

# Nuts & Volts

Exploring Electronics And Technology For The Hobbyist And Professional

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December 1999 Vol. 20 No. 12

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## BOTBASH '99

This yearly event held in Phoenix is an excellent venue for both those just starting out in robot combat events, and seasoned vets. *Dan Danknick*

## USING LOW-COST MELODY AND SOUND-EFFECTS GENERATORS ICs

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## A+ CERTIFICATION — WHAT CAN IT DO FOR YOU?

You've probably heard of the A+ certification for computer technicians. But what can it do for you? Read on ... *Larry Ball*

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**DECEMBER 1999**

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by Dan Danknick

# BotBash'99

**A**fter welding and machining until 2 a.m. every night of the preceding week, 6 a.m. sure did come early on Friday. Mike Regan had just arrived at my shop, his 25 kg robot "Deathtrap" in tow, along with tools and spare parts. Thirty minutes later, we were clipping along at 75 mph, sipping coffee and on our way eastward to Phoenix, 420 miles away. We were robot builders and off to BotBash'99 where we hoped to inflict more radio-controlled damage than we received.

Neither of us were veterans of this annual competition; Mike won the 12.5 kg robot class last year while I was an event judge. This year, nothing was going to keep me out of competing, unless it was another ruthless monsoon system sweeping through the area. But on top of it all — a new arena had been built! It was better, stronger, faster.

Unfortunately, it was on a truck about 100 yards away from the plaza in which the event would be held. And, being a Friday, most members of the sponsoring robot club, PAREX, were still at work. As Mike and I joined in the move and set-up party in the 104-degree heat, I wondered if this was just a clever scheme by the other competitors to wear us down for the robot battles tomorrow.

The BotBash website lists a simple purpose, "To provide a most excellent event for robotic warriors and enthusiasts to get together and get some!" On Saturday morning as my fellow competitors began uncrating their teleoperated machines of mayhem, I

realized just how much trouble I was in. Christian Carlberg, a robot combat veteran, fielded "Toe Crusher," complete with purple anodizing and racing slick tires off a go-cart. "My battery chargers have a special chip in them just for these Hawker batteries" he explained, smiling. Powered by wheelchair motors and swinging a hardened steel spike back and forth, it could easily chip the concrete floor with a reactionary blow.

On the other end of the pit area, local engineer Chris Harriman rolled in with "Carnage," a black open-frame design with knobby wheels not too unlike Toe Crusher. Except Carnage had a 10 lb. axe head on a 36 inch arm that could be whipped around left and right. The axe worked pretty well on "Saber" much to the amazement of Tony Buchignani, a lawyer from Los Angeles. "That axe just crushed my aluminum frame. It just barely missed my power controller!"

Fortunately, I was in the next lower weight class with a 12.5 kg robot I had named "Venus Probe." It was an experiment from the start, a steel frame covered with 3mm carbon

fiber and driven by two wheels in the back. Most feared in my class was "Dr. Inferno," a reanimated Tomy Omnibot by the sinister hand of graduate student Jason Bardin. Gone were the Omnibot's plastic arms, in their place hung cordless drill motors, one with a 12" auger bit and the other a hole saw. And the eyes still glowed red.

Back in the 25 kg class, my friend Mike had just taken his robot off

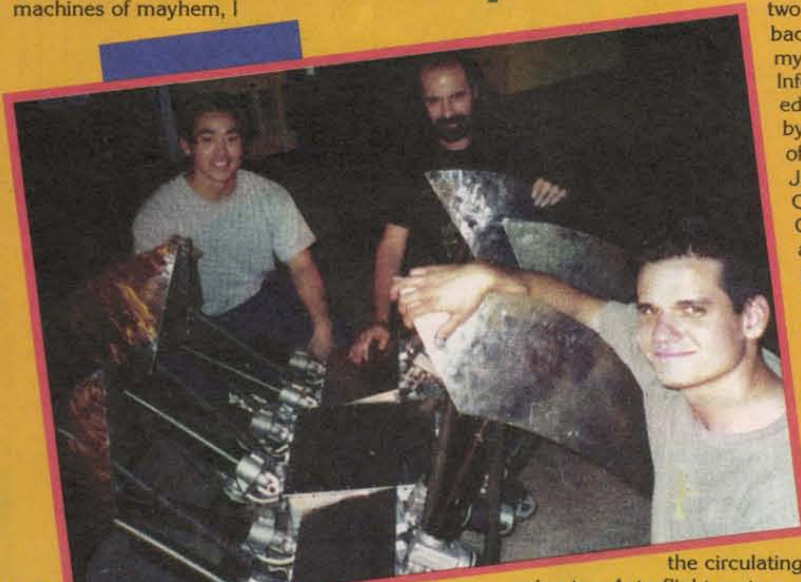
the circulating fan. Mike was using two Astroflight motors, one for each side of his drive system. Super high performance brushed DC with rare earth magnets, they could each put out 1/2 of a horsepower and were draining 7Ah gel cells in four minutes. All of this

energy was converted to heat so the entire robot frame had to be force-cooled between matches to keep everything from melting. In the end, Mike took home the trophy after fighting Carnage for the title. They say you just can't beat a lot of steel and that proved correct when that axehead kept throwing sparks off Deathtrap's frame. And Deathtrap kept on coming in for the kill.

As for me, I managed to squeak out a win by one point in my class. Cleverly, the competition rewards not only one-on-one fighting but a sumo-style pushing competition and driving through a timed obstacle course. Good thing I had spent time learning to drive my robot.

BotBash is a yearly event and if you're with-in driving distance of Phoenix, it's well worth your weekend. It's an excellent venue for those just starting out in robot combat events: low stress but a lot of seasoned builders to ask questions of. And hey, you can take me on in the 25 kg class come 2000. **NV**

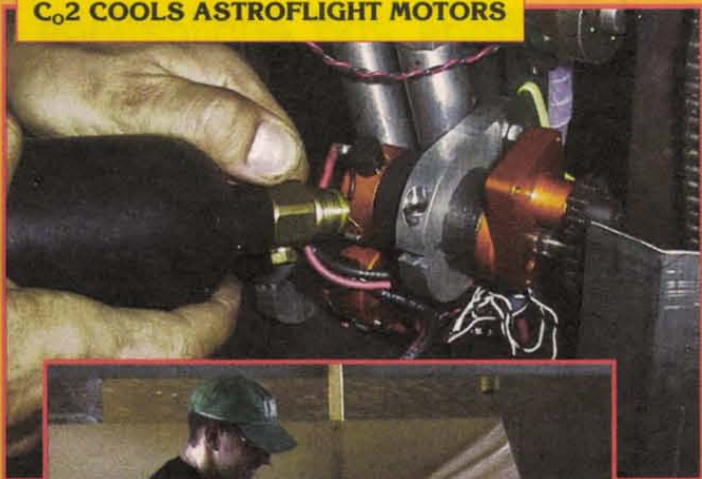
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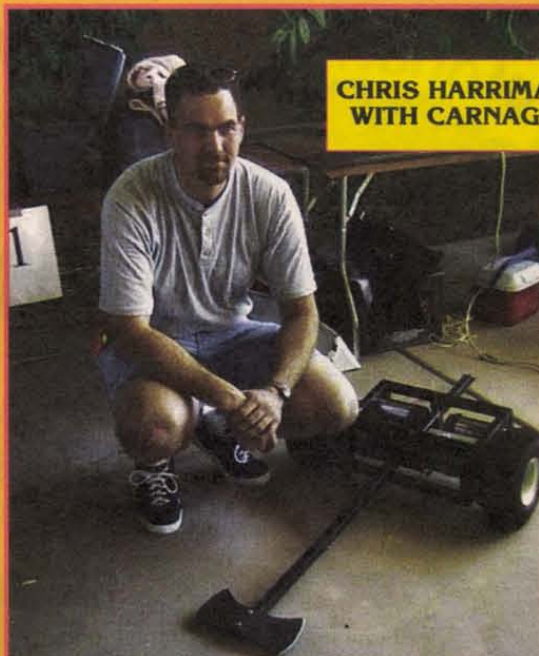
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**C<sub>0</sub>2 COOLS ASTROFLIGHT MOTORS**



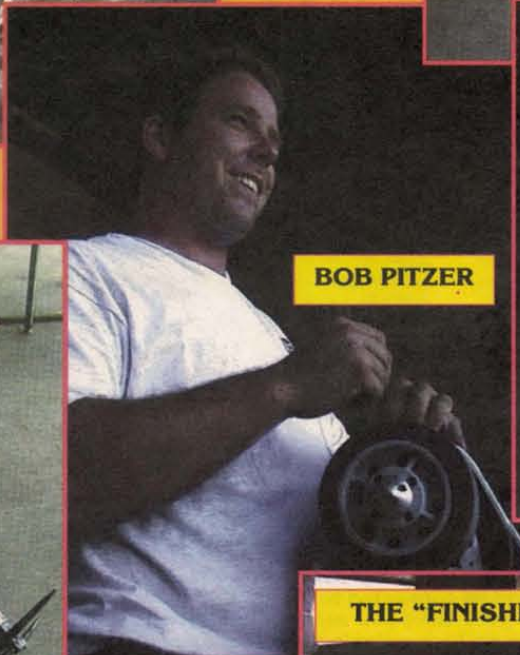
**CHRIS HARRIMAN  
WITH CARNAGE**



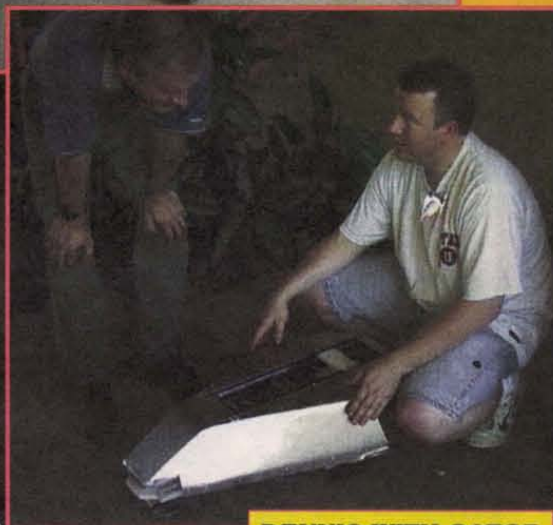
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THE ARENA**



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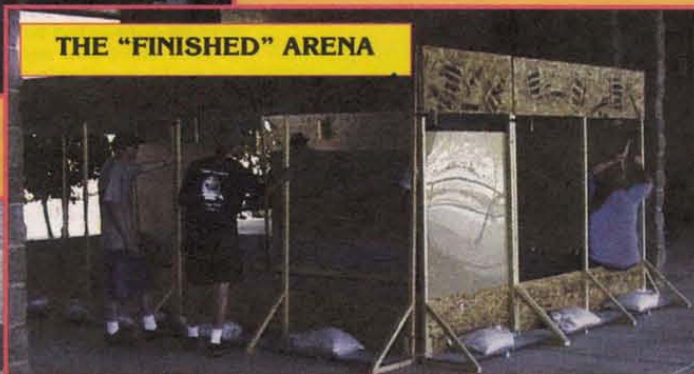
**DENNIS WITH GATOR**



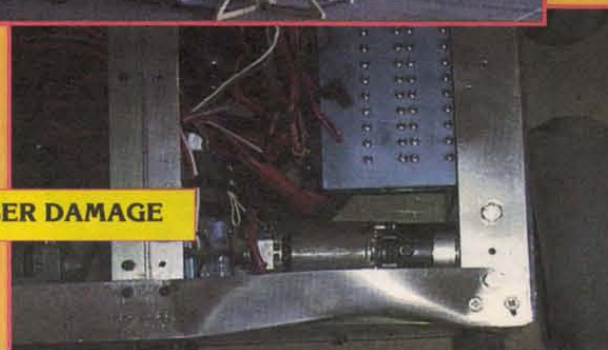
**TOE CRUSHER**



**THE "FINISHED" ARENA**



**SABER DAMAGE**



**DEATHTRAP**





# The Computer Controlled World: RS-232 Network Control Methods and Applications

## Advanced RS-232 Control of Relays

by Ryan Sheldon, National Control Devices • (417) 646-5644 • [www.controlanything.com](http://www.controlanything.com)

**Here's a preview of what you can expect in 2000. We'll start with the R16 relay controller coming out in January. It is the largest and most powerful one so far.**

Over the past couple of years, I have spent a lot of time talking to readers. It's my job to get to know what you want, and balance that with what I can provide. But sometimes, I have to go out on a limb and do things the way I want to, experiment a little, and see if I can come up with something that you can use.

When I am designing a new product, I try to

keep in mind what you have said. I keep mental lists of all the good ideas that you have given me and mix that up with my own ideas. It has changed the way I look at my hobby of computer control, and it has subsequently changed the way I develop products to help you.

In January, I will be releasing my R16 relay controller. Put simply, it is a marriage of your ideas and mine, packaged in the form of an experimental product that represents what I have learned. The R16 is not simply another device. In my mind, it represents a new way of thinking.

Our next generation of computer control devices will be released throughout the year of 2000, beginning with our January release of our R16 16-relay controller. For those of you unfamiliar with relays, a relay is simply a switch. Our relay controller allows a computer to control a bank of 16 relays. Up to 256 relay controllers can share a single serial port, allowing your computer or BASIC Stamp to control up to

4,096 relays from a single RS-232 output.

While it is not the first relay controller we have released, it is the largest and most powerful one, foreshadowing the way our devices will work in the future. Like our original 16-device network, all new devices will work together, allowing you to control various displays, relay controllers, and many other upcoming devices (up to 256) using a simple two-wire interface and a powerful command set that eliminates hours of work. This article serves a real-world preview of what you can expect in 2000.

### Connection

The R16 relay controller is easily connected to the serial port of your computer or microcontroller. Figure 1 illustrates the connection of the R16 to the BASIC Stamp II SX. Figure 2 illustrates the connection of the R16 to the serial port of your computer.

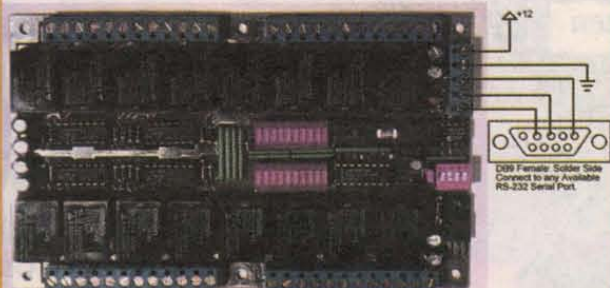
### Configuration

Once connected, simply set the four dip switches to configure the relay controller for your installation. In test mode, each relay is activated in sequence, then deactivated. Once the test cycle has completed, the board is ready to accept data at 9600 baud.

1	2	3	
Off	Off	Off	Test Mode, 9600
On	Off	Off	2400 Baud
Off	On	Off	4800 Baud
On	On	Off	9600 Baud
Off	Off	On	19.2K Baud
On	Off	On	38.4K Baud
Off	On	On	57.6K Baud
On	On	On	115.2K Baud

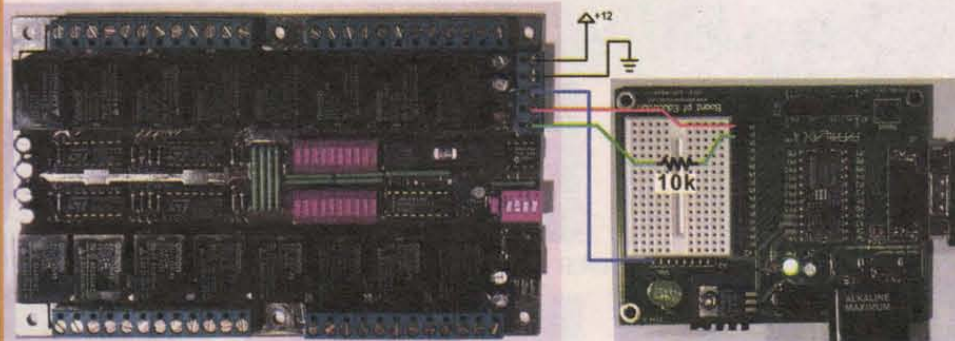
Dip switch 4 controls the mapping of relays 9-16. If this switch is set to the OFF position, then relays are numbered in the pattern shown in Figure 3, otherwise the relays are numbered in the pattern shown in Figure 4.

**Figure 1: The prototype of the R16 relay controller is easily connected to Parallax's BASIC Stamp. The Board of Education is used as a carrier board for the BASIC Stamp II SX providing convenient connection to the relay controller.**



**Figure 2: The R16 relay controller can also be connected to the RS-232 port of your computer using a DB9 female connector available from your local RadioShack.**

**"The R16 is not simply another device. In my mind, it represents a new way of thinking."**





## Communication

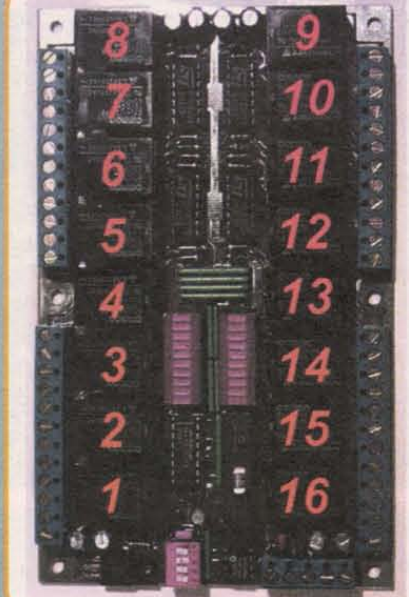
The way you speak to a device determines how easy the device is to use. It was our goal to minimize the amount of programming you have to do to control our devices. Starting this year, we are making it easier than ever to control all of our devices by introducing a simple ASCII-based command set. Commands to all devices must begin by sending ASCII character code 254. Once received, the device will enter command mode. In the case of the relay driver, the next ASCII character code that is received can trigger a relay or issue other commands for advanced functions. Figure 5 illustrates example source code for controlling the R16 using the BASIC Stamp II SX.

It is also possible to ask the relay controller what the current status is of any or all relays. Figure 6 illustrates example source code for asking the relay controller the status of individual relays.

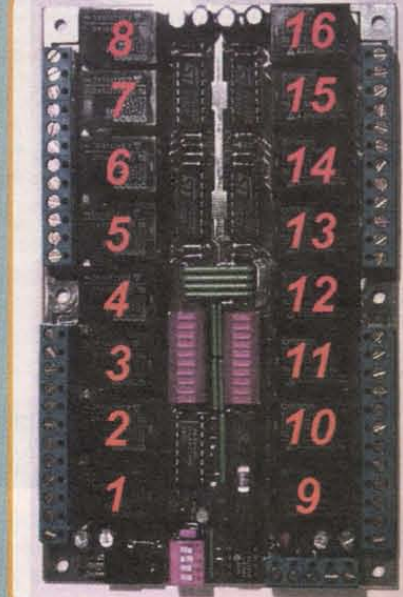
It is also possible to control the R16 from Visual Basic. Figure 7 illustrates a program that is currently under development for providing a complete GUI for the R16. Advanced functions include macro commands for enabling and disabling banks of relays and setting the device number. The R16 is also capable of memorizing the on/off status of all 16 relays into 256 memory banks. Using a simple memory recall command, the relays are instantly activated and deactivated in the stored pattern.

## Command Set

The R16 has many commands to simplify the control of relays. To send a command to the R16, you must first send ASCII character code



**Figure 3:** When the MAP dip switch is set in the OFF position, relays are numbered as shown above.



**Figure 4:** When the MAP dip switch is set in the ON position, relays are numbered as shown above.

254, then the command number. Some commands have parameters. In this case, send ASCII character codes (with a numeric value of 0 to 255). The following list provides a brief

description of the R16 command set.

- 0 Turn Off Relay 1
- 1 Turn Off Relay 2
- 2 Turn Off Relay 3
- 3 Turn Off Relay 4
- 4 Turn Off Relay 5
- 5 Turn Off Relay 6
- 6 Turn Off Relay 7
- 7 Turn Off Relay 8
- 8 Turn Off Relay 9
- 9 Turn Off Relay 10
- 10 Turn Off Relay 11
- 11 Turn Off Relay 12
- 12 Turn Off Relay 13
- 13 Turn Off Relay 14
- 14 Turn Off Relay 15
- 15 Turn Off Relay 16

**Figure 5:** The BASIC Stamp II SX is used to generate the control codes for the R16 relay controller. Relays will be turned off and on in sequence as shown in the program.

**Figure 6:** Ask the R16 for the current status of each relay. It is also possible to ask the R16 what the status is of each bank of relays (returning a byte) or ask for the status of both banks (returning two bytes).

```

BASIC Stamp - C:\WINDOWS\Desktop\NV Dec 99\Rel...
File Edit Run Help
[Icons]
0:RelayOnOff.bas
'Basic Stamp II SX Source Code to Turn Relays
'Off and On. Set Baud Rate on Board to 38.4
'for FAST Operation. Output Pin P0 connects
'Directly to the RS-232 Input of the Relay
'board. Connect the Ground of the Stamp to
'the RS-232 Ground on the Relay Board.

SerOut 0, 16429, [254, 0] 'Turn Relay 1 Off
SerOut 0, 16429, [254, 1] 'Turn Relay 2 Off
SerOut 0, 16429, [254, 2] 'Turn Relay 3 Off
SerOut 0, 16429, [254, 3] 'Turn Relay 4 Off
SerOut 0, 16429, [254, 4] 'Turn Relay 5 Off
SerOut 0, 16429, [254, 5] 'Turn Relay 6 Off
SerOut 0, 16429, [254, 6] 'Turn Relay 7 Off
SerOut 0, 16429, [254, 7] 'Turn Relay 8 Off
SerOut 0, 16429, [254, 8] 'Turn Relay 9 Off
SerOut 0, 16429, [254, 9] 'Turn Relay 10 Off
SerOut 0, 16429, [254, 10] 'Turn Relay 11 Off
SerOut 0, 16429, [254, 11] 'Turn Relay 12 Off
SerOut 0, 16429, [254, 12] 'Turn Relay 13 Off
SerOut 0, 16429, [254, 13] 'Turn Relay 14 Off
SerOut 0, 16429, [254, 14] 'Turn Relay 15 Off
SerOut 0, 16429, [254, 15] 'Turn Relay 16 Off

SerOut 0, 16429, [254, 16] 'Turn Relay 1 On
SerOut 0, 16429, [254, 17] 'Turn Relay 2 On
SerOut 0, 16429, [254, 18] 'Turn Relay 3 On
SerOut 0, 16429, [254, 19] 'Turn Relay 4 On
SerOut 0, 16429, [254, 20] 'Turn Relay 5 On
SerOut 0, 16429, [254, 21] 'Turn Relay 6 On
SerOut 0, 16429, [254, 22] 'Turn Relay 7 On
SerOut 0, 16429, [254, 23] 'Turn Relay 8 On
SerOut 0, 16429, [254, 24] 'Turn Relay 9 On
SerOut 0, 16429, [254, 25] 'Turn Relay 10 On
SerOut 0, 16429, [254, 26] 'Turn Relay 11 On
SerOut 0, 16429, [254, 27] 'Turn Relay 12 On
SerOut 0, 16429, [254, 28] 'Turn Relay 13 On
SerOut 0, 16429, [254, 29] 'Turn Relay 14 On
SerOut 0, 16429, [254, 30] 'Turn Relay 15 On
SerOut 0, 16429, [254, 31] 'Turn Relay 16 On
1.1

```

```

BASIC Stamp - C:\WINDOWS\Desktop\NV Dec 99\RelayFun2.B52
File Edit Run Help
[Icons]
RelayFun2.B52
'Basic Stamp II SX Source Code for Getting the Status of Relays. Set Baud
'Rate on Board to 38.4 for FAST Operation. Output Pin P0 connects
'Directly to the RS-232 Input of the Relay Board. Connect the Ground of
'the Stamp to the RS-232 Ground on the Relay Board. Connect Pin P1 of
'the Stamp to the RS-232 Output on the Relay Board.

Status var Byte 'Stores the Status of an Individual Relay

SerOut 0, 16429, [254, 43, 0] 'Send Command to Get the Status of Relay 1
Gosub Report 'Display the Status on the Terminal Window

SerOut 0, 16429, [254, 43, 7] 'Send Command to Get the Status of Relay 8
Gosub Report 'Display the Status on the Terminal Window

SerOut 0, 16429, [254, 43, 11] 'Send Command to Get the Status of Relay 12
Gosub Report 'Display the Status on the Terminal Window

SerOut 0, 16429, [254, 43, 15] 'Send Command to Get the Status of Relay 16
Gosub Report 'Display the Status on the Terminal Window

Report:
SerIn 1, 16429, 100, Timeout, [Status]
Debug ? Status
Timeout:
Return
1.20

```



Figure 7



- 16 Turn On Relay 1
- 17 Turn On Relay 2
- 18 Turn On Relay 3
- 19 Turn On Relay 4
- 20 Turn On Relay 5
- 21 Turn On Relay 6
- 22 Turn On Relay 7
- 23 Turn On Relay 8
- 24 Turn On Relay 9
- 25 Turn On Relay 10
- 26 Turn On Relay 11
- 27 Turn On Relay 12
- 28 Turn On Relay 13
- 29 Turn On Relay 14
- 30 Turn On Relay 15
- 31 Turn On Relay 16

It is also possible to set the status of all relays or groups of relays simultaneously. Relays are divided into two groups called "Banks." The left bank of eight relays can be controlled independently from the right bank of eight relays, allowing you to send commands to speak to each bank individually, or both banks simultaneously. A "Pattern" parameter of 0 to 255 is sent to control the status of eight relays simultaneously. A value of 0 turns off all relays, while a value of 255 turns all relays on. Any value in between turns off relays in the equivalent binary pattern. Relays are updated as soon as all parameters are received.

- 32 Set Left Bank Relays

- 0-255 Pattern
- 33 Set Right Bank Relays
- 0-255 Pattern
- 34 Set Status of All Relays
- 0-255 Left Bank Pattern
- 0-255 Right Bank Pattern

The following commands are used to control the status of all relays simultaneously:

- 35 Turn Left Bank Relays Off
- 36 Turn Left Bank Relays On
- 37 Turn Right Bank Relays Off
- 38 Turn Right Bank Relays On
- 39 Turn All Relays Off
- 40 Turn All Relays On
- 41 Disable Relay Bank — All Relays Disabled, relays will all be turned off
- 42 Enable Relay Bank — All Relays Enabled, relays are capable of activation, but not necessarily on

It is also possible to ask the R16 what relays are currently activated. The following commands return a byte of data (except where noted) indicating the on/off status of individual or all relays.

- 43 Get Relay Status
- 0-15 for individual status
- 16 for status of Left Bank
- 17 for status of Right Bank
- 18 for status of Both Banks (Returns 2 Bytes)

#### NEW CONTACT INFO:

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Osceola, MO 64776  
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FAX: (417) 646-8302  
ncdryan@aol.com  
www.controlanything.com

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Osceola, MO 64776  
Phone: (417) 646-5644  
FAX: (417) 646-8302  
www.controlanything.com  
ncdryan@aol.com

We also added a unique memory function for storing and retrieving relay patterns. Imagine you have some relays on and some off. It is possible to store this pattern in

#### SOURCES:

BASIC Stamp II SX, Board of Education  
Parallax, Inc.  
3805 Atherton Road, #102  
Rocklin, CA 95765  
Phone: (888) 512-1024  
FAX: (916) 624-8003  
www.parallaxinc.com  
info@parallaxinc.com

ASEL Video Switcher, R85 Relay Controller, VF Display/Controller

one of 256 memory banks. It is very easy to recall these relay patterns using only a few simple commands.

