when a high-to-low transition is detected on the Set input. This allows the preset count value to be set one digit at a time and the mode to be selected.





Construction

Kit 129 and Kit 154 include all components, a high-quality PCB, and a pre-programmed microcontroller. All you will need is a power supply and a clock source.

Start construction by separating out all the components into values, use the parts list provided in the kit as a guide. I'd suggest a fine conical tip on your soldering iron, as there are some small, closely-spaced pads, especially for the transistors. The PCB is very good and has a solder mask, so it isn't too difficult to avoid solder bridges.

Start by installing the resistors. Pay particular attention to R4 as it is situated under the socket for the microcontroller. You may want to leave it for last and ensure the socket fits over it before soldering it and the IC socket in.

Next, put in the capacitors, paying attention to C5 as it is polarized and laid over. I'd suggest that you bend the leads at a right angle and then insert into the board and solder to avoid having the legs too short to bend over later.

Install the two diodes next, ensuring that the stripe on the cathode (striped) end matches the stripe on the PCB overlay.

Now install the transistors and IC2. Don't get these confused; there are four BC557s (Q1 to Q4), one BC547 (Q5), and the 78L05 (IC2). Use the outline on the PCB as a guide for orientation. Q1 to Q4 and IC2 are close together and close to the edge of the LED display so get them as low as possible and as straight as you can so they won't get in the way.

Double-check that you don't have any solder bridges across the transistor pins as they are close together.

If you're building Kit 154, install the two switches. They will fit with the pins coming out towards the display and the connector.

Install the LED display; the decimal points go towards the microcontroller. Then install the two-pin header for power (Kit 129 only) and the 10-pin 90-degree header for the inputs and outputs. The kit also includes a socket for this header; this doesn't mount on the PCB, but can be used to make connections to the completed module.

Install the microcontroller into its socket and you're done. Apply power to the unit and you should see 0000 displayed (this is the power on default for both modules). If you short the two count pins (or press the Inc button on Kit 154), the display should increment (or decrement).

If it Doesn't Work

Poor soldering (dry joints) is probably the most common cause of problems. Check all your joints under a good light; they should all be smooth and shiny. Resolder any suspicious ones. Keep an eye out for solder bridges and pads that you may have forgotten to solder, as well.

Make sure that you inserted the diodes the correct way and that the microcontroller is also the correct way around and securely sitting in the socket. Also check the electrolytic capacitor C5.

Make sure that you didn't mix any of the transistors up and they are in their correct places. This includes IC2.

Use a multimeter to check the supply voltage. Measure it from the cathode (strip end) of D1. It should be at least eight volts or IC2 (the five-volt regulator) will have difficulties and not operate correctly.

Using the Modules

The counter module has three or four inputs and one output that are accessed via a 10-way header. The input lines are all active low, which means that grounding them performs their function. More correctly, each of the inputs is normally pulled high by the module circuitry and must be pulled low to become active.

Each of the lines has a corresponding ground pin beside it, simplifying the connection to a switch. The input lines may be connected to simple 'make' contacts, switches, relays, or even open collector outputs from other circuits.

The module requires a 9 to 15 volt DC power supply and consumes between 20mA and 40mA, depending on the number being displayed. A small plug pack will easily supply enough power for several modules. Alternatively, the module could be battery powered.

Kit 129, the Up/Down Counter is fairly straightforward. Just connect a switch to the count input and set the direction on the Down input and you're ready to go. However, Kit 154 is a little more complex.

Connect the count input and output as needed, and then apply power to the unit. By default, it will display 0000. It will overflow to 9999 and continue counting down with clock inputs until it reaches 0000 again. This is Mode A, and it is the default mode. The following is a description of each of the modes.

Mode A: Count Stop, Output Hold.

When the count reaches 0000, the output goes low and stays low. The counter stops counting. The counter must be reset to continue counting again and to reset the output. When reset, the count is set to the preset value.

Mode B: Over-Count, Output Hold.

When the count reaches 0000, the output goes low and stays low. The count will wrap around to 9999 on the next count input and continue counting from there. The output will remain low until the module is reset.

Mode C: Auto-Reset, One-Shot Output.

When the count reaches 0000, the counter automatically resets itself to the preset value and the output pulses go low until the next count pulse occurs.

Mode D: Over-Count, One Shot Output.

When the count reaches 0000, the output goes low until the next count pulse occurs. The count will wrap around to 9999 and continue counting from there.

The two push buttons marked SET and INC are used to configure both the preset value and the operating mode. The preset value is entered one digit at a time starting at the thousands and then the Mode is selected.

To enter the programming mode, press the SET button. The display will show the preset value for the thousands digit and the rest of the display shows a minus (-) sign. Use the INC button to select the required value, then press the SET button to advance to the next digit.

Continue setting each of the preset digit values unit the last one is set. The display will now show the current operating mode with the letters A, b, C, or d. Use the INC button to select the desired mode and press the SET button to accept it. This will also exit programming mode and the counter is ready for use.

Software Flexibility

To illustrate the power of using a microcontroller versus a discreet logic circuit, the following "user requested" modifications have been made to K129 at no cost to the user since the change was very easy to do in software.

1. Count by five instead of by one.

2. Show digits "upside down" so the PCB could be placed in a pre-designed box upside down.

3. Only display digits on a "keypress" so that the kit could be more efficiently battery powered.

These were done by simply changing the software. Try doing that with discreet logic circuits!!! **NV**

NEWS BYTES *Continued from page 13*

shared or guessed. These keychain-sized iKey tokens are configured by the security officer, who may be the company's network administrator, business manager, or security director. Each user can set their own Personal Identification Number (PIN). With this combination of hardware and PIN, there is no risk of users giving away their passwords to other users, or passwords being stolen from the user's computer or intercepted over a network.

SecureBat! has all of the features of The Bat! and AuthenticBat!, and adds transparent, on-the-fly encryption of the e-mail message base, address books, and configuration files. OpenPGP or S/MIME techniques protect messages in transit, and unencrypted files are never stored on disk. SecureBat!'s use of iKey technology ensures that only authorized users can access their e-mail accounts, and the most powerful encryption methods available ensure that messages are secure while in transit.

AuthenticBat! and SecureBat! contain all of the functionality of RITLABS' flagship product, The Bat!. All three e-mail clients support an unlimited number of accounts and users. Powerful filtering lets users automate message handling, filing important messages, disposing of junk mail automatically, and deleting dangerous mail before it is downloaded.

These programs avoid the virus problems associated with e-mails because they don't rely upon the Windows address book (which has been the target of the Melissa and I-love-you attacks), their built-in, system-independent HTML viewer can't be attacked by script viruses, and they unconditionally block suspicious attachments such as PIF files.

Novice users will appreciate the Explorer-style folder structure for storing and retrieving messages, the easily configurable user interface with message preview option, the built-in HTML e-mail viewer, message editor with spell-as-you-go, the ease of importing data from other e-mail clients, and customizable message templates that save time and improve efficiency.

Power users will like the mail dispatcher for managing e-mail on remote servers, and the support for all Pretty Good Privacy (PGP) versions from 2.6x through 6.5, as well as Gnu Privacy Guard (GnuPG). Users will feel more secure knowing that with AuthenticBat! and SecureBat!, their passwords cannot be read or captured from their computers or workstations, or intercepted over a network.

The Bat! runs under Windows 95/98/Me/NT4/2000, costs $45.00 US for a single-user business license, and may be purchased securely online at http://www.ritlabs.com/. Educational and personal licenses are available. You can download a free, fully-functional 30-day trial version of The Bat! from http://www.ritlabs.com/. Complete with an iKey token, AuthenticBat! costs $100.00 US and SecureBat! is priced at $140.00 US. For more information, contact RITLABS S.R.L, 180 Stefan cel Mare, Chisinau MD-2004, Republic of Moldova. 1-312-577-0481 (USA) or + 49 69 255-77-631 (Germany). E-mail: office@ritlabs.com

LISTENING TO LEARN JAVA

Learning Java is now easier with a product just released by CDLearning.com. "Speaking of Java" does what its name implies – it talks to you about Java. By letting you listen to experienced programmers explain the Java language, this multimedia CD-ROM teaches in a way that's easier to understand and easier to remember. Animated graphics reinforce the material presented by the narrators.

"Speaking of Java" offers a unique dual-track feature. With this feature, people who know C++ are taken on one track through the material, while those without C++ knowledge take another. This allows those with C++ knowledge to shorten their training, and to learn Java features in comparison to their C++ counterparts. People who have no experience with C++ will learn Java from the ground up – without references to C++.

The product provides a thorough introduction to Java, covering such topics as data types, classes, interfaces, access modifiers, garbage collection, exception handling, and collections. A companion product which covers writing graphical Java programs with the Swing library will be released in July 2001.

Each of the 13 lessons on "Speaking of Java" lasts from 20 to 30 minutes. Periodic quizzes help to reinforce what is being heard. There are exercises to do at the end of each lesson, and answers to the exercises are also included.

CDLearning has been producing CDs about programming since 1996. Some of the other topics their products cover are C++, Visual Basic, and HTML.

CDLearning.com's web site includes a downloadable sample of the CD's style. This sample uses the same multimedia software available on the CD, and demonstrates the "learn by listening" approach.

For further information or to download the free sample, visit the company's web site at www.cdlearning.com or contact them at 800-364-3048.

JAMMER PROTECTS YOUR SYSTEM WHILE YOU'RE SURFING

Agnitum has released Jammer 2.0, a multi-barrier firewall which investigates incoming and outgoing Internet traffic, monitors applications, and protects the Windows Registry. Unlike complicated firewalls, Jammer is easy to install and use, without being – or hiring – a network administrator.

Jammer's AppWall™ technology lets the user define which applications may access the Internet. This eliminates the risk of Trojan horses transmitting your passwords or credit card information over the Internet. It also protects you from adware, spyware, and other programs sending private information to other servers on the Internet.

Jammer's scanning detection monitors all of your computer's ports to stop intruders from entering your system. The program alerts the user whenever there is an attempt to access the system through any of its ports. You can set Jammer to simply stop all port probes and other attacks, or send a message to the attacker's ISP, telling them that their service is being used for unauthorized purposes and asking them to stop the crackers' illegal activity.

Jammer 2.0 runs under Windows 95/98/Me/NT4/2000, costs $24.95 US, and may be purchased securely online at http://www.agnitum.com. You can download a free, fully-functional, 30-day trial version of Jammer from the same address. For more information, contact Agnitum at info@agnitum.com. **NV**

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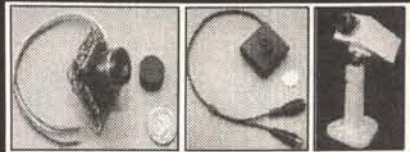

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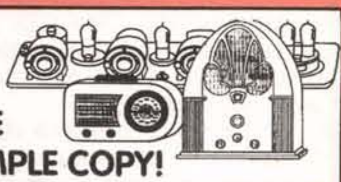

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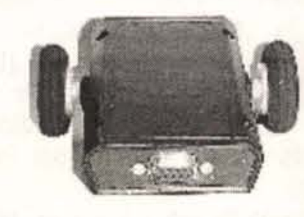

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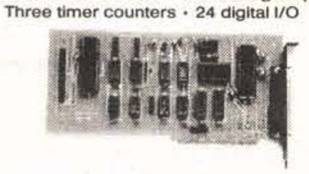

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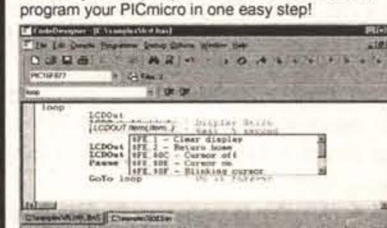

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Questions & Answers

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QUESTIONS

I'm interested in purchasing any small device which can be connected to a phone socket (U.K. frequency). I will block the pulses to the telephone exchanges computer (and enable me to make outgoing calls).

If these devices aren't supplied fully assembled, please let me know how much it would cost to have this device built.

6011 **Jason A. Christie**
England

I'm in need of the pinout of an MM58167AN microprocessor real-time clock.

6012 **L. J. Patelunas**
Langhorne, PA

I'm looking for a converter to convert my CCD camera from PAL to NTCS. I have the model YH-8B50P made by Sharp.

Can anyone show me the right direction to get one, or give me a circuit that will do the job?

6013 **U. Diaz**
Bayamon, PR

I'm trying to find any information relating to electro magnetic or magnetic power.

I have searched the libraries in California and here in Arizona, and can't seem to find anything that doesn't require a degree in nuclear science.

Can anyone refer me to any publications that can be understood by the average person?

6014 **Mel Hughes**
via Internet

I'm a falconer and a wildlife rehabilitator. I'd like to build my own transmitters to attach to the hawks, owls, etc., that I release so I can track them to make sure they are adjusting to the wild okay.

Commercially-available transmitters are too expensive to put on every bird released.

I need a circuit design for something that transmits at 216.1 MHz, with an approximately 1 Hz beep. The modulation can be 400 to 1,000 Hz (hearing range). These units usually have about a 5-10 mile line-of-sight range, working off a button watch or hearing aid battery, and obviously needs to be packaged in a pretty small and light unit (i.e., the simpler the circuit, the better).

6015 **Jeff Lewis**
Freeville, NY

How can I convert a three-phase electric motor to single phase 220?

6016 **A. J.**
via Internet

My question is about proper operating voltages of my Uniden BC2500XLT scanner. The charge voltage is 12 VDC, either from a car battery or a 12-volt wall wart. There are five 1.2 VDC batteries contained in the battery pack that add up to 6 VDC. What I'm not sure of is whether the radio operates on 6 or 12 volts.

I don't know the purpose of the small circuit card inside the battery pack. Is it a voltage requlator or does it convert 12 VDC into 6 VDC for battery charging or radio operation?

6017 **John Putt**
via Internet

Like everyone else, I'm being dragged, kicking and screaming into the digital age. A victim of computers that obsolete themselves every 20 to 30 minutes, companies that produce products that I don't need and I don't even understand what they do. Well, there is one product I need and I think that many other people are in the same boat.

I have about 600 stereo LP records many of which I love and would like to keep. Because I like them, I used them a lot and they have dust "clicks and pops" on them, most of which won't clean out.

About 1978 or 1980, a friend who was an audio freak had a "black box" that would take out the clicks and pops from dirt and scratches. It seemed to be able to "hear" a "pop" coming and replace that fraction of a second with the previous good note by extending it for a fraction of a second. That was way before digital buffers and other delay type circuits that are common place now.

So, my question is, have you heard of any program or black box that I could play my LPs through to clean up the sound before (or while) I transfer them to CDs. Perhaps, I could just play them through the device to listen to them without having to transfer to a CD.

There must be some company out there that makes such a device, but I just haven't been able to locate one.

6018 **Robert D. Gardner**
via Internet

I'm using a 120 VAC screwjack drawing 2.1 amps no load to open and close a large heavy door.

What I would like is a circuit that will monitor the motor's current draw, so if someone or something gets in the path of the moving door, it will give me a high output so I can have the door reverse direction.

6019 **Mike**
via Internet

I'm trying to find a circuit that will replace a voltage regulator assembly from a Homelite EHE 4400 AC generator. I don't have a booklet or information on this machine. From what I see, it's a revolving field type with an exciter coil in the stator.