- 44 Store Status of Relays
- 0-255 Memory Bank
- 45 Recall and Set Status of Relays
- 0-255 Memory Bank
- 46 Store Current Status of Relays as Power-up Default
- 47 Clear Power-up Default Status so Relays do not actuate on Powerup

The R16 can acknowledge the receipt of ASCII commands by returning ASCII character code 85 every time a command has finished execution. By default, the R16 does NOT reply after every command, making it respond faster to incoming ASCII characters.

- 48 Reporting Mode: ASCII 85 is returned to the computer for confirmation, slower communication
- 49 Non-Reporting: FAST but no confirmation of relay activation
- 50 Store Reporting Settings

#### Networking Command Set

It is possible to attach up to 256 R16 relay controllers to a single serial port and control each one individually or several simultaneously. Each device is assigned a device number, stored in non-volatile EEPROM memory. Simply send commands to enable and disable individual devices and store/recall the device number. The following list of commands is used for controlling 256 R16 relay controllers from a single serial port.

- 246 Store Device Number
- 0-255 Device Number
- 247 Retrieve Device Number
- Device will reply with 0-255
- 248 Enable All Devices
- 249 Disable All Devices
- 250 Enable a Selected Device
- 0-255 Device to Enable
- 251 Disable a Selected Device
- 0-255 Device to Disable
- 252 Enable Selected Device Only, Disable Others
- 0-255 Device to Enable
- 253 Disable Selected Device Only, Others Enabled
- 0-255 Device to Disable **NV**

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## THE COMPUTER CONTROLLED WORLD



# reader FeedBack

## Dear Nuts & Volts:

Just a note to congratulate you on the series of CNC articles featured in *Nuts & Volts* this year. They are the most interesting, informative, and well-presented articles I have ever read in an electronics magazine since 1968. Thanks for the information and efforts you have put into these articles.

**Wolfgang Maier/ Australia**

## Dear Nuts & Volts:

Your magazine is responsible for something wonderful: An article explaining how to build a Tesla coil ran in your Sept. '99 issue by Walt Noon. In a world of hi-tech items such as cell phones, computers, etc., —that are constantly getting smaller and faster — a Tesla coil

almost seems primitive.

The beauty of it though is in its simplicity. I'm very grateful that you do what you do. And also grateful for awakening an old interest for me, the hobby of building kits. Thank you!

**Frank Gutierrez/Kingsville, TX**

## Dear Nuts & Volts:

I happened to see the Sept. '99 issue in Barnes & Noble today. I was hooked. And I loved the article on the Tesla coil! I happened to see more info in than I have seen or read in any other articles. What an informed piece of work!

**Vince Adams  
Internet**

## Newsbytes

### HIFI.COM TO OFFER FREE DVD PLAYERS TO KICK OFF HOLIDAY ONLINE SHOPPING SEASON

While supplies last, when consumers purchase any complete Dolby Surround® system from Hifi.com they will receive a brand name DVD player absolutely free — a precedent setting offer from a consumer electronics e-tailer. Dolby Surround systems, providing everything the online shopper needs for top-notch home entertainment in any room in the house, start at \$299.99. The package also includes coupons for 21 free DVD rentals and five free DVDs, with free shipping. First time buyers who purchase \$100.00 worth of merchandise will also receive a \$25.00 registration credit with their first purchase.

In addition to the free DVD player promotion, there are a number of other merchandise specials at Hifi.com this holiday season: A) When consumers purchase a complete stereo system valued at \$499.99 or more, they receive a free model 88 table radio by Henry Kloss. B) A Kodak DC215 digital still camera for \$324.95 (\$299.99 after \$25.00 merchandise credit).

"The Grinch stole last year's Christmas for many consumers

with the lack of post-sale customer support from e-tailers in all markets," says Michael Sullivan, president of Hifi.com "We are dedicated to helping our customers every step of the way in purchasing the ideal home entertainment system for their needs — from online product selection and free shipping to hook-up and installation advice. Keeping our call center open on Christmas day to assist families in the hook-up and assembly of their purchases shows our dedication to our customer service."

For more information, contact: Mullen, Cameron Smith 978-468-1155, E-Mail: csmith@mullen.com

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Continued on page 85

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by Ray Marston



Create your very own festive holiday atmosphere using these melody ICs. Add sound effects to gifts or cards. Or give your doorbell a special holiday chime.

# USING LOW-COST 'MELODY' AND 'SOUND-EFFECTS' GENERATOR ICs



PLEASE NOTE that most of the ICs described in this article are CMOS types with unprotected inputs, and are thus highly susceptible to catastrophic damage from electrostatic discharges when being handled. Readers wishing to experiment with any of these ICs are strongly advised to take all normal 'CMOS handling' precautions, including the wearing of a grounded wrist strap.

This special 'basic usage data' article looks at various low-cost melody generator and sound-effects generator ICs and circuits that are particularly useful in simple 'entertainment' or 'fun' applications.

All of these ICs are pseudo-linear types that contain digital elements such as clock generators and ROM-controlled counter/dividers and tone/noise generators, but are configured to generate analog-type output waveforms.

Note that most ICs of the various major types described in this article are manufactured in a wide variety of sub-types (which each generate specific sounds or tunes) that are intended mainly for use by bulk-purchasing commercial users, and that relatively few of these sub-types are available in one-off quantities, from a few specialist suppliers. All of the ICs used by the author were obtained directly from the manufacturers or from **Maplin Electronics**, P.O. Box 777, Rayleigh, Essex, SS6 8LU, in the UK.

## MELODY GENERATOR IC CIRCUITS

Melody generator ICs are sophisticated but inexpensive and easy-to-use low-fi 'tune player' devices, usually housed in three-pin TO-92 packages that are each capable of playing a simple (up to 64 or 128 notes) melody. They are often used as basic tune generators in greeting cards or gifts,

in toys and games, and in telephones and various other electronic gadgets. The three most popular ranges of melody generator ICs are the UM66T series from UMC, the M66T series from Micro-E, and the HT381xx series from Holtek; the rest of this section presents practical usage information on ICs from these three particular ranges.

### The UM66T series (UMC)

Figure 1 shows basic details of the UM66T melody generator IC, which is housed in a three-pin TO-92 package, can be powered from a 1.3V to 3.3V battery supply, consumes a quiescent current of less than 1µA, and can play a tune of up to 64 notes (determined by the IC's internal ROM).

The diagram shows [in (b) and (c)] basic ways of using the IC to

make a complete melody generator with either a piezo sounder or a loudspeaker output. Note in these and most other melody generator IC circuits that, after connecting the supply by closing S1, the melody plays once and then stops; the supply must be broken and then reconnected to retrigger the IC.

The basic UM66T-series IC is currently (at the time of writing) manufactured in a total of 14 basic 'English-language Tune' sub-variants (indicated by the first two bits of a three-digit/letter suffix to the main IC part number), each of which plays a different tune or abbreviated set of melodies, as indicated in the table shown in Figure 2. The two most popular of these sub-variants are the UM66T08x, which plays *Happy Birthday To You*, and the UM66T09x, which plays *Mendelssohn's Wedding March*.

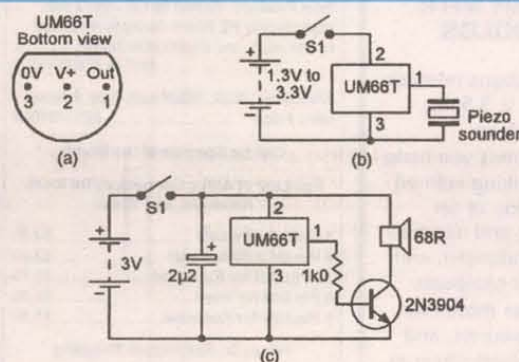


Figure 1. Outline and basic application circuits of the UM66T melody generator IC.

### IC PART NO.

UM66T01x  
UM66T02x  
UM66T04x  
UM66T05x  
UM66T06x  
UM66T08x  
UM66T09x  
UM66T11x  
UM66T13x  
UM66T19x  
UM66T32x  
UM66T33x  
UM66T34x  
UM66T68x

### SONG NAME

Jingle Bells + Santa Claus is Coming to Town + We Wish You a Merry Christmas  
Jingle Bells  
Jingle Bells + Rudolph the Red Nosed Reindeer + Joy to the World  
Home Sweet Home  
Let Me Call You Sweetheart  
Happy Birthday to You  
Wedding March (Mendelssohn)  
Love Me Tender, Love Me True  
Easter Parade  
For Elise  
Cuckoo Waltz  
Mary Had a Little Lamb  
The Train is Running Fast  
It's a Small World

Figure 2. Tune-play details of 14 English-language sub-variants of the basic UM66T-series IC.



Remember, you're not limited to holiday songs. Use tunes like: Old MacDonald Had a Farm; Love Me Tender; Twinkle, Twinkle, Little Star; You Are My Sunshine; Greensleeves; the list goes on. *Plus*, don't forget about available sound effects like police cars, rockets, cows, dogs, jets, and chickens, just to name a few.

ohm speaker when the circuit is powered from a 1.5V battery supply. Alternatively, Figure 4 shows basic ways of using the IC as a melody generator that uses a 1.5V to 3.5V supply and has either a piezo sounder or a loudspeaker output.

The basic M66T-series IC is manufactured in more than 200 sub-variants (each indicated by a suffix to the main part number), each of which plays a different tune or abbreviated set of melodies. The table in Figure 5 presents basic 'tune' details of the five most popular and widely available 'English-language Tune' ICs in the range.

### The HT381xx series (Holtek)

The Holtek HT381xx series of melody generator ICs (strangely listed as the 'HT3810' series in the Holtek data book) is far more sophisticated than the UM66T-series or M66T-series devices, and is intended primarily for use in telephone and toy/game applications, rather than in greeting cards. The IC incorporates two tone generators and a 'CHA' sound generator, etc., and can play a tune of up to 128 notes; the IC needs a 2.4V to 5V DC supply, consumes a typical standby current of 10µA, and plays one complete tune each time the supply is connected to the IC.

The HT381xx series of ICs are produced in both 11-pad 'chip' form (for use by bulk-purchase companies) and in standard three-pin TO-92 package form. Figure 6 shows

basic details of the TO-92 package, plus two basic ways of using the IC as a melody generator that uses a 2.4V to 5V supply and has either (b) a piezo sounder or (c) a loudspeaker output.

The HT381xx series of ICs are currently produced in a total of 74 sub-variants, each indicated by a two-part (one numeral plus one letter) suffix to the main part number; each IC variant plays a different English-language tune or abbreviated set of melodies. The available tunes are, for IC numbering purposes, classified in four basic 'class' groups; the table in Figure 7 shows the basic relationship between the IC numbers and the general class of tune that they play. Figure 8 shows specific tune-play details of 12 popular sub-variant ICs in the basic HT381xx range of devices.

### SOUND-EFFECTS GENERATOR IC CIRCUITS

Sound-effects generator ICs are sophisticated but inexpensive and easy-to-use devices that (usually) contain both tone and white-noise generators and are intended mainly for use in toys and in domestic gadgets such as alarms and doorbells. Very simple ICs of this type generate only one specific type of sound; other — more sophisticated — types can generate several different sound effects.

Holtek is the leading producer of sound-effect generator ICs, and produce the devices in both chip and encapsulated versions, and in both custom-programmed and general-purpose form.

The rest of this section presents practical usage information on the most popular 'encapsulated' versions of various general-purpose CMOS sound-effects generator ICs that are currently available from the Holtek range.

When using these ICs, note that

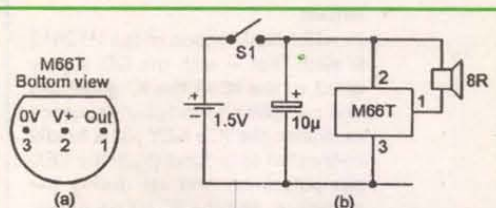


Figure 3. Outline and simple application circuit of the M66T melody generator IC.

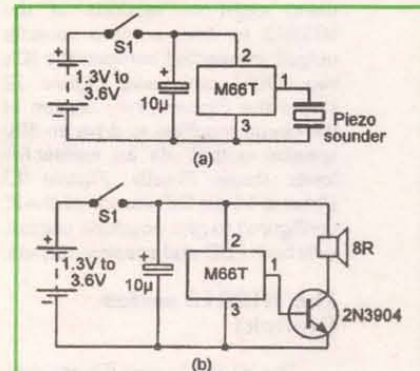


Figure 4. General-purpose application circuits for the M66T IC.

many of them have one or more 'TEST' (T) pins, which should be left open when the IC is in normal use. Readers seeking additional up-to-date information on the Holtek range of ICs can access it via the Holtek web site at <http://www.holtek.com>.

### The HT2812 series (Holtek)

The HT2812-series ICs each generate a single sound effect in an external speaker or piezo sounder; they operate from a 2.4V to 3.3V DC supply, consume a typical

standby current of 1µA, have their main oscillator frequency controlled by a single external 'Rosc' resistor, and feature built-in envelope control and automatic power-off action.

The series is currently produced in nine popular sub-variants, each indicated by a one letter suffix to the main part number; each IC variant generates a different sound effect, as shown in the table in

IC PART NO.	MELODY/SOUND	DURATION
M66T-02B	Twinkle Twinkle Little Star	16.4 secs
M66T-11	Rock-a-bye Baby	21.6 secs
M66T-36	Old MacDonald Had a Farm	24.8 secs
M66T-205	I'd Like to Teach the World to Sing	20.4 secs
M66T-214	White Christmas	49.5 secs

Figure 5. Tune-play details of the five most popular English-language sub-variants of the M66T IC.

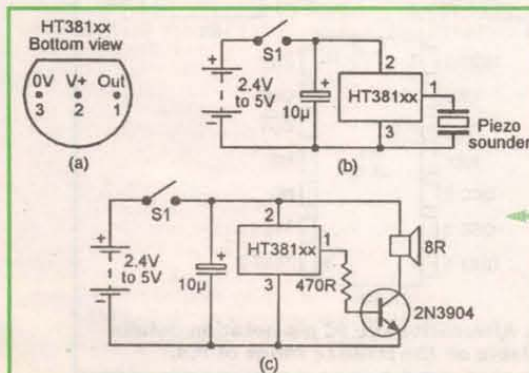


Figure 6. TO-92 outline and basic application circuits of the HT381xx melody generator IC.

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Figure 9, which also shows the nominal  $R_{OSC}$  value for use with each IC variant.

The HT2812 series is produced in three alternative package forms, as shown in Figure 10. The 14-pin DIL type has both LED output and envelope-control (ENV) pins; the eight-pin DIL type has a LED output on pin 4 in the Figure 10(a) variant, or an ENV pin in the Figure 10(b)

variant.

The basic action of the HT2812 is such that — with the DC supply wired to the IC — the IC generates one complete sound-play sequence each time the IC's KEY pin is briefly connected to ground ( $V_{SS}$ ); the LED pin pulses on and off during the sequence, and the IC automatically goes into the 'standby' mode at the end of the sequence.

Figure 11 shows basic ways of using eight-pin versions of the HT2812 to drive a piezo sounder output, connected between the IC's two 'OUT' pins, and Figure 12 shows the Figure 11(b) version of the circuit modified to drive an 8Ω speaker output via an emitter-follower stage. Finally, Figure 13 shows a 14-pin DIL version of the IC configured to give envelope control, with both LED and speaker outputs.

### The HT2813 series (Holtek)

The HT2813-series ICs are similar to the HT2812 type, but generate a different range of sound effects and are each encapsulated in a 16-pin DIL package. Figure 14 shows basic sound-play and ' $R_{OSC}$ ' resistor value details of the five most popular ICs in the range, and Figure 15 shows the IC's outline and pin notations. Figure 16 shows the basic connections for using an HT2813 IC with a speaker or (shown dotted) a piezo sounder output.

### The HT2821 series (Holtek)

The HT2821-series ICs are similar to the HT2812 type, but each generate two different sound effects

IC PART NO.	SONG (TUNE) SERIES	NO. OF SONGS
HT3810A to HT3810Z	Children's Songs	25
HT3811A to HT3811G	Children's Songs	7
HT3812A to HT3812Q	Lyrical Songs	16
HT3813A to HT3813M	Christmas Songs	13
HT3814A to HT3814M	Popular Songs	13
		Total = 74

Figure 7. Relationship between HT381xx IC numbers and the general class of tune that they play.

IC PART NO.	SONG NAME
HT3810B	Happy Birthday to You
HT3810N	London Bridge is Falling Down + The Train is Running Fast
HT3810W	Old MacDonald Had a Farm
HT3811A	Popeye the Sailor Man
HT3811G	Mary Had a Little Lamb
HT3812A	Greensleeves
HT3813A	Jingle Bells
HT3812G	Love Me Tender
HT3813E	We Wish You a Merry Christmas
HT3813M	Hark, the Herald Angels Sing + The 12 Days of Christmas
HT3814A	You Are My Sunshine
HT3814K	I Just Called to Say I Love You

Figure 8. Tune-play details of 12 popular sub-variants of the HT381xx melody generator IC.

IC PART NO.	SOUND EFFECT	$R_{OSC}$ VALUE (nominal)
HT2812A	Airplane	390k
HT2812B	Rocket	220k
HT2812C	Siren II	390k
HT2812D	Police Car	150k
HT2812E	Fire Brigade	150k
HT2812F	Siren I	390k
HT2812H	Dialing Tone	390k
HT2812J	Chicken Sound	62k
HT2812K	Ambulance Sound	390k

Figure 9. Sound-play and  $R_{OSC}$  details of nine popular sub-variants of the HT2812 sound-effects generator ICs.

(each controlled by its own key switch) and are encapsulated in a 14-pin DIL package; they operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1μA, and have their main oscillator frequency controlled by a single external ' $R_{OSC}$ ' resistor.

The two most popular ICs in the range are the HT2821A, which generates machine gun and bombing sounds and needs a 180k ' $R_{OSC}$ ' value, and the HT2821E, which generates brake and explosion sounds and needs a 560k ' $R_{OSC}$ ' value.

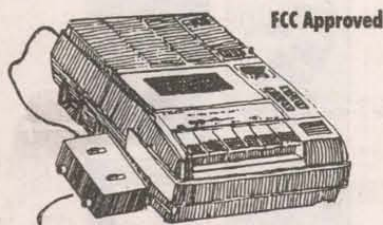
Figure 17 shows the outline and pin notations of the HT2821 IC, together with the basic connections for using it with a speaker or (shown dotted) a piezo sounder output, but

with the ENV facility unused.

### The HT2830 series (Holtek)

The HT2830-series ICs use an 18-pin DIL package and each generate a push-button controlled variable-rate 'base' sound (such as that of a jet engine, a helicopter rotor, or a train), plus two push-button controlled 'fighting' sounds (such as a machine gun and a missile, or a bell and a horn). The ICs operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1μA, have their main oscillator frequency controlled by a single external ' $R_{OSC}$ ' resistor, and have provisions for driving two external LEDs, which flash

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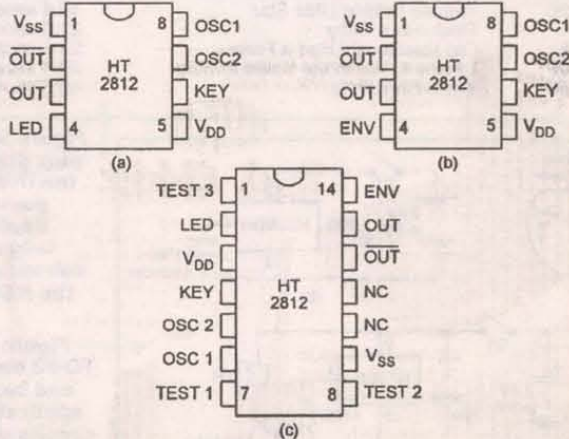


Figure 10. Alternative DIL IC pin-notation details available on the HT2812 range of ICs.



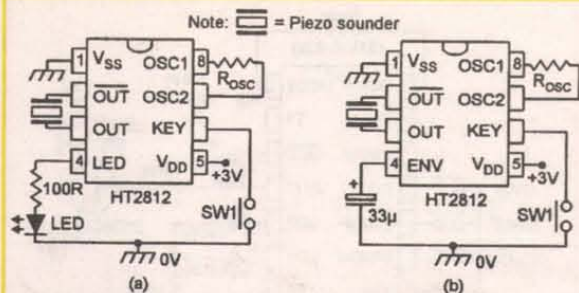


Figure 11. Eight-pin DIL HT2812 piezo-output application circuits with (a) LED display and (b) envelope control.

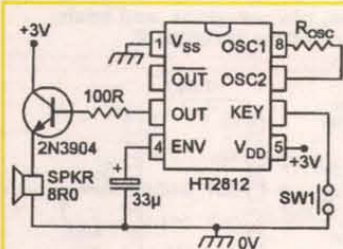


Figure 12. Eight-pin DIL HT2812 speaker-output application circuit with envelope control.

at a rate proportional to the base sound rate.

Figure 18 shows the outline and pin notations of the HT2830 IC, together with the basic connections for using it with a speaker or (shown dotted) a piezo sounder output. The

IC's base-sound rate can be increased via SWUP or decreased via SWDN, and the two fighting sounds can be selected via SWA or SWB. The  $R_{OSC}$  value is typically in the range 51k (for the HT2830B 'helicopter sound' IC) to 82k (for the HT2830C 'train sound' IC).

#### The HT2844 series (Holttek)

The HT2844-series ICs use a

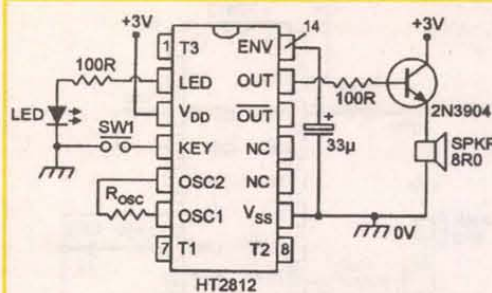


Figure 13. 14-pin DIL HT2812 speaker-output application circuit with LED output and envelope control.

#### IC PART NO.

HT2813D  
HT2813E  
HT2813F  
HT2813G  
HT2813H

#### SOUND EFFECT

Ghost  
Bird Song 1  
Bird Song 2  
Cow  
Little Dog

#### $R_{OSC}$ VALUE (nominal)

120k  
56k  
56k  
62k  
300k

Figure 14. Sound-play and  $R_{OSC}$  details of five popular sub-variants of the HT2813 sound-effects generator ICs.

16-pin DIL package and each generate four independent push-button activated sound effects. The ICs operate from a 2.4V to 3.3V DC supply, consume a typical standby current of 1µA, have their main oscillator frequency controlled by a single external ' $R_{OSC}$ ' resistor, and have provisions for driving one external LED.

The series contains seven general-purpose ICs, which each gener-

ate four sounds of a particular type; Figure 19 shows the sound-play and  $R_{OSC}$  details of these seven ICs,

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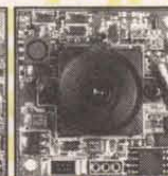
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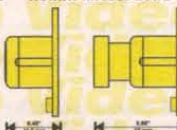


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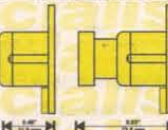


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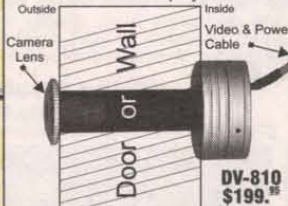


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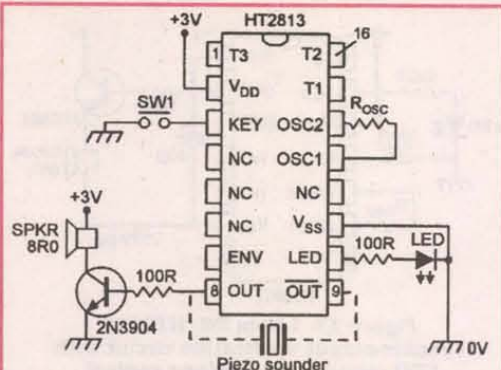
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**Figure 16.** Basic connections for using an HT2813 IC with a speaker or (shown dotted) piezo sounder output.

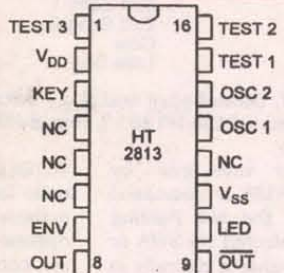
K1, etc.) for the duration of the multi-ple-switch closure.

The HT2860-series ICs operate from 2.4V to 4.5V DC supplies, consume a typical standby current of 1µA at 3V, have their main timing controlled by two external resistors, have a power-on reset (PWR) feature that is controlled by a single external 102pF capacitor, and use either a 16-pin or 18-pin DIL package.

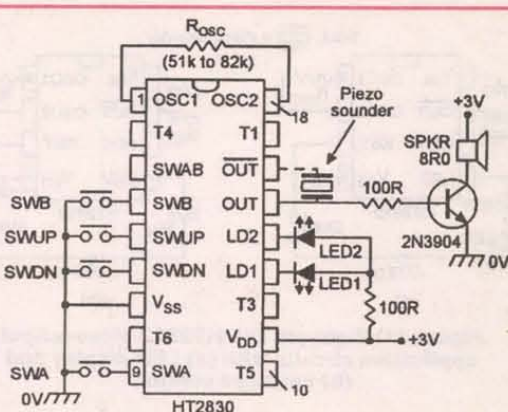
The two most popular ICs in the range are the HT2860B, which uses an 18-pin DIL package and generates six different alarm sounds, and the HT2860C, which uses a 16-pin DIL package and generates four different alarm sounds plus a horn sound (K5) and an ambulance sound (K6); Figures 21 and 22 show the IC outlines, pin notations, and basic usage circuits of these two ICs.

## The HT2883/HT2885 series (Holtek)

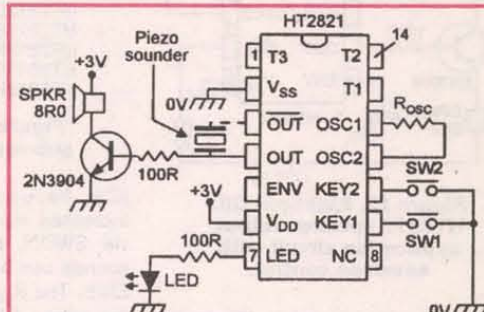
The HT2883 and



**Figure 15.** Outline and pin notations of the HT2813 range of ICs.



**Figure 18.** Outline, pin notations, and basic usage circuit of the HT2830 IC.



**Figure 17.** Outline, pin notations, and basic usage circuit of the HT2821 IC, with ENV facility unused.

and Figure 20 shows the outline, pin notations, and basic usage circuit of the HT2844 IC, using either a speaker or a piezo sounder output.