The rotor and stator are both two pole (3,600 RPM). Their slip ring/brush assembly connecting the rotor to the regulator is, I assume to deliver DC excitation current to the rotor. When I run the engine and connect DC from my power supply to the rotor, the generator works fine. I rang out all windings and none of the resistance values seem out of the ordinary. Any information on a replacement part or a circuit diagram would be greatly appreciated!

60110 **Davison Harvey**
Marshfield, MA

Does anyone have any information on how the remote control features can be accessed on a Sony EVO-210 8mm VCR? This is the

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed. Be sure to include your mailing address if responding by E-Mail 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 FOR PUBLICATION

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

INFORMATION/RESTRICTIONS

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

HELPFUL HINTS

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

ANSWERS TO 5011 - MAY 2001

While in Vietnam, one way to write home was to use a 1/4" tape recorder. These small 1/4" reel-to-reel tape players were a method to not just write, but to exchange between family and friends.

I have a few tapes and no recorder/player.

Is there anything available that I can acquire, bid, or build to play these tapes or transfer to cassette, or even load them into my computer (sound card input)?

#1 After reading your question re: 1/4" Vietnam-era tape recorder, I was reminded of the one my father had given me back in 1971, which I still have. It's still in excellent condition, if you're interested, my email address is: **bndertech@nctimes.net**.

Dean Solorzano
Oceanside, CA

#2 When small 3-1/4 or 3-1/2-inch diameter 1/4-inch wide reel tapes were in common use over 30 years ago on small reel-to-reel recorders (for personal correspondence or recording lectures), there were two basic recording types: rim-drive and capstan-drive.

With rim-drive machines, typically sold by Lafayette Radio for $10.00, the take-up reel was driven at a constant speed, so the tape passing the record/playback head would increase in speed as the tape built up on the take-up reel, increasing the length of tape with each turn.

With the more standard and more expensive machines, capstan-drives fed the tape across the head at a constant speed of 1-7/8 or 3-3/4 inches per second, selected by the user. Also, while many of these machines were built ONLY for the small tapes, most of the larger machines designed for 5-inch or 7-inch reels at up to 7-1/2 inches per second could also play the 3-1/2-inch reels at the slower speeds.

So, first you need to determine if the reel tapes you have were made on a rim-drive or capstan-drive machine, and if a capstan drive, at what speed? This becomes very obvious on playback.

These days, you will have a lot of trouble finding a rim-drive machine (although, I have one). But capstan-drive reel recorders are still around.

When playing your tape on a capstan-drive machine, if the voice keeps decreasing in pitch as the tape is being played, it was made on a rim-drive. If it is obviously playing properly, it was recorded on a capstan-drive machine at that speed. If playing too fast or slow, select another playback speed, often accomplished by placing or removing a supplied sleeve over the capstan to change the speed.

It is MOST likely the tapes were made on a capstan-drive machine at 3-3/4-inch speed. Swap meets and electronic repair shops are the best source for old machines.

On an Internet search at **www.google.com**, I found 94 responses to a search for "reel-to-reel recorder" (using the quotes and hyphens as shown).

Fred "Sparks" Blechman
West Hills, CA

#3 This is likely "half-track mono" at 3.75 or perhaps 7.50 IPS (inches per second). As the higher speeds are used for high-quality music (or non-audio data-logging), and the lower speeds were less commonly used for dictation.

I saw what looked like a suitable unit close to the center of page 19 of catalog WS-01 from **Fair Radio Sales** — Tested for 'basic playback/record operation; adjustments may be required — at $75.00 with manual at $10.00. You may want to check eBay, garage sales, and similar locations first.

J. D. Arbaugh
Pearblossom, CA

#4 A very good place to find vintage 1/4" reel-to-reel tape player/recorders is eBay. A recent search of eBay came up with over 60 auction listings for these older hard-to-find machines. Many were listed for less than $20.00. If you not are able to access eBay, you might check out some of your local garage sales.

Once you do acquire a reel-to-reel tape player it would be an easy job to re-record your tapes to cassette or onto your computer. Just connect a cable between the earphone or line-out jack of the reel-to-reel player and the mic or line-in of a cassette recorder or computer sound card.

John McMichael
Laramie, WY

#5 Almost any stereo or mono reel-to-reel will play back your 1/4 inch tapes, in mono. These are probably 1/2 track mono tapes, if played back on a stereo reel-to-reel one channel will be backwards, but the other channel will be fine.

Many times these recorders can be picked up at low cost in thrift or second-hand stores. Test it to be sure it works. I have a couple around, if you wish to purchase one, email me and I'll let you know. I can also transfer them to cassette for you if you wish, as I have several reel-to-reels in my stereo system.

Tony Serra
tonyserra@prodigy.net

#6 My son was in Vietnam, and I understand the interest Mr. Benson has in converting his tapes to a different media.

I would be willing to convert his tapes to cassettes if he supplies the cassettes and pays all postage and insurance expense. Also, some of these tapes could be damaged from age, heat, light etc. I will not be responsible in any way for their condition or for the quality of reproduction.

No consideration involved, only the appreciation for someone who spent valuable time in Vietnam.

I know these tapes contain personal material, but you can be assured that the content will not be divulged.

John W. Lippert
Menomonee Falls, WI

industrial model of a similar unit sold on the consumer market in the late 80s. I need to mount this unit and be able to control it remotely via a wired remote.

60111 **Jerry**
via Internet

Does anyone have any information as to how I can build a device that will take an alarm input and emit an IR signal that can start and stop the recording features of any standard home VCR? It would also have to be programmable to most any of the consumer VCRs on the market.

I thought I had seen something in a past issue of *Nuts & Volts*, but several of my year 2000 issues are missing.

60112 **Jerry**
via Internet

ANSWERS

ANSWER TO 5016 - MAY 2001

I was wondering how this Motorola "can" is controlled? It was used to cut power to hot water heaters at peak demand hours. It has eight coils, an enclosed RF section, an antenna, and a plug-in "cube" with a Bramco patent, Part No. A01648 and frequency code 0757.5 (a crystal, I assume?).

The Motorola 'can' is a remote RF switch used in load control systems in areas that have a lot of electric water heaters.

The code is a proprietary Motorola code. The A01648 is a mechanical read on 757.5 Hz. These are crystal- controlled, single-channel receivers of simple design.

Most of the units we have seen are VHF on a splinter channel. The receiver is very simple. We have a copy of the VHF manual which we could copy for Pete.

The model number stamped on

ANSWERS TO 5015 - MAY 2001

I bought an Icom PCR-1000 receiver and I had hoped to take it with me along with a new Toshiba 2805-S201 laptop computer.

When I bought the laptop, I assumed it had a DB9 serial port. It didn't.

Is there any way I can control my Icom PCR-1000 through my current laptop? USB-to-serial adapters have not worked.

#1 We were faced with a similar problem with our new Toshiba notebook, no serial port. Like you, we purchased a USB-to-serial port adapter and found it didn't work. Our need was a port for PLC serial port programming cables. We purchased a PCMCIA serial port card. This worked okay. We are using Windows 98se.

John Olson
via Internet

#2 You have at least one, and maybe two problems. First, USB-to-parallel or serial adapters are notoriously flakey, particularly when working with two-way communications (which the PCR-1000 needs).

I would strongly recommend forgetting about this approach and getting a PCMCIA serial card. These are available new from Socket Communications via dealers such as **www.igo.com**. See **www.socketcom.com/product/serial.htm** for more information.

These are pretty pricey new ($150-$250), so you might want to check eBay. A search for "PCMCIA serial" turned up a dozen items with many under $50.00. If you can find and old "Options by IBM" card, you may be able to pick it up very cheap, because many people believe it needs an unobtainable drive. Actually, by selecting "Standard Serial or Parallel Port" during the Win98 installation process, it should come right up.

Now to the second possible problem. Icom doesn't state that the software they supply will work under Win98, only Win95. This software has been noted for being very fussy about even what version of Win95 it runs (or doesn't run) under, so you may still have difficulties after sorting out the serial port issue. I'd suggest trying a third-party control program such as TalkPCR available from **www.mahy.demon.co.uk/**.

You can read a review of TalkPCR at **http://qsy.to/pcr/talkpcr.html**.

Bob Scott
Alexandria, VA

#3 I have the same problem connecting the Icom PCR-1000 to my Toshiba Portege 320CT. They don't have a serial port. Most new computers switched to USB ports and discontinued RS-232 and parallel ports, however, I solved this problem by purchasing a PCMCIA serial port, from SOCKET model S-I/O. More information at their web page www.socketcom.com. This card comes with a dongle about one foot long ends on a DB-9.

I also use this card to interface my computer and several PLC controllers to monitor operation and program.

I use this card under Win 95, Win 98, and Win 2000, and it works fine every time.

Dan Virgilio
via Internet

the chassis will specify the frequency range of the units. The model number looks like "CRD0000" The third character denotes frequency "D" in the example notes VHF 150-174 MHz. A "B" would be 30-50 MHz. An "E" would be 450-470 MHz.

There is no audio circuitry, the decoder looks at discriminator audio level.

These would work as alarm receivers or switches, but little else could be done with them without a great deal of imagination.

Ted Bleiman
MDM Radio Ltd.
sales@mdmradio.com
Melrose Park, IL

ANSWER TO 5014 - MAY 2001

I bought a Piculator from Fred Eddy after seeing an article in Micro Computer Journal. I've lost the cable that connected the emulator to the PC and understand it was a special cable. I have been unable to contact Fred. Can you help with the specifications of this cable?

I believe the article you are referring to was actually published in *Electronics Now*, Jan. and Feb. 1994 issues. I think I have all issues of *Micro Computer Journal* that were published and I could not find the article in any of them. However, the article in *Electronics Now* pretty much matches what you are describing.

Fred Eady is still writing articles on almost a monthly basis for another electronics publication. He can be reached via email at fred@edtp.com.

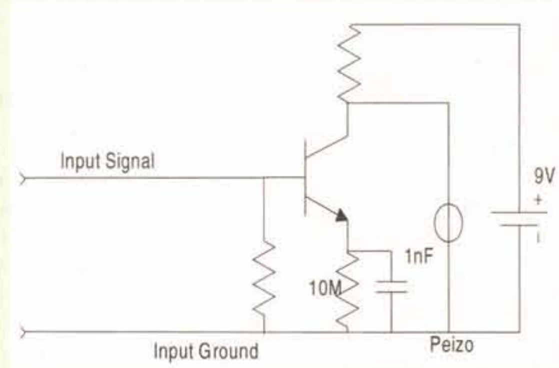
Raymond C. Buck
Phoenix, AZ

ANSWER TO 4016 - APR. 2001

I would like to put a smoke detector in my garage and extend the wires to put the buzzer inside my house, about 25 feet away.

Would the smoke detector put out enough current to drive the buzzer at that distance or do I need some kind of transistor build-up to make the signal reach me and how far could one make it go? Fifty feet, 100 feet?

Here's a nice little circuit we use in Detroit to condition our analog signals. You should use at least a 22 AWG twisted pair. The 1nF cap allows additional noise immunity and the 10M ohm should reduce any transmission spikes with minimal drain on the battery and can be removed if you're not in a harsh environment.



Transmissions can be received about 1,000' away, using a shielded cable, of course.

Robert D. Miller
Westland, MI

Continued on page 85

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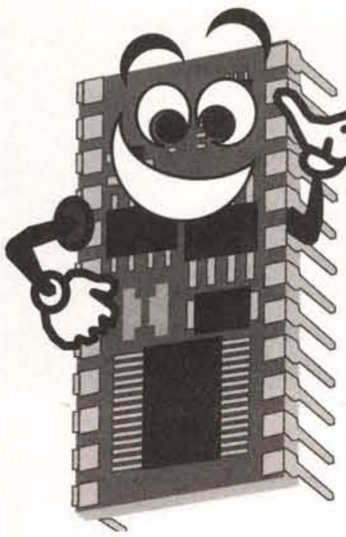

by Jon Williams

Stamp Applications

SOUNDING OFF ... AGAIN! (PART 1)

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

Of the 20-something articles I've written for *Nuts & Volts*, none has generated as much email as my articles on using the ISD2560. Any why not? Adding sound to BASIC Stamp projects is a lot of fun, and now it's a whole lot easier.

The Quadravox QV306M4-P

Of its product line, the Quadravox QV306M4-P is probably the most interesting offering for the Stamp user. The Quadravox guys think so too — their documentation includes a BS2 demonstration (that we'll expand on here).

The QV306M4-P is a small (2.3" x 1.7") PCB that holds an ISD4003-04, an audio amplifier, and a serial controller (programmed PIC) that makes interfacing the device a snap. The QV306M4-P connects to the outside world through a 16-pin SIP header.

> I've said it before: the Dallas metroplex is a great place. A recent discovery for me is a local company called Quadravox. These guys — all former engineers with Texas Instruments — know their sound and speech stuff. They know it *really* well. So much so that these are the folks who create the development tools for ISD (now part of Winbond). Since leaving TI, they have focused on making ISD devices easy to use and integrate into OEM products.

The heart of the unit is, of course, the ISD4003-04. This gives the QV306M4-P the ability to store up to four minutes of high-quality sound. The "-P" designation at the end indicates that the unit comes pre-programmed from Quadravox. There are 240 pre-programmed sound files; professionally-recorded numbers, letters, and technical terms.

Playing any of these "files" is as simple as sending the file number (0 to 239) through a serial connection. That's it! Tough, huh? Volume control and low-power (sleep) mode is handled serially, as well. The QV306M4-P is a Stamp-user's dream. Since the QV306M4-P doesn't have a multi-byte serial buffer, there is a busy line to indicate that the device is currently playing. We'll monitor the busy line when creating complex phrases.

Okay, let's just hook it up and try it out. The connections to the Stamp — four of them — are easy. To hear how good the unit sounds, you'll need to connect a decent-quality, enclosed speaker. If you use a small speaker that is not enclosed, you'll be robbed — trust me on that. The onboard amplifier is capable of delivering 300 mW, so a nice speaker will give you a room full of sound. I picked up a little eight-ohm bookshelf speaker from RadioShack and it works great.

Listing 1 is the updated demo. This code takes advantage of the preprogrammed sound files in the QV306M4-P. Don't let the length of the listing fool you; this program is deceptively simple.

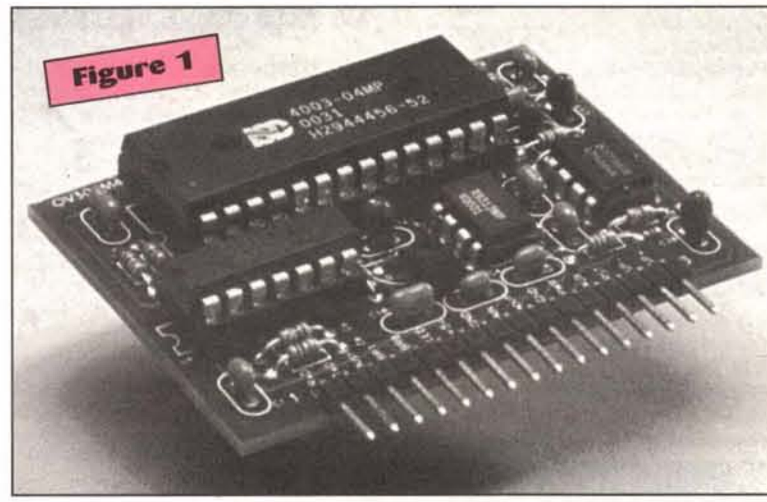

Figure 1

We start by initializing the QV306M4-P. This is done by momentarily dropping the RESET line. When raised, we'll pause a bit to allow the QV306M4-P to count the number of stored sound files. If we ever send a file that is out-of-range, the QV306M4-P will play its first file.