## The HT2860 series (Holtek)

The HT2860-series ICs each generate six different sound effects, which can each be triggered via an external key (K) switch. The six sound effects are priority rated from K1 (highest priority) to K6 (lowest priority); thus, if a single K switch is closed, the associated sound effect plays for the duration of the switch closure, but if a number of K switches are closed simultaneously (say K1, K3, and K5), the IC repeatedly plays through the selected sound effects in their priority sequence (K1-K3-K5-

## IC Part Number & Sound Type

IC Part Number & Sound Type	Sound 1	Sound 2	Sound 3	Sound 4	Rosc Value (nominal)
HT2844 (toy guns)	Rifle	TV Game	Bombing	M.G.	220k
HT2844C (animals)	Chick	Cricket	Frog	Bird	220k
HT2844M (helicopter)	Rotor (fast)	Rotor (slow)	Explosion	M.G.	270k
HT2844N (racing cars)	Engine (slow)	Engine (fast)	Horn	Brake	270k
HT2844P (jet aircraft)	Jet (slow)	Jet (fast)	Missile	M.G.	430k
HT2844S (morning call)	Phone	Siren	Ambulance	Melody*	560k
HT2844T (alarms)	Four different 'alarm' sounds				220k

\*Melody is London Bridge is Falling Down

**Figure 19.** Sound play and Rosc details of seven popular variants of the HT2844 sound-effects generator ICs.

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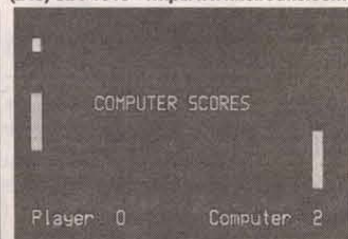
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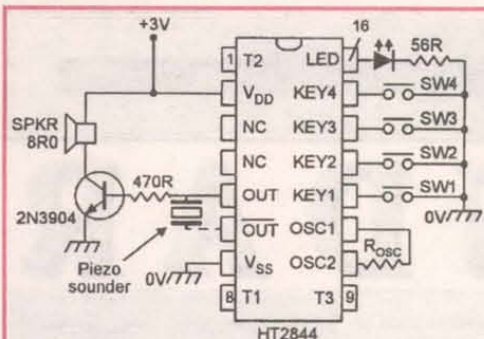


Figure 20. Outline, pin notations, and basic usage circuit of the HT2844 IC.

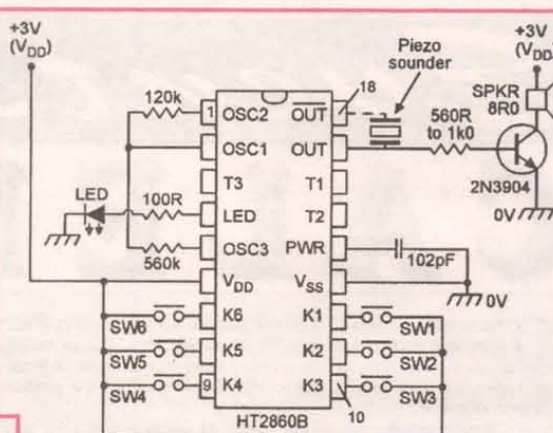


Figure 21. Outline, pin notations, and basic usage circuit of the HT2860B IC.

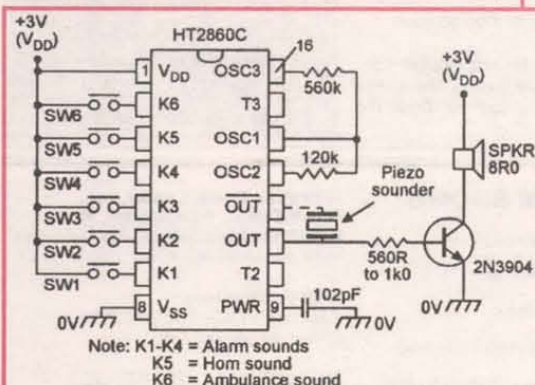


Figure 22. Outline, pin notations, and basic usage circuit of the HT2860C IC.

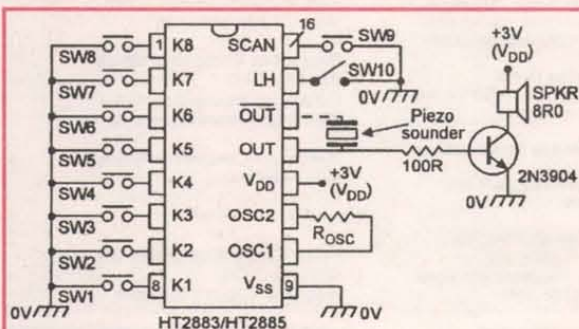


Figure 23. Outline, pin notations, and basic usage circuit of the 16-pin version of the HT2883/HT2885 IC.

HT2885 series ICs operate from 2.4V to 3.3V DC supplies, consume a typical standby current of 1μA, have their main timing controlled by a single external 'R<sub>osc</sub>' resistor, and are each capable of generating eight different sound effects, which are priority rated from K1 (highest priority) to K8 (lowest priority); ICs in the series are produced in 16-pin DIL and/or eight-pin DIL forms.

Figure 23 shows the outline, pin notations, and basic usage circuit of the 16-pin DIL version of the HT2883/HT2885, using either a speaker or a piezo sounder output. The basic action of this IC is such that any one of the eight available sound effects can be individually activated by closing its own key (K) switch, or the effects can be activated sequentially—in their priority order—by activating SCAN switch SW9.

When the sounds are keyed independently, they are keyed in the 'one-shot' (fixed duration) mode when the LH (level hold) pin is open

(SW10 open), or are keyed for the duration of the 'K' switch closure when the LH pin is grounded (SW10 closed).

When the IC is keyed in the sequential mode, the sounds scan sequentially throughout the duration of the SCAN key (SW9) closure in the HT2883, or scan one step and then repeat for the duration of the SW9 closure in the HT2885 (this SCAN function is independent of the LH key and is the only difference between the HT2883 and HT2885 versions of the IC).

Figure 24 shows the outline, pin notations, and basic usage circuit of the eight-pin DIL version of the HT2883/HT2885, which is designed to drive a speaker output and operates in the sequential scanning mode only.

The HT2883/HT2885 series of ICs is produced in a variety of sub-variants; Figure 25 lists basic details of the six most important and generally-available ICs in the series. **NV**

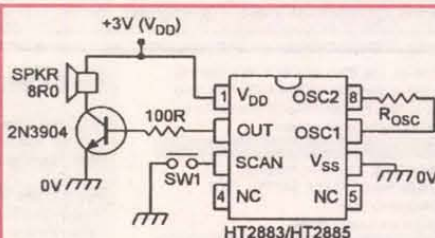


Figure 24. Outline, pin notations, and basic usage circuit of the eight-pin version of the HT2883/HT2885 IC.

#### IC Part Number

HT2883  
HT2883E  
HT2883F  
HT2883I  
HT2885  
HT2885D

#### Manufacturer's Classification of the Eight Available Sound Effects

Toy Gun Sounds  
Submarine War Sounds  
Helicopter War Sounds  
Racing Car Sounds  
Toy Gun Sounds  
Toy Phone Sounds

#### Available DIL IC Types

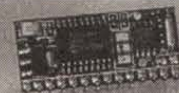
8-pin/16-pin  
16-pin  
16-pin  
16-pin  
8-pin/16-pin  
16-pin

#### R<sub>osc</sub> Value (nominal)

150k  
330k  
330k  
330k  
150k  
270k

Figure 25. Sound play, IC packaging and R<sub>osc</sub> details of the main variants of the HT2883/HT2885 sound-effects generator ICs.

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# Events

## DECEMBER 1999

### DECEMBER 4

**AL - DOTHAN** - Hamfest. Wiregrass ARC, Percy Garrett KF4DYV, 334-692-3689  
Web: <http://www.qsl.net/warc/eflyer.htm>  
**AZ - MESA** - Hamfest. AR Council of AZ, Mark Kesauer N7KKQ, 602-779-2722.  
E-Mail: [arcatill@aol.com](mailto:arcatill@aol.com)  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in.  
619-561-0052  
**FL - OKEECHOBEE** - Hamfest. Okeechobee ARC, Bill Gastle.  
E-Mail: [wgastle@okeechobee.com](mailto:wgastle@okeechobee.com)  
**GA - CLAXTON** - Hamfest. Claxton ARES, John Perkins W4HYU, 912-739-4589.  
E-Mail: [w4hyu@juno.com](mailto:w4hyu@juno.com)  
**LA - MINDEN** - Hamfest. Minden ARC, Lowell A. "Dusty" Collins KB5WFE, 318-371-0636.  
E-Mail: [dusty1@microgear.net](mailto:dusty1@microgear.net) Web: <http://www.microgear.net/gwinford/mara.htm>

### DECEMBER 4-5

**FL - STARKE** - Hamfest. Waldo Trading Post Bluegrass area, US 301 S, behind the flea market. Sat: 9am-5pm, Sun: 9am-4pm. Talk-in: 145.150. ARC Bradford Area, John Bradley, 904-782-1185; E-Mail: [jbradley@techcomm.net](mailto:jbradley@techcomm.net). Tony Spatafore, 904-964-9328; E-Mail: [wb2lqj@techcomm.net](mailto:wb2lqj@techcomm.net) Web: <http://www.angelfire.com/fl/arba/index.html>

### DECEMBER 5

**IN - GREENFIELD** - Hamfest. Greenfield Central High School Pavilion, N. Broadway St. Talk-in: 145.330, 444.725. Hancock ARC, Tom Donaldson N9LFU, 317-326-3168.  
E-Mail: [tomd@freeweb.com](mailto:tomd@freeweb.com) Web: <http://www.wei.net/~n9hqo>

### DECEMBER 11

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**SC - UNION** - Hamfest. National Guard Armory, Industrial Park Dr. 8am-2pm. Union County ARC, Roger W. Gregory K14RG, 864-427-1462.  
E-Mail: [K14RG@arrl.net](mailto:K14RG@arrl.net)

### DECEMBER 18

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in.  
619-561-005

## JANUARY 2000

### JANUARY 7-8

**FL - GAINESVILLE** - Hamfest. Alachua County Fairgrounds, SR-222 (3400 NE 39th Ave.), 1/2 mi. E. of SR-24 (Waldo Rd.). Talk-in: 146.820 (-). Gainesville ARS, Tom Scott KF4L, 352-378-9711 eves. E-Mail: [k4gnv@arrl.net](mailto:k4gnv@arrl.net) Web: <http://www.gars.net/hamfest/>

### JANUARY 8

**CO - LOVELAND** - Hamfest. Larimer County Fairgrounds, 700 Railroad Ave. 9am-3pm. VE exams. Talk-in: 145.115 (- offset, 100Hz) or 146.52. NCARC, Michael Robinson N7MR, 970-225-7051. E-Mail: [michael@frii.com](mailto:michael@frii.com) Web: <http://www.info2000.net/~ncarc>  
**WI - WAUKESHA** - Hamfest. Waukesha Co. Expo Center Forum, 8am-2pm. VE exams. West Allis RAC, Phil Gural W9NAW, 414-425-3649.

### JANUARY 8-9

**FL - FT. MYERS** - Hamfest. Ft. Myers ARC, Doug Douglas N8SAQ, 941-542-4741.  
E-Mail: [douglas2@iline.com](mailto:douglas2@iline.com)

### JANUARY 9

**IN - SOUTH BEND** - Hamfest. Century Center, US33 N. & Jefferson Blvd. 8am-3pm. Talk-in: 145.290. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, 219-291-0252, M-F 7pm-10pm

### JANUARY 15

**AZ - GLENDALE** - Hamfest. ARCA & ADAW, Mark Kesauer N7KKQ, 602-779-2722.  
E-Mail: [arcatill@aol.com](mailto:arcatill@aol.com) Web: <http://www.phx-az.com/arca>  
**LA - HAMMOND** - Hamfest. South East LA ARC, Nathan Gifford N5BFC, 504-465-7522.  
E-Mail: [n5bfc@arrl.net](mailto:n5bfc@arrl.net) Web: <http://www.selarc.org/selarchamfest.html>  
**MI - FLUSHING** - Hamfest. Amateur Radio & Youth, Clay Hewitt KF8UI, 810-233-7889.  
E-Mail: [clay@iavbbs.com](mailto:clay@iavbbs.com) Web: <http://www.qsl.net/ary/page6.html>  
**MO - ST. JOSEPH** - Hamfest. Ramada Inn, 129 & Frederick Ave. (exit 47). 8am-3pm. FCC

# 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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Phone 909-371-8497

Fax 909-371-3052

E-mail [events@nutsvolts.com](mailto:events@nutsvolts.com)

## COMPUTER SHOWS

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**Blue Star Productions**  
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<http://www.supercomputersale.com>

**Computers And You**, 734-283-1754.  
[www.a1-supercomputersales.com](http://www.a1-supercomputersales.com)

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E-Mail: [diamondb@space4less.com](mailto:diamondb@space4less.com)  
Web: [www.space4less.com/usr/mmarc](http://www.space4less.com/usr/mmarc)  
**OH - DOVER** - Hamfest. Tusco ARC, Billy Harper KB8CQG, 330-484-4634.  
E-Mail: [bharper@neo.rr.com](mailto:bharper@neo.rr.com)

## FEBRUARY 2000

### FEBRUARY 4-5

**MS - JACKSON** - State Convention. Jackson ARC, Ron Brown AB5WF, 601-982-0101 or 601-956-1448. E-Mail: [ab5wf@arrl.net](mailto:ab5wf@arrl.net) Web: <http://www.jxnarc.org>

### FEBRUARY 5

**KS - LA CYGNE** - Hamfest. Mine Creek ARC, Mike Eymann W0XM, 913-898-4695.  
E-Mail: [w0xm@arrl.net](mailto:w0xm@arrl.net)  
**MI - NEGAUNEE** - Hamfest. Hiawatha ARA, Bill Beitel N8NRG, 906-226-2779.  
E-Mail: [n8nrg@portup.com](mailto:n8nrg@portup.com)  
**SC - NORTH CHARLESTON** - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: [brycemyers@aol.com](mailto:brycemyers@aol.com) Web: <http://www.qsl.net/wa4usn/index.html>

### FEBRUARY 5-6

**FL - MIAMI** - Southeastern Division Convention. Fair Expo Center, 10901 SW 24th St. (Coral Way). Sat: 9am-5pm, Sun: 9am-4pm. Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139.  
E-Mail: [edg@gzinc.com](mailto:edg@gzinc.com) Web: <http://www.hamboree.org>

### FEBRUARY 11-12-13

**FL - ORLANDO** - State Convention. Orlando ARC, Ken Christenson KD4JQR, 407-291-2465.  
E-Mail: [KD4JQR@Juno.com](mailto:KD4JQR@Juno.com) Web: <http://www.oarc.org/hamcat.html>

### FEBRUARY 12-13

**TN - MEMPHIS** - State Convention. W. Ben Troughton KU4AW, 901-372-8031. E-Mail: [bktrough@mem.net](mailto:bktrough@mem.net) Web: <http://www.dixiefest.org>

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[www.gibraltartrade.com](http://www.gibraltartrade.com)

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**MarketPro, Inc.**, 301-984-0880.  
E-Mail: [md@marketpro.com](mailto:md@marketpro.com)  
<http://marketpro.com>

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**Peter Trapp Computer Shows**  
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Web: [www.petertrapp.com](http://www.petertrapp.com)

### FEBRUARY 13

**OH - MANSFIELD** - Hamfest. Richland County Fairgrounds. Talk-in call W8WE 146.34/94. InterCity ARC, Inc., Pat Ackerman N8YOB, 419-589-7133

### FEBRUARY 19

**AR - RUSSELLVILLE** - Hamfest. AR River Valley AR Foundation, Jonathan Setzer KC5BRY, 501-968-2938. E-Mail: [hamfest@setzer.com](mailto:hamfest@setzer.com)  
**MA - MARLBOROUGH** - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988

### FEBRUARY 20

**MI - FARMINGTON HILLS** - Hamfest. William M. Costick Activities Center, 28600 Eleven Mile Rd. 8am-3pm. Talk-in: 145.350, 146.52 simplex. Livonia ARC, Neil Coffin WA8GWL, club phone 734-261-5486. E-Mail: [swap@larc.mi.org](mailto:swap@larc.mi.org) Web: [www.larc.mi.org](http://www.larc.mi.org)

### FEBRUARY 26

**IN - LA PORTE** - Hamfest. Civic Auditorium, 1001 Ridge. 7am-1pm. Talk-in: 146.520 simplex, 146.610 (131.8 PL). Neil Straub W2ZN, 219-324-7525. E-Mail: [nstraub@nla.net](mailto:nstraub@nla.net)  
**VT - MILTON** - NVT Winter Hamfest. High School, Rt. 7. Mitch Stern W1SJ, 802-879-6589. E-Mail: [w1sj@arrl.net](mailto:w1sj@arrl.net) Web: <http://www.ranv.together.com>

### FEBRUARY 27

**FL - ZEPHYRHILLS** - Hamfest. Zephyrhills ARC, Ernie Vanselow KD4VRV, 813-783-8389  
E-Mail: [kd4vrv@gte.net](mailto:kd4vrv@gte.net)  
**VA - ANNANDALE** - Hamfest. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021.  
E-Mail: [k3mt@erols.com](mailto:k3mt@erols.com) Web: <http://www.erols.com/k3mt/vws>

## MARCH 2000

### MARCH 4

**NJ - PARSIPPANY** - Hamfest. Splitrock ARA,



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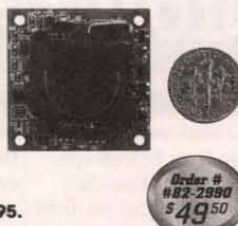


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# Events CALENDAR

Peter Glenn KC2KI, 732-457-4342 or 973-442-0772. E-Mail: peteg@interactive.net

## MARCH 4-5

**FL - NEW PORT RICHEY** - Hamfest. Gulf Coast ARC, Rickie Brown KF4QXS, 727-863-1457. E-Mail: richar@gte.net. Don KK4VK, 727-848-8000. Web: <http://homel.gte.net/koerner/gcarc.htm>

## MARCH 5

**NY - LINDENHURST** - Hamfest. GSBARC & SCRC, Lenore N2KYP, 516-785-0826. E-Mail: info@gsbarc.org Web: <http://www.gsbarc.org>

## MARCH 10-11

**NE - NORFOLK** - State Convention, Elkhorn Valley ARC, Fred Wiebelhaus N0VLX, 402-379-

1929. E-Mail: dfwiebel@sufia.net

## MARCH 11

**WA - PUYALLUP** - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 253-631-3756 or 425-867-4797. E-Mail: mwink@eskimmo.com

## MARCH 11-12

**NC - CHARLOTTE** - Charlotte Hamfest and Computerfair. Charlotte Merchandise Mart, 2500 E. Independence Blvd. Mecklenburg Amateur Radio Society, Tom Hunt KA3VVJ, 704-948-7373 until 9pm EST. E-Mail: dealers@w4bfb.org Web: [www.w4bfb.org/hamfest.html](http://www.w4bfb.org/hamfest.html)

## MARCH 12

**PA - YORK** - Hamfest. Keystone VHF Club, Dick

Goodman WA3USG, 717-697-2353.

E-Mail: wa3usg@compuserve.com

Web: <http://members.aol.com/yorkfest>

**WI - WAUKESHA** - Hamfest. County Expo Center, N1 W24848 N. View Rd. 8am-2pm. Talk-in: 146.820 PL 127.3. SEWFARS ARC, John Breecher, 414-835-7035

## MARCH 17-18

**GA - MARIETTA** - Hamfest. Kennehochee ARC, Charles Golsen N4TZM, 404-252-3303. E-Mail: cgolsen@atlanta.com

## MARCH 18

**FL - STUART** - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841

**NJ - NORTH HUNTERDON** - Hamfest. Cherryville Repeater Assn., Marty Grozinski

W2CQ, 908-788-2644 or 908-730-2771.

E-Mail: w2cq@ar1.net

**WV - CHARLESTON** - Hamfest. Jimmie Hewlett WD8MKS, 304-768-1142

## MARCH 18-19

**TX - MIDLAND** - West Texas ARRL Section Convention. Midland County Exhibit Bldg. Sat: 8am-5pm, Sun: 8am-2pm. VE Exams. Beverly Harwood KC5BNT, 915-686-1841. E-Mail: shamrock@apex2000.net, Web: <http://www.txnet.net/dge/midswap.htm>. Larry Nix N5TQU, E-Mail: oilman@ix.net Web: <http://www.w5qgg.org>

## MARCH 19

**OH - MAUMEE** - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+ or 442.85+. Toledo Mobile RA, Paul Hanslik, 419-385-5056. Web: [www.tmrhamradio.org](http://www.tmrhamradio.org)

## MARCH 24-25

**OK - TULSA** - West Gulf Division Convention. Green Country Hamfest Assn., Merlin Griffin WB5OSM, 918-622-2277. E-Mail: megriffin@ionet.net Web: <http://www.greencountryhamfest.org>

## MARCH 25

**WV - BECKLEY** - Hamfest. Plateau ARA & Black Diamond RC, James Martin KC8JSZ, 304-465-1428. E-Mail: w373@ionet.net Web: <http://members.spreed.com/sip1/plateau>

## MARCH 25-26

**MD - TIMONIUM** - Greater Baltimore Hamboore & Computerfest/MD State ARRL Convention. Timonium Fairgrounds, York Rd. Sat: 8am-5pm, Sun: 8am-4pm. VE Exams. Baltimore ARC, Sharon Dobson N3QQC, 410-HAM-FEST or 800-HAM-FEST. E-Mail: n3qqc@amsat.org Web: <http://www.gbhc.org>

## MARCH 26

**OH - MADISON** - Hamfest. Lake County ARA, Roxanne N8BC, 440-209-8953. E-Mail: tbrown@ncweb.com

## APRIL 2000

### APRIL 1

**MO - LEBANON** - Hamfest. Lebanon ARC, Mick Jensen KC0EEX, 417-588-2335. E-Mail: mjensen@llion.org

**TX - BRENHAM** - Hamfest. Brenham ARC, Dan Lakenmacher N5JUN, 409-836-8739. E-Mail: lindan@phoenix.net

### APRIL 2

**CT - SOUTHTON** - Hamfest. Southington ARC, Chet Bacon KA1ILH, 860-628-9346. E-Mail: chet@chetbacon.com

Web: <http://www.chetbacon.com/sara.html>

**NC - KINSTON** - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724

### APRIL 7-8

**WI - MILWAUKEE** - Hamfest. Amateur Electronic Supply, Ray Grenier K9KHW, 414-358-4088. E-Mail: rayk9khw@aol.com

Web: <http://www.aesjam.com>

### APRIL 8

**TN - CLINTON** - Hamfest. Oak Ridge ARC, David Bower K4PZT, 865-690-8360. E-Mail: d.bower@ieee.org Web: <http://www.kornet.org/orarc>

**WA - SPOKANE** - Hamfest. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

### APRIL 9

**NC - RALEIGH** - State Convention. Raleigh ARC, Chuck Littlewood K4HF, 919-872-6555. E-Mail: k4hf@ar1.net Web: <http://www.rars.org>

**PA - MONROEVILLE** - Hamfest. Two Rivers ARC, Michael Kowalchek KV3L, 412-751-9657. E-Mail: w3oc@nb.net Web: <http://www.qsl.net/w3oc>

**WI - STOUTTOWN** - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. E-Mail: n9vwh@ar1.net

### APRIL 14-15-16

**CA - VISALIA** - International DX Convention. Southern CA DX Club, Cathy Gardenas KF6LFB, 909-862-0720. E-Mail: wu6d@dreamsoft.com Web: <http://www.scdxc.org>

### APRIL 15

**AL - ALBERTVILLE** - Hamfest. Marshall County ARC, Buddy Smith KC4JRL, 256-593-2516. E-Mail: kc4jrl@airnet.net

**MN - BLAINE** - Hamfest. Robbinsdale ARC, Harriet Johanson KB0JPG, 612-474-7346

**NC - MORGANTON** - Hamfest. Tom Taylor KC4QPR, 828-433-6205. E-Mail: kc4qpr@vivatech.net Web: <http://www.wp.cc.nc.us/~cvhamfest/>

### APRIL 16

**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XMR/PL 114.8 (2A). Nick

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# Events CALENDAR

Altenbernd KA1MQX, 617-253-3776 (9-5). Web: <http://web.mit.edu/w1mx/www/swapfest.html>  
**MI - GROSSE POINTE** - Hamfest. South Eastern MI ARA, Jerry Rosner N8FGK, 313-331-3336. E-Mail: n8fgk@amsat.org  
 Web: <http://members.home.net/semara>

## APRIL 21-22

**AR - LITTLE ROCK** - Little Rock Hamfest, Jim Blackmon K5VZ, 870-246-7833 (h) or 870-246-6734 (w). Fax: 870-246-6736. E-Mail: lhamfest@usa.net  
 Web: <http://www.aristotle.net/~ares/hamfest/>

## APRIL 22

**ID - IDAHO FALLS** - Hamfest. Eastern ID UHF Society, Jay Greenberg WA4VRV, 208-524-1388 or 208-526-7033. E-Mail: wa4vrv@srv.net  
 Web: <http://www.srv.net/~wa4vrv/hamfest.htm>  
**NH - NASHUA** - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

## APRIL 29

**AL - MOULTON** - Hamfest. Bankhead ARC, Rex Free KN4CI, 256-905-0822. Web: <http://www.homestead.com/n4idx>  
**IA - DES MOINES** - Hamfest. Des Moines RAA, Duane Bower WB0UCY, 515-287-6542. E-Mail: duaneab@uswest.net

## MAY 2000

### MAY 6

**WI - CEDARBURG** - Hamfest. Ozaukee RC, Joe Holly AA9HR, 262-377-2137; E-Mail: aa9hr@execpc.com. Skip Douglas, 262-284-3271

### MAY 6-7

**AL - BIRMINGHAM** - Hamfest. Glenn Glass KE4YZK, 205-681-5019. E-Mail: ke4yzk@bellsouth.net Web: <http://www.bro.net/barc/slideshow/index.html>

### MAY 7

**MD - HAGERSTOWN** - Hamfest. Antietam Radio Assn., Tina Jones KB8ZQM, 304-728-7769. E-Mail: kb8zqm@intrepid.net Web: <http://www.qsl.net/w3cwc>  
**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: <http://www.metro70cmnetwork.com>

### MAY 12-13

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

### MAY 19-20-21

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

### MAY 21

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

### MAY 27-28

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

## JUNE 2000

### JUNE 2-3-4

**NY - ROCHESTER** - Atlantic Division ARRL Convention. Harold Smith K2HC, 716-424-7184. E-Mail: rochfst@frontiernet.net Web: <http://www.rochesterhamfest.org>

### JUNE 3-4

**OR - SEASIDE** - Northwestern Division ARRL Convention. Convention Center. VE testing. Talk-in: 146.660 (-600). SEAPAC, Randy Stinson KZ7T, 503-297-1175. Web: [www.seapac.org](http://www.seapac.org)

### JUNE 4

**IL - PRINCETON** - Hamfest. Starved Rock Radio Club, Alan Erbrederis N9PIB, 815-498-9675. E-Mail: w9mks@arrl.net Web: <http://www.qsl.net/w9mks>  
**VA - MANASSAS** - Hamfest. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-330-7987. E-Mail: N4YIC@arrl.net or patnjack@erols.com Web: <http://www.qsl.net/olevahams/>

### JUNE 10

**NC - WINSTON-SALEM** - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: <http://members.xoom.com/w4nc/hamfest.htm>  
**PA - BLOOMSBURG** - Eastern PA Section

Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. E-Mail: n3kyz@epix.net Web: <http://www.bafn.org/~cmarc>

### JUNE 11

**IL - WHEATON** - Hamfest. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. E-Mail: wa9rij@mc.net Web: <http://cyberconnect.com/orion/smcc.html>  
**TN - KNOXVILLE** - Hamfest. RAC of Knoxville, David Bower K4PZT, 423-670-1503. E-Mail: rack@kornet.org Web: <http://www.kornet.org/rack>

### JUNE 18

**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 &

449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: <http://web.mit.edu/w1mx/www/swapfest.html>

## JULY 2000

### JULY 2

**PA - WILKES-BARRE** - Hamfest. Murgas ARC, Stanley Perry KE3TC, 570-735-2385. E-Mail: slperry@epix.net

### JULY 7-8-9

**UT - BRYCE CANYON** - State Convention. UT Hamfest Committee, Kathy Rudnicki N7JSH, 801-547-9218

### JULY 8

**GA - GAINESVILLE** - State Convention. Lanierland ARC, Ken Johnson NZ4Q, 706-335-9658. E-Mail: nz4q@aol.com  
**MO - KANSAS CITY** - Hamfest. PHD ARA, Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@worldnet.att.net Web: <http://members.tripod.com/~PHDARA/>

### JULY 9

**IL - PEOTONE** - Hamfest. Kankakee Area Radio Society, Don Kerouac K9NR, 815-939-7548. E-Mail: k9nr@juno.com Web: <http://www.w9az.com>

### JULY 16

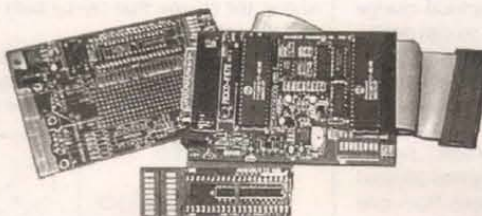
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Continued on page 72

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# Open Channel

## Electrostatic Discharge (ESD)

This month,  
let's talk a little  
about electrostat-  
ic discharge. It is  
very important  
in electronics,  
especially where  
MOSFET or  
CMOS devices  
are in use (other  
components are  
ESD sensitive,  
as well).

The fundamental aspect of matter that permits the flow of electricity is the existence of free electrons in that matter. The electrical resistance of a material is defined by how many free electrons exist in the material. Metals, for example, have many free electrons so it is relatively easy to generate a current flow in them. Insulators, on the other hand, have few free electrons so current flow is proportionally lower. An attribute of insulators is that they do not allow redistribution of electrical charge across their entire surface, so can permit local electrical charge to build up. This is static electricity, and leads to electrostatic discharge (ESD) damage to electronic devices.

Triboelectric generation results whenever sufficient energy has allowed the transfer of free electrons from one insulating material to another by means of contact or friction. Table 1 shows the triboelectric series, which is the electrostatic relationship between the items.

Materials on the top end of the chart have a greater tendency to lose electrons, so are considered "increasingly positive." Figure 1 shows what happens when wool is rubbed against hard rubber. Electrons are transferred from the wool to the rod. This occurs because the energy level of the valence electrons is raised to the point where they become free electrons, and can escape to the hard rubber rod.

Materials can be classified according to the surface resistance in ohms per square (ohms/sq). Table 2 shows the resistance of materials in ohms per square.

Metals and other conductors are not triboelectric generators because they can redistribute electrical charge received by rubbing over their entire surface, avoiding the local build-up of charge. Insulative materials can be charged by triboelectric generation.

The amount of moisture in the air is the humidity, and it can determine the amount of electrical charge that an object can hold. The air resistance can control this charge, and will "bleed off" electrostatic charge.

This explains why electrostatic discharge (ESD) will occur more often in the winter time when the humidity is low and air resistance is high.

The threshold of feeling for electrostatic discharge is around 4,000 volts. Any potential below 4,000 volts cannot be felt, but is still dangerous to electronic equipment. If the static electric spark is heard, then it is in the range of 5,000 to 50,000 volts. It is quite possible for the human body to have an electrostatic charge of 35,000 volts! Table 3 shows the charge that can be built up by various activities.

This is compared with various electronic devices' electrostatic voltage tolerance of 30 to 7,000 volts (Table 4).

laboratories are equipped with scanning electron microscopes needed to see the damage. Figure 2 shows two views of a MOSFET transistor with both non-damaged (Figure 2A) and damaged (Figure 2B) versions. Hard faults are immediate and catastrophic failures due to ESD, and are immediately apparent. The critical part of the MOSFET device is the thin dielectric insulator between the gate and the substrate/drain/source structure. If enough heat is generated by the static charge, then metallic ions will flow into the void created by the ESD, shorting the structure.

Far more devastating are the soft faults to electronic equipment. These faults do not appear immediately because the void (Figure 2B) is not filled with metal, but rather metal ions migrate into the space from the gate structure over time. Statistics indicate that 90 percent of all ESD may be this type. It is far harder to diagnose because it takes from 90 days to six months of operation to fill in the void, with nothing to show for it other than (possibly) reduced performance.

### Identification by Class

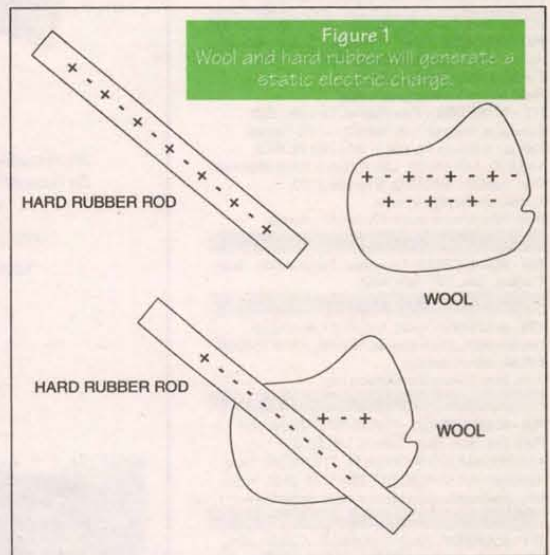
Electronic components can be

### ESD Effects

The effects of ESD damage can be devastating to electronic equipment, but it is often misdiagnosed. This is due to the following:

1. Failures are analyzed as being due to electrical transients other than electrostatics.
2. Categorized by random, unknown, "manufacturing defects," or other causes.

Very few failure modes and effects





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classified according to electrostatic discharge capability. Class-1 is the most sensitive, class-2 is less sensitive, and class-3 is the least sensitive. Obviously, class-1 includes MOSFETs and JFETs, or anything on the list that has susceptibility less than 1,000 volts. Class-2 devices have a sensitivity range of 1,000 to 4,000 volts, and class-3 devices have a sensitivity range of 4,000 to 15,000 volts.

## ESD Control Procedures

The key to a good program for controlling ESD is found in creating an environment that is protected against generating static electricity. The environment must consider things such as floors, workbenches, materials, equipment, and operating procedures. At the very least, one must equip the technicians and other workers with electrostatic wrist straps, a portable protective work mat, and protection for the parts being placed into the equipment. A manufacturing facility may include an elaborate grounded workbench made of ESD protective materials, humidity controls, conductive flooring, and air ionizers, in addition to the above.

An Electrostatic Location Meter will help you determine whether or not static has built up. You can sense voltages from 500 to 50,000 volts with these instruments, depending on the model.

In the discussion below, the terms "hard ground" and "soft ground" will be used. The term hard ground means that the item is connected to ground through copper or aluminum wiring, while the term soft ground means that it is through a resistance.

## Work Areas

The work area should be controlled access, which means that people should be kept out unless they are trained. At the least, protect an area approximately one meter surrounding the work area. The following should be avoided:

- No tapes (3M Magic, masking), except where installed and removed under controlled ionization.
- No vinyl-covered notebooks or instruction folders.
- No telephones, unless designed for the area.
- No plastic note holders, pen holders, calendar holders.
- No plastic cased vacuum cleaners or heat guns.
- No unapproved soldering irons.
- No unapproved solder suckers.

## Protective Flooring

Floors are very important in protecting against ESD damage. Only use conductive, static dissipative

floors, anti-static carpeting, conductive vinyl, or terrazzo floor tiles. When vinyl tiles are used, the adhesive should be conductive, also. Use conductive wax on floors, or leave them un-waxed. Static charge builds up on normal wax.

Painted or sealed concrete floors or finished wood floors should be covered with ESD floor mats.

Or treat them with a topical anti-static compound if no floor mats are available. In any event, the floor should be tested periodically to determine if it is still conductive.

Use of a grounded floor is not terribly useful if the individual worker is not soft grounded, also. Use conductive shoe covers, conductive shoes, heel grounders, or some similar devices to ground the body of the worker. Conductive work stools or chairs should also be used.

## Workbenches

Figure 3 shows a workbench set up for ESD protection. It is set on conductive flooring or a conductive mat, and is made of conductive materials.

There is a protective wrist strap on the bench that grounds the work-

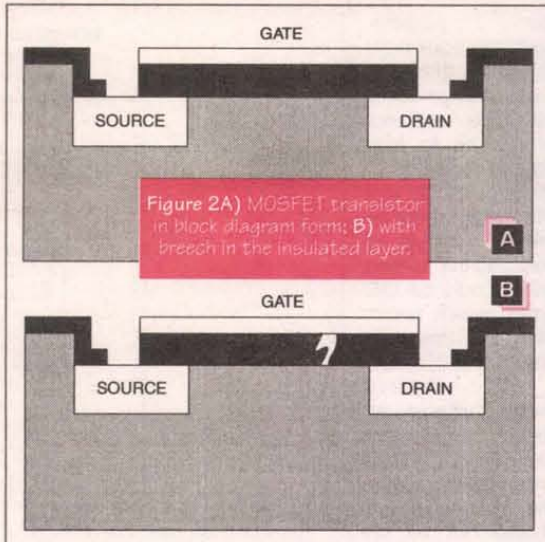


Figure 2A) MOSFET transistor in block diagram form; B) with breach in the insulated layer.

er. It should have a resistance that limits current flow to 5 mA — the threshold of perception — at the voltages that will be worked on the bench. For 240 volts, that means the resistance should be higher than  $240/0.005 = 48,000$  ohms.

Two types of ESD wrist straps are used: carbon impregnated plastic and insulated metal conductor. The carbon impregnated type distributes the resistance over its entire length, so it should be insulated to guard against touching hard grounds. The insulated metal conductor type contains a built-in resistor. The strap should include an alligator clip, or snap, or other form of quick disconnect to permit the user to disconnect in emergencies or when leaving the work area.

There is an ionizer and monitor on the bench in cases where manu-

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facturing or very sensitive work is taking place.

## Equipment

The equipment used on the ESD workbench should be designed for

## REMOTE CONTROL TV A/B SWITCH

## SHOWDOWN



VS.



- HAS SEPARATE REMOTE FOR A/B
- MUST PLUG INTO AN A.C. OUTLET
- HAS EASILY DAMAGED R.F. RELAY
- A TO B ISOLATION IS MARGINAL
- POOR R.F. SHIELDING, CAN CAUSE DIAGONAL LINES IN TV PICTURE

- CONTROLLED BY EXISTING TV REMOTES
- NO A.C., RUNS A FULL YEAR ON 2 "AA"s
- 100% SOLID STATE, NOTHING TO BREAK
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Nor-fax Doc. #5545

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Nor-fax Doc. #5759

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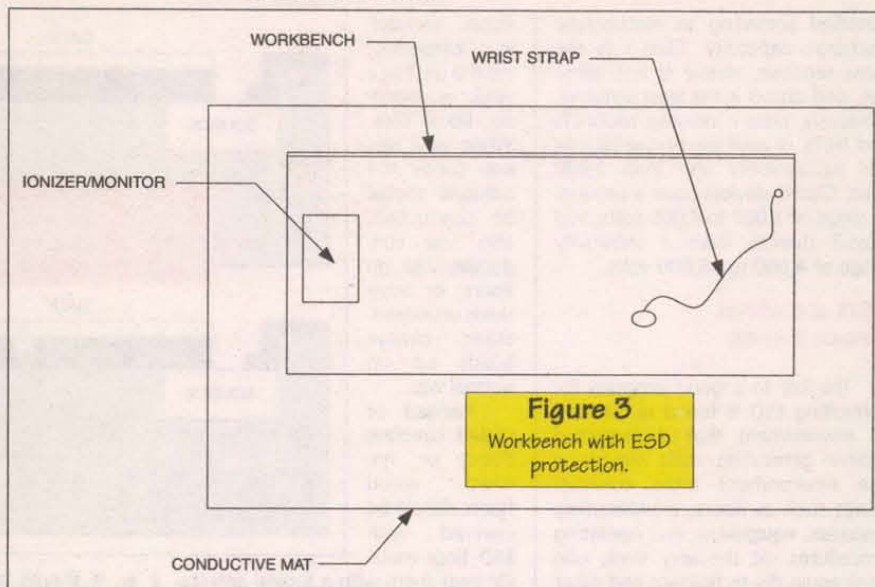
the purpose. Soldering equipment should be three-wire types with grounded tips. The resistance of the tip to hard ground should be 20 ohms or less so that the voltage build-up will be less than 15 volts. Solder suckers used should be ESD types, which means at least they will have conductive tips.

All exposed metal surfaces on test equipment should be hard grounded. However, the test equipment should not be set directly on the workbench's conductive surfaces for fear of rendering the surface — and the person using the equipment — at hard ground potential. Ground fault interrupters should be used on all outlets on the workbench.

### Clothing

People handling ESD sensitive electronic products should be properly attired to do so. They should wear long-sleeved ESD smocks or close fitting short sleeve shirts. The use of ESD protective aprons is encouraged. Never use smocks or

### Open Channel



gloves made of common, ordinary plastic as it is not ESD protective.

### ESD Protective Materials

Protective materials should be used to protect electronic products containing ESD sensitive components. Chips should be mounted on those foam carriers and not removed until they are ready for use. The finished, printed circuit cards should be stored in ESD bags, wrappings, or boxes.

### Conclusion

ESD protection is not a very difficult thing to do, and is so very important in electronics. It is a limited and low impact concept, so should be done whenever electronic gear is being serviced. **NV**

### Connections ...

I can be reached by snail  
mail at P.O. Box 1099, Falls  
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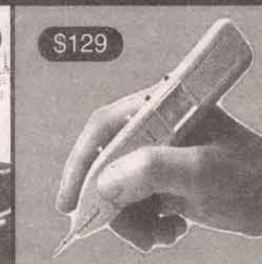
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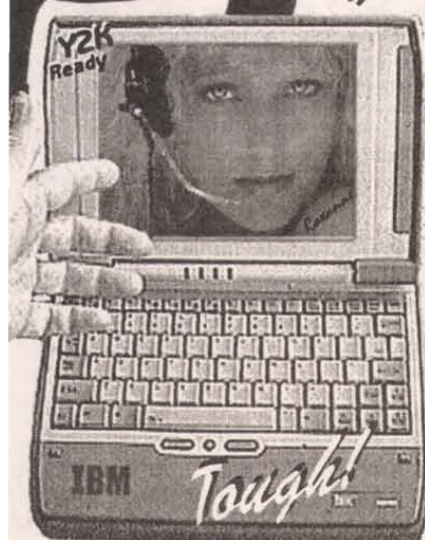
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# ELECTRONICS

# Q & A

With TJ Byers

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

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

You can reach me at:  
**TJBYERS@aol.com**  
**TJBYERS@juno.com**

or by snail mail at  
Nuts & Volts Magazine,  
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## What's Up:

Two Christmas wishes fulfilled and remote control/paging basics.

Another round of PC hardware pinouts and adapters. An excellent

look at AT keyboard codes, plus a couple of books for novice 68HC11 users.

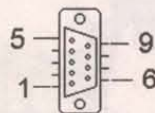
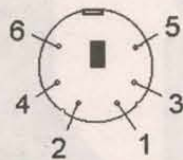
### PS/2 to Nine-Pin Adapter

**Q** I have several computers. Some have a PS/2 mini-DIN mouse port, while others have the standard nine-pin serial port, and I'd like to swap between one machine and another at will. For example, I have a Memorex Trackball with a nine-pin connector that I'd like to use on my PC with the PS/2 connector. Eventually I'd like to hook-up all my PCs with the various keyboard and mice combinations to one of those monitor/keyboard/mouse switchboxes. But, before I do, I need to resolve this first step of having multiple keyboards and mice. So, can you give me a schematic to convert back and forth between the two connector types? Also, is there any actual difference between a PS/2 and nine-pin serial port other than just a connector issue?

Gary DePietro  
Deltona, FL

**A** This is exactly why the USB (Universal Serial Bus) was concocted. Its intent is to resolve compatibility problems just like you're experiencing — well, when it's finally completed. Meanwhile, your only choice is finding a suitable adapter between the PS/2 and serial mouse. Here's the pinout of that adapter cable, which is available from several sources, including **Digi-Key** (800-344-4539; <http://www.digikey.com>), for about \$3.00.

	PS/2 Mouse Connector	9-pin Serial Mouse Connector
GND	3	5
RxD	2	2
TxD	6	3
+5V	4	7



As for swapping between the PS/2 mouse and PC serial port, there's no guarantee it's a two-way street. Without going into detail, the data exchange protocol of the PS/2 and serial port isn't exactly the same, and I doubt your Memorex serial Trackball will work with your PS/2 port — but try it, who knows?

### Remote Control Basics

**Q** My Chaparral CR10 satellite receiver has a UHF remote. By searching the FCC database, I've learned that it operates at 418 MHz. Is there a way I can determine the modulation method, and possibly the code set used to control the receiver?

Ray Dabkowski  
via Internet

**A** Like most remote controls, the Chaparral receiver uses pulse code modulation. In normal operation, pressing any key on the remote control gen-

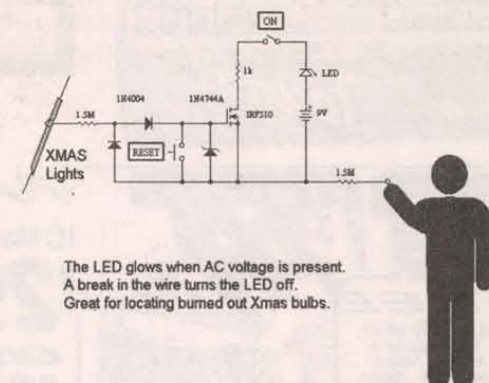
erates a 38 kHz pulse code signal which modulates the 418 MHz UHF signal. This is the same carrier frequency and modulation method used by most standard TV infrared remote controls — but instead of using infrared light to communicate with the receiver, a 418 MHz is used as the transmission medium. (BTW, your Chaparral remote has an IR remote built into it, too.) At the UHF antenna module, the UHF signal is converted to a 38 kHz pulse code data signal which is sent to the VHF jack on the back of the satellite receiver. As to the code pattern, it can be measured at the UHF antenna module using a computer or digital storage oscilloscope.

### Bad Bulb Detective

**Q** A friend of mine tried building the "Bad-Bulb Locator for the Holidays" in the Dec. '98 issue, but he seems to be having some problems with it. It appears that the circuit functions, but is grossly insensitive. If he puts an input signal into the wand, and bypasses the 1.5M resistor, it makes the needle deflect. However, he had to use the output from a squarewave generator with about 7 volts, peak to peak, to make it work. Will this circuit detect a break in a DC circuit, or does it work only with AC? I suppose if you had some kind of frequency generator you could use that to put some AC on a normally DC circuit, and then use the unit to locate the break. BTW, it would have been nice if you had labeled the transistor leads in the schematic.

Gene Zastera  
via Internet

**A** Yes, that circuit proved to be less sensitive than I anticipated. It works great with large outside bulbs, but lacks detail when trying to find a break in tiny "star-like" light strings. Now that I've had a year to work on the problem, here's an updated version of the Bad Bulb Locator.



This time, I've used a single enhanced FET (field-effect transistor) instead of two depletion FETs as before. This alone makes the circuit more sensitive. The meter has been replaced with an LED and I'm using the human body as a conductor. When the hook-tip wand, which can be anything from a piece of solid copy wire to a paper clip, is slipped over the insulated AC wire, the voltage is rectified by the two 1N4004 input diodes and placed on the gate of the FET. The 1N4744A clamps this input at 15 volts to prevent damage to the FET. The source lead of the FET is connected to the negative end of a 9-volt battery, and the drain to the positive end via the 1k resistor, ON/OFF switch, and LED. Your body provides the ground connection (don't worry, the current isn't enough to even give you a tingle).

To use the wand, hold it in your hand and slip the loop over the AC wire. If AC voltage is present, it will generate an electric field which causes the FET to conduct and turn on the LED. If there is no AC voltage in the wire, the LED won't light. Start at one end of the chain and go from bulb to bulb until the LED doesn't light. If the LED lights on one side of the bulb but not the other, it's burned out. Because of the high input resistance of the FET, a reset switch is needed to turn



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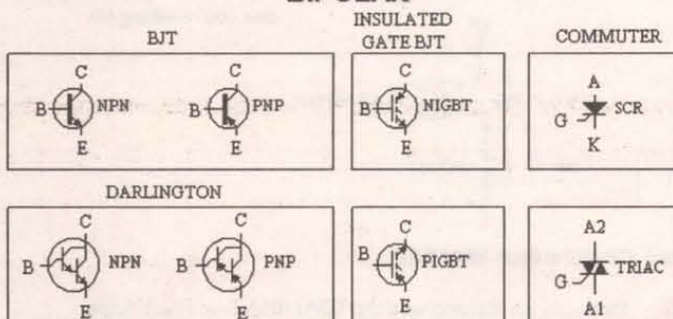
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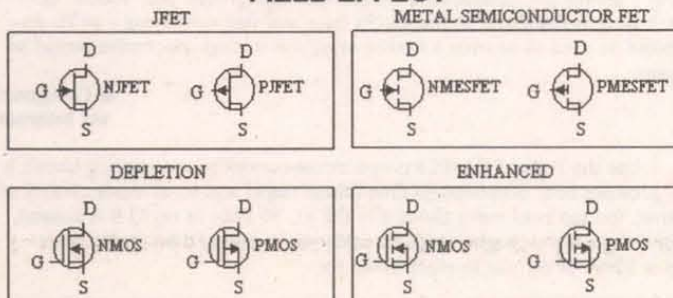
off the LED between bulbs.

BTW, adding identification labels to transistors clutter the drawing and they're hard to read, that's why I don't use them. Unlike ICs (which I always label), the transistor's symbol tells you all the pinout information you need. Here's a handy chart that you might want to copy and add to your electronics notebook or tape to your workshop wall for future projects. In fact, I receive enough requests like this that you can find this chart on our Web site (<http://www.nutsvolts.com>) under the name XISTOR.PCX, which you can download and then print out using Windows Paint.

## BIPOLAR



## FIELD EFFECT



### LEGEND

C = COLLECTOR      D = DRAIN      N = NEGATIVE  
B = BASE            G = GATE            P = POSITIVE  
E = EMITTER        S = SOURCE  
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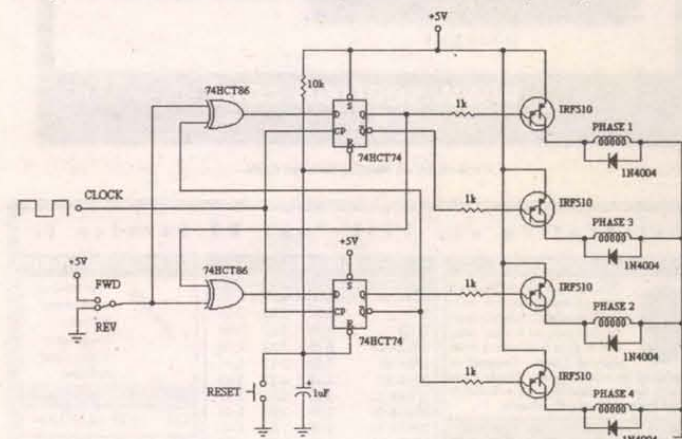
## Make It A Merry Christmas!

I work with a bunch of retirees who refurbish old computers that we then give to needy non-profit organizations. In the last five years, we have given away over 2,000 computers. My expertise is with printers, which are mainly of the dot-matrix variety. When a printer is beyond repair, I cannibalize them best I can — and as a result have acquired quite a collection of stepper motors. The problem is that the motors from Epson printers only have an "EM" designation on them. Do you possibly know where I could get the specs on these motors? Who knows, I might be able to come up with a unique toy for less fortunate kids. What I basically need is the voltage of the

motors and possibly a controller circuit that doesn't require a computer interface.

Ken Zeman  
Kpzeman@aol.com

The part number is EM210 ... and its kin. It's a 12-volt, six-wire unipolar stepper motor. Here's a simple driver circuit for this stepper motor that you can build for under \$10.00 (even at RadioShack prices!).



As you can see, this driver is for a five-wire unipolar stepper motor, which you can easily create. Two of your four stepper coils already have one leg in common. Using an ohmmeter, find the other two coils with a common and tie the two commons together to make one common. The resistance of each of the four coils is equal and measures between 35 and 75 ohms. And that's it. Finally, decipher the wire colors for phases 1 through 4. The table below kinda depicts the industry standard, but I've seen steppers with nothing but brown leads, so ...

Table: Typical Unipolar Stepper Motor Color Code

Coil	Color
Phase 1	Red
Phase 2	Green
Phase 3	Brown
Phase 4	White
Common	Black

I applaud the work you and your friends do, and I urge our readers who are going to toss out an old computer because Santa delivered a new one to consider tossing it in the direction of Ken and his group. Contact him at the e-mail address above. He and everybody involved will thank you for your generosity!

## Serial Port Voltages

I'm looking to send a signal from my PC's serial port that will close a set of contacts or impulse a relay. I have Visual Basic 4.0 and feel capable of writing the software needed. What I don't know is which pins are what and what the voltage level would be. I need this interface to activate a security-door strike that requires 12 volts DC at 51 mA. Could you show me a circuit that would do this? I'm considering an optoisolator or transistor interface.

Larry Fostano  
via Internet



## Serial in, graphics out. Almost too easy.

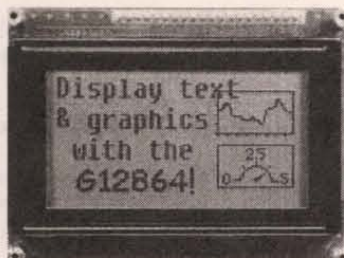
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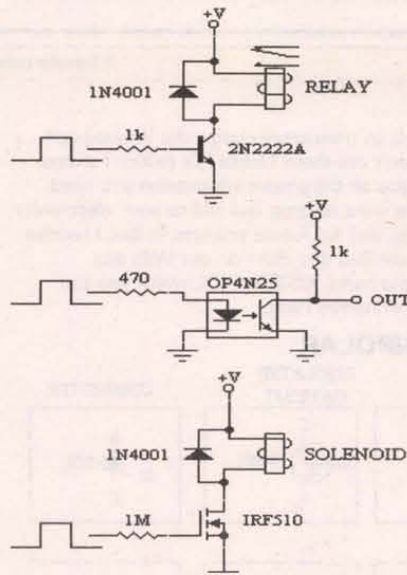
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## Electronics Q & A

**A** • Excellent choice on the opto or transistor interface. That'll certainly protect the PC from damage through the port. Now, about the port. Inside the PC, the part you don't see, is an IC driver chip that's controlled by the CPU. On the other side of this chip is the RS-232 port — better known as the serial port. This port comes in two versions, one with a 25-pin connector and the other with a nine-pin connector. Here are the pinouts for both.