The first step in the demo is to display the device and revision type. Each command sends a single byte and expects one back from the QV306M4-P. The subroutines for these functions include a serial timeout so that they "don't" hang if you choose not to connect the serial input. Once we've displayed the device type, it's time to start talking.

As I indicated earlier, the QV306M4-P comes preprogrammed with 240 sound files. The first set of files are numbers that, when properly concatenated (chained together), will cause the device to say just about any number you wish. This is convenient for talking devices like clocks and thermometers.

Since the Stamp uses 16-bit numbers, I created a couple of subroutines to say them. The first to be demonstrated is called Say_Unsigned. This subroutine will "say" (literally) any number between zero and 65,535. A small loop in the main body feeds a table of numbers to exercise all the elements of the Say_Unsigned subroutine.

The nature of Say_Unsigned is to parse the number passed to it and then say the parts just as we would. If our number is 65,535, the routine will start by saying "Sixty five thousand." The routine separates thousands, hundreds, and then the rest. It is supported by another routine, Say_Val_XX, which will say any value between 0 and 99.

Say_Val_XX checks to see if the value passed is 20 or higher. The reason for this is that every number lower than 20 is a unique file. Anything 20 and higher is created by saying the tens value, then the ones. Notice that all the organization of the sound files ("zero" is file 0, etc.) makes this routine easy to use. Should you decide to custom-program your QV306M4-P, it's a good idea to keep the numbers as they are so you don't have to fix these subroutines.

Saying a negative number is just as easy. In the BASIC Stamp, a signed number is negative when bit 15 is set to one. In this case, the other bits represent the two's compliment value of the number. If bit 15 is set, the QV306M4-P will say "negative," then convert the value to positive with the ABS function and pass it on to Say_Unsigned to finish up.

Sounding Off ... Again! (Part 1)

The next part of the demo says a time; in this case, using the 12-hour, AM/PM format. By taking advantage of Say_Val_XX, this routine is fairly straightforward. The only thing we need to accommodate is the way we say time values that have minutes less than 10. In that case, we tend to say "oh-six" if the time is six minutes past the hour.

Say_Time12 does a quick range check, announces "The current time is ..." then says the hours using the Say_Val_XX subroutine. It then checks to see if the minutes are less than 10. When this is the case, the QV306M4-P will say "oh" and then the minutes value. When the minutes is 10 or greater, we skip the "oh" and say the value with Say_Val_XX. Since "AM" and "PM" are stored in consecutive locations, a bit of math is all that is required to select the correct phrase based on this one-bit value.

Moving on, we'll use the QV306M4-P to say the date. By now, you've got the hang of how this works, so I'm not going to rehash the details. The only note here is that when the century value is 19 and the year value is less than 10, we have to insert the "oh" before the year, just as we did with the time.

Finally, there will be projects where we'll want to create a complex phrase or sentence from the fragments that are included in the QV306M4-P. The method I prefer is to build the complex phrase in a DATA table, then play each phrase in order. Since the valid range for phrase files is zero to 239, any value greater than 239 will cause the Say_Sentence subroutine to terminate. I chose to use $FF as the terminating value in the demo. To play a stored sentence, we need to put the starting location in the variable, addr, then call Play_Sentence.

One of the coolest aspects of the QV306M4-P is the digitally-controlled amplifier. The onboard controller actually modulates the amplifier to eliminate the clicks and pops that seem inherent with the ISD chip. The last portion of the demo repeats the word "Hello" through the volume range of the circuit.

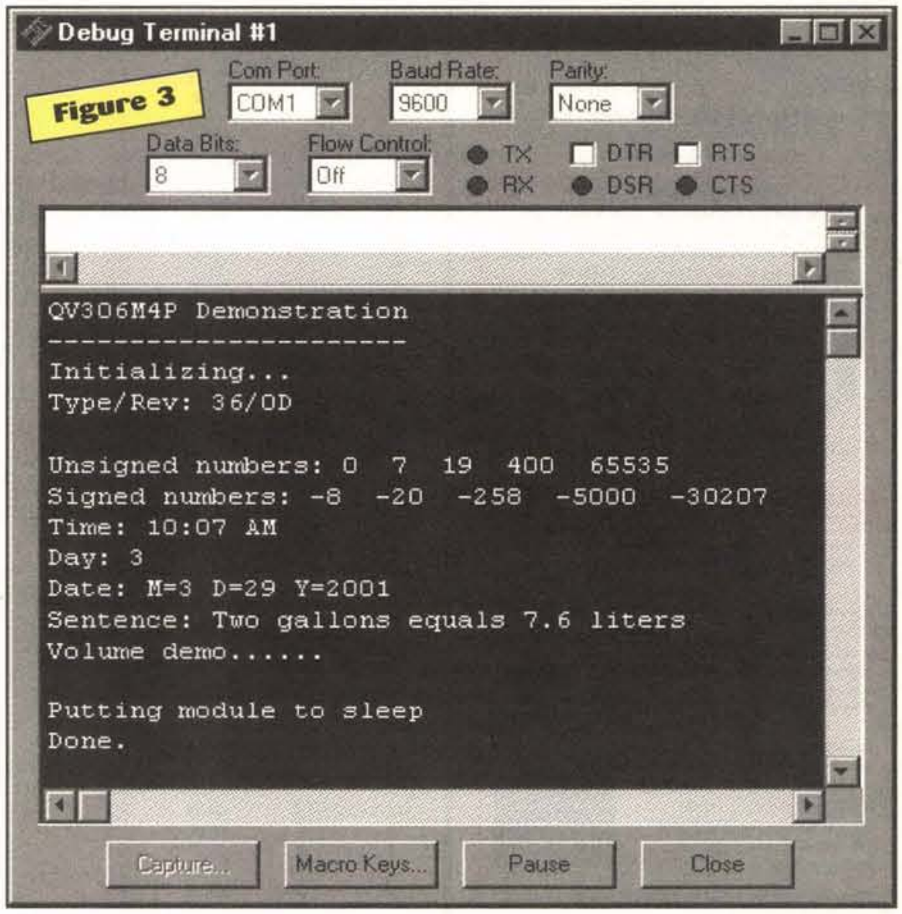

Figure 3

Next Time ...

Well, with our long code listing, that's about all we can squeeze in this month. Next month, we'll continue working with the QV306M4 by putting our own sounds into it and creating a sound effects sbox for fun. Be sure to visit the Quadravox web site and download their excellent documentation.

Jon Comes Out of the Closet

In April, I had the opportunity to attend the Embedded Systems Conference in San Francisco. It was a lot of fun; there were some really neat things to see. One of my greatest pleasures was the very cool opportunity to meet some of the readers of this column. That was fun. It's one thing to get an email, quite another to meet that person face-to-face. I strive to keep my writing easy-going and accessible, so it was a pleasure to meet a few of you that felt like you "know" me. And now you do.

Well, that works both ways. I had the opportunity to meet Steve Ciarcia, well-known electronics guru and publisher of *Circuit Cellar* magazine. Like many of you, I've been reading Steve's materials and learning from him for a long time. Meeting him was a genuine thrill. Imagine my surprise when he told me he knew who I was — from this column, no less! Way cool.

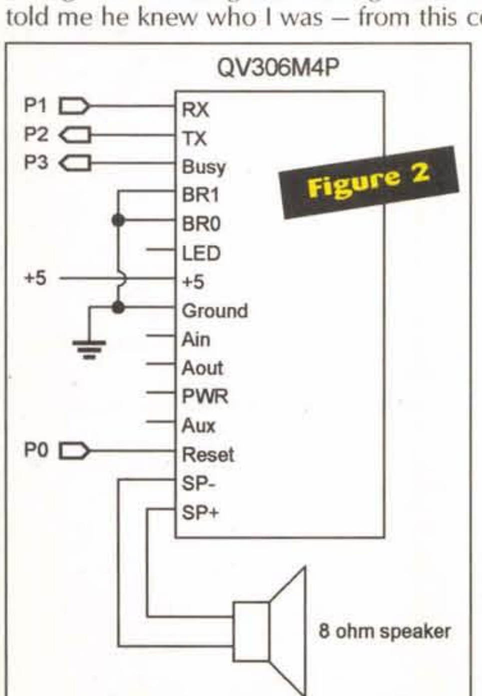

Figure 2

And then it happened ... With a furrowed brow, Steve looked right at me and said, "But you don't actually work for Parallax, do you?" (At the time, I was standing in the Parallax booth wearing Parallax attire.) "Yes," I replied, "I've been working for Parallax since August."

In a nutshell, Steve took exception (or raised an exception for your hardcore programmers) to me not coming out early on and telling you that Parallax had hired me. So now I'm doing it. Does my employment with Parallax change the way I feel about Stamps and how I approach this column? Of course not! And now I get to work "on the inside" with Parallax's incredibly talented engineering staff to make Stamps more fun to use.

Okay, there you have it — I'm out. I work for Parallax now (Applications Engineer). I still live in Dallas and I'm still working part-time as an actor (commercials, mostly, but recently worked two days on the Matthew Perry comedy, "Servicing Sara"). I've never tried to hide my Parallax employment, I just didn't think it was necessary to wave a flag. Parallax did make an announcement to its distributors. Perhaps I should have said something here sooner.

This column is — and always has been — about programming BASIC Stamps. And through an incredible bit of good luck, I happened to land a job that pays me to do that.

Until next time, Happy Stamping. **NV**

Resources:

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jonwms@aol.com

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

Quadravox
1701 N.Greenville Ave., Suite 608
Richardson, TX 75081
1-800-779-1909 or 972-669-4002
www.quadravox.com

```
' -----[ Vocabulary ]----------------------
'
_zero       CON   0     ' message # in QV306M4P
_one        CON   1
_two        CON   2
_three      CON   3
_four       CON   4
_five       CON   5
_six        CON   6
_seven      CON   7
_eight      CON   8
_nine       CON   9
_ten        CON   10
_eleven     CON   11
_twelve     CON   12
_thirteen   CON   13
_fourteen   CON   14
_fifteen    CON   15
_sixteen    CON   16
_seventeen  CON   17
_eighteen   CON   18
_nineteen   CON   19
_twenty     CON   20
_thirty     CON   21
```

Listing 1

This month's listing was really long and there wasn't enough space to print it here. We have included the vocabulary portion so you can see the capability of the QV306M4-P.

The entire program listing can be viewed or downloaded from our website.

www.nutsvolts.com

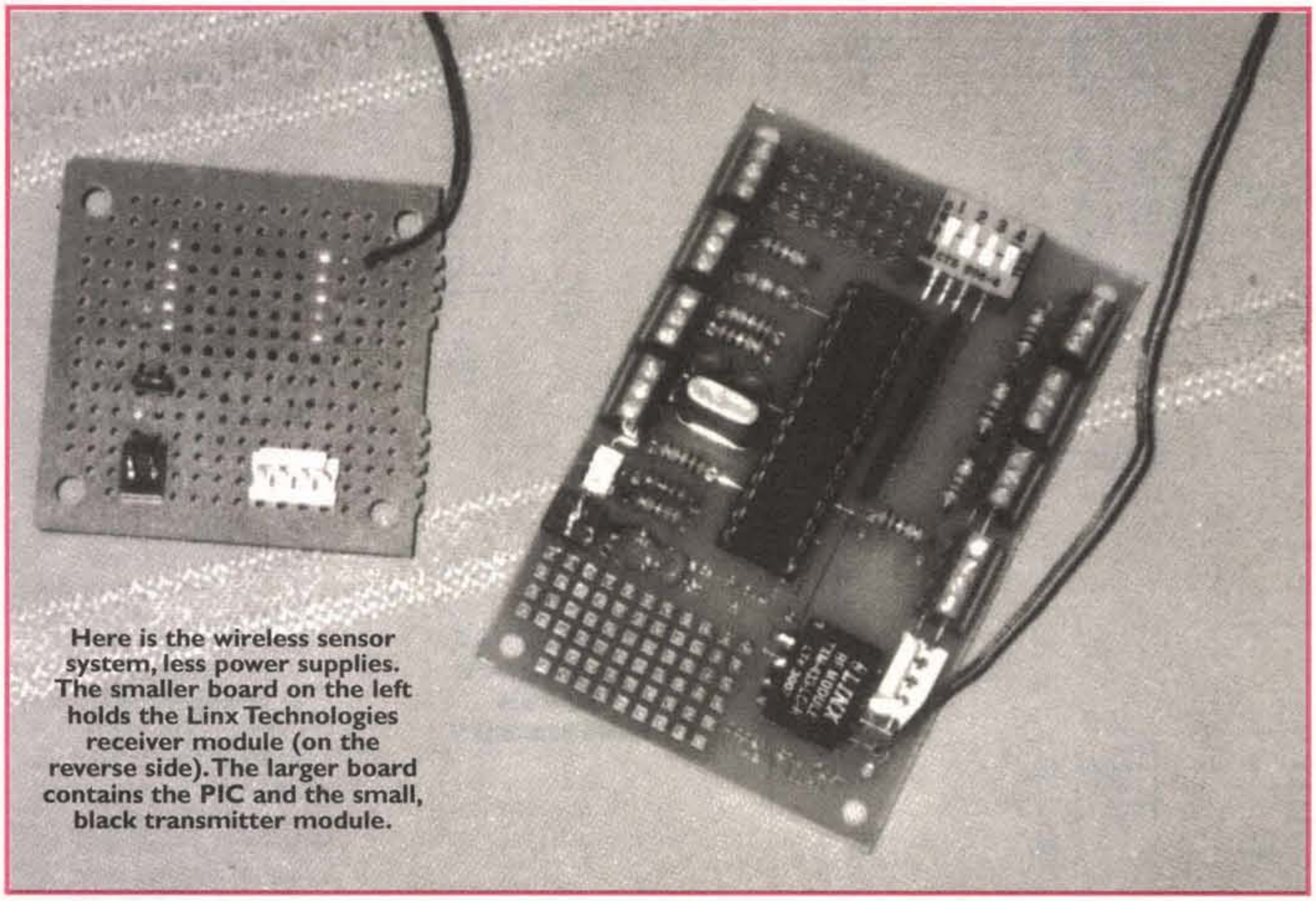
Sounding Off ... Again! (Part 1)

```
_forty          CON     22
_fifty          CON     23
_sixty          CON     24
_seventy        CON     25
_eighty         CON     26
_ninety         CON     27
_hundred        CON     28
_thousand       CON     29
_million        CON     30
_billion        CON     31
_2000           CON     32      ' "two thousand"
_am             CON     33
_pm             CON     34
_a              CON     35
_alpha          CON     36
_b              CON     37
_bravo          CON     38
_c              CON     39
_charlie        CON     40
_d              CON     41
_delta          CON     42
_e              CON     43
_echo           CON     44
_f              CON     45
_fox            CON     46
_g              CON     47
_golf           CON     48
_h              CON     49
_hotel          CON     50
_i              CON     51
_india          CON     52
_j              CON     53
_juliet         CON     54
_k              CON     55
_kilo           CON     56
_l              CON     57
_lima           CON     58
_m              CON     59
_mike           CON     60
_n              CON     61
_november1      CON     62
_o              CON     63
_oscar          CON     64
_p              CON     65
_papa           CON     66
_q              CON     67
_quebec         CON     68
_r              CON     69
_romeo          CON     70
_s              CON     71
_sierra         CON     72
_t              CON     73
_tango          CON     74
_u              CON     75
_uniform        CON     76
_v              CON     77
_victor         CON     78
_w              CON     79
_whiskey        CON     80
_x              CON     81
_xray           CON     82
_y              CON     83
_yankee         CON     84
_z              CON     85
_zulu           CON     86
_monday         CON     87
_tuesday        CON     88
_wednesday      CON     89
_thursday       CON     90
_friday         CON     91
_saturday       CON     92
_sunday         CON     93
_january        CON     94
_february       CON     95
_march          CON     96
_april          CON     97
_may            CON     98
_june           CON     99
_july           CON     100
_august         CON     101
_september      CON     102
_october        CON     103
_november2      CON     104
_december       CON     105
_amp            CON     106
_amps           CON     107
_bars           CON     108
_bit            CON     109
_bits           CON     110
_black          CON     111
_blue           CON     112
_brown          CON     113
_byte           CON     114
_bytes          CON     115
_cable          CON     116
_celcius        CON     117
_centimeter     CON     118
_centimetrs     CON     119
_cents          CON     120
_chip           CON     121
_connector      CON     122
_cubic          CON     123
_degrees        CON     124
_divided_by     CON     125
_dollars        CON     126
_down           CON     127
_equals         CON     128
_fahrenheit     CON     129
_farads         CON     130
_feet           CON     131
_foot           CON     132
_gallons        CON     133
_gigahertz      CON     134
_go             CON     135
_gold           CON     136
_good_aft       CON     137     ' "good afternoon"
_good_morn      CON     138     ' "good morning"
_goodbye        CON     139
_gram           CON     140
_grams          CON     141
_gray           CON     142
_green          CON     143
_hello          CON     144
_hertz          CON     145
_hour           CON     146
_hours          CON     147
_inch           CON     148
_inches         CON     149
_indoor_tmp     CON     150     ' "indoor temperature"
_is             CON     151
_key            CON     152
_kilobit        CON     153
_kilobits       CON     154
_kilobyte       CON     155
_kilohm         CON     156
_kilometer      CON     157
_kilometers     CON     158
_kiloohms       CON     159
_light          CON     160
_liters         CON     161
_mega           CON     162
_megabytes      CON     163
_megaohms       CON     164
_megohms        CON     165
_meter          CON     166
_meters         CON     167
_micro          CON     168
_micron         CON     169
_microns        CON     170
_midnight       CON     171
_mile           CON     172
_miles          CON     173
_milli          CON     174
_minus          CON     175
_minute         CON     176
_minutes        CON     177
_noon           CON     178
_oclock         CON     179
_of_Merc        CON     180     ' "of Mercury"
_of_Water       CON     181
_ohms           CON     182
_orange         CON     183
_pascals        CON     184
_per_hour       CON     185
_per            CON     186
_percent        CON     187
_pico           CON     188
_pink           CON     189
_plus           CON     190
_point          CON     191
_pound          CON     192
_pounds         CON     193
_psi            CON     194
_purple         CON     195
_rpm            CON     196
_red            CON     197
_second         CON     198
_seconds        CON     199
_silver         CON     200
_square         CON     201
_start          CON     202
_stop           CON     203
_switch         CON     204
_tan            CON     205
_temp_is        CON     206   ' "temperature is"
_t_cur_t_is     CON     207   ' "the current time is"
_t_currnt       CON     208   ' "the current"
_t_outside      CON     209   ' "the outside"
_t_speed_is     CON     210   ' "the speed is"
_the            CON     211
_thee           CON     212
_times          CON     213
_up             CON     214
_volt           CON     215
_volts          CON     216
_white          CON     217
_wire           CON     218
_yard           CON     219
_yards          CON     220
_yellow         CON     221
_y_spd_is       CON     222     ' "your speed is"
_the_date       CON     223
_is_more        CON     224
_pls_wait       CON     225     ' "please wait"
_please         CON     226
_is_less        CON     227
_thank_you      CON     228
_than           CON     229
_and            CON     230
_are_closed     CON     231
_are_down       CON     232
_are_off        CON     233
_are_on         CON     234
_are_open       CON     235
_are_up         CON     236
_is_closed      CON     237
_is_down        CON     238
_is_off         CON     239
```

Build an RF Sensor Block

by Karl Lunt

The second installment in a series of articles to turn your home into a robot ...



Here is the wireless sensor system, less power supplies. The smaller board on the left holds the Linx Technologies receiver module (on the reverse side). The larger board contains the PIC and the small, black transmitter module.

In my previous article, I described the first steps needed to turn your home into a robot. That initial article on home robotics dealt primarily with using off-the-shelf X10 modules as the robot's main actuators, permitting it to control your house lights and plug-in appliances. That article also introduced x10dos, my DOS-based program for transmitting X10 control signals from a PC, using an X10 Firecracker RF module.

But a robot must have input, as Number 5 was wont to demand. Sensor signals from small robots present few problems; just run a cable harness from wherever the sensor is to wherever the computer board is, and you're done.

Adding sensors to a home robot, however, offers a bigger challenge. There is no short length of wire run in most cases; either you need to cover long distances or you have to go up and down floors. There never seems to be convenient access points, and hiding the cabling is such a pain.

One solution to this problem of getting sensor data from point A to point B lies with RF. A technology similar to that used in the home robot actuators can just as easily carry data from wide-ranging sensors. That doesn't mean I'll be using X10 for sensors, but I do need a wireless scheme that gets data to the computer reliably and cheaply, over a useable distance.

Design of a sensor board

First up, I designed a simple sensor board, based on Microchip's PIC16f873 microcontroller (MCU). This nifty little device comes in a 28-pin skinny DIP package; the through-hole design means I can use conventional soldering techniques and a socket in my board design. More importantly, this MCU has a nearly ideal feature set. The DIP version contains five eight-bit A/D channels, a serial port for RS-232 communications, a good mix of timers, and plenty of digital I/O lines.

Another benefit to using this chip lies in the PIC bootloader I described in a previous *Nuts & Volts* article. I burned the bootloader into the upper 512 bytes of the 16f873, so I can use an RS-232 cable and a comm program to load new firmware into the device any time I need.

I've already described my PIC 16f87x bootloader in a previous article; you can get the source code for that project from my website at www.seanet.com/~karllunt. The bootloader in this design lets me easily upgrade the firmware in the finished board, without having to pull the MCU from its socket.

Using this chip as the core for my sensor block design was easy; the accompanying schematic shows how little is involved (Figure 1). You can see the standard crystal oscillator and reset pull-up resistor. I added several three-pin KK-style male headers, one for each input channel. As designed, the board sports connectors for four A/D channels, shown here as AN0 through AN3. I also brought out three binary inputs on connectors BI0 through BI2.

The fourth binary input connector — BI3 — is a bit special. I expanded this to four pins; the added pin provides a 40-kHz square-wave, suitable for driving an infrared (IR) LED. This lets me run four wires to a module consisting of an IR LED and a matching IR detector module, creating a simple object detector or beam-break sensor. By setting up the proper optics — such as a lens and mirror arrangement — I can make a doorway monitor or an intrusion detector system.

Note that resistor R9 limits the current to the IR LED. Depending on your use, you may need to adjust this value. The value shown is suitable for a beam-break sensor over a distance of several feet, but could prove too low if you want to make a reflective object detector. If you get a lot of false signals on your object detector, try increasing R9 to 1K or more.

Connector SL1 is the power-input connector; the board requires a regulated 5 VDC power supply. The four-pin connector at SL2 is the customary serial I/O channel found on nearly all of my robots. It provides TTL-level signals to an external circuit that translates these signals to the required RS-232 levels.

Since I intend to use several of these boards in my system, I needed some way to assign an address to each board, so the receiving computer can sort out the incoming data stream. This explains the four-position DIP switch and nine-pin resistor pack. Three of the DIP switches let me assign a board address from 0 to 7. The fourth DIP switch controls the bootloader's mode select line, RB1.

Linx Technologies

The major addition to this board is the 433 MHz Linx Technologies transmitter (TXM-433-LC-R) at U1. This device is slightly larger than an eight-pin DIP device, but it adds wireless serial data transmission with little hassle. As you can see, all it takes is power and ground connections, a line to the MCU's serial output line (TX), and a two-pin connector to hold an external antenna. Soldering this device to the circuit board can be a bit tricky, as the TXM is a surface-mount device.

Build an RF Sensor Block ...

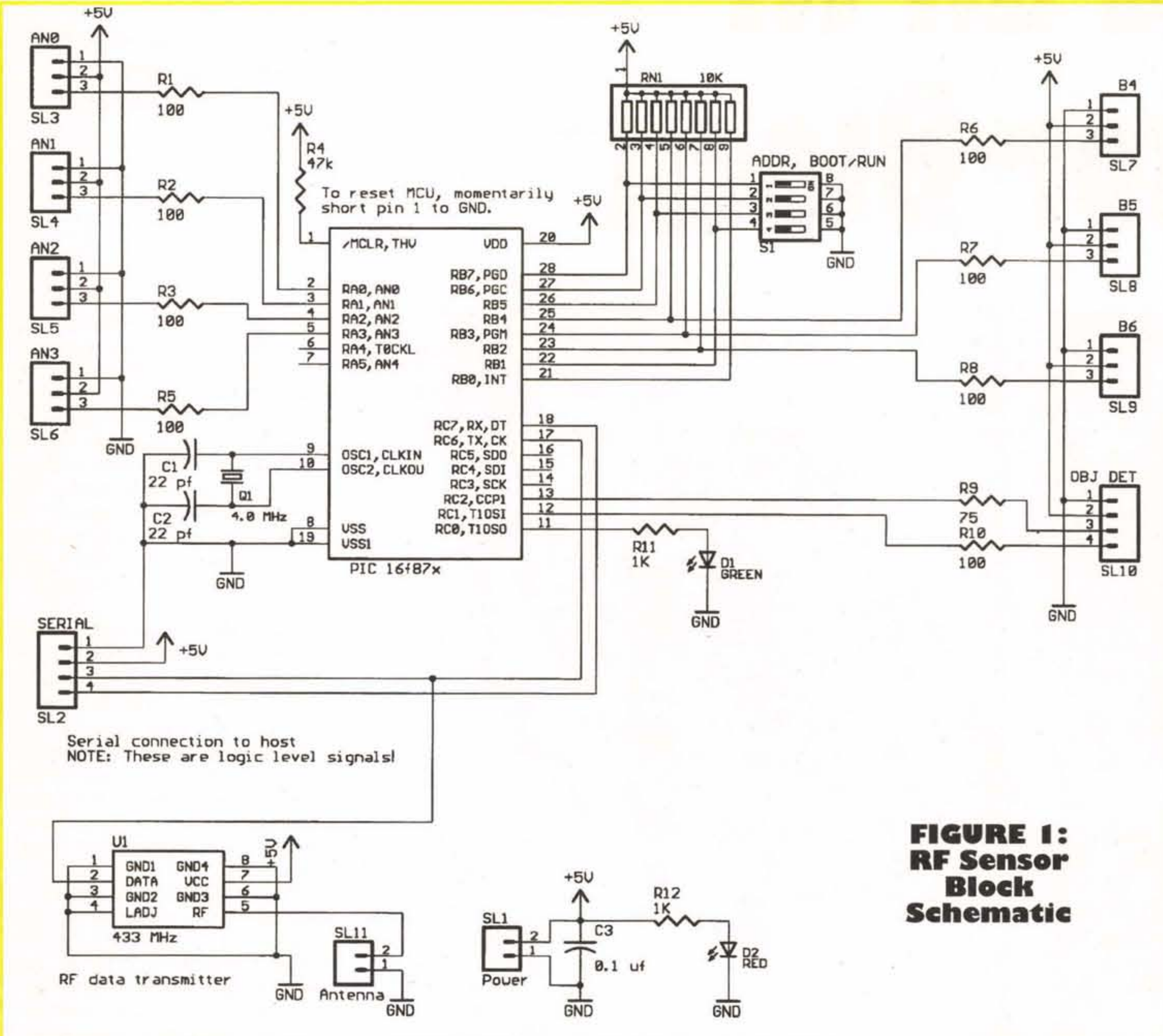


FIGURE 1: RF Sensor Block Schematic

(See the section below on building the RXM receiver board for details on soldering these surface-mount devices.)

I used about the simplest antenna possible. I cut a piece of 24 AWG solid-core wire to the proper length (6.5 inches) and soldered it to the antenna pin on the board's two-pin connector. But don't let this simple system fool you. I get clean data transmission from one end of my 2,000 square-foot rambler to the other at 4,800 baud. Best of all, this device only costs about $5.00 when purchased directly from Linx Technologies.

Note, however, that Linx Technologies has an interesting distribution requirement. They will not sell their modules to you unless you first buy a development system from them. I went into great length over this issue with a representative from Linx. She said that Linx used to spend an inordinate amount of time talking first-time users through the set-up of their devices, and ultimately the time spent proved too costly. She claimed that after requiring users to purchase a development kit first, the amount of customer support dropped dramatically.

I have mixed feelings about this. On the one hand, Linx knows their customers and their equipment better than I do. The representative mentioned several times that the worst problems were with college students trying to put together class projects. I will admit to having seen first-hand some pretty clueless engineering graduates struggling with what I thought were simple concepts, such as reset circuitry. I'm not saying that all new engineering grads are clueless, only that I've personally worked with a disturbing number of them that are.

On the other hand, the Linx modules are so bloody simple to use that I can't fathom how anyone could get them wrong. You can see in the schematic how easy it is to hook up the transmitter, and the receiver is only slightly more difficult. Honestly, how much easier can it be?

The gripping hand is that, whether you agree with Linx' policy or not, you aren't going to get any RF modules out of them without buying a development kit first. Happily, there is an alternative. Digi-Key now carries the entire Linx Technologies line. Granted, you pay a slight premium because of Digi-Key's legendary service. Expect to pay about $7.00 for the transmitter and not quite $14.00 for the receiver. But at least you don't have to buy the development kit.

Note, however, that if you do go the Digi-Key route and end up having problems, you will get no support from Linx Technologies; at least, that was the company's position during my conversation earlier this year.

As I was starting this project, I looked for an alternative RF link; I was already aware of Linx Technologies' requirement. I first tried using the Abacom devices, but I was never able to make them work. After several attempts, I finally talked the matter over with some of the hardware types at work. My feeling here was that, being primarily a firmware guy, I was obviously missing something.

This is not intended as a slam on Abacom. I've seen the fabrication of their products, and they are impressive. I have no doubt that, given sufficient technical background, I could make them work well in my project. As I said, I might have been overlooking something that would be obvious to someone else with a strong RF background. That's what led me back to Linx Technologies.

Sending data

Getting data from point A to point B over a one-way RF link takes a bit of planning. The sensor board cannot receive anything from the host PC, so the sensor board cannot determine if the transmission was successful, nor can the host request that the sensor board resend. So the sensor block must use a suitable protocol to allow the host PC to validate each data transmission. Additionally, the protocol should have built-in redundancy, to allow for

PREF0 PREF1 LEN ADDR RECN DIGIN AD0 AD1 AD2 AD3 CHK

PREF0	0xa5
PREF1	0x5a
LEN	number of bytes in record from LEN to CHK; does not include either preface byte (9 for the above format).
ADDR	unit addr
RECN	this record's number
DIGIN	four digital input bits, expressed as four pairs of sticky bits
AD0 - AD3	values of A/D ports AD0 through AD3
CHK	8-bit additive checksum, excluding carries, of LEN to AD3; does not include preface bytes or CHK.