Function	Mnemonic	Input/Output	DB-25 pin	DB-9 pin
Protective GND	—	—	1	—
Transmitted Data	TD	Input	2	3
Received Data	RD	Output	3	2
Request To Send	RTS	Input	4	7
Clear To Send	CTS	Output	5	8
Data Set Ready	DSR	Output	6	6
Signal GND	GND	—	7	5
Received Line Signal	CD	Output	8	1
Data Terminal Ready	DTR	Input	20	4
Ring Indicator	RI	Output	22	9



All RS-232 outputs are TTL compliant. That means they are capable of driving at least one LS/TTL logic gate (typically 10 gates) at a 5-volt logic level. This is more than enough power to trigger semiconductor devices like an optoisolator or 2N2222 transistor. All RS-232 inputs are TTL/CMOS compliant, which is typically less than one TTL load. Here's a medley of interface designs that work — plus the specific one you're asking for.

### Triac Controller Wanted

**Q** • Motorola has discontinued the TDA1185A Triac Phase Angle Controller. I would appreciate your help in locating a substitute, not necessarily a pin for pin replacement. On another topic, I read your article "EL Light: Playing In The Dark" in the Jul. '99 issue and was wondering if an EL driver could be used to provide a tickling sensation through electrodes placed on the skin.

**Al Colaguori**  
via Internet

**A** • Use the Philips TDA1023 proportional-control triac triggering circuit. It provides both proportional time (phase angle) and burst mode control of the triac. You can read more about it in the Jul. '99 issue in my Q & A column. As for using a high-voltage source to tickle your senses, I'd be careful. All it takes is 20mA of current to electrocute you.

### PC Won't Start

**Q** • My ATX computer doesn't turn on when I press the front power button. I believe the switch starts the motherboard components to trigger the power supply on. When I measured the voltage at one connector, I could only find a +4.98-volt source. I think there should be more voltages on this connector before the power supply can be started. Any information would be appreciated.

**Jim**  
via Internet

**A** • You're correct in reckoning that there is handshaking between the power supply and motherboard before the system will power up. However, it all starts with the power supply, which the front panel switch is wired to. When the power switch is closed, a high-frequency inverter inside the power supply generates four output voltages: +5V, -5V, +12V, and -12V. All four must be present for the system to work; when all four are available and stabilized, the motherboard returns a "Good Power" indicator and the system pow-



ers up. Any break in this loop will prevent the power-up sequence from happening and shuts the power supply down.

So where do you start? The fact that you have +5 volts leads me to believe that the power supply is working. To verify that all the voltages are correct, locate the P8 and P9 power connectors from the power supply that plug into the motherboard. The voltages should measure according to the table below. If these voltages aren't present, replace the power supply.

PS Plug	Pin	Name	Color	Description
P8	1	PG	Orange	Power Good; +5V when all voltages are ready
	2	+5V	Red	+5 volts (optional)
	3	+12V	Yellow	+12 volts
	4	-12V	Blue	-12 volts
	5	GND	Black	Ground
	6	GND	Black	Ground

PS Plug	Pin	Name	Color	Description
P9	1	GND	Black	Ground
	2	GND	Black	Ground
	3	-5V	White	-5 volts
	4	+5V	Red	+5 volts
	5	+5V	Red	+5 volts
	6	+5V	Red	+5 volts

If the power supply is okay, then you need to look at the system itself. Have you changed the system lately — like install new software or added/subtracted a piece of hardware? My first suspicion would be a software program that's preventing the system from booting. This could be anything from a software patch to "fix" a bug that's now even buggier to a new screen saver that doesn't agree with your system. My second choice would be a Plug-n-Play modem that ain't playing.

(Editor's note: Jim sent the follow-up message after reading my E-mail response. "Thank you for the information on the ATX power supply. It gave me the voltages I needed to determine that my power supply was indeed bad (the problem was intermittent and hard to locate). Thanks again for the help.")

## Remote Pager On The Cheap

**Q** . I need help! I'm a novice when it comes to electronics, but I love the hobby and I'm learning more every day. What I need is a circuit that, to the best of my knowledge, should be simple to find and build. Despite searches via the Internet, magazines, and books, I've had no luck. Everything I've seen is way more complicated than I need for my project. What I'm trying to do is have two transceivers with a range of approximately 150 feet that can trigger which can be heard by both transceivers with an audio tone when a switch is pressed. This tone will continue until the sending transceiver is reset. Is this as simple as it sounds, or as complicated as others make it seem?

**Kim Vertner**  
QA Engineer — ImageBuilder Software

**A** . It all depends on how you view the problem. First, you need to build a transceiver, which consists of a transmitter and receiver in one package — done twice. Next, you need an audio generator for the tone, another small but significant part of the project. So far, three modules plus a power source; things are adding up. Finally, a way to latch the signal until reset — another building block. When you look it in this prospective, it's a rather complex device. Know what I'd do? Go to Toys-R-Us or a department store and buy a pair of those cheap Morse code walkie-talkies. This is the kind that lets two kids send audio tones to each other using dots and dashes — it even has the code printed on the case. Many manufacturers make them, and they sell for less than \$20.00. Moreover, each handset has all the building blocks outlined above and just before Christmas is an excellent time to find what you're looking for. Next open the case and locate the Morse code key button. Then go to Radio Shack and buy a cheap toggle switch that will fit inside or outside the cabinet and wire it in parallel with the Morse code button. When the external switch is closed, the audio generator will yell its head off in both transceiver speakers until that switch is turned off. That's a whole lot simpler and cheaper than building a walkie-talkie from scratch.

## Op-Amp Substitute

**Q** . I'm repairing a Wavetek audio function generator and need two Motorola MC1712CP or Fairchild A702C op amps. I've tried the sources you list in your column, as well as a few that I've found on the Internet with no luck. The op amps run off a dual voltage of  $\pm 6$  volts. Could you suggest an alternate op amp?

**Cliff Mueller**  
via Internet

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Write in 56 on Reader Service Card.

**A** . If memory serves me correctly, the UA702C was the forerunner of Fairchild's (now a part of National Semiconductor) popular 709 and today's LM741 high-performance op amp. It was housed in an eight-pin TO-99 metal case. However, I can't remember (or find) the pinouts for this device, so I asked the Guru, Robert A. Pease. Bob works for National Semiconductor and has roots in engineering that go all the way back to the early '60s. I figured that if anybody could dredge up the pinout, he could. He did, and here it is.

Function	A702C	Pins LM741H/LM741CH
GROUND	1	—
Inverting input (- input)	2	2
Non-inverting input (+ input)	3	3
-6 volts	4	4
Lag	5	—
Lead	6	—
Vout	7	6
+6 volts	8	7

I suspect an LM741 would work in your Wavetek generator, but you'll need to make certain changes. For instance, make sure you get the LM741H or LM741CH version which uses the same TO-99 metal can. You can buy both from QuestLink (<http://www.questlink.com>) for about \$2.00 each. This amp will almost drop into your existing socket with just two exceptions. Leads 6 and 7 of the LM741 plug into holes 7 and 8 of the UA702 socket, and holes 5 and 6



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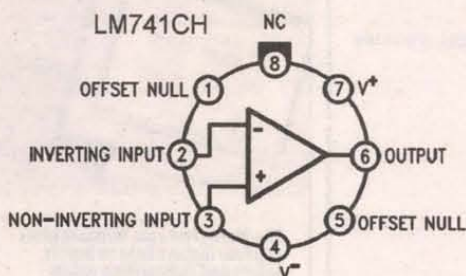
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of the UA702 socket are left open. That's because the LM741 is internally compensated, whereas the UA702 had external compensation between the Lag and Lead pins. You also don't need to plug anything into the number 1 pin hole because the LM741 case isn't grounded. Here's what the bottom of the LM741CH op amp looks like.



## Keyboard Codes

**Q** I've looked far and wide, yet I still can't find the codes used between the PC and keyboard to set-up and turn on the Caps Lock, Num Lock, and Scroll Lock LEDs. I need this information for a project I'm building.

Julian Restituyo  
via Internet

**A** Well look no further than <http://www.geocities.com/SiliconValley/Bay/8302/keybrd.htm>. Meanwhile, the following commands are sent by the PC to the keyboard to set/reset the status LEDs:

EDSet — This command alerts the keyboard that a command will be forthcoming to set/reset the status of the following LEDs:

- Num Lock
- Caps Lock
- Scroll Lock

After sending EDSet, the keyboard will reply with ACK (FA) and wait for the byte that will set the status of the keyboard LEDs:

- Bit 0 controls Scroll Lock
- Bit 1 controls Num Lock
- Bit 2 controls Caps Lock
- Bits 3 to 7 are ignored

FFReset — This command resets the keyboard.

## MC68HC11 Tutorial Material

**Q** About a year or so ago you mentioned a book that you wrote titled *Microprocessor Design Made Easy* published by AMS. I need a beginner's guide to the MC68HC11 series and would like to purchase this book, but the number you published doesn't work. Any suggestions?

Tom Miller  
via Internet

**A** Unfortunately, AMS is out of business and the book is no longer available. Fortunately, there are several 68HC11 tutorials available that should fill your needs. Here are two that I recommend.

**MC68HC11 an Introduction:  
Software and Hardware Interfacing**

Han-Way Huang, Ph.D. Iowa State University  
Paperback/Published 1998

Price: \$54.95

**Book Description:** This text has been designed to be a comprehensive first-semester book for an introductory course in microprocessors. The book is centered around the popular MC68HC11, with many examples, and is as close as I can find to my own.

**68HC11 Microcontroller**

Joseph D. Greenfield  
Hardcover/Published 1992

Price: \$87.50

**Book Description:** Teaches how to write programs for the microprocessor, particularly the powerful 68HC11, and has a reference section on the specifics of the MC68HC11. Intended as a text for a one-semester introductory microprocessor course.

Of course, you can download 68HC11 data sheets and application notes from **QuestLink** (<http://www.questlink.com>) at no charge, but it may take a while to digest the material in this very technical format.

*Seasons Greetings!*

TJ Byers Q & A Editor

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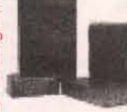
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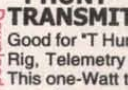
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### OSCILLOSCOPES

TEK 2445 150 MHz 4-channel Oscilloscope	\$1,400.00
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TEK 7844 400 MHz Dual Beam Oscilloscope with 7A24, 7A26, 7B80, 7B85	\$900.00
TEK 7904 500 MHz Oscilloscope, with 7A24, 7A26, 7B80, 7B85	\$900.00
TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series	\$375.00

### PROBES

HP 1122A Probe Power Supply	\$150.00
HP 54701A 2.5 GHz 10X FET Probe, for 54700 series oscilloscopes	\$1,000.00
TEK 1101 Accessory Power Supply, for FET probes	\$200.00
TEK A6901 Ground Isolation Monitor	\$200.00
TEK A6902B Voltage Isolator, DC-20 MHz, 20 mV-500 V/div	\$600.00
TEK P6046 100 MHz Differential Probe	\$500.00
TEK P6201 900 MHz 1X/10X/100X FET Probe	\$450.00
TEK P6202A 500 MHz 10X FET Probe	\$250.00
TEK P6204 1 GHz 10X FET Probe, for TDS series	\$450.00
TEK P6205 750 MHz 10X FET Probe, for TDS series	\$325.00
TEK P6701-opt.02 O/E Converter, 450-1050 mV/0-1 mV, DC-700 MHz, ST conn.	\$175.00

### CALIBRATION

TEK 067-0587-02 Signal Standardizer Calibration Fixture	\$750.00
TEK SG503 Level Generator, 250 kHz-250 MHz, TM500 series	\$600.00

## WAVEFORM GENERATORS

### FUNCTION

HP 3312A 13 MHz Function Generator	\$500.00
HP 3325A 21 MHz Synthesized Function Generator, HP1B	\$1,000.00
HP 3325A-002 21 MHz Synthesized Function Generator, HV output option	\$1,500.00
HP 8155A-002 Prog. Signal Source, 1 mHz-50 MHz, log sweep	\$1,250.00
HP 8904A-001, 002, 004 Multifunction Synthesizer, DC-600 kHz	\$2,500.00
TEK AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$900.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$1,250.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$275.00
TEK FG501 1 MHz Function Generator, TM500 series	\$225.00
TEK FG502 11 MHz Function Generator, TM500 series	\$300.00
TEK FG503 3 MHz Function Generator, TM500 series	\$250.00
TEK RG501 Ramp Generator, TM500 series	\$175.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB	\$750.00

### PULSE

BERKELEY NUCLEONICS 7085B Digital Delay Generator, 0-100 mS, 1 nS res., 5 Hz-5 MHz	\$750.00
HP 8007B 100 MHz Pulse Generator	\$600.00
HP 8012B 50 MHz Pulse Generator, variable transition time	\$600.00
HP 8080A/81A/83A/84A 300 MHz Word Generator	\$800.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
HP 1111A-001 20 MHz Pulse/Function Generator, counted burst option	\$1,250.00
HP 1122A 50 MHz Programmable Pulse Generator, HP1B	\$4,000.00
HP 1115A 50 MHz Dual Channel Pulse Generator, HP1B	\$2,750.00
HP 1116A 50 MHz Pulse / Function Generator, HP1B	\$3,500.00
HP 1116A-001 50 MHz Pulse / Function Generator, HP1B; burst option	\$3,900.00
TEK PG502 250 MHz Pulse Generator, Tr=1nS, TM500 series	\$600.00
TEK PG505 100 kHz Pulse Generator, 80 V peak, TM500 series	\$275.00
TEK PG508 50 MHz Pulse Generator, TM500 series	\$400.00
WAVETEK 802 50 MHz Pulse Generator	\$300.00

## VOLTAGE & CURRENT

### VOLTMETERS

FLUKE 845AR High Impedance Voltmeter / Null Detector	\$400.00
HP 3456A 6-1/2 Digit Voltmeter, HP1B	\$500.00
HP 3457A 7-1/2 digit Voltmeter, HP1B	\$1,200.00
HP 3478A 5-1/2 digit Multimeter, HP1B	\$600.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$900.00
SOLARTRON 7081 8-1/2 digit Voltmeter	\$3,250.00
TEK DM5010 4-1/2 digit Multimeter, TM500 series plug-in	\$300.00
TEK DM5011A 4-1/2 digit Multimeter, TM500 series plug-in	\$225.00

### CALIBRATION

FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA	\$450.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$900.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A	\$3,000.00
VALHALLA 2703 AC Volt Std., 0-120V/10 Hz-100 kHz; 120-1200V/10 Hz-1 kHz	\$1,500.00

### VOLTAGE SOURCES

HP 6114A Precision Dual Range Power Supply, 20 V 2 A/40 V 1 A	\$850.00
HP 6115A Precision Dual Range Power Supply, 50V 0.8A/100V 0.4A	\$850.00
KEITHLEY 228 Programmable Voltage/Current Source	\$1,900.00

## CURRENT METERS & SOURCES

HP 1410B Picoammeter / DC Voltage Source, without test fixture	\$2,000.00
HP 6177C DC Current Source, to 50 V, 500 mA	\$500.00
HP 6181C DC Current Source, to 100 V, 250 mA	\$500.00
HP 6186C DC Current Source, to 300 V, 100 mA	\$750.00
KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance	\$500.00
KEITHLEY 227 Current Source, 1 uA-1 A, 0-50 V compliance	\$800.00
TEK CT-5 High Current Transformer for P6021/A6302, to 1000A	\$375.00
TEK P6022 AC Current Probe w/termination, 935 Hz-120 MHz, 6 A pk	\$275.00

## IMPEDANCE & COMPONENTS

### L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
BOONTON 72BD 1 MHz Capacitance Meter, 3-1/2 digit display	\$650.00
HP 4262A-101 3-1/2 digit LCR Meter, 120 Hz/1 kHz/10 kHz test, HP1B	\$1,500.00

### STANDARDS

E.S.I. SR-1 Resistance Resistor, various values	\$125.00
E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step	\$550.00
E.S.I. SR1050-1M Resistance Transfer Standard, 1 Megohm/step	\$2,000.00
GR 1404-A 1000 pF Reference Standard Capacitor	\$700.00
GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc.	\$375.00
GR 1432-4-D-10 Ohm Resistor, 0-111.10 Ohms, 0.01 Ohm resolution	\$100.00
GR 1433-J 4-Decade Resistor, 0-11,110 Ohms, 1 Ohm resolution	\$150.00
GR 1433-K 4-Decade Resistor, 0-1,110 Ohms, 0.1 Ohm resolution	\$150.00
GR 1433-L 4-Decade Resistor, 0-111,100 Ohms, 10 Ohms resolution	\$150.00
GR 1433-N 5-Decade Resistor, 0-111,111 Ohms, 0.1 Ohm resolution	\$200.00
GR 1433-P 6-Decade Resistor, 0-111,111.0 Ohms, 0.1 Ohm res.	\$250.00

### HI & LO RESISTANCE

HP 4328A Milliohmeter	\$1,200.00
TEK 1503B-03.04 T.D.R., 0-50,000 ft., chart recorder & battery power	\$3,000.00
TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$1,400.00

## POWER SUPPLIES

### SINGLE OUTPUT

HP 6032A 0-60 V 0-50 A 1000 Watt max. Autorange Power Supply	\$2,000.00
HP 6200B Dual Range Supply, 0-20 V 0-1.5 A/0-40 V 0-750 mA CVCC	\$200.00
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply	\$250.00
HP 6265B 0-10 V 0-20 A CV/CC Power Supply	\$250.00
HP 6263B 0-20 V 0-10 A CV/CC Power Supply	\$400.00
HP 6266B 0-40 V 0-5 A CV/CC Power Supply	\$400.00
HP 6267B 0-40 V 0-10 A CV/CC Power Supply	\$550.00
HP 6274B 0-60 V 0-15 A CV/CC Power Supply	\$650.00
HP 6281A 0-7.5 V 0-5 A CV/CC Power Supply	\$150.00
HP 6282A 0-10 V 0-10 A CV/CC Power Supply	\$200.00
HP 6289A 0-20 V 0-1.5 A CV/CC Power Supply	\$200.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply	\$200.00
HP 6384A 0-40 V 0-5 A CV/CC Power Supply	\$125.00
HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply	\$450.00
HP 6574A 0-60 V 0-35 A CV/CC Power Supply	\$1,675.00
HP 6672A 0-20 V 0-100 A CV/CC Power Supply, HP1B, 191-250VAC line	\$2,750.00

KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply	\$900.00
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply	\$375.00
LAMBDA LK-352-FM 0-60 V 0-15 A CV/CC Power Supply	\$600.00
SORENSEN DCR 150-3B 0-150 V 0-3 A CV/CC Power Supply	\$550.00
SORENSEN DCR 600-75B 0-600 V 0-750 mA CV/CC Power Supply	\$650.00
SORENSEN DCS 40-25 0-40 V 0-25 A CV/CC Power Supply	\$400.00
SORENSEN SRL 20-12 0-20 V 0-12 A CV/CC Power Supply	\$400.00
SORENSEN SRL 60-8 0-60 V 0-8 A CV/CC Power Supply	\$600.00
TEK PS501-1 Power Supply, 0-20 V, 2 mV res., 400 mA, TM500 series	\$175.00

### MULTIPLE OUTPUT

HP 6205C Dual Power Supply, 0-40 V 300 mA & 0-20 V 600 mA, CV/CL	\$300.00
HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply	\$450.00
HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply	\$450.00
HP 6255A Dual 0-40 V 0-1.5 A CV/CC Power Supply	\$450.00
KEPCO MPS-620M Triple Output Supply, dual 0-20V 1A tracking & 0-8V 5A	\$250.00
LAMBDA LPD-422-FM Dual 0-40 V 0-1 A CV/CC Power Supply	\$300.00
LAMBDA LPT-7202-FM Triple Output Power Supply	\$450.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$650.00
TEK PS503A Dual Power Supply, TM500 series	\$200.00

## MISCELLANEOUS

ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max.	\$350.00
ELGAR 501C/400SD AC Power Source, 45 Hz-5 kHz, 500 VA, 0-135 VAC	\$1,150.00
HP 59501B HP1B Isolated DAC/Power Supply Programmer	\$175.00
KEPCO BOP 20-20M Bipolar Op Amp/Power Supply, to 20 V 20 A	\$675.00
KEPCO BOP 36-5M Bipolar Op Amp/Power Supply, to 36 V 5 A	\$400.00
KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, to 50 V 2 A	\$400.00
TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max.	\$200.00

## TIME & FREQUENCY

### UNIVERSAL COUNTERS

HP 5314A-001 100 MHz/100 nS Universal Counter, TCXO reference option	\$275.00
HP 5315A-001 100 MHz/100 nS Universal Counter, TCXO reference option	\$450.00
HP 5315A-002,003 100 MHz/100 nS Univ. Counter, batt. power & 1 GHz C-ch.	\$650.00
HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option	\$550.00
HP 5315B 100 MHz/100 nS Universal Counter	\$500.00
HP 5316A 100 MHz/100 nS Universal Counter, HP1B	\$600.00
HP 5316A-001,003 100 MHz/100 nS Univ. Counter, HP1B, TCXO, 1 GHz C-ch.	\$750.00
HP 5316B 100 MHz/100 nS Universal Counter, HP1B	\$750.00
HP 5370A 100 MHz/20 pS 11 digit Universal Time Interval Counter	\$750.00
HP 5370B 100 MHz/20 pS Universal Counter, 11 digits	\$1,200.00
PHILIPS PM6672/411 120 MHz/100 nS Universal Counter, C-channel 70-1000 MHz	\$450.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$250.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$400.00
TEK DC5010 350 MHz / 3.125 nS Universal Counter, TM5000 series	\$950.00
TEK DC503A 125 MHz/100 nS Universal Counter, TM500 series	\$275.00
TEK DC509 135 MHz/10 nS Universal Counter, TM500 series	\$275.00

### FREQUENCY COUNTERS

EIP 545A 18 GHz Frequency Counter	\$750.00
FLUKE 7220A-010, 131,351 1.3 GHz Counter, battery power, OCXO, and res. mult.	\$500.00
HP 5342A 18 GHz Frequency Counter	\$1,250.00
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference	\$3,000.00
HP 5343A-001,011 26.5 GHz \$3,500.00 Frequency Counter, OCXO reference, HP1B	\$3,500.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter	\$3,500.00
HP 5350B 20 GHz Frequency Counter, HP1B	\$2,900.00
HP 5351B-001 26.5 GHz Frequency Counter, HP1B, OCXO reference	\$4,250.00
HP 5364A Microwave Mixer / Detector, for modulation domain an.	\$3,000.00
HP 5385A-004 1 GHz Frequency Counter, HP1B; OCXO ref. osc. option	\$800.00
HP 105B Quartz Oscillator, 0.1/1.0/5.0 MHz, battery power	\$1,500.00
HP 5065A-003 Rubidium Freq. Standard; clock & battery power options	\$2,750.00
HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz	\$1,750.00

## AUDIO & BASEBAND

### SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,200.00
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### DISTORTION ANALYZERS

HP 8903A Audio Analyzer, 20 Hz-100 kHz	\$1,500.00
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### RMS VOLTMETERS

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

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

### MISCELLANEOUS

HP 3575A-002 Phase-Gain Meter, 1 Hz-13 MHz, dual display	\$850.00
HP 461A Amplifier, 20 dB or 40 dB gain, 1 kHz-150 MHz	\$125.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms	\$125.00
HP 467A Power Amplifier, X1/X2/X5/X10, DC-1 MHz, 10 W output	\$375.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave	\$350.00
KROHN-HITE 3200 High Pass / Low Pass Filter, 20 Hz-2 MHz, 24 dB/octave	\$275.00
KROHN-HITE 3302 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave	\$450.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$900.00
ROCKLAND 852 Dual Highpass / Lowpass Filter, 0.1 Hz-111 kHz	\$900.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$475.00
WAVETEK 716 Brickwall Filter	\$1,500.00





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## RF & MICROWAVE

### SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A	\$500.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz	\$1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz	\$1,400.00
HP 70620B Preamplifier, 1.0-26.5 GHz, for 70000 series	\$3,900.00
HP 8559A/853A-001 Spectrum An., 0.01-21 GHz, 1 kHz res., w/rackmount frame	\$3,750.00
HP 85640A Tracking Generator, 300 kHz-2.9 GHz, for HP 8560 series	\$5,000.00
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res.	\$8,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res.	\$7,500.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz	\$1,500.00

### NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7	\$600.00
HP 35676A Reflection/Transmission Test Kit, 5 Hz-200 MHz	\$1,000.00
HP 85502A Directional Bridge, 10-4300 MHz, N(f) test port	\$650.00
HP 85027C Directional Bridge, 0.01-18 GHz, N(f) test port	\$1,750.00
HP 85027E Directional Bridge, 0.01-26.5 GHz, APC3.5(f) test port	\$1,900.00
HP 85046A S-Parameter Test Set, 300 kHz-3 GHz	\$3,000.00
HP 85054A Type N Calibration Kit, for HP 8510 series	\$1,800.00
HP 8757C-001 Scalar Network Analyzer, fourth detector input option	\$5,500.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series	\$1,200.00
WILTRON 560-98KF50 SWR Autotester, 10 MHz-40 GHz, for Wiltron 560 series	\$1,800.00

### SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB	\$1,900.00
FLUKE 6060B/AK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res.	\$1,900.00
GIGATRONICS 1018 Synthesized Signal Gen., 50 MHz-18 GHz, 1 MHz res.	\$4,500.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 kHz res., GPIB	\$2,500.00
GIGATRONICS 840-18 Freq. Multiplier, 18-26 & 26-40 GHz outputs 0 dBm	\$2,750.00
GIGATRONICS 875/86 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$2,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$3,750.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res., GPIB	\$2,500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio	\$450.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$3,750.00
HP 8840B Signal Generator, 0.5-512 MHz, AM, FM, pulse modulation	\$950.00
HP 8857A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HP1B	\$3,250.00
HP 8860C/88602B-002 Synth. Sig. Gen., 1-1300 MHz, 10 Hz res., w/86635A	\$2,750.00
HP 8860C/88603A/88633B Synthesizer, 1-2600 MHz, 1 Hz res., AM / FM	\$3,250.00
HP 8872A Synthesized Signal Generator, 2-18 GHz, +3 dBm output	\$5,500.00
HP 8873E Synthesized Signal Generator, 2-18 GHz, +8 dBm output	\$9,500.00
HP 8873G-004, 008 Synth. CW Signal Generator, 2-26 GHz, +8 dBm output	\$12,500.00
HP 8884B Signal Generator, 5.4-12.5 GHz, AM/ WBFM Pulse	\$3,500.00

### SWEEP GENERATORS

HP 8341B-003 Synthesized Sweeper, 10 MHz-20 GHz, low harmonics opt.	\$16,000.00
HP 8341B-004 Synthesized Sweeper, 10 MHz-20 GHz, +10 dBm, rear output	\$14,500.00
HP 8350A/83540A-002, 004 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step attenuator	\$4,000.00
HP 8350A/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator	\$4,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$400.00
HP 8620C Sweep Oscillator Frame	\$550.00
HP 8622B-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten.	\$1,250.00
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 86245A-001 RF Plug-in, 5.9-12.4 GHz, +17 dBm levelled	\$600.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$500.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$500.00
HP 86290A-004 RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled, rear output	\$1,750.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld	\$1,250.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled	\$4,500.00

### POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm	\$2,500.00
BOONTON 42841-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$450.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz	\$900.00
HP 435B/8481B Power Meter, 0 to +43 dBm, 10 MHz-18 GHz	\$1,500.00

HP 435B/8482H Power Meter, -10 to +34 dBm, 100 kHz-4.2 GHz	\$900.00
HP 436A-022/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HP1B	\$1,400.00
HP 436A-022/8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HP1B	\$1,400.00
HP 8477A Power Meter Calibrator, for HP 432 series	\$500.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series	\$350.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8	\$1,500.00

### RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00
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### AMPLIFIERS, MISCELLANEOUS

ENI 1040L Amplifier, 55 dB gain, 10-500 kHz, 400 Watts	\$2,750.00
HP 415E SWR Meter	\$200.00
HP 8406A Comb Generator, 1/10/100 MHz increments, 100 kHz	\$500.00
HP 8447A Amplifier, 23 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output	\$375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output	\$750.00
HP 8447F-H54 Dual Amp., 25 dBG 0.1-1300 MHz & 28 dBG 9 kHz-50 MHz	\$900.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz	\$2,500.00
HP 8901B-1.2.3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO	\$3,000.00
HP 8970A Noise Figure Meter	\$4,000.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V	\$350.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz	\$5,000.00

## COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00
AVANTEK AMT-400X2 WR28 Active Doubler, 13-20 GHz +10 dBm in, +10 dBm out	\$450.00
BAYTRON 3-28-300/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$300.00
BIRD 8735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter	\$650.00
BIRD 8201 500 Watt Oil Cooled Load, DC-2.5 GHz, N(f)	\$350.00
BIRD 8251 1 kW Oil-Dielectric Load, DC-2.4 GHz, N(f)	\$500.00
CONTINENTAL MW RAE28-K-M WR28 x K(m) Endfire Adapter	\$225.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$125.00
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GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f)	\$300.00
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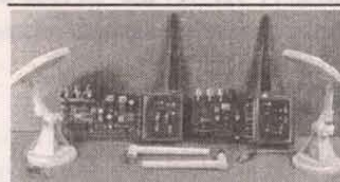
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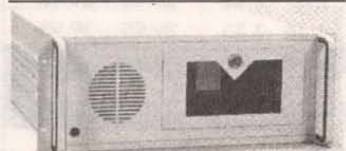
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**EQUIPMENT SALE:** Hewlett Packard 1024MHz signal generator 8640B opt 002, 003, \$1,050; HP 83592B, opt 002 .01-20GHz sweeper, \$6,250; 18GHz spectrum analyzer, 141T, 8552B IF, 8555A RF, \$825; Hewlett Packard 3336C synthesizer & level generator with options 004, 005, \$700, plain \$300; Wavetek 3001 signal generator, \$275; Hewlett Packard 8015A opt 03, \$250; 8015A, \$200; HP 3403C opt 03 TRMS voltmeter, \$200, 3403C, \$150; HP 3763A error detector, \$300. Offers accepted. Psitech Plus 707-745-4804, check our new www.psitech-plus.com

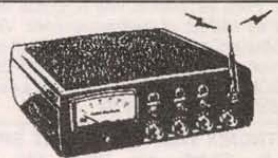
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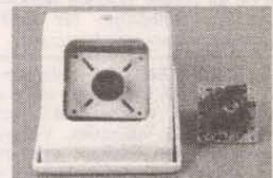
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## Controlling The World With Your PC...

Here's a useful book that tells you how to connect your personal computer to the real world and make it do useful

work like controlling stepping motors, monitoring fluid levels, or switching appliances on and off. No PC modification necessary for these projects either - every circuit in this book connects directly to the parallel printer port of your PC! Also included are a circuit diagram and listings for control software written in Pascal, C, and BASIC. AND (this is the good part) the accompanying disk contains full source code in all languages plus compiled (.EXE) files - (that means no typing... yeah!) Whether you want to generate audio tones and speech, drive high power loads and DC relays, or convert DTMF tones to binary values, this book is a great source for information, projects, and ideas. There are also 9 appendices (that's plural for appendix - that hunk of helpful info that didn't fit into any one chapter of the book!) They cover such topics as expanding the parallel port for 24 bit I/O, bidirectional printer port use, and using your PC's game port for input. Controlling The World with Your PC is \$35.00

## RF DETECTION DISK \$15.00

Are you being bugged? Curious about the RF near your radios? Ever wonder how much wave you get from your microwave? This little unit illuminates into blinking mode when near any RF. Cell phones, PCS phones, cordless phones, hand held transceivers - they all activate the detection disk. (Don't worry, your unit in standby mode won't activate the disk - transmissions and incoming calls cause it to blink!) Compact RF disk can be worn on a neck chain, attached to your key ring, hung from your rear view mirror, or shoved in your pocket until you want to use it! Detects RF 1 Mhz to 2.5 Ghz, and is only activated at close range. Uses a CR-2032 battery - yes, it is included! (Light may be hard to see in bright areas.)

## PHOTON II MICROLIGHT

The popular photon microlight has been improved. These super-bright (better than 8 candellas!) LED lights are visible over a mile away. The LED is secured in a tough ABS case and offers a squeeze button for quick use, and a constant on slide switch for prolonged lighting needs. The lithium batteries last a very long time (10 year shelf life!) and are included. The light won't burn out because it is an LED! Specify your choice of five incredible bright colors. Great for home or office use, popular with fire and rescue professionals, pyrotechnicians, stage performers, and dimly lit restaurant patrons. PHOTON II microlights include a keyring and come in ruby red (\$13.50), amber yellow (\$13.50) orange (\$13.50), sapphire blue (\$17.50), diamond white (\$17.50), turquoise (\$17.50), and emerald green (\$17.50). Includes two replaceable 2016 lithium batteries.

## TV TRANSMITTER KIT \$27.95

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 straining 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 channel 2-6, runs on 12 VDC, and accepts standard audio and video signals. Optional matching case set, \$14.95

## 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 GEOSOURCE KIT...\$ 9.95  
GEOSOURCE UNIT ONLY...\$7.95

## 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!

## 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, studyhall, and workouts. Battery and nugget style earphones included.

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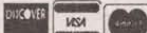
### Talking Motion Detector III \$27.50

"Stay out of that refrigerator!", "Watch your step!", "Do your homework", "Don't touch that remote!" ... The possibilities are mind-boggling with this talking motion detector. You speak into it to record your message (upto 12 seconds long), turn the unit on, and instantly your voice (or your mother-in-law) reminds anyone in the vicinity that you were expecting them. Message can be changed with the flip of a switch. Uses 4

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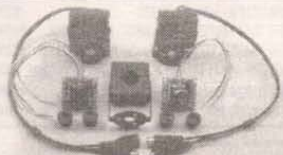


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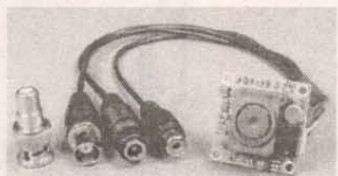




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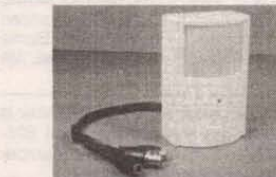
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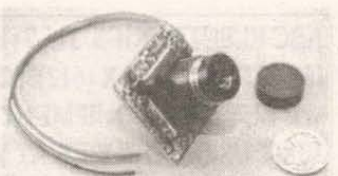
**B/W BOARD camera w/audio**, \$49 @ qty 10, 1.27" x 1.27". Enclosure available for \$10. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com



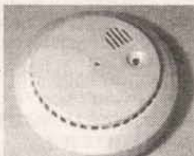
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Sumitomo Type 35SE, Fus. Spl.  
TEK 1780R WFM  
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Wavetek 1175 Benchmark  
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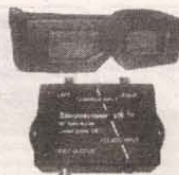
**SYNC-A-LINKS's 3-D Scopers™** digital color CCD cameras for stereoscopic imagery. At a reasonable cost. Phone 918-479-6451, E-Mail: rlc@sstelco.com or write to **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352.

**SONY PLAYSTATION MODCHIPS.** Allows playing of CDR backups & imports. \$10 + \$3 shipping. 619-590-9320.

**FREE LASER CATALOG.** Helium-Neon, Argon, ruby, visible laser diode modules, lightshows, holography, laser pointers. Lowest prices. Midwest Laser Products, PO Box 262, Frankfort, IL 60423. 815-464-0085 [www.midwest-laser.com](http://www.midwest-laser.com)

**VIDEO PROJECTORS:** GE Tularia up to 2,000 watt. Projects to 20' wide screen, will accept smaller lamps. With spare parts and lens, \$5,000 ea. or best, 3 available. 760-736-4411.

**SYNC-A-LINK UNIVERSAL video sync generators.** For more details phone 918-479-6451, E-Mail: rlc@sstelco.com or write to **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352.



**STEREOSCOPE VR** is a stereo multiplexer that creates 3D stereoscopic video from two genlock cameras. Stereoscope VR comes with LCS glasses and driver. 90 day warranty \$247 or write to **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352. Phone 918-479-6451, E-Mail: rlc@sstelco.com

## CABLE TV

**ATTN. DEALERS:** Are you a current dealer or just getting started? Buy factory direct & save. New 125 channel volume control converter, 800MHz tuner. Also available non-volume converters. Call for lot pricing. A & S Wholesale, 1-800-370-0801.

**GENUINE UNMODIFIED JERROLD DPBB 7312.** 410-485-7772. E-MAIL: [CLEWIS7298@AOL.COM](mailto:CLEWIS7298@AOL.COM)

Continued on page 55

# Electronics made easy **velleman** kits IT'S THE SEASON

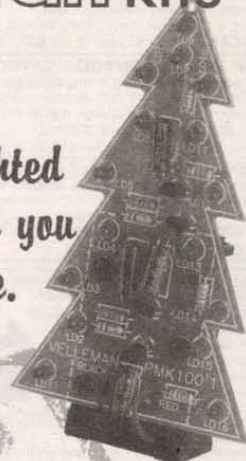
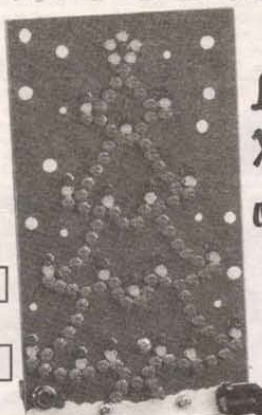
Let one of our lighted Xmas trees remind you of this special time.

**MK117**

**\$19,95**

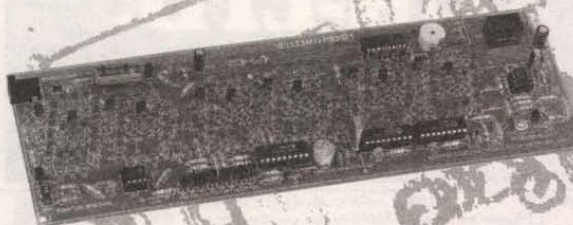
**MMK117**

**\$24,95**



**MK100 \$9,95**

**MMK100 \$12,95**



**K8009**

**\$89,95**

**Y2K ... Time is on your side !**  
**This clock does it all and much more ...**  
Time / date / temperature / chronometer / score / etc.  
and remote control. (optional housing : B8009)

Here comes SANTA ...  
Let him brighten your days !!!



**MK116 \$19,95**

**MMK116 \$24,95**



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4 Channels, 500ps per div. in normal room light.

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

New.....\$12K Now TEK2467.....\$3250.

**MAGNETIC STRIPE READER, with BAR CODE WAND.**

New, from United Barcode Industries, MAGSCAN model 1P0-155000-14-01 on-line magnetic stripe and BAR CODE reader designed for compactness and flexibility. The Magscan connects to the keyboard port via the standard mini-DIN connector. Perfect for use with a laptop. A good read is indicated by an audible beep and a visual signal from its LED. The unit reads track 1, track 2, or track 1 & 2. No software is required. Simply plug it in and start scanning/reading. Very compact. 5.7" x 2.7" x 1.5". No external power is required. 60 page manual included with complete user configuration info. (Done using the wand!) One manual per order. A super hacker device. SPECIAL.....\$49ea. or 2 for \$79

**MINIATURE AND, PRECISE, PORTECAP, SWISS, GERMOTOR.**

State of the art "ironless" type, mini motor type M11-230-54-0 with approx. 40:1 gearbox. Size: 16mm d. x 43mm L. Operating parameters: @6VDC input, 8mA, 141RPM No load, @ 12VDC input, 12mA 290RPM No load.

**PORTECAP, TYPE B: \$15ea. 2 for \$27, Special....10 for \$125**

**ULTRA MINI AND WEATHERPROOF, "LIPSTICK" CAM**

Sleek black anodized, alum. housing. O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. -counselor IR SENSITIVE. 23mmx45mm, 36" cable with BNC video & DC barrel jack.

**GM-200K, PINHOLE Model.** So tiny you can install it directly into a door. Only a 0.9" diameter hole! Specs as above. 90° FOV Pinhole lens. 1/2" once! Size only 23mm d. x 35mm long. Think of the places you could put this little jewel.

**GM-200K-STD.....\$99**  
**GM-200K-PH lens.....\$99**

**PORTABLE MINI PRINTER, 40 COLUMN, with INTERNAL NI-CAD POWER!**

The model SD222-1000 is a NEW and very cool, self contained, alphanumeric, impact type printer. It features a standard parallel port and an internal Ni-Cad power supply. Can also be powered via the 9VDC power adapter supplied. Uses standard 2" wide paper rolls available everywhere. Has self test function and diagnostic mode. Can emulate Epson and Citizen 560. It will print from the LPT port of your PC. Very rugged and well made. Perfect for any remote printing or data logging application. Size: 8" x 4.1" x 3.5".

**OUR PRICE.....\$49ea. or 2 for \$75**

**NEW, "STEALTH CAM", MICRO SIZE, with AUDIO!**

The sleek aluminum housing fits like a glove! Removable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., internal mic & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "STEALTH CAM" 1/3" CCD • 410 Lines • 0.3 Lux • AGC • Auto Shutter • Pwr. 12V @ 110mA • 250k pixels • Std. 4mm, 78° FOV lens • Pinhole, 90° FOV • Focus: 10mm to Inf. • NTSC video • -counselor IR SENSITIVE • Size Std: 30mm sq. x 29mm d. PH: 16mm d. Don't confuse with LOW RES. HIGH LUX C-MOS CAMERAS. **GM-2000S-STANDARD OR PINHOLE, w/aud., XMAS SPECIAL.....\$69**

**NOW YOU CAN SEE WHAT THE "FISHES ARE DOING" (down 60 ft., UNDERWATER B&W CAMERA with INTERNAL, INFRARED ILLUMINATOR)**

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustable mount incl. Specs: 1/3" CCD, 400 Lines, res., 0.05 Lux sensitivity, AGC, Auto Shutter. 12VDC @225mA, 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 inspection camera. Great for general outdoor use as well. **GM-300KIR.....\$179**

**NEW, GM960 TIME LAPSE VIDEO RECORDER**

Finally a brand new, 4 head, 7/8" recorder with all the features at a price you can afford. Features: • Up to 960 hours on a standard T-120 VHS tape • 12 different modes for record and playback • Audio recording in time 12H and 24H mode • 30Day memory backup • Easy mode setting • On-screen menus • Auto-repeat recording mode • Serial or One-shot recording • Time, Date, speed, and Alarm indicators on screen. These deluxe units are front loading and are 14"W x 3.5"H x 12.2"D, 110VAC powered. **SPECIAL.....\$699ea. or 2 for \$1349**

**FUTABA, 2X20 VACUUM FLUORESCENT DISPLAY MODULE**

New or like new, model M2025D series. Can directly replace LCD displays. The module includes the VFD, microcomputer and driver. Connects directly to the system bus. Display up to 40 dot matrix, 5 x 7 characters (222 characters and symbols), 5mm. H x 3.5mm W with cursor. Display color is green at 505nm. Brightness is 690 cd/m² with four level dimming function. Weight: 5 oz. Size: 6.7" x 2.6" x 1" thick. Power required is 5VDC @ 350mA. Serial or parallel interface selectable. Perfect for any high visibility display requirement. With data. **SPECIAL FUTABA.....\$15ea. 3 for \$39**

**DAYLIGHT/LOW LIGHT MINI CAM & A/I LENS.** For down hill 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. **SPECIAL, GM-510A/I.....\$189 or 2/\$349**

**NEW! 4 or 8 CHANNEL, SEQUENCER**

Model GM34 or GM38. Connect to any four standard video signals and they will be sequentially output to the dual rear panel BNC outputs. Front panel user adjustable, variable dwell 1 to 15 sec per channel. Auto or manual switching with channel bypass. Compact only 8.6" W x 3.7" D x 1.75" H, ac powered. Video loop through. **Special, GM-34.....\$69, GM-38.....\$89**

**WORLD'S SMALLEST \*\*\* 100mW \*\*\***

**VIDEO TRANSMITTER, ON SALE**

Incredibly only 0.9" x 0.8" x 0.37" Transmits crystal controlled hi-res. images with 100mW output! The transmitter you've been waiting for. Shown actual size. Much smaller than the 9V battery which powers it. Draws only 35mA! Factory tuned. Receive on cable channel 59. Will work with color or B&W cameras. Ultra low loss antenna with bakun and 3' F cable for TV included. Perfect with our GM1000A. **SPECIAL TVX-100.....\$159. TVX100 with GM1000A CAMERA.....\$209.**

**MOTORIZED LINEAR SLIDE, offers 0.001" per step travel.**

A THK, LWL-12 series re-circulating, ball bearing slide with a 4.7" long steel rail is mounted to a 0.2" thick, black anodized, aluminum plate. The slide has a right angle bracket attached to a spring loaded, anti backlash, drive nut. Riding on a 0.37" diam. 10TPI lead screw which is coupled to one end of a dual 1/4" shaft, stepper motor with specs: 1.8°/step, 5V @1Amp, 4 wire. One optical end of travel sensor is also in place. Ex. Cond. Ltd. Qty **LWL12-2.5 adapter.....\$59ea.**

**NEW! 0.008lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE. Our GMV-2K, DOES IT IN COLOR TOO!**

For covert, military & scientific applications that must be color, this is it. Performance is enhanced through low speed electronic shuttering and digital frame memory. With the optional, auto iris lens, 24 hour monitoring is possible. Auto sensitivity mode starts as it becomes dark. Eight Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64, X128. These provide frame rates of 60, 15, 8, 4, 3, 2, 1, and 0.5 per second. Auto/Man. white balance. Alum. housing, dual 1/4x20 mtg. Specs: 1/3" CCD, with 29K pixels, 320 Lines, 12VDC @200mA, Std. video out on BNC. Size: 54mmx50mmx94mm long. With pwr. adapter. All functions can be externally controlled via an 8 pin mini DIN. Use std. c-mount lens not incl. **GMV2K.....\$549ea. OPT. 4mm, f1.4 A/I lens w/cable \$119**

**CLOCK RADIO. COVERT CAMERA, New, Magnavox clock radio with covert low light video camera.**

Specifications per our GM1000A shown on page one. Connect the output to anything with a "video input" jack, via RCA style output. **SPECIAL, CRC-1-STD.....\$119. ea**

**CO2, 120Watt CW, SEALED GLASS LASER HEADS**  
Integral Hard Sealed Mirrors, NEW!

High quality water cooled heads. Were originally designed for medical application. All models are similar in construction. Size of the model 103: 60"L x 3.2" diam., Model 160: 44"L x 3.2" diam., Model 135: 35"L x 3.2" diam. Power requirement, model 103, 40KV trigger with 25KV @ 10 to 30ma operating current. Model 160 and 135, 30KV trigger with 15-20KV @ 7 to 20mA operating current. These are not toys. They must conform to Class IV CDRH regulations when assembled into a functioning system. Perfect for engraving, cutting and drilling most materials. Only three available. We don't expect any more.

**Limited Qty., 100+ Watts.....\$1475., 60Watts.....\$1095., 35Watts.....\$895.**

**SONY, ROBOTIC, COLOR CONFERENCE CAMERA, 450Line, 8X, NTSC & Y/C OUT, Serial Control of Pan, Tilt, Zoom, Auto Iris and Auto Focus too!**

Like having your own R2D2. Intended for use in fortune 500 board rooms. The video performance is stunning. Superior to almost anything we have seen. Camera and lens is an integral assembly. Excellent condition. Rugged black ABS enclosure. 8 pin mini-DIN & Std. 5VHS jack. Size: 8"D x 5.5"H. Data on using the serial port is provided. The units self test on power up and the video is active. Reg price over \$4K. **SPECIAL PRICE.....\$249ea.**

**NEW, 2.4GHz VIDEO + STEREO AUDIO TRANSMITTER with SONY, CCM-PCS COLOR CAMERA.**

Originally sold for \$500! Now available for a fraction of that price. Great looking styling. Camera has a very stable, adjustable tilting base, front panel LED pwr. indicator and sensitive built in electret mic, providing excellent audio and video performance from one compact package. Simply connect camera to the completely self contained 2.4GHz transmitter. All cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. Camera has adjustable focus 6mm lens. (I) to infinity, macro capable! Auto power off when the privacy shutter is closed. Power is 7-13VDC (all pwr. adapters and cables included) 1/3" CCD, 330lines res. 35% better than standard VHS! Can also be used to transmit VCR output to another TV for remote viewing. **SONY-ASTROVIEW COMBO.....\$189ea. or 2/\$339**  
**2.4GHz TRANSMITTER & RECEIVER.....\$129 pair.**  
**SONY COLOR CAMERA with AUDIO.....\$69ea.**

**HAPPY HOLIDAYS!**

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**NEWPORT TRANSLATION STAGES.**

MODEL:	DESCRIPTION:	EACH
605-4	With differential Mic.	\$849
605-4	With Screw Adjust	\$449
600A-3	W/Micrometer Adj.	\$159
270	LAB JACK	\$249
RSA-2T	360 deg. Rotary Stage	\$129
625A-4	Laser Holder	\$149
481A	Rotary Stage	\$189
M36	Translation Stage	\$249
460A-XY	X-Y Translation Stage	\$189
460A-XYZ	X-Y-Z Translation Stage	\$299
M37	3 Axis Trans. Stage	\$289
415	Vertical Trans. Stage	\$129
M360-90	Mtning. Plate 90deg.	\$29
M436	Translation Stage	\$199
M150	Magnetic Mtg. Base	\$129
420	Linear Trans. Stage	\$119
CYM-2	Square mnt. (screw)	\$99
13270	ORIEL Adj. IRIS	\$99

**10V @ 2.5 AH SEALED, LEAD ACID, PACK.** Each pack has 5. 2 Volt cells. D-size cells are arranged as 1X5 cells. Enclosed in an ABS outer shell. Removed for photo. Perfect for high drain applications. Make custom packs of any rating. Size: 7.5" L x 2.8" H x 1.5" D. **SALE! 6-five packs for \$20, 40 for \$99**

**SUPER, MINI C-MOUNT CAMERAS, Super sensitive, GM410 or the general purpose GM412.**

The GM-412 specs. B&W, size 1.5" sq. X 2.4", 250,000 Pixels, 380 Lines Resolution, Sensitivity 0.3 Lux, The GM410 specs: size only 1.5" sq. x 1.6", >270,000 Pixels, 400 Lines Res., Sens. 0.05 Lux. Both cameras are 1/3" CCD with AGC & Electronic shutter, 12V @100mA power NTSC out. IR SENSITIVE. BNC video out. Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform ANY camera in this magazine. Multi-lens options are available to exploit their superior performance. GM412 shown bottom. GM410 shown top. **GM412, less lens.....\$119, GM410, less lens.....\$169**

**low cost MICRO CAMERAS, w/audio 1/3" CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter.**

Pwr. from 9 to 12VDC @100mA, 250k PIXELS, Std. model, 4mm, 78° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2 ounce! SENSITIVE to IR. Size Std: 1.25" sq. x 1" d. PH is 0.6", 1.6M long wiring harness with connectors included. **WARNING: Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS.**

**GM-1000A-STD.....\$59 GM-1000A-STD/Aud.....\$64**  
**GM-1000A-PH.....\$59 GM-1000A-PH/Aud.....\$64**  
**GM-1000A-CMNT.....\$59 GM-1000A-CMNT/Aud.....\$64**

**Micro Lenses for GM1000 series**

2.5mm, 150°.....\$22	8.0mm, f2.0.....\$22
4.3mm, 78° f1.8.....\$22	12.0mm, f2.0.....\$22
6.0mm, f2.0.....\$22	5mm, 70°PH.....\$22

**C-MOUNT LENSES**

LOW LIGHT	STANDARD
16mm, f1.6, 15° FOV.....\$39	4mm, 80° FOV.....\$24
8mm, f1.3, 40° FOV.....\$49	8mm, 40° FOV.....\$24
4mm, f1.4, 78° FOV.....\$49	12mm, 28° FOV.....\$24

Please fax us your list of unique surplus material.

**MOTORIZED ZOOM LENS SPECIAL**

**6X magnification, 12X on a 1/3" camera! Auto iris too!**

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from \$600 to \$1500. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. Auto iris has a built in amp which works with any camera video output for control.

**Type B-6, 12.5 to 75mm, 6X, f1.2.....\$179 or 2 for \$349**  
**ZOOM LENS CONTROLLER, NEW.....\$169**

**END FIELD OF VIEW GUESSWORK! 3.5 to 8mm VARI-FOCAL LENS**

Brand New, super f1.8 lens allows you to smoothly adjust from a 97° FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris.

**SPECIAL.....\$89ea. or 2 for \$169**

**NEW, TRIPLE OUTPUT, 60W, POWER SUPPLY**

Astec model: SA40-1313, outputs of +12VDC @ 3Amps, +5V @ 5Amps and -12V @ 350mA. 110VAC input. Very compact size: 3"W x 5"L x 1.3"H. Perfect for many hobby applications as well as an external clock drive power supply.