FIGURE 2: Format of a data packet

```
;
; The code starting at bigloop marks the start of the mainline
; code. The MCU performs all tasks within this loop until the
; timeout flag is set. When that happens, control falls out of
; the loop into the task section below.
;
; You can add small tasks to the loop, if you want. These will
; be run every pass through the loop. Depending on how simple
; the tasks are, you could get a few to several hundred tasks
; completed between timeouts.
;

bigloop:
;
; Replace these comments with any tasks you want executed at
; every pass through the loop.
;
        brset   PORTB,BI0,big1      ; test for clear
        bsf     sticky,SBI0CLR      ; record it
        goto    big2
big1:
        bsf     sticky,SBI0SET      ; no, it was set
big2:
        brset   PORTB,BI1,big3      ; test for clear
        bsf     sticky,SBI1CLR      ; record it
        goto    big4
big3:
        bsf     sticky,SBI1SET      ; no, it was set
big4:
        brset   PORTB,BI2,big5      ; test for clear
        bsf     sticky,SBI2CLR      ; record it
        goto    big6
big5:
        bsf     sticky,SBI2SET      ; no, it was set
big6:
        brset   PORTC,BI3,big7      ; test for clear
        bsf     sticky,SBI3CLR      ; record it
        goto    big8
big7:
        bsf     sticky,SBI3SET      ; no, it was set
big8:
        movf    timeout,f           ; test timeout flag
        beq     bigloop             ; branch if not yet time

;
; This is the task section. Put whatever you want your machine
; to do at each timeout in this section. If your program might
; be disturbed by background interrupts from the 1-msec timer,
; you can disable interrupts immediately. Regardless, you should
; disable interrupts before calling SetCount to reload the timer
; values.
;
        movf    xmtcntr,w           ; get current counter
        bne     big9                ; branch if not first time
        movf    sticky,w            ; get sticky byte
        movwf   stickysnd           ; save for SendData
        clrf    sticky              ; clear sticky byte for next loop
big9:
        bsf     LED_PORT,LED_OUTPUT
        call    SendData            ; send the data
        bcf     LED_PORT,LED_OUTPUT
        incf    xmtcntr,f           ; count this time
        movfw   xmtcntr             ; get the counter

        select
        case    1                   ; if first transmission...
        movlw   (DLY_50MSEC&0xff)   ; change delay
        movwf   dlyl
        movlw   (DLY_50MSEC>>8)
        movwf   dlyh
        endcase

        case    2                   ; if second transmission...
        movlw   (DLY_50MSEC&0xff)   ; change delay
        movwf   dlyl
        movlw   (DLY_50MSEC>>8)
        movwf   dlyh
        endcase

        case    3                   ; if third transmssion
        movlw   (DLY_XMISSION&0xff) ; get low half of delay count
        movwf   dlyl                ; init the delay variable
        movlw   (DLY_XMISSION>>8)   ; get high half of delay count
        movwf   dlyh                ; init the delay variable
        clrf    xmtcntr             ; restart counter
        incf    recnumber,f         ; bump the record number
        endcase
        endselect

        bcf     INTCON,GIE          ; shut off interrupts
        call    SetCount            ; rearm timer
        bsf     INTCON,GIE          ; turn interrupts back on
        goto    bigloop             ; do forever
```

FIGURE 3: Code section showing main loop

instances of lost data. Though not essential, it is handy to include in the protocol a means for the host PC to detect that one or more data transmissions didn't get through at all.

The protocol I used in my RF sensor block meets all of these requirements, and has proved to be very robust. Each transmission consists of a group of 11 bytes, sent at 2,400 baud, 8N1. Although the RF connection works fine at 4800 baud between the sensor block and a large PC, I had to use the slower baud rate when receiving with my hacked Itronix T5000 PC.

The format of a data packet appears in the accompanying table (Figure 2). The following paragraphs describe each byte of the data packet in detail.

Each data packet begins with two preface bytes, $a5 and $5a. These bytes alert the receiving unit that a data stream is inbound.

The LEN byte contains the number of bytes in the data packet, including the LEN byte itself, but not including either preface byte. For the data packet format given here, LEN is always nine.

The ADDR byte contains the address value read from the set of DIP switches on the RF sensor block. This byte identifies the sensor block that is transmitting the data packet.

The RECN byte holds the record number for the packet being transmitted. Each unique data packet sent by an RF sensor block carries a different record number. The record number starts at 0 following power-up and increments each time a data packet is transmitted. This lets the receiving PC determine if one or more data packets were simply missed, as the RECN bytes for two data packets will be out of order.

The DIGIN byte contains the value of the four digital inputs on the RF sensor block. This byte actually assigns two bits for each digital input, using a technique called "sticky bits." I'll go into detail on sticky bits later.

The four bytes labeled AD0 through AD3 each contain the values of the corresponding four A/D inputs.

Finally, the CHK byte contains an eight-bit additive checksum, excluding carries, of all bytes transmitted from the LEN byte to the AD3 byte inclusive. The receiving PC should verify this checksum by adding all received data from the LEN to the AD3 bytes; the resulting sum will match the CHK field if the data packet was received properly.

This packet design allows the host PC to determine if a packet is corrupt upon receipt, but does nothing to correct a bad packet. To help ensure that the data get through even if a packet is damaged, a data packet is transmitted three times in rapid succession, with a delay of 50 msecs between the three transmissions.

To receive a data packet, the host PC begins by waiting for the receipt of the first preface character. After detecting both preface characters in sequence, the host begins reading each incoming byte and building up a duplicate of the transmitted packet. After receiving the checksum byte, the host compares the received packet's CHK field with the computed checksum to test for packet validity.

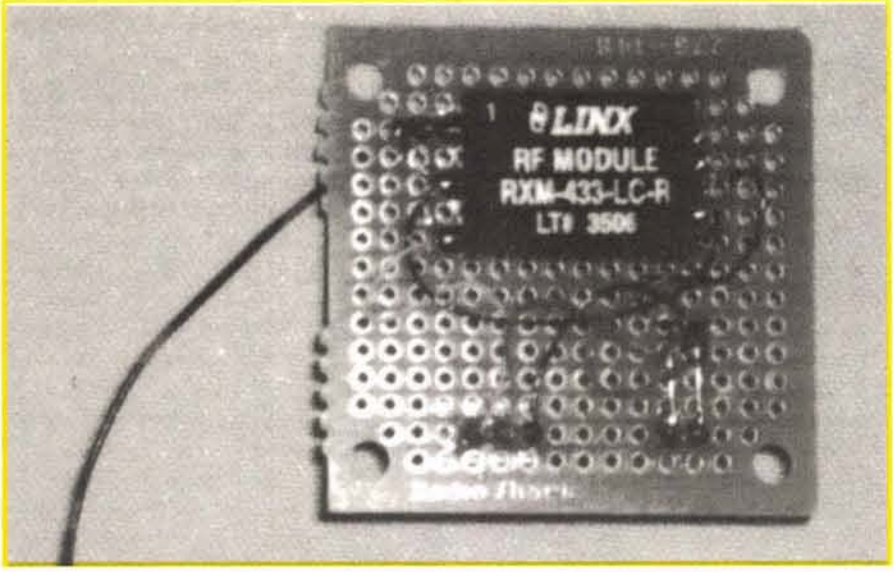
Each transmitted byte requires about 8 msecs, given a 2,400 baud transmission rate. If the receiving PC detects a gap of more than two character times during receipt of a packet, it can assume that the packet has been damaged and restart listening for the first preface byte.

The receiver

The other end of this data link consists of a Linx Technologies RXM-433-LC-R receiver module, a 5 VDC power supply, and a four-pin connector for hooking to a serial cable. This board is so simple that I didn't even bother to generate a schematic for it. I just took a small RadioShack project board and soldered the components and wiring directly to it.

Note that — like the TXM transmitter module — the RXM is a surface-mount device. You can still use it on a RadioShack board, but mounting gets a bit tricky. Turn the project board upside down so you are working on the copper pads. Position the RXM so each surface-mount pad rests on a separate copper pad. Hold the RXM firmly to prevent it from shifting, then use a fine-tipped soldering iron to make a solder bridge between pin 1 and its adjacent copper pad. Verify that you

Build an RF Sensor Block ...



This view of the underside of the receiver shows how I soldered the SMT receiver to the pads on the experimenter board.

have a good electrical and mechanical connection before proceeding. The solder on your connection should be shiny and smooth; if it is not, reheat the connection.

Verify that all RXM pads are still properly positioned on their adjacent copper pads. If the RXM has shifted so the pads are not aligned, redo the connection to pin 1. Move to pin 5 of the RXM and repeat the above soldering technique. Now recheck your pin alignment one last time, then solder all remaining RXM pads to their adjacent copper pads.

Using 30 AWG wirewrap wire, connect pin 3 or 8 of the Linx RXM module to ground. Wire pin 10 of the RXM to a 5 VDC source, such as a two-pin KK-style power connector; tie your ground wire to this connector also. Wire pin 1 of the RXM to an antenna such as described in the transmission section above.

I added a four-pin KK-style male header to bring out the data stream from the RXM. This four-pin serial connector uses the same pinout that all of my previous robot designs use, letting me reuse my BOTBoard serial adapter cable. Pin 1 of this connector is on the left side as you look at the front of the connector from the board edge. Wire pin 1 to ground, pin 2 to 5 VDC, and pin 3 to the data out signal at pin 5 of the RXM. Leave pin 4 of the serial connector empty.

To connect your receiver board to a host PC, plug the DB9 connector end of a BOTBoard serial adapter cable into the COM port on your PC. Plug the four-pin female KK-style connector on the other end of the BOTBoard cable into the four-pin serial connect of your RXM board. Apply 5 VDC to the RXM board and you should be in business.

If you don't have a BOTBoard serial adapter cable, you can use any of several similar cables available to robot experimenters. These cables contain a tiny circuit board that translates the digital signals from the RXM board into the RS-232 signals used by the PC. One source for the BOTBoard cable is Kevin Ross, who sells several robot-related tools and boards. You can reach Kevin's website through links on the Seattle Robotics Society website at www.seattlerobotics.org.

A look at the code

I'm not going to include the entire listing for the RF sensor block code, as it would fill too many pages. I will, however, go over the mainline section and touch on some of the design ideas I used.

Following power-up, the code first initializes the various subsystems, such as the serial port and the timers. It then reads the lines tied to the first three switches on the DIP switch, deriving an address from 0 to 7. This address is saved in a variable for later use. The code then clears a couple of variables, sets a counter/timer for use as a periodic interrupt, and enables all interrupts. The timer will cause an interrupt every one millisecond.

When the timer interrupt fires, control passes to the interrupt service routine (ISR) handler. This code uses separate variables count0l and count0h to track how many time delays have occurred. When these variables both reach zero, the ISR will set a timeout flag to indicate the requested delay has elapsed.

The mainline code now enters a loop, executing a foreground task. This task is to sample all four of the digital inputs and record their states in a set of eight sticky bits, stored in variable sticky. The sticky variable records if any digital input was ever 0, and it records if any input was ever 1.

Assume that the sticky variable starts out at 0, which it will at the beginning of each time interval. Each time the mainline code loop runs, it reads the four digital inputs, then tests each input in turn. If an input is 1 in that sample, the code sets the proper bit in the sticky variable to show that the bit was high. If an input is 0, however, the code sets the proper bit to show that the input was low. Note that the mainline code never clears a sticky bit; it only sets them. Thus, any time a bit assumes a state, even if only during a single sample, the sticky variable will record the event.

The mainline code also tests the timeout flag during each loop. When the timeout flag goes non-zero — indicating that the ISR has detected a suitable delay — the mainline code falls into the data transmission task. This task records the current value of the sticky variable, clears the sticky variable to 0 for the next use, then sends a data frame to the host PC. Code in this section also sets a counter so the data frame will be sent a total of three times.

After each transmission, a new delay value is loaded into the timer variables, to prepare for the next delay. After each of the first two transmissions, the timer variables are loaded with a small value. This causes a short delay before the second and third transmissions. After the third transmission, however, a much larger value is loaded.

This introduces a long dead time between the groups of transmissions. This dead time acts as the data sampling period; remember that the mainline code is sampling data as it waits for the timeout flag to be set. This dead time also provides a gap so other RF sensor blocks have a chance to transmit. Since the sensor blocks cannot tell if a transmission gets through, the dead times help ensure that each block gets an adequate amount of air time.

This program was written in PIC assembly language, and can be assembled with the Microchip MPASM assembler. I made heavy use of two macro libraries in this code module. The library file bank.mac contains macros for switching among the different memory banks in the PIC; the bootloader program mentioned above also uses this macro library. The library file macros.asm is my own PIC macro library, which provides many powerful programming constructs such as SELECT-CASE, IF-ELSE-ENDIF, and FOR-NEXT blocks.

Note that to assemble my code, you will need to use at least version 2.20 of MPASM; the Windows version of this program is named mpasmwin.exe. This is available from the Microchip website as part of the MPLAB programming package.

You can edit the source file in a programmer's editor such as PFE32, then double-click on the Mpasmwin.exe icon to launch the assembler. Change the assembler settings to match those required, then click the Assemble button. The resulting assembler listing file will be written to a .lst file and the object file will be written to a .hex file.

You can write the object file into the target PIC chip in one of at least two ways. If your PIC chip already contains a copy of my PIC bootloader from a previous *Nuts & Volts* article, you can simply use a serial comm program like Hyperterm or Procomm to do a text file transfer; the bootloader will program the object file into the PIC on its own. Alternatively, you could use a PIC programmer such as the PICStart Plus to program the device.

Wrapping up

This code serves as the core to a wireless sensor block, and those starting out with PIC assembly language projects will find some useful techniques here. Feel free to tinker with the design of both the protocol and the firmware. You might want to change the number of A/D channels reported, the delay between transmissions, or even the make-up of the data packets. This is an excellent learning project.

This wireless link provides me with a fairly robust data stream from up to eight different sensor modules. But the data stream does little good without a host PC to receive the transmissions and act on them.

That piece of the home robot is a large C program running on a surplus T5000 embedded PC, and is the subject of the next article in this series ... **NV**

If you missed the first installment of this series, and would like to get a copy of the magazine, you can order a back issue of May 2001 by calling our order-line only at 1-800-783-4624 or you can order on-line at www.nutsvolts.com. Cost is $5.00 and must be prepaid.

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ANSWERS TO
#5012 & #5019 - MAY 2001

#5012 *I purchased a Fujitsu Stylistic 1000 with a 340 MB PCMCIA hard drive. On start up, the display shows "non-system disc." I have a laptop that I can use to modify the drive. Any suggestions?*

#5019 *I recently got a Fujitsu Stylistic 1000 pad computer, no longer supported by Fujitsu.*

Does anybody have the DOS/WIN operating system for this machine or know where to get a copy?

I'm also interested in add-ons like floppies and documentation.

#1 To get your computer to boot, you'll need to insert the PCMCIA drive into a computer with Win95. Hopefully, you'll hear a beep, then see the drive appear in the drive panel of the Windows File Explorer. Right click it and select "FORMAT" from the pop-up menu. Make sure the "Full" and "Copy system files" boxes are checked.

When the process is done, you can insert the drive back into the Stylistic and it should boot to a DOS prompt. At this point, you can install Win95 from floppies.

If you want to install from a CD, you'll have to attach a CD drive (PCMCIA or parallel) and install the manufacturer's DOS drivers so you can see the drive.

Another trick is to copy the Win95 install CD to a zip cartridge and install on the Stylistic using a parallel port ZIP — the DOS drivers for this drive are very robust and will run off nearly anything.

You'll have to install the special drivers from Fujitsu to enable the touch screen, etc. These are available from **www.fujitsupc.com/www/support_home.shtml** or you can navigate there using obvious links from **www.fujitsu.com**.

If this all seems too much trouble, try **California Digital** at **310-217-0500**, who sell surplus Stylistic 1000s with Win95 installed. Maybe you can work something out with them to purchase a drive with Win95 installed.

Bob Scott
Alexandria, VA

#2 I have a couple of these Stylistic 1000 computers working now. The first place to look is the Fujitsupc web site, under support. There is very little for the 1000, but the 500 and 1200 documentation and some files are there. Grab them, as they are similar, and are very helpful. Their email address is out of date, and since you already know the ST1000 is not supported, you won't get far that way anyway.

The ST1000 will use a generic DOS-operating system, and I put on DOS 6.22. I have been told that the ST1000 will even run windows, but I haven't tried that.

First, take the hard drive out and put it in the PC Card slot of another machine that has the card services for a hard drive, and is running DOS 6.22, or your favorite flavor. Delete everything on the hard drive, including the hidden files. You can use format/s for that. That will copy the four most critical files to the hard disk.

Now, I have had a little problem and actually had to FDISK the hard drive and delete the partition and recreate it. I used FDISK with the little known qualifier at every restart (FDISK/MBR). This rewrites (I think) the Master Boot Record on the hard drive. Make absolutely sure you are doing this to your Fujitsu disk, and not your C: drive. It is critical that the operating system files are the first files on the hard drive, so that is why I deleted everything first, and just for good measure, did a format/s.

I have been told that it can be done without using format, but be very careful in deleting all the files, then copying the hidden files in the order that they would be put on the hard disk with the format command.

If your laptop is a Windows machine, the easiest thing to do is to make a DOS bootable diskette with the PC Card services for it and boot the floppy.

My biggest problem was that all the computers I could use had Windows and not DOS. If I made a DOS boot floppy, then I didn't have PC Card services and could not get to the hard drive. The standard disclaimer applies here, you must have a licensed version of DOS or Windows.

If you need more help, I could put your DOS onto your hard drive for you, but you have to pay the shipping both ways. If I get deluged with requests, things may take a little while.

I was able to get the PC Card services working, along with the virtual keyboard (a keyboard that shows up on the LCD and you use the stylus to pick keys). If you want more information contact me via email: **HECK@NEU.EDU**.

I have to say that the folks at Fujitsu were very helpful when I contacted them, but their hands are tied because it is obsolete as far as they are concerned. They cannot expend time and resources supporting us with the ST1000. I was fortunate to get some help from them, and I thank them for that here, and I will pass on whatever I can to who needs it.

Perhaps somebody can set up a website/ftp site where those of us can exchange ideas and software for this nifty computer! I hope somehow we can get a waiver for the licensing requirements for the DOS and the Fujitsu utilities.

Joe Heck
via Internet

#3 I'm assuming you have a PCMCIA drive in this machine or at least a hard drive you can maybe, temporarily transfer to another machine to do the following instructions. NOTE: the following instructions reference a PCMCIA drive and an "outside" machine for loading, etc. However, a "regular" hard drive can be "built" as long as the proper "translated" instructions are followed ("hard drive" for "PCMCIA drive," "modifying machine" for "modifying laptop," etc.).

If the Fujitsu is "completely empty" of drives (floppy or whatever), you'll have to see if a standard 3.5" or smaller IDE drive can be installed. Again, an "outside" machine can be used to format the drive and install the "system" to the drive.

I'm going to assume the PCMCIA drive is DOS formatted, but NOT bootable.

Insert the PCMCIA drive in the "modifying" laptop and issue the DOS command "FORMAT <drive> /s," where <drive> is the letter the laptop assigns the PCMCIA drive slot (i.e., D:, E:). This should make the drive bootable. If it doesn't, and you can access the drive (like a floppy or another drive), issue the DOS command: "SYS <drive>." This should transfer system boot files to the PCMCIA drive and make it bootable.

If, however, the PCMCIA drive is not DOS formatted (i.e., "completely" blank), you need to FDISK the drive and make it bootable. Just run the DOS command "FDISK <drive>" from the laptop's DOS directory and follow the screen instructions to make it an "active" DOS drive. Then, reboot the laptop with the PCMCIA drive REMOVED, insert the PCMCIA drive after it's done booting, and issue the DOS command "FORMAT <drive> /s (/x too, only if needed!)" to format it and transfer the system boot files.

Now, you need a system to "make it go." Since I doubt you can find a "Fujitsu DOS" package, I suggest you go to **www.caldera.com** and download the Caldera DRDOS package. The Caldera DRDOS is about as "system neutral" as is possible, so I'm sure it'll run just fine on the Fujitsu.

Create a directory called "CALDERA" (or similar) on the PCMCIA drive and save the downloaded file package in that directory on the PCMCIA drive. It will probably be a self-extracting archive — execute the self-extract program to extract the files to the directory on the PCMCIA drive.

Now, transfer the newly-bootable PCMCIA drive to your Fujitsu machine and boot it up. You should be greeted by a DOS prompt, displaying the version of DOS used on the laptop.

Assuming you've made it this far, go to the CALDERA (or whatever) directory that holds the downloaded/extracted Caldera DRDOS files and run the INSTALL.EXE program. Answer the questions to install/configure the Caldera DRDOS to the PCMCIA drive. A "full" installation will only consume around 3 MB of disk space.

Since I doubt you can run Windows 9x or later on this machine, consider using it as a portable DOS machine OR, if you "absolutely, positively need Windows," see if you can find a complete Windows 3.x package and install it.

Of course, it'll help immensely if the Fujitsu has a floppy drive as you can back-up the DRDOS install files or create "install" disks on the laptop used to format the PCMCIA drive in the first place. If you make "install" disks, you don't have to "clutter" the PCMCIA drive with them.

As for Fujitsu "add-ons, etc.," you might have to scour flea markets, computer "swap meets," or search the Usenet.

Ken Simmons
Auburn, WA

#4 In answer to question 5012, and possibly also 5019. Rather than trying to get the original system software for the Stylistic 1000, an alternative would be to install Linux on the hard drive. Use an older Linux version/distribution, such as Mandrake 6.1, which has a "text install" option that works with limited memory, and select the "custom install" option. Install only the very minimum of packages, otherwise it will not fit the HD.

The only problem would be getting X-Windows, the Windows server, to run on the Stylistic 1000 hardware — can't help you here), you'll have to experiment.

I managed a usable Mandrake 6.1 Linux installation on an old 270 meg laptop HD I had lying around. I even got X-Windows working, and this was on an old 760EL Thinkpad.

Mendel Cooper
St. David, AZ

#5 You need to put an operating system on that disk. Note that the "Boot Block" must match the operating system, as they all use their own, except that MS-DOS 6 uses the same block as MS-DOS 5. (It even says MSDOS 5.0 on it!)

For MS-DOS, and work-alike's, prior to 7.0 (windows 9x) you use the SYS command to add the operating system key files, and initialize the correct boot block. The files are typically IO.SYS and MSDOS.SYS, but branded versions, and other systems, use different names, and some need more files. Just copying the files will not update the boot block.

Without turning this into a tutorial, the basic procedure is:

1: Partition the disk. Avoid large partitions unless using an operating system that uses FAT32 or other advanced operating system.

FAT16 Maximum size is about 1 Gig. (not recommended!). Most operating systems will only boot from a "primary" partition, and only allow you to see one "primary" partition (the one that you booted from) at a time.

2: "Format" the partition: with most hard disks today, this only initializes the tables, and perhaps partly tests the partition's data integrity. It is the test that takes so much time!

3: Install the operating system. When doing this from "install disks" this can (most often will) include the ability to do the above two tasks, if needed.

If this all confuses you, then perhaps you need to contact a local computer geek.

J. D. Arbaugh
Pearblossom, CA

Continued from page 50

else. This year, the organizers created two new divisions: High School and Expert.

Junior Division is now for kids up through 8th grade, while High School is for grades 9 through 12. In Junior Division, only two of the four rooms in the maze are used, making the contest easier for younger entrants.

Senior Division is the same as in years past, but Expert Division provides more of a challenge to those with advanced skills. Robots in this division must operate untethered using either on-board computers or an external desktop computer with an RF link – no wires from the external computer to the robot allowed. Robots running in this division must operate in Sound, Non-Dead-Reckoning, and Furniture modes. In addition, Expert Division competitors must cope with a variety of running surfaces such as carpet and linoleum. The entrances to rooms are no longer marked by stripes, nor is the candle position marked by a white circle, though the robot must still approach the candle within 30 cm before attempting to extinguish the flame, making this a very difficult division to compete in.

And how did the competition go this year? The Israeli teams – the top winners in both divisions last year – continued strong this year, taking three of the top 10 slots in the High School Division. The big story, though, was how well the Chinese teams did in the Junior and High School divisions. This was their first time competing at Hartford, but they took 1st in the High School Division and both 1st and 2nd in the Junior Division. The tables included here show the stats and rankings for all cash prize winners.

I'll let the photos tell the rest of the story. Those curious to see the full rankings of all 107 competing robots and how their scores were calculated should check out the official website at www.trincoll.edu/events/robot/. **NV**

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

Robert Nansel
Box 228
Ambridge, PA 15003

Email: bnansel@nauticom.net

2001 Trinity Fire-Fighting Home Robot Contest Results

2001 Trinity Fire-Fighting Home Robot Contest Results
2001 Trinity Fire-Fighting Home Robot Contest Results

Division	Qualified & Ran	Total Registration
Expert	5	9
Senior	54	71
High School	36	40
Junior	12	13
Total Robots	107	133

EXPERT DIVISION

Place	Score	Robot	Occupation/Affiliation	Location	Team member(s)
1	4.57	Oculus	Software Engineer	Maryland	Jim Cannaliato
2	401.79	Mini-Bob	Trinity College	Connecticut	Mark McSharry, Amir Tamrakar, Melissa Crodon, Kundan Nepal, Eric Biegeleisen, Andrew Robinson, Sean Harris, Marin Kobilarov, Shyam Gourisuresh, Trishan DeLanerolle
3	436.71	Nancy	Engineer	Colorado	Mark R. Whitney
4	451.99	The Wrong Trousers	Bermita Electronics	Rhode Island	Mitch Berkson
5	900.00	Bob(2)	Trinity College	Connecticut	Amir Tamrakar, Melissa Crodon, Kundan Nepal, Eric Biegeleisen, Andrew Robinson, Sean Harris, Trishan DeLanerolle, Mark McSharry, Marin Kobilarov, Shyam Gourisuresh

SENIOR DIVISION

Place	Score	Robot	Occupation/Affiliation	Location	Team member(s)
1	2.01	Snuffy the Shamfire Slayer	Robotics Society of So. Cal.	California	Alex Brown
2	3.03	NMT2	New Mexico Tech	New Mexico	Jose Guilberto, Kevin Wedeward, Stephen Bruder
3	4.13	Ken's Robot 2001	Info Systems Specialist	North Carolina	Ken Boone
4	5.87	Tail	New Mexico Tech	New Mexico	Michael Berg, Seth Schuyler, Bill Willems, Thomee Wright
5	9.62	Ye Olde Robot	Cedarville University	Ohio	Jerred Davis, Roy Mwangi, Nathanael Weygand
6	10.62	Hades	New Mexico Tech	New Mexico	Kyle Lamb, Michael Carpenter, Daniel Rodriguiz

HIGH SCHOOL DIVISION

Place	Score	Robot	Occupation/Affiliation	Location	Team member(s)
1	2.90	Superstorm	Xi'nan Weiyu Middle School	China	Du Erbin, Xu Liwen, Ye Xinjian
2	8.56	Bentz	Herzliya Hebrew Gymnasium	Israel	Tal Magen, Yavon Conary, Gal Aharon, Gilad Shalem, Lior Paritzky, Ron Lerner, Doron Cohen
3	10.46	Bender	Hanover HS (gr10)	New Hampshire	Patrick Marion
4	61.63	Z	Council Rock HS	Pennsylvania	David Lafferty
5	321.08	Charcoal Avenger	CSVRGS	Virgina	Alathea Jensen, Crystal Dettweiler, Becky Easley
6	435.67	Njord	CSVRGS	Virgina	Jacob Garbe, Jim Lind

JUNIOR DIVISION

Place	Score	Robot	Occupation/Affiliation	Location	Team member(s)
1	25.56	Firebaby	Mingzhu Middle School	China	He Gang, Li Banruo, Zhou Miyuan
2	95.62	UFO	Shanghai 2nd Middle School	China	Gu Chengzhe, Shen Miao
3	417.38	Windy	Cartersville MS (gr8)	Georgia	Philip Bartlett, Justin Burnett
4	487.14	Bad Dawg	Cartersville MS (gr6)	Georgia	James Hart, Austin Myrick
5	542.35	Snuffbot	Grade 6	Massachusetts	Eric Willisson
6	850.00	Aquatrac	Wellesley MS (gr8)	Massachusetts	Nikolai Begg

by Tim Deagan

Wireless Webcams from X10

Who could resist all these boxes?

X10 Meets Video

I love X10. I confess this because I wanted to write a hard-boiled review of the latest X10 technology, but the fact is, I love the stuff. The deeper I looked into the latest X10 product set and the website that supports them, the more sure I became. The folks at X10 get it. They've got more than their share of a clue.

X10 has been around for decades. They brought affordable home automation (via AC power control) to market when nobody else had a clue. Their secret: build simple things and make them work together. X10 modules sold in 1979 are still compatible with current products. First, it was AC outlets and switches, then they added alarm systems, then computer control. Along the way, they incorporated telephones, wireless controllers, timers, and infrared. Now they've added video and a host of other technologies into the mix. The potential is amazing and, at the price, astonishing.

I recently purchased one of the new X10 bundles, the "3 Camera SuperDeal with XRay Vision Kit: $229.99." I expected three wireless color cameras and the means to hook them up to the Internet. I got a whole lot more.

The Components

When you say X10, the first thing most people think about is power control.

This kit provided three X10 addressable 'wall wart' 12V DC 80mA power supplies (part #XM10A.) These are darn useful items for the gadget hacker. Instead of attaching a wall wart to a regular X10 module, you could use this unit directly (if the power is adequate). X10 then adds wireless control of these units (or any other X10 units) by providing a handheld controller (#CR12A) and a transceiver module (#TM751).

These components allow the addressable power supplies (and whatever is attached to them) to be turned on and off via wireless control.

The handheld controller is unique from other X10 wireless controllers in that it incorporates a 'scan' feature. This is used to turn the power supplies on and off in sequence with the push of a single button. This allows the user to view each of the cameras in turn (in blocks of four) for monitoring purposes.

This is going to start sounding like an infomercial as I continually shout 'but wait, there's more!' The wireless control doesn't stop at the handheld, the bundle also included the X10 FireCracker Computer Interface (#CM17A). This is a very exciting component. It attaches as a small device on a computer serial port and allows the computer to talk through the TM751 wireless transceiver to control X10 units.