**SPECIAL.....\$5ea. or 5 for \$20**

**DEL TRON LINEAR SLIDE with CLEVER LEVER**

An interesting assembly, consisting of a Del Tron mini linear, ball bearing slide (2.5" x 1" W x 0.56" H) with 2" travel. Slide is placed next to a 2" diam. stepper mounted wheel. A 1.5" sq. Four wire stepper, rated at 4V, 0.95A, 1.8°/step. The bottom side of the wheel acts as a cam with roller and moves a spring loaded arm (3.4" L x 1" W) up and down 1/2". All components, including an optical end of travel detector are mounted on precision machined, 0.2" thick, black anodized aluminum. Overall size: 8.5" L x 3" D x 2.5" H. Ex. Cond. Ltd. Qty. **DelTron-W.....\$39ea.**

**COMPACT, THK, LINEAR SLIDE WITH STEPPER DRIVE,**

A really slick, super precision, THK LWL-12 series, recirculating ball slide with a 3.6" long toothed rack (14TPI) mounted next to the rail. The rack mates with a 0.6" diam. nylon drive gear mounted to a compact, (1.5" sq.), four wire stepper, rated at 4V, 0.95A, 1.8°/step. One full step moves the slide approx. 0.050". All components, including an optical end of travel detector are mounted on precision machined, 0.2" thick, black anodized aluminum. Overall size: 5.5" W x 3.3" D x 3.4" H. The system provides 3.1" of extremely rigid travel. Ex. cond. Ltd. Qty. **L5-LWL-12.....\$49ea.**



# ORBITAL E-MAIL — AN AFFORDABLE SOLUTION

by Gordon West

The little handheld data communicator from **Magellan Corporation** has become a real favorite among hikers, RVers, boaters, and backpackers. Short E-Mail messages are composed on the little keyboard, sent to an orbiting Orbcomm satellite, and received back down on earth to the directed party within minutes. And the same thing happens in reverse — anyone may E-Mail you on your little Magellan GSC-100 handheld; and if you regularly check in with the satellite, you could get your message within minutes on the little tiny LCD screen.

Best of all, this service is not outrageously expensive — from \$30.00 to \$50.00 per month depending on the volume of incoming and outgoing E-Mails, or as little as \$39.95 a month if you keep your E-Mails to less than 10 messages per month, up to 500 characters per message, and \$99.00 equipment-cost from one supplier.

## THE SPACE COMPONENTS

The 28 low-earth-orbit satellites are a partnership owned by Orbital Sciences Corporation, Dulles, VA, and Teleglobe, Inc., of Canada. This Orbcomm partnership provides two-way monitoring, tracking, and messaging services through these 28 low-earth-orbit satellites. Some of the applications include monitoring of electric utility meters, oil and gas storage tanks, wells, environmental projects, tractor/trailer vehicles, rail cars, heavy equipment, fishing vessels and, for us, data messaging for the recreational land and sea explorers.

The satellites are launched into their low earth orbits by the Delta and Taurus rockets, and not by the space shuttle. There have also been successful launches of these satellites from rockets carried by high altitude aircraft.

The Orbcomm system has absolutely *nothing* to do with the Motorola Iridium system — the Motorola Iridium system was intended for digital voice messaging, and the Orbcomm system is designed specifically for low-cost data messaging. While there has been much attention on the Motorola Iridium system (some good, some not so good), the Magellan Orbcomm system has quietly become the number one choice for low-cost handheld messaging.

The Orbcomm satellites are in five low-earth-orbit planes:

- A-plane: 45 degrees (eight satellites)
- B-plane: 45 degrees (eight satellites)
- C-plane: 45 degrees (eight satellites)
- F-plane: 70 degrees (two satellites)
- G-plane: 108 degrees (two satellites)

There has almost *always* been a satellite in view during the last full year of testing I have done at sea and on land with my Orbcomm Magellan GSC-100 data communicator. One time I think I had to wait for about 15 minutes for a favorable pass down low in Bryce Canyon.

A "straight shot" to the satellites is necessary because they require a modest signal at 148 MHz-150.05 MHz to receive the 2400 bps data-stream. The orbiting satellites transmit back to the handheld communicator at 137 MHz-138 MHz, 4800 bps.

"Our satellites are controlled via our network control center in Dulles, VA,"

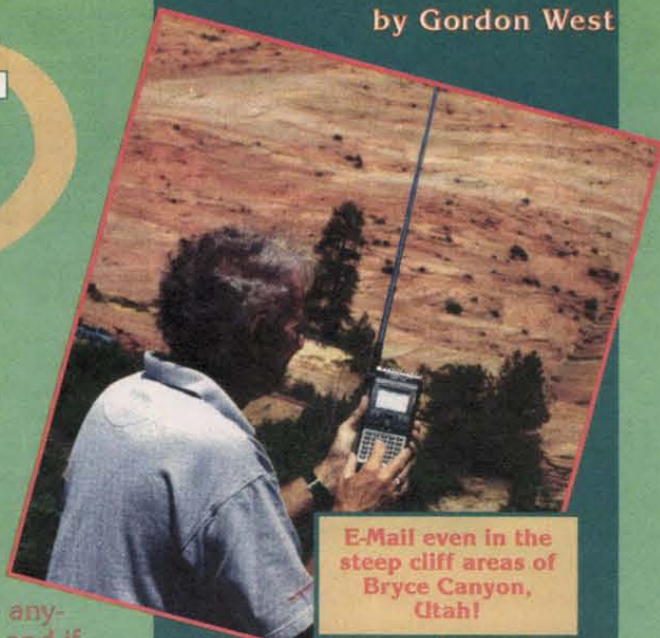
**Check out Magellan's  
website at  
[www.magellangps.com](http://www.magellangps.com)  
or call them at  
1-800-669-4477**

comments Wende Cover, Director of Marketing Communications at Orbcomm.

"Our satellites will transmit to four Gateway earth stations — one here in Washington, D.C., or one in New York, or one in Georgia, or for the West Coast, one in Arizona," adds Ms. Cover.

Since the 28 satellites — many of them launched by an L1011 aircraft on a Pegasus rocket — cover all of the world with E-Mail capabilities, my next question was where in the world can you use the equipment? Last year, I had tried unsuccessfully to E-Mail from England, and while my equipment could see the Orbcomm satellites, I couldn't get through.

The answer to where in the world



E-Mail even in the steep cliff areas of Bryce Canyon, Utah!



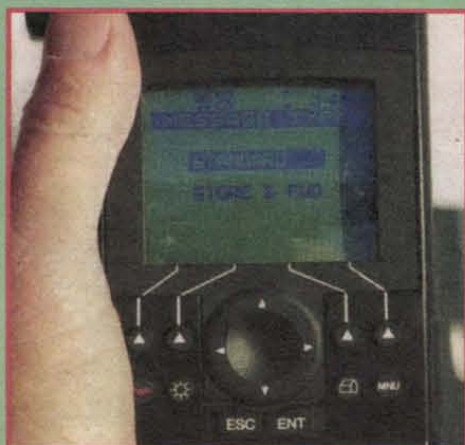
E-Mail from the pastures of Colorado.



Working the GSC-100 on the test bench before the RV or boat trip.



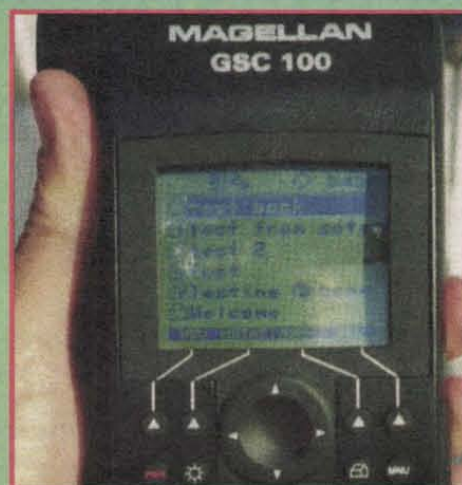
# ORBITAL E-MAIL — AN AFFORDABLE SOLUTION



In the USA, Canada, and Mexico, we would signal in the "standard" mode (store and forward not needed).



Checking the Orbcomm satellite pass.



Reviewing incoming E-Mail headers.

you can use the system depends on what piece of uplink equipment you are operating, and what agreements they have with each country. Since my equipment was from Magellan Corporation, I found out quickly that they have recently acquired rights in most of the European countries for unlimited use of their equipment abroad.

For sailors out on the high seas, they will always be able to see the low-earth-orbit satellites, but the satellites might not be able to see a Gateway earth station. When this occurs, the satellites will go into a "store and forward" mode

where your message is held in space until the satellite passes over a ground receiving station. This is no big deal — it might take an extra 30 minutes to finally get your message across the seas.

"Check us out on the web at [www.orbcomm.com/globalgram](http://www.orbcomm.com/globalgram)," adds Ms. Cover. It's a great web site.

## HANDHELD COMPONENT

Chances are you have heard the name

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# ORBITAL E-MAIL — AN AFFORDABLE SOLUTION

Orbcomm system is a 30-ounce handheld two-way radio communicator, Model GSC-100. It transmits 2400 bps up, and receives 4800 bps back from the satellites on the 138 MHz and 148 MHz VHF band. The Magellan GSC-100 also contains a Magellan GPS receiver, so what you carry is both a two-way data communicator to the Orbcomm satellites, as well as a built-in GPS receiver capable of finding your position down to the radius of a 100-meter circle.

The Magellan GSC-100 operates for about six continuous hours on a 9.6 volt, DC, rechargeable, nickel cadmium battery pack. The pack fits into the rear of the units, and spare packs are available for a plug-in quick swap-out. The portable system is also shipped with an AC adaptor cable, and may also be ordered with a 10-30 volt DC external power cable. The external cables plug into the side of the unit with a screw-lock sleeve. The eight-pin proprietary plug receiver also carries pins for NMEA and RS232 transmit and receive data. Magellan offers a complement of accessory cables that could give you the option of running several things in parallel from this single port.

There is also an additional output jack for an external GPS antenna, as well as an external VHF Orbcomm antenna for data transfer. But you don't need external antennas to operate this equipment in the totally portable mode — there is a yard-long telescopic whip that may be extended for data transmission and reception, as well as a patch antenna built in for simultaneous GPS positioning.

To get started operating the equipment, you must first be registered for Orbcomm service. This is done at the time of equipment purchase for a one-time registration fee of \$49.95. The selling dealer will assist you with registration and the entering of your unique E-Mail number in the equipment. This E-Mail number will be the same number that your friends or the office will send E-Mail to when you are out in the yonder using this equipment far from conventional telephone lines.

The equipment may be purchased or leased through authorized selling dealers. Right now the equipment sells for \$999.00, but I understand a prominent marine electronics chain is now offering a package plan where you might be able to score a brand new receiver for under \$99.00 if you'll commit to three years of service at \$39.95 a month. This is identical to cell phone marketing — just about give away the handset, and offer a three-year service commitment (West Marine 1-800-262-8464).

And I don't suggest you sign up early — I'm not aware of a plan that would allow you to deactivate

your monthly service for a few months when you are stuck at the office and won't be able to take some vacation time. Once you sign up, use it or not, your minimum is \$39.95 a month. But hey — for what the GSC-100 can do, it's nice to know you can grab your equipment and go at a moment's notice and be able to send E-Mail almost anywhere in the world.

Once your equipment is registered and you are all set to do your first E-Mail wireless test,

turn on the GSC-100, and let the GPS initialize and come up with your position. This automatically transfers over to the built-in satellite almanac, and you will constantly receive on-screen messages that will tell you exactly where the E-Mail satellites are, how long the pass may last, or when the next satellite is expected to come up over the horizon. As I mentioned before, the longest you may need to wait is only five or 10 minutes for the next passing low-earth-

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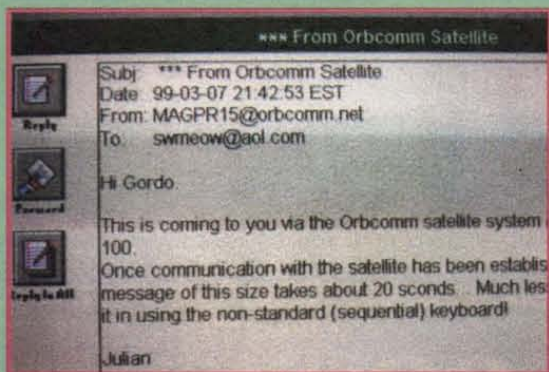
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# ORBITAL E-MAIL — AN AFFORDABLE SOLUTION



Outgoing message sent to the Magellan data communicator.

orbit Orbcomm satellite.

To compose and send an E-Mail, you simply press the MSGS soft key from the main menu, click on a standard "GlobalGram," enter the



The data communicator is also a GPS receiver, too!

recipient's E-Mail address, choose CC or not, key enter the subject, and then up comes the 2000 character text screen for sending a standard GlobalGram message. If you're way out on the other side of the world, far away from any earth station, you must go into the store and forward mode where your message is limited to a short 229 character text.

It's a little tedious punching out your message on the A to Z built-in keyboard, but you are not charged for keyboard entry time, so take your time and do as many abbreviations as you can. Remember, if you exceed 10 GlobalGram messages per month, up to 500 characters per message, you pay an additional one cent per character.

Your character message count also applies to incoming messages. Be sure and let everyone know ahead of time that your system is designed for telegram-type messages, not regular E-Mail messages that could easily eat up your monthly free message units. I tell everyone no more than two or three lines of computer text, using as many abbreviations as possible.

This will probably be the toughest part of running this equipment — keeping incoming messages short and concise. Since your friends and workers out there in E-Mail land are using a computer, it's easy for them to compose and send an extra long message without realizing you are only looking for two or three lines of text.

To send your text that you just composed on the screen, pull up the telescopic whip, stand in an area that shows you an on-screen strong satellite signal, hit the send soft key, and that's it. If your screen says you've got five more minutes until another satellite comes up, hit the send soft key anyway, and walk away from the equipment. It will automatically catch the next satellite, upload the message, and give you a confirmation that it was properly entered into the E-Mail



The port seen here takes the power plug for external AC or DC operation. The lower jack is for the antenna.

system.

Your equipment will also download any E-Mail messages holding. The screen will tell you how many E-Mails you have waiting, presently stored in your equipment's memory. You read them "off line" at anytime. This means you don't need to stand there with the antenna pointing in the air to look at the incoming messages.

And, if you want to reply to the incoming message, it's just a few keystrokes to transfer the message address into the send address, and away you go with your text. You also have mailboxes where you can store E-Mail addresses.

## NO E-MAIL — NO PROBLEM

You are out in the boondocks, and your sister sends you an E-Mail that mom finally got over her pneumonia and is out of the hospital and back home again. You want to send mom a welcome home message, but she doesn't have a computer. No problem!

Type up a short message for mom, and address it through the Orbcomm operator in Dulles, VA. For only \$3.00, the message from your handheld communicator will be spoken over the telephone by a friendly Orbcomm operator, just for mom! And certainly mom will want to say a few words back to you, so a few minutes later one more buck buys you a screen message that says, "... How sweet of you to think of me out in the boondocks ...," or something like that.

In fact, I use this "Orb2y" service a lot for my computer eloquent friends when I tell them the only way they can reach me on my data communicator is to say their short message to an operator that will then transcribe it and deliver it to me. I also leave a message with the Orbcomm service that tells any incoming callers to say their piece in less than 20 words. This prevents someone from filling up my account with costly diatribe that I really don't want to read or pay for.

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# ORBITAL E-MAIL — AN AFFORDABLE SOLUTION

Orbcomm is also offering additional services, and this includes weather and may soon include selected news or stock reports.

The recreational user of the GSC-100 is just a micron of the total Orbcomm service. This means calling up Orbcomm or Magellan and trying to get user information about their equipment or service is downright frustrating. I asked the simple question on whether or not my equipment would work in England. Orbcomm says the satellites work anywhere in the world, but tells me to call Magellan to see if we have an agreement with the host country. You call Magellan, and they tell you to call Orbcomm to see whether or not they have an agreement.

I ultimately get the answer that it will work throughout most of Europe and most definitely will work from Alaska to South America, but both companies continue to pass the question back and forth hoping someone will take responsibility for the answer.

**And now for things they won't tell you about in the book or at the companies ...**

Yes, the equipment will upload and download messages quite nicely with the antenna horizontal to the ground up inside a fiberglass roofed motorhome or boat cabin. Yes, the equipment is sensitive to external ignition noise, so don't try and download any messages with the antenna near the engine compartment.

No, the equipment and service has absolutely nothing to do with the Motorola Iridium system. This is actually competition. And it appears Orbcomm/Magellan is winning, hands down.

Yes, long-winded data senders can push your monthly bill up to around \$80.00. But if you selectively only give out your GSC-100 E-Mail address to those who know the GlobalGram system, your monthly bill will probably be much like mine — under \$45.00 a month for a good amount of uploading and downloading SHORT E-Mail communications.

Yes, the equipment worked satisfactorily in the heavy forest. At times, we were unable to get GPS satellite reception, but we could still see the incoming signal strength of the E-Mail satellites.

No, it won't do voice. Yes, there is error correction so the Orbcomm service knows that you have successfully downloaded E-Mail traffic.

And, yes, this device can be a lifesaving tool in case of an emergency and you have no other way to signal for help. Most recently, some boaters started to sink hundreds of miles offshore, and their emergency Mayday message on their GSC-100 with the embedded latitude and longitude was able to get help from a nearby marine rescue agency. Had it not been for

their GSC-100, they would have surely gone down with the ship. You could get the same kind of emergency help if you were stranded in the desert, marooned on a mountain peak, or simply snowed in out in the forest. A simple solar charger could easily supplement the internal nickel cadmium batteries for extended periods of use away from home.

So, if you can't leave without E-Mail, the Orbcomm system is now in its third year of success, and "specials" on equipment acquisition may soon become available if you start shopping for the GSC-100 down at the local marine stores.

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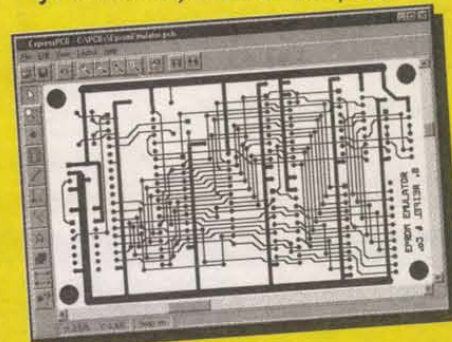
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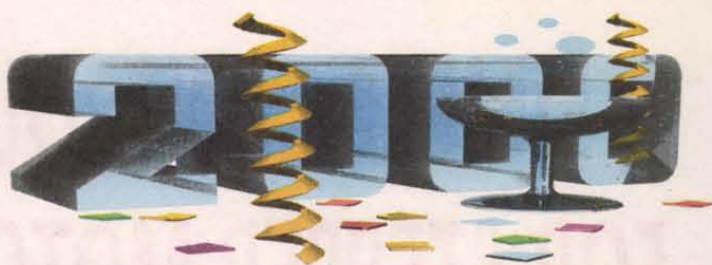
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# A SIMPLE CONTROLLER FOR STEPPER MOTORS

## to use with Microprocessors



by  
James Lyman

I have some surplus five-volt unipolar stepper motors which I've been wanting to use in robot experiments, but didn't have an easy way to drive them. Then I found just what I've been looking for in my Mar. '98 issue of *Nuts & Volts* magazine.

In the Electronics Q & A was the "Space-age Stepper Motor Controller Update" with a simple schematic which was just what the doctor ordered — except it was for bipolar motors and I had unipolar motors — but after playing with the circuit on Electronics Workbench, I converted the circuit to a unipolar design.

**T**his controller is based on a design from the Jet Propulsion Laboratory and is ideal for use with microprocessors. It has just two control lines: one to control the stepping of the motor and the other to control the direction of the motor's rotation.

Having two common TTL chips (Figure 1), this controller greatly reduces software requirements to drive a stepper motor, as well as reducing the number of port bits by half. With this simple circuit, the microprocessor has only to set an output pin high or low to select the motor's direction of rotation and pulse the other to step the motor. The programmer doesn't need to write code to generate four phase outputs complicated by having to reverse those phases to reverse motor rotation.

Since the rising edge of the motor drive pulse steps the motor, there are no restrictions of duty cycle, so the microprocessor's program only needs to time the overall period, then output a short pulse. This is ideal for using a microprocessor's internal timer to accurately control the motor's rotation speed in background. Changing the

direction of motor rotation is done by setting a static output level high or low, so there is no need to synchronize it with the motor drive pulse. The microprocessor's program controls the motor in the foreground while the background program (timer interrupt) actually initiates the change when it outputs the next stepping pulse. The only consideration for changing direction is the motor's inertia during rotation.

Like most engineers, I naturally look for ways to improve things and this circuit was no exception. I wanted to use this controller with different motor drive voltages and so designed three different ways to provide the +5 volts for the controller's logic circuit.

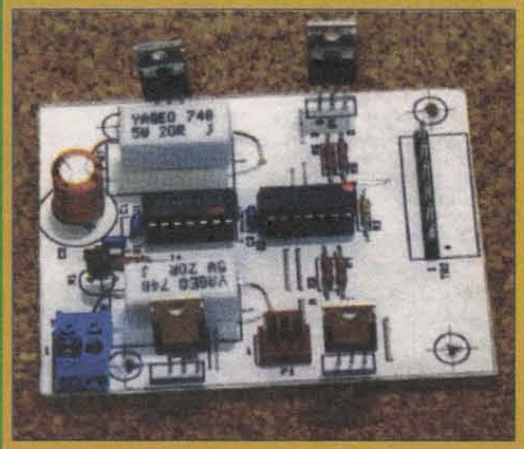
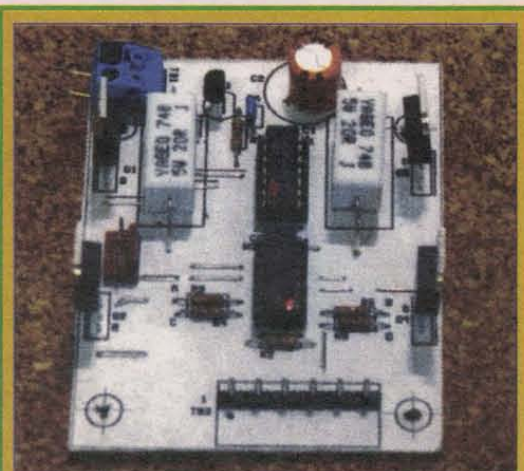
For motor drive voltages greater than 7.5 volts, the voltage regulator A1 — which regulates the motor drive voltage down to five volts for the logic — is installed along with capacitors C2 and C4. When using a five-volt motor, a jumper wire is installed in place of the voltage regulator as indicated by the line on the board's silkscreen (Figure 2) between A1's outer leads. Both C2 and C4 should still be installed to protect against any voltage transients from the motor's stepping.

If neither A1 or the jumper wire is installed, then the logic voltage is provided directly via the connecting plug P1-2 in which P1 also has the ground and motor control lines. This allows the controller's logic to be connected directly to the power supply of the microprocessor's board.

When this external power option is used, capacitors C2 and C4 are not required and can be omitted. When C2 is installed, its voltage rating should be at least 20% greater than the voltage of the motor's power supply with 50% being preferable. To accommodate a wide range of capacitor voltage ratings for electrolytic capacitor C2, the circuit board has two sets of mounting pads to allow installation of either 5 or 7.5 millimeter lead spacing.

Power for the motor is provided to the controller board via TB1 — a pluggable ter-

минаl block where connecting wires are installed in screw terminals, but the terminal block plugs into pins on the circuit board. This allows the circuit board to be quickly removed and installed without disconnecting the wires. This same type of connector is also used to connect the motor to the controller board via terminal block TB2. There is no need to label the motor's six wires each





**MotorControl:**  
 IF Counter = 0 THEN OutPulse  
 DEC Counter  
 RETURN  
**OutPulse:**  
 SETBIT OutPort,DriveBit  
 CLRBIT OutPort,DriveBit  
 Counter = StartValue  
 RETURN

' interrupt service routine  
 ' test if end of time interval  
 ' decrement loop counter  
 ' return from interrupt  
 ' bring motor drive pulse high  
 ' bring output low to complete pulse  
 ' reinitialize counter value  
 ' return from interrupt

**TABLE 1**

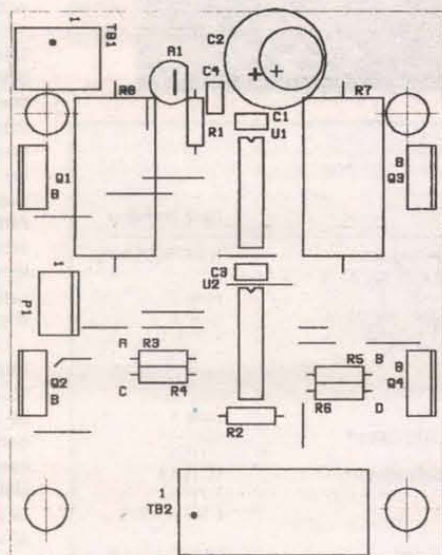
time you remove the motor from the controller board — something that happens frequently when experimenting with a new design.

The circuit board is a simple single-sided design which allows easy prototyping using the toner transfer system. To facilitate using this method, the board uses oversize circuit lands which are widely spaced to reduce the chance of shorted lands from toner bleed-over. The wide lands also reduce toner lift-up so common when narrow lands are used.