I'll talk more about the software for the FireCracker a bit later and some of the third party tools for it at the end of the article.

This is a very clever device and could attach to anything with a serial port (Palm Pilot, WinCE, etc.). The software may not be available on every platform that it will connect to, but that's a 'simple matter of programming (SMOP).' Programmers may feel free to grind their teeth at my use of that horrid phrase.

The bundle also included a Wireless Motion Sensor (#MS13A). This unit can send an X10 unit code when it detects motion, when it detects a change from light to dark (and dark to light,) or only when it detects motion while it's dark. A variety of features are programmable including type of trigger, house/unit code sent, and how long to wait to send an OFF code after having sent an ON code (if no additional motion has been detected).

The package contained three XCam2 cameras (#XC10A). These are DC-powered color cameras that broadcast video and audio up to 100 feet at 2.4GHz. They are described as indoor/outdoor units, but X10 recommends that they not be exposed to rain. The picture from these cams ranges from fair to poor, depending on lighting. They like a lot of light. The cams have an antenna, long cord with power socket, thru-holes for mounting, and a tripod mounting screw.

The bundle I purchased came with one battery power pack for a camera as well. This allows one of the cameras to be carried about from room to room. The battery pack is not an X10 unit. It powers a camera continuously.

A 2.4GHz Wireless Video Receiver (#VR31A) receives the signals from the cameras. This is a unit very much like the VCR Rabbit™ that allows video and audio to be sent from room to room. The device works from a 12V DC wall wart power supply and has both A/V jacks (mono, not stereo audio) and a coax F-cable type TV output connector. Additional transmitters and receivers are available.

Images from the cameras are brought into the computer via a USB converter (#VA10A). This device inputs either S-Video or NTSC video. Installation is drop dead easy, plug it into a USB port and you're done. This device describes its driver as "USB Live! Video Capture (DirectShow)." The USB Live! Video Capture device is a common USB OEM product (lots of folks resell this as their own). Assuming it is the same device, it has excellent potential as a general-video capture device. I've included a link to a different company who sells the USB Live! device and lists its specs.

X10 provides free downloads of the associated software for this bundle. The first is the FireCracker control software, a simple tool that lets you control X10 devices through a picture of a handheld controller with the FireCracker serial interface. The second is the X-Ray Vision software.

The X-Ray Vision package will accept video

The amazing explosion of parts after unpacking.

from a variety of video capture devices. The software has some very helpful features such as motion detection and 'wake up.' Wake up listens through a modem for a user-defined combination of number of calls, time between calls, and number of rings. When the defined combination is detected, the software can then initiate a call to an ISP to upload single or multiple images, email a picture, or do any of a number of other actions.

These actions can also be triggered by other events such as the motion detection feature. The X-Ray Vison software works with the FireCracker software to control and sequence the cameras and send other X10 control codes. The driver for the USB converter is included in the X-Ray Vision download. X10 also provides a free download of remote control software that lets you control the X-Ray Vision set-up from a different location on the Internet.

The Combinations

There are a lot of ways to use the parts of this bundle. The simplest thing to do is to hook the receiver up to a TV or VCR and watch the output of one of the cameras. Using the camera with the battery pack can be especially fun, instant 'dogcam,' 'kidcam,' or impromptu baby monitoring is quick and easy. When you want to use additional cameras, the X10 features come into play.

Since the power supplies for the cameras are X10 units, it is a snap to turn them on and off at will. The handheld controller has the aforementioned sequencing feature that will turn the cameras on and off in order. This allows you to watch all of the cameras in turn. This is starting to get pretty fancy. But being connected to the X10 world allows for many interesting possibilities. By setting up the motion detector included in the bundle, monitoring can occur when motion is detected. Imagine the TV coming on and displaying a view of your doorstep whenever someone walks up. All the items in this bundle are compatible with other X10 units. So it would be very easy to add video and audio monitoring to an existing X10 alarm system.

The thing that made me take the plunge on this bundle was the integration with my computer. The USB video converter was trivial to set up and get working. I starting watching the cams through my computer well before I ever tried watching them through a TV. The FireCracker unit allowed instant control of all my X10 devices through a very simple interface — an exact replica of the handheld controller. The X-Ray Vision software was easy to use, as well. I am able to sit at my computer and check out the back door, front door, and side yard. Dangerous for the couch potato, but handy for working at home.

With the remote control software, I was able to check in on my house from my office. Using the software that simply posts images on a web page, I set the system up to create a slow-speed web videophone to let Grandma take a tour of the house via the battery powered cam and a wireless phone. New software available from X10 allows streaming video from the units, so the web videophone idea is about to improve. The current software provides for image upload; this is practically maxed out at about four frames a second for a small resolution image. Streaming should improve this. The USB Video Capture uses a DirectShow interface. Microsoft does not directly support streaming from DirectShow, but workarounds exist.

Setting up webcams with this system just couldn't be easier. Not having to pull wires to multiple cams makes for all kinds of possibilities. The software provided will automatically upload images or send them via email.

Do It Your Way

The beauty of the X10 approach is that the devices aren't proprietary. They use AC power outlets, standard NTSC video, and normal audio. It's easy to use the USB video capture device to capture video from any type of standard video source. It's easy to integrate with other X10 devices such

X10 (USA), Inc.
http://www.x10.com/

BottleRocket software
http://mlug.missouri.edu/~tymm/

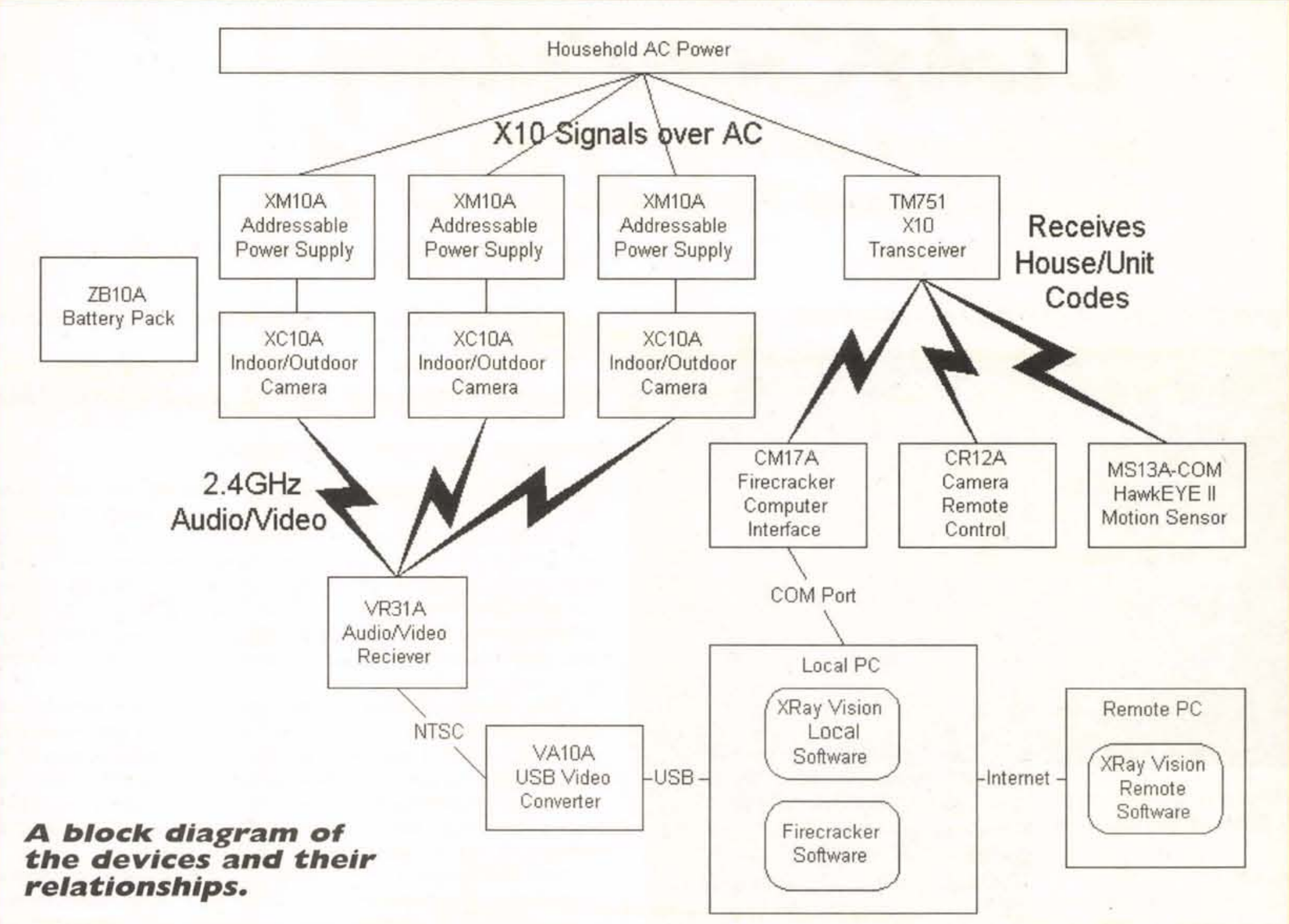
X10 ActiveX Control
http://keware.hypermart.net/download.htm#hscm17

JenniCam
http://www.jennicam.com

X10-Men
http://www.x10.com/news/x10men/index.htm

Microsoft DirectShow
http://www.microsoft.com/directx/dxm/help/ds/c-frame.htm#default.htm

Synchrotech's iREZ USB Live! Video Capture
http://www.synchrotech.com/product-usb/video_11.html#features



A block diagram of the devices and their relationships.

as a unit that will send infrared codes to turn on your VCR and start recording when it gets an X10 signal. I used a Snappy™ frame grabber unit to get images from the cameras and use them with a third-party video webcam software. Simple standard interfaces are the secret. The X10 site has an amazing list of alternate cameras, e.g., infrared, long cord, wide angle, etc., and other types of devices.

Hardware hackers will really get excited when they explore the world of alternate software for X10. Writing our own programs to control the world of your home, science project, art exhibit, or robot is incredible fun. Tymm Twillman has really enhanced these opportunities with his BottleRocket software. Written for use on Unix/Linux platforms, it will be showing up soon on Win32 platforms and even PalmPilots! An ActiveX control is also freely available. There is a lot of interesting code out there. In large measure, this is due to a savvy move on the part of X10 to make the details of programming their devices publicly available.

The Bottom Line

By this point, you may be wondering where the hidden 'gotcha' in the whole deal is. I honestly didn't find one. A lot of folks seem unhappy with the quality of the images from the cameras. I believe that they are great quality for the money. I received one manual and nine instruction pages. They were not coordinated very well, but were easy to understand.

This is because the package was a 'bundle' of mutually-useful devices rather than a single 'package.' I am in favor of this since I believe it keeps cost down and allows greater freedom of connectivity. The only down side to this is that X10 offers almost too many products; it can be difficult to sort out the minor distinctions among similar offerings. They could improve this with better associations between part numbers and devices on the web site.

It is true that X10 runs the most aggressive email campaign I have ever seen a company operate (short of outright spam operations). Hardly a day goes by that I don't get a HOT, LAST CHANCE, BIGGEST EVER, FREE email from X10. Five to seven emails a week. This can be a bit frustrating, but does allow me to see some of the other good deals that they offer. Be careful about giving them your email address if you don't want to know ALL ABOUT their NEW PRODUCTS EVERY DAY!!

The X10 web site is very interesting. I keep finding new areas. They have news, manuals, how to's, free software, project descriptions by users, and even fan fiction about X10-enabled superhero teams. They're having a really fun time. I like to interact with companies that are having fun selling me something I want to buy. It can be a bit frustrating navigating to a portion of the site that you remember visiting before, so bookmark pages in the site that you are interested in.

All in all, I have to say again that I love this stuff. Dollar for dollar, it's one of the best gadget buys I have ever made. I have reconfigured the devices at least 15 times for different uses and I still have a bunch of ideas to try out. The bundle pricing is a great way to make this affordable, there's really nothing comparable out there anywhere near the price.

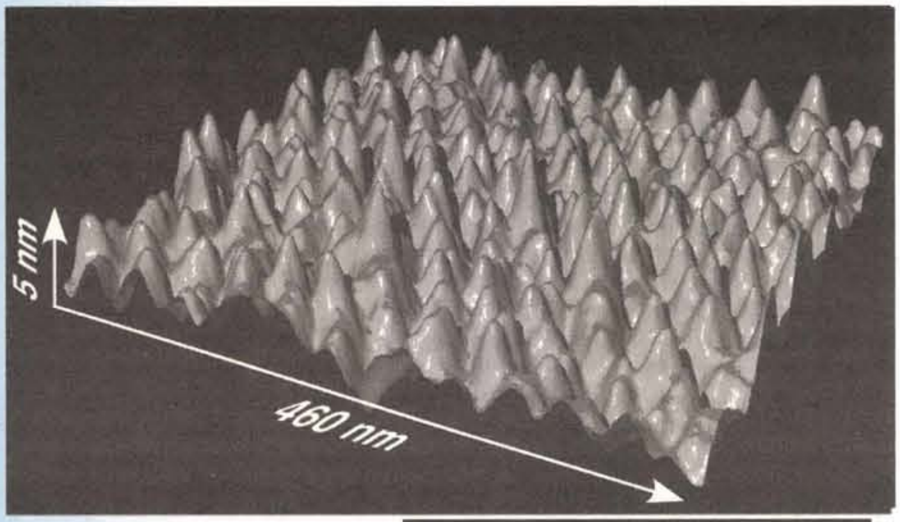
So if you're contemplating setting up your own JenniCam©, want to add flexible monitoring to your home or business, or just have a craving for a really cool tech goodie, try out the new offerings from X10. **NV**

TechKnowledgey 2001

Events, Advances, and News From the Electronics World

by Jeff Eckert

Advanced Technologies



Atomic force microscope image of a silicon surface showing average spacing between nanobumps of 38 nm and average nanobump width of 25 nm. Photo by Stephen Sass and Melissa Hines, copyright Cornell University.)

New Process Generates 25 nm Silicon Structures

Researchers at Cornell University (www.cornell.edu) have come up with a process, called "controlled etching of dislocations," that produces silicon structures that are only 25 nm in width, which is equal to only about 75 silicon atoms.

In comparison, today's photolithographic processes have not been able to produce geometries any smaller than 150 nm in width on silicon wafers.

The process is based on the formation of a "twist-bonded bicrystal" in which a very thin silicon crystal is bonded to a thicker one, with the two crystals being intentionally misaligned. The misalignment causes inconsistencies in atomic bonding, with some bonds being very strong and others relatively weak. Using a solution of chromium trioxide and hydrofluoric acid, the poorly bonded atoms, called "dislocations," are etched away, leaving the tiny "nanobumps" shown in the above photo.

The researchers — Stephen Sass and Melissa Hines — have calculated that a twist of four degrees could reduce the size of the nanobumps to only 5.5 nm in width, or about 20 atoms.

There has been considerable speculation about potential applications for the technology, but the most practical ones at this point appear to be in the realm of light-emitting silicon devices that could be used in flat-panel displays. It is also believed that magnetic material could be deposited on the nanobumps to create an extremely high-density storage medium. A report on the process can be found in *Applied Physics Letters*, a publication of the American Institute of Physics.

Computers and Networking

Bluetooth Encounters Setbacks

The Bluetooth wireless LAN concept — basically intended as a means of eliminating the "rat's nest" of wires and cables presently used to connect computers, cellular phones, and other devices — has been experiencing some difficulties. At the recent CeBIT trade show in Hannover, Germany, 100 Bluetooth transmitters were set up to demonstrate how the technology could transform the convention hall into a wireless data network for visitors who carried palm-top computers. Unfortunately, the network failed to operate, most likely because of incompatible protocols and an overload of devices trying to access the single network.

More recently, Microsoft announced that it will not support Bluetooth in Windows XP, the next major version of its operating system. Instead, XP will support the similar but more stable 802.11b standard. The view at Microsoft is that Bluetooth has not yet achieved an acceptable quality level, and compatible hardware and software products just have not emerged as expected. Bluetooth-oriented companies still speak optimistically, but widespread deployment is now seen as being three to five years away.

In the meantime, Gartner Dataquest, a market research company, has noted that 802.11b networks have already been implemented by as many as 15 to 20 percent of all US companies, and that the percentage could jump to 50 percent next year. In addition, Dataquest is predicting 50 percent 802.11b penetration into US homes by 2005. It may be difficult for Bluetooth vendors to overcome such an advantage.

Networked Coffee Houses

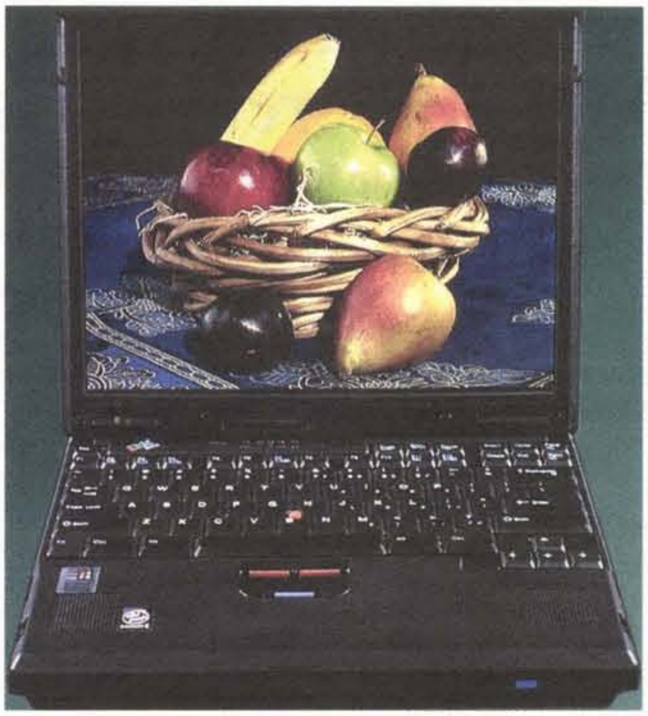
Compaq Computer (**www.compaq.com**) and Starbucks Corp. (**starbucks.com**) have formed what promises to be an interesting alliance. The companies recently announced a five-year strategic relationship in which Compaq will provide information technology equipment and services for Starbucks retail stores and corporate headquarters. The deal involves creation of a high-speed wireless broadband network in Starbucks locations across North America so that customers can access broadband content and services while getting their daily fix of caffeine. Network access will be available via the Compaq's iPAQ Pocket PCs and other wireless devices.

For example, you can pick up an iPAQ model H3670 with 64 MB of RAM and a color display for a mere $649.00. Then buy yourself an Italian-style espresso with grated cinnamon and chocolate sprinkles for maybe $4.50. Then, when you spill the drink all over the iPAQ, the total cost of your coffee break will be $653.50 (plus tax).

Circuits and Devices

New Display Technology Emerges

Researchers at IBM's Yorktown Heights, NY, research facility (**www.research.ibm.com**) have discovered a new process for manufacturing computer displays. Reportedly, it will result in better image quality and improved viewing angles while saving millions of dollars in manufacturing costs. Today, manufacturers of flat-panel liquid crystal displays use a 95-year-old process that involves rubbing a polymer substrate with a velvet cloth and placing liquid crystal molecules on the substrate. The molecules align themselves in the rubbing direction, and the alignment allows them to turn pixels on and off in response to electronic signals sent by the microprocessor.



This Thinkpad display was built using IBM's new manufacturing technique. Courtesy of International Business Machines Corporation. Unauthorized use not permitted.)

The new process is based on the use of ion beams to align the crystal molecules. This non-contact technique employs a thin layer of diamond-like carbon instead of a polymer substrate. Atoms are shot at the substrate from an ion gun at an angle that pushes aside some of the surface carbon atoms to form rows. Rod-shaped liquid crystal molecules are then added. One end of each crystal molecule attaches to an exposed carbon atom, producing precision alignment. This eliminates many potential defects caused by the rubbing process and eliminates some off-line leaning steps. IBM, which expects to have a full-scale production line operating by the end of this year, may license the patented process to other manufacturers.

Fuel Cells Reach Delivery Stage

For quite some time, we have been hearing about the benefits of replacing batteries, generators, and engines with fuel cells for applications ranging from automobiles to cell phones. For the most part, the products have been slow to emerge. However, Ball Aerospace (http://www.ball.com/aerospace/) has shipped eight of its Portable Power Systems to military customers, representing the first sale of these units. The units were sold to the Maryland Procurement Office (four units), Natick Soldier Systems (two units), and the US Marine Corps (two units).

The small, lightweight units provide portable power for a variety of applications, using electrochemical energy created by the reaction of hydrogen and oxygen. The PPS-100 supplies 100W of power at 24V, and it weighs only 8.5 lbs. Its polycarbonate construction is designed to withstand shock, vibration, and harsh environments. It includes an RS-232 data port for computer status reporting and control, and an external DC-DC converter can be provided to convert the 24V output to levels required to power computers, receivers, transmitters, and other equipment. Ball also offers the PPS-50 model, which supplies 50W at 12V and weighs 6.5 lbs. Several other models are available in the range of 5W to 500W and voltages from 8V to 36V.

Industry and the Profession

Semiconductor Sales Continue to Slide

According to a recent report from the Semiconductor Industry Association (www.semichips.org), worldwide sales of semiconductor chips have continued a decline that began last November. Overall, revenues were $14.4 billion in March 2001, a 4.5 percent decline from the $15.07 billion during the same period in 2000. Revenues appear to be lower in every product sector and in almost all geographic locations. In comparison to March of last year, sales were down by 0.7 percent in Europe, down by 10.6 percent in the Americas, and down 10.4 percent in the Asian-Pacific region. The only exception to the rule was Japan, where sales grew by 7 percent.

The semiconductor industry typically undergoes a slump every four years or so, generally when manufacturing capacity grows faster than the demand for semiconductor devices. However, the problem is presently compounded by a declining demand in all product areas, and particularly in the fields of PCs and communication devices, which is generating a surplus of inventory. Bad news for vendors may translate into good news for consumers, however, as price reductions probably will be offered to stimulate sales. In particular, DRAM prices may drop considerably in coming months.

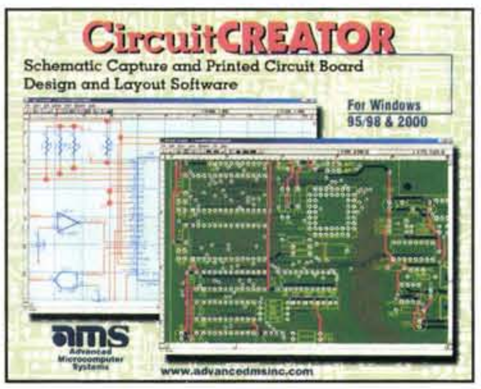
Telephone Service Company Files for Bankruptcy, Sues Lucent

Winstar Communications, Inc., recently filed for Chapter 11 bankruptcy protection after announcing that it could not make interest payments totaling $75 million. The company subsequently was bumped from Nasdaq Stock Market listings. Winstar holds the Federal Technology Service Metropolitan Area Acquisition contracts under which it provides telephone services to the US federal government in the cities of Atlanta, Baltimore, Boston, Cincinnati, Dallas-Ft. Worth, Denver, Indianapolis, Los Angeles, Miami, Minneapolis-St. Paul, Philadelphia, and St. Louis. The contracts bring in an estimated $3 billion annually. Winstar claims that the bankruptcy filing will not effect services, but the General Services Administration indicated that it would be closely monitoring the company's performance.

The company's cash problems should go away, however, if it is successful in its recently-filed lawsuit against Lucent Technologies (www.lucent.com). The suit seeks $10 billion in damages for Lucent's alleged breach of obligations under a strategic partnership agreement with Winstar. This includes payment of more than $90 million that Winstar says was due on March 30. **NV**

New Product News

LOW-COST ELECTRONIC CAD FOR WIN95/98, 2000, AND NT WORKSTATIONS



Advanced Microcomputer Systems, Inc., announces the availability and shipping of Circuit Creator™ Windows 2000 and NT compatible Computer Aided Engineering (CAE) software product.

Circuit Creator is the most complete and comprehensive electronic design system available for Windows 95/98, 2000, and NT computers.

This fourth-generation software integrates three essential components in a single product: schematic capture, board design, and auto routing.

The Circuit Creator system includes the best selling Logic Creator™ schematic design and capture software. This software provides facilities for full hierarchical schematic creation, and editing, while providing on-line, on-demand context sensitive help. Users can design up to "E" size schematics in single file, with additional sheets linked using hierarchical designs.

The most important modules of Circuit Creator are Board Creator™ – printed circuit board design software, and the Route Creator™ – PC board automatic router software.

Board Creator includes the ability to interactively and automatically check for errors and design rules while editing. It allows interactive component placement, support for blind and buried vias, as well as automatic footprint mirroring for surface mount device support.

The software includes important features that are available only in high-end products: A user-expandable symbol library of over 25,000 components that allows user-defined symbols to be added easily; object oriented parts and symbols with DeMorgan equivalents, rotation and mirroring of parts from a single definition; symbols are vector-based allowing more flexibility, automatic rerouting of connections of moved symbols makes schematic routing very easy; and true bezier curves instead of curved lines makes Logic Creator very flexible to use, line widths and colors may be assigned to specific schematic elements for improved clarity and understanding.

Circuit Creator software includes additional features: copper pouring, support for 32 inch by 32 inch large board size, up to 256 multi-layer board designs.

Circuit Creator is available from stock. Circuit Creator Pro™ version has a suggested retail price of $695.00 and Circuit Creator Std™ has a suggested retail price of $295.00.

For more information, contact:

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TYPE NPD ANALOG DISPLAY DIALS

National RF's NPD series of analog display dials were inspired by the earlier National Radio Company's vernier dials.

Recognizing a need for analog displays in the digital world, National RF's engineers incorporated existing vernier mechanisms with a base plate, scale, and pointer to provide an affordable reduction drive assembly. Two uncalibrated paper scales are provided with the unit, as well as a clear plastic scale protector. The user may calibrate or mark the scales as required for the intended application. Mitered plastic trim pieces secure the scales to the base plate.

Three different display dials are offered, depending on the user's applications. The type NPD-1 measures 2-3/4 inches high by 3-3/4 inches wide and utilizes a 1-1/2 inch diameter, 6:1 drive dial. The types NPD-2 and NPD-3 are both 5-1/8 inches wide by 3-5/8 inches high. The NPD-2 incorporates a 2 inch diameter, 6:1 drive. The NPD-3 is the same mechanical size, but utilizes a different 8:1 drive vernier. All three units use a 1/4 inch shaft coupling to the load.

The display dial assemblies are ideal for RF tuning applications, such as receiver main tuning and antenna tuner applications. The Type NPD-1 retails for $34.95, the NPD-2 for $44.95, and the NPD-3 for $49.95. Shipping and any sales tax are extra.

For more information, contact:

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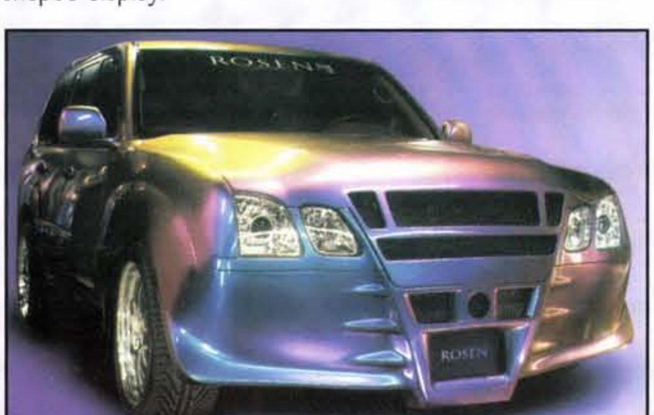
UV-1 CONCEPT VEHICLE

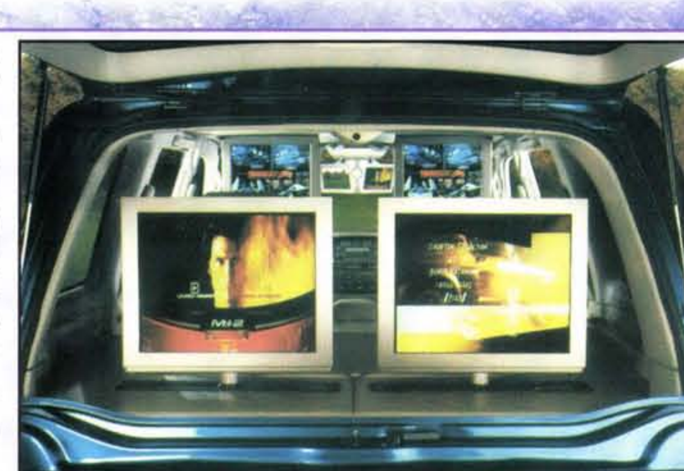
The UV-1 (Unlimited Vision-1), is Rosen Products, LLC concept vehicle for the future of vehicle electronics. The highly-customized Lexus LX-470 is Rosen Product's vision of the potential for in-vehicle telematics.

The UV-1 has a total of seven flat-panel LCD monitors, two 500 MHz computers, five cameras, one GPS, three DVD players, two PC gaming stations, two RF headphones, both joystick and wireless remote control for video gaming, and bass seat shakers for interactive gaming in the rear seats.

The flat panel monitors on the UV-1 are positioned two in front, two in the center, two in the rear, and one serving as the vehicle's license plate. The two monitors in the front take the place of the vehicle's rear view mirror. They are 8-inch diagonal 16x9 wide aspect ratio monitors, mounted on a split-screen, V-shaped display.



This unique, patent-pending mounting system allows the driver to view GPS information or camera feeds, which replace rear view mirrors, without looking away from the road and allows the front seat passenger to watch entertainment programs or view other data.



Two 15-inch diagonal monitors are suspended from the ceiling for viewing by the rear seat passengers. From their positions in the rear seat, they can use the vehicle-mounted game controllers to play video games, or use the remote controls to watch entertainment programs. The bass seat shakers in the rear seats makes gaming a whole-body experience.

In the rear, two 20-inch diagonal LCD monitors are installed on motorized mounts. Using this mounting system, the displays can be raised for viewing at tail-gaters or completely lowered out of sight. Finally, a 14-inch diagonal LCD replaces the UV-1's front license plate.

The five cameras installed in the vehicle are positioned to perform a variety of functions. One camera is focused on the driver's seat, another is trained on the passenger seat to serve as a vanity mirror, a camera is focused on each rear passenger seat serving the "mom cam" and the final camera serves as a rear-view mirror.

For more information, contact:

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