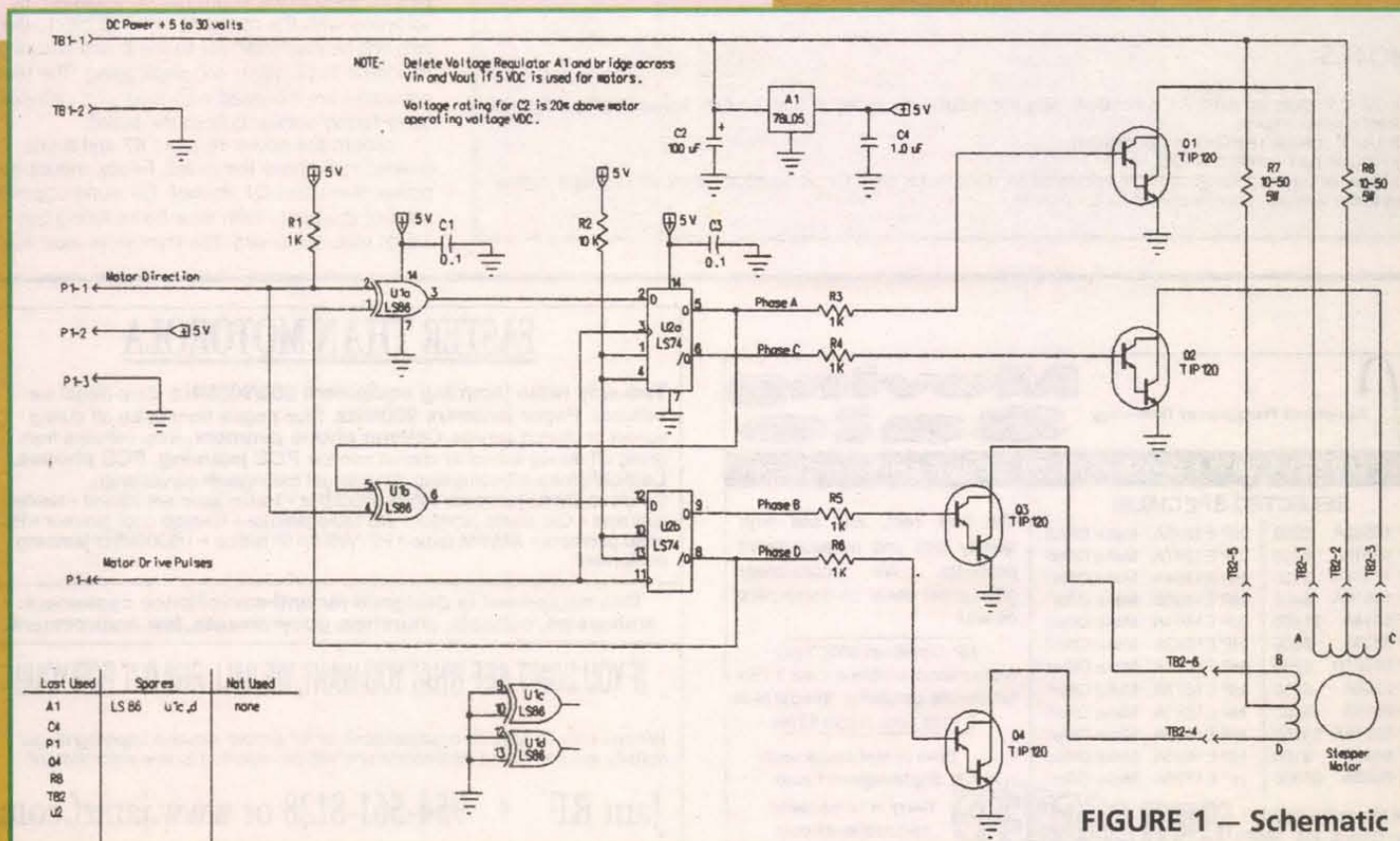
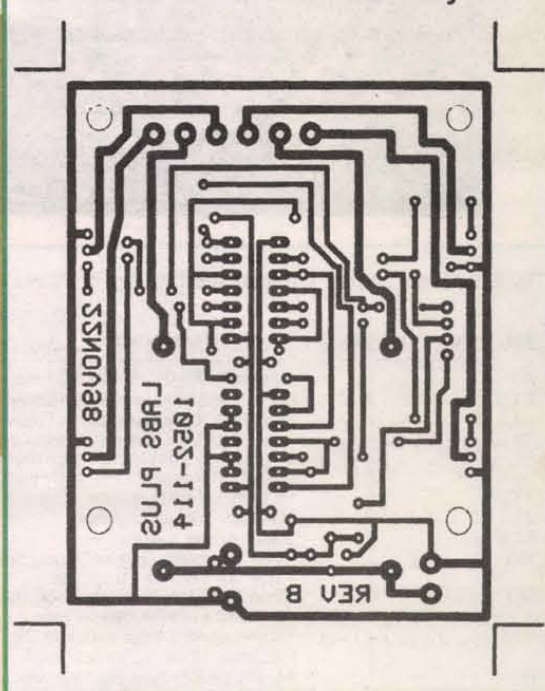
The circuit board layout in Figure 3 can be copied directly to the toner transfer paper. To further increase the toner's adhesion to the blank circuit board, wet sand the copper surface with 400 grit sand paper to give it a uniform buffed appearance, then wash the board first with a soap impregnated steel wool pad and finally with rubbing alcohol to remove any traces of oil. As soon as the board is completely dry, iron on the toner copy of the circuit board, then etch it before the copper can oxidize or be contaminated by finger print oil, either of which will make etching more difficult.

An easy way to "silkscreen" your board is to make a full size copy of the silkscreen artwork and glue it to the top of the circuit board prior to drilling the holes.

**FIGURE 2 — Silkscreen for Board**

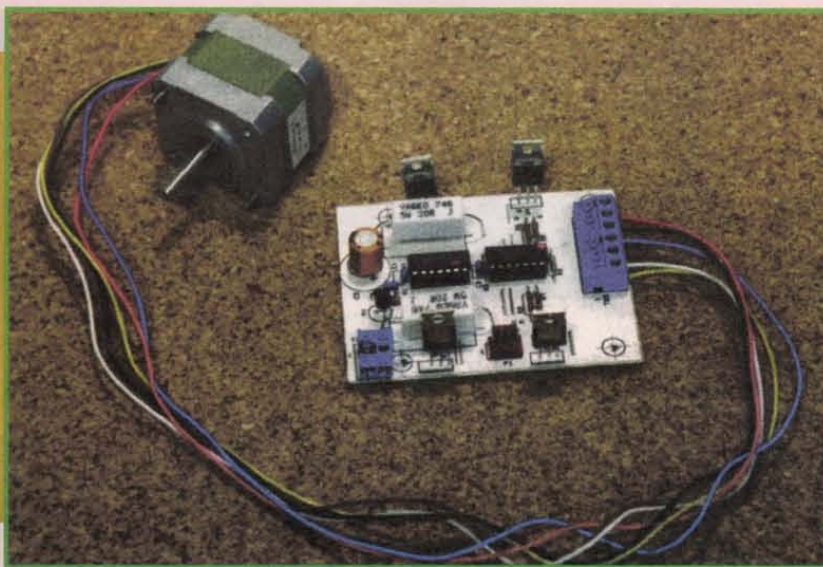


**FIGURE 3 — Circuit Board Layout**



**FIGURE 1 — Schematic**





Use a brushable contact or rubber cement such as DAP Weldwood contact cement which can be found in most office supplies and hardware stores. Place the etched circuit board on a light table with its top side up. Now apply a liberal amount of contact cement to the board's top surface, then carefully lower the silkscreen down onto the board's surface. Using a light table or a glass with a light shining up from below allows you to see the circuit board's shadow through the silkscreen and to exactly position it on the board. Remember, for a rectangular circuit board, there are two ways for the silkscreen to fit so be sure you have it oriented correctly before starting because once it contacts the glue, you can't peel it up to start over. Now, carefully press the paper of the silkscreen to smooth it out on the board. A small printer's roller works good for this, but you can do it with your fingers if you're careful and work quickly.

After the silkscreen has dried for 15 minutes, take a razor blade and trim the paper flush with the edge of the circuit board. Now turn the board over to drill the pads from the bottom side. To avoid scuffing the silkscreen — particularly if you're using a drill press — place the circuit board on a folded paper towel, which allows you to slide the board around to position under the drill. Although the paper of the silkscreen will "ball up" around the hole, this seldom presents any problem when mounting components. A razor knife can be used to quickly trim any paper that gets in the way.

Since the circuit board is single-sided, it requires 15 jumper wires. These jumpers are well spaced from components so bare buss wire may be used without fear of shorting to other components. The jumper wires are installed first, followed by 1/4-watt resistors, then the capacitors. Unless you are using the five volts for the motor to power the logic, don't install the jumper wire at voltage regulator A1; IC's U1 and U2 can be mounted either directly or in IC sockets.

Insert terminal blocks TB1 and TB2 with their pins installed in the board before soldering. By soldering with the complete terminal block, the pins will be perpendicular to the board ensuring their ease in plugging and unplugging. The terminal blocks are mounted with their wire clamping holes facing outwards from the board.

Mount the power resistors R7 and 8 one quarter inch above the board. Finally, mount the power transistors Q1 through Q4 along opposite sides of the board with their backs facing outwards from the board. The transistors must have

Unless noted, all part numbers are Digi-Key numbers

## PARTS LIST

Ref. Desg.	Qty.	Nomenclature	Part Number
A1	1	(optional) 78L05 +5 volt, 100 ma, voltage regulator	NJM78L05A
C1,3	2	0.1 uF Capacitor, Monolithic Ceramic, 0.2 inch sp, 25 V	
C2	1	(optional) 100 uF Electrolytic Capacitor	note 1
C4	1	(optional) 1.0 Capacitor, Mono Cer., 0.2 inch sp, 25 V	note 2
P1	1	4 contact straight friction lock header, 0.1 inch sp	WM4202
Q1-4	4	TIP-120 NPN Power Darlington transistor, TO-220	note 3
R1,3-6	5	1K ohm 1/4 watt resistor	
R2	1	10K ohm 1/4 watt resistor	
R7,8	2	5 watt power resistors	note 4
TB1	1	2 Pos. Pluggable Terminal Block, 5m sp., side mount	ED1613
	1	2 pins cut from Pin Header Strip	ED1682
TB2	2	3 Pos. Pluggable Terminal Block, 5m sp., side mount	ED1614
	1	6 pins cut from Pin Header Strip	ED1682
U1	1	74LS86 Quad 2-input Exclusive OR Gate	DM74LS86N
	1	(optional) 14 pin IC Socket, solder tail	
U2	1	74LS74 Dual D Type Flip Flop with Set & Reset	DM74LS74AN
	1	(optional) 14 pin IC Socket, solder tail	
8in		AWG # 24 Solid Bare Buss Wire	

### NOTES:

- 1) Use if voltage regulator A1 is installed. May use radial lead spacing of 5 or 7.5 mm. Voltage rating is 50% of motor's rated voltage.
- 2) Use if voltage regulator A1 is installed.
- 3) Jameco part number 32993.
- 4) Value of power resistors must be calculated for each motor type. Circuit board accommodates 5 watt outline, but lower wattage may be used if motor permits.



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insulators when using a common metal heatsink or when individual heatsinks are grounded.

Prior to applying power, use an ohmmeter to test for shorts between power input and ground. Place one probe on terminal block TB1-1, the other on TB1-2, and check if shorted. Now test the five-volt logic supply by placing one probe on pin 14 of either U1 or U2 and the other on pin 7. Do not apply power if you read near zero ohms for either of these tests until the short has been found and removed.

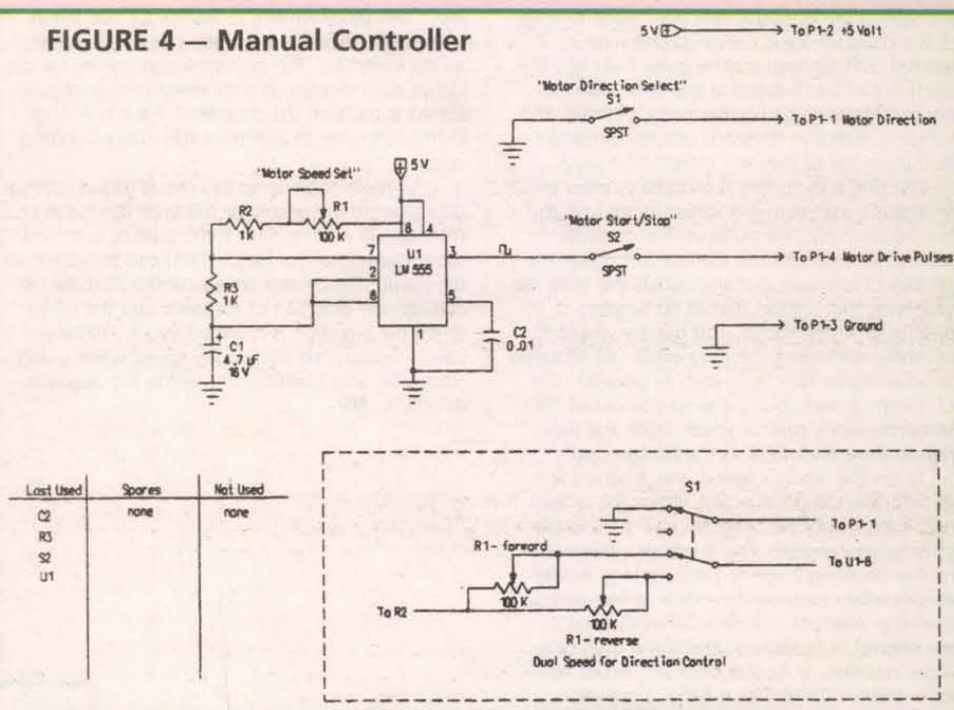
The controller board is connected to a microprocessor's board using a four conductor cable connected to plug P1. Motor drive pulses are applied to P1-4 while the direction control is through P1-1. Ground connection is through P1-3 and, if the logic power is provided by the microprocessor's board, the +5 volts connects to P1-2. Wire size is not critical but, since pulses are present, the cable length should be kept to a minimum. Power for the motor is provided by terminal block TB1 with TB1-1 for the positive voltage input and TB1-2 the negative or ground. Each of the six motor wires connect to terminal block TB2 per the table below.

#### Coil Phase Terminal of TB2

A	1
A-C common	2
C	3
D	4
B-D common	5
B	6

Interfacing this controller with a microprocessor is simple from both the hardware and software standpoint. Only two bits of an output port are required to fully control the motor's speed and direction; the only restriction is that both are

**FIGURE 4 — Manual Controller**



TTL signals. The Motor Drive signal (P1-4) is a positive pulse which "steps" the stepper motor on each positive transition. The microprocessor's motor control program drives the motor by outputting pulses whose spacing is controlled by timing loops or its internal timer. The resulting frequency of this pulse train controls the motor's rotational speed. Changing motor speed is done by simply changing the period of the pulse train.

Since a microprocessor can accurately time intervals, and duty cycle is not critical, the motor's speed can be accurately maintained. Even when running the motor at very low speeds, its accuracy is easily maintained.

Selecting direction of motor rotation is done using the Motor Direction (P1-1) input signal with a constant high or low level. A logic high level selects one direction of rotation, while a logic low

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level selects the opposite direction. Since this signal is a constant level, no synchronization is required with the motor drive pulse train and the direction can be changed at any time with the only consideration being the motor's inertia. The change in direction does not actually occur until the rising edge of the next motor drive pulse.

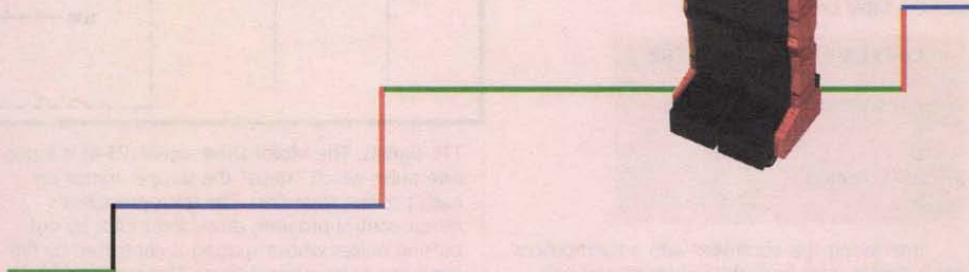
The simplicity of this circuit places most of the motor's control in the software, and yet the port requirements are minimal. The controller's circuitry not only reduces the number of output port bits to just two, but also avoids the need for generating four signals spaced 90 degrees in phase to drive the motor. This greatly simplifies the motor-controlling software while still retaining the other motor functions such as position control, ramp up and down, and speed control. The microprocessor's internal timer allows the program to drive the motor in the background.

To set the motor's speed, the program sets the timer's counter value and, when the timer ends, it interrupts the program and goes to the motor control routine. This interrupt service routine has counting loops to produce long timing intervals when running the motor at low speeds. When the interrupt routine reaches the end of a time interval, it outputs a drive pulse then reinitializes counters. A typical interrupt service routine is given in Table 1 as a BASIC program.

This controller can also be used as "stand alone" by using an external pulse generator. A simple pulse generator (Figure 4) is made with a 555 timer chip U1 in the astable mode which produces a continuous squarewave. Variable resistor R1 is used to vary the oscillator's frequency and hence the motor's speed while the motor's direction is controlled with S1 — an SPST switch to ground. Since the Motor Direction control has a pull-up resistor, switch S1 only needs to pull the

input low by grounding it. Switch S2 starts and stops the motor by interrupting the drive pulses to the controller. The current requirements for this circuit are low enough that when voltage regulator A1 is used on the controller, there is enough current capacity to also drive the manual control circuit.

A simple addition to this circuit allows setting different motor speeds for different directions of rotation. By making S1 a DPDT switch, a second motor speed control (second R1) can be added to the circuit. One motor speed control is in the circuit for one direction of rotation, and the other when the direction is changed by S1. Therefore, you can rotate the motor one speed when going clockwise, and a different speed in the opposite direction. **NV**



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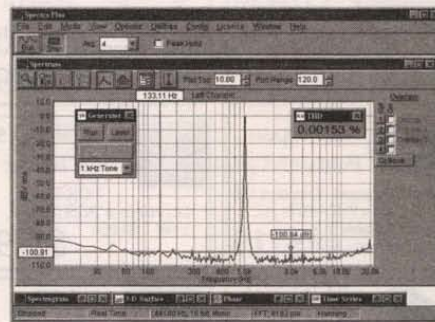
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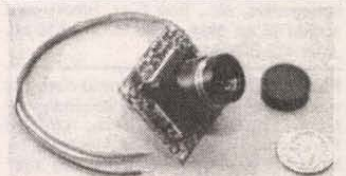
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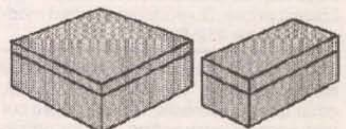
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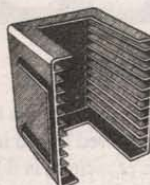
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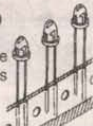


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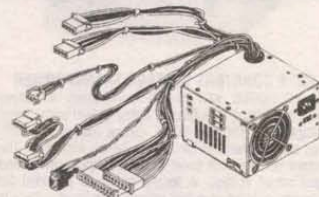
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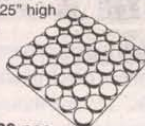
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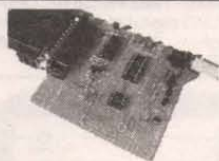
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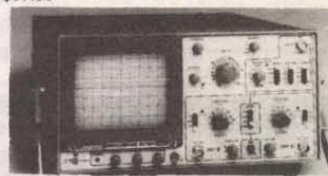


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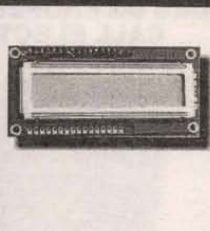


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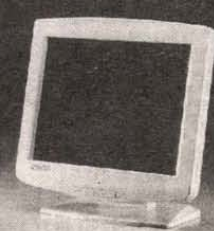
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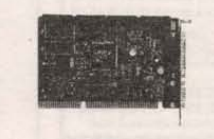
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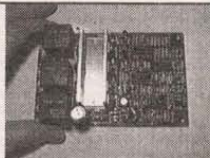
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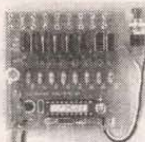
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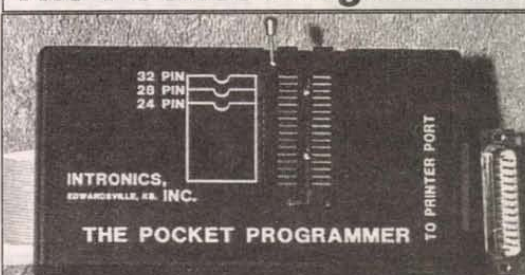
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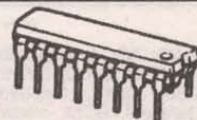
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# AMATEUR ROBOTICS

# NOTEBOOK

by Robert Nansel

Last month, I got my software-only I2C master and slave talking (sort of) by the simple expedient of the master sending all ones for the second byte of the data-gram so the slave could echo the first byte. That was good enough to check out the low-level slave routines but, this month, I'll continue with the next iteration: making the master actually pay attention to what the slave is doing. I'll also give a book review to close out the year — some good winter reading for the amateur roboticist.

First up, though, is Pulse Width Modulation and a nifty new PWM part that will be of interest to robot builders.

## PWM Motor Control

The Breadbot design, like most amateur robots its size, relies on hobby servos for its drive system. Hobby servos are easy to modify for continuous rotation, and they are simple to control. You merely provide them with a 1.0 to 2.0 millisecond pulse repeating at, say, 50 Hz, and you are in business.

It's the ease of generating these

control pulses in software that is the reason why hobby servos have been so popular. After all, they are not all that precise, and the analog circuitry contained in the servos drifts with time, temperature, humidity, and phase of the moon, so even a carefully calibrated servo will not stay calibrated. And they are only really good for small robots weighing under a pound.

When you start building larger robots (as I intend to in the coming year), or when you need more precise control than hobby servos can provide, you have to start looking at how to control more powerful DC motors, and the most common way to do this is with Pulse Width Modulation (PWM). PWM varies the duty cycle of a fixed-frequency digital pulse stream. The most common form of PWM control is so-called "Sign/Magnitude" control where the direction ("Sign") is relatively fixed and the speed ("Magnitude") is determined by a PWM waveform.

In principle, the duty cycle can vary over the whole range from 0% (full OFF) to 100% (full ON), but most cheap permanent magnet gearhead motors only run with decent torque

above 30% to 50% duty cycle; below a certain critical duty cycle (which varies with motor design and construction), the torque drops drastically, going completely nonlinear.

There is another form of PWM called Locked Anti-phase control. For Locked Anti-phase, the motor direction is controlled by PWM and the Magnitude is fixed. In other words, the direction is switched back and forth at the PWM rate so that the motor is motionless when the duty cycle is 50%, and rotates one way or the other as the duty cycle rises above or falls below 50%. It's useful for situations where you need to smoothly control a motor down through zero velocity without encountering the nonlinearities of Sign/Magnitude control.

## PWM Whiners

I'll talk more about the subtleties of these Sign/Magnitude vs. Locked Anti-phase PWM control schemes in future columns. For this column, I'm more interested in how to generate the PWM. And how to avoid whining.

The problem with doing PWM control in software with either Sign/Magnitude or Locked Anti-phase

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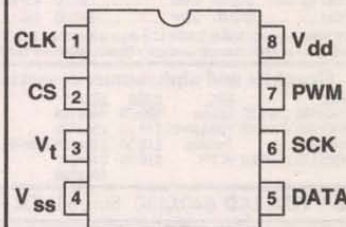


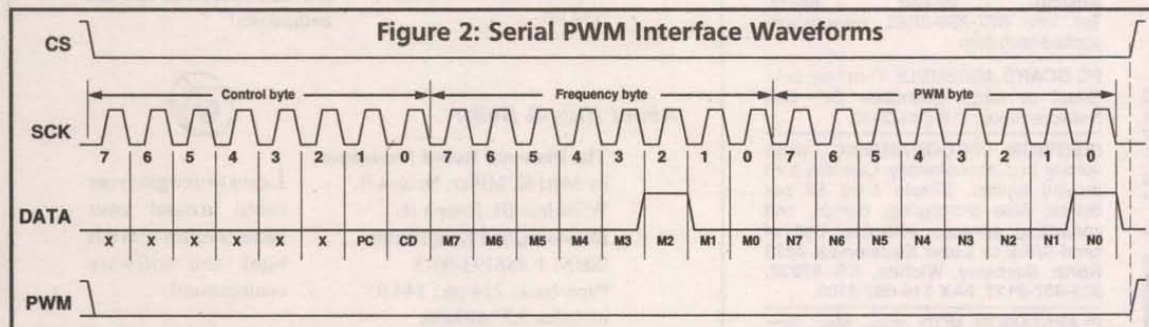
Figure 1: CMOS Serial Digital Pulse Width Modulator

is that the output frequencies achievable are low using software-only approaches — in the audio range. This means these systems whine, which can be annoying.

The only way to silence a whining motor is to increase the underlying PWM frequency above the audio range — to about 20 KHz, say — by using hardware to generate the PWM signal. Many microcontrollers provide some or all of the hardware you need to do PWM with minimal software overhead, but what if your processor doesn't? You'll have to add the extra hardware yourself.

Traditionally, this involves a high-frequency oscillator (in the MHz range) driving a collection of TTL or CMOS counters and binary magnitude comparators. The counters are typically a few four-bit 74HC160 or 74HC193 chips cascaded to form a synchronous counter of the number of bits you want. The outputs of the counters connect to the "A" inputs of the binary comparators — typically a few four-bit 74HC85 magnitude comparators — again cascaded to the desired word length.

Figure 2: Serial PWM Interface Waveforms



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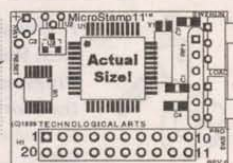
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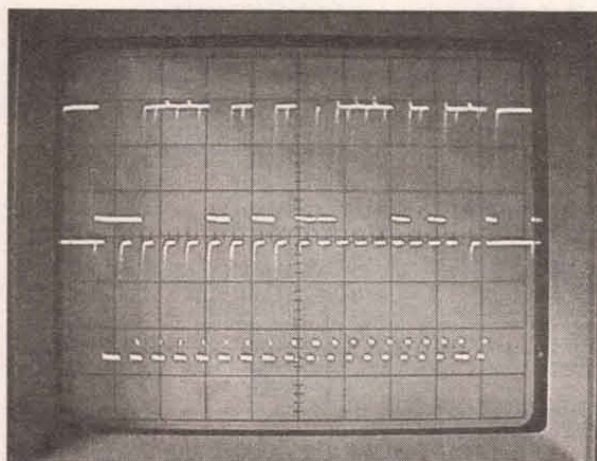
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# NOTEBOOK

## Shot of Oscilloscope I2C Waveforms



A register containing the binary word representing the PWM pulse width is tied to the corresponding "B" inputs of the comparators. The PWM output itself derives from the "A < B" output of the comparators so that the output is high as long as the binary count is less than the desired pulse-width count, and low thereafter. The high-frequency oscillator determines the maximum PWM frequency achievable, and the width of the counter and PWM words determine the resolution.

A four-bit PWM generator requires at a minimum three discrete logic chips — a counter, a comparator, and a register — using the above approach. This isn't counting the high-frequency oscillator, but that can often be shared with other PWM generators in your design. Likewise, an eight-bit PWM requires six chips. If you use an eight-bit counter and an eight-bit register, this drops the chip count down to four.

Unfortunately, eight-bit comparators are hard to come by, and using a simple eight-bit equality comparator — such as the 74HC688 — still requires the use of an additional flip-flop, so the chip count would still be four.

A 12-bit generator — not out of line for a precision servo-positioning system — would require as many as 12 logic chips. A 12-bit generator is about as far as you can go using readily-available logic because the required high-frequency oscillator for a 20-KHz PWM is over 80 MHz. To do it, you'd need to use ACT-family components, at least for the first four bits of the divider and comparator, since they must deal with the full clock rate of

the oscillator.

Going to more than 12 bits isn't practical unless you resort to brute force approaches involving ECL chips. In high resolution PWM systems, it actually turns out that it's easier — and cleaner, from a digital noise perspective — to use a precision DAC to drive the input of an analog PWM generator.

## Drowning in Chips

The thought of adding a dozen chips to a system as small as Breadbot is ludicrous and, even with larger robots, it would be nice to have a lower chip-count solution. It's not just the chips required, but also the number of I/O lines you need to drive the generators. An eight-bit system might need as many as 10 control lines just for the PWM generator: one to reset the counters and inhibit counting on startup, one to latch the control byte, and eight for the control byte itself. You can multiplex some of these lines, of course, but that makes your overall system more complicated.

There are some ways to reduce chip count when you are talking about more than one PWM channel. For instance, as with the high-frequency oscillator, the counter section can also be shared among more than one PWM generator. As long as you are within the fanout capacity of the counters, you can add as many comparators on the counter outputs as you like. Using this method, plus using an eight-bit counter, comparator, and eight-bit registers, a four-channel eight-bit PWM could be constructed from one counter, four registers, and four comparators, for nine chips total. If you have to use four-bit comparators, the chip-count would be 13.

This does nothing to alleviate the number of I/O lines required, though. The above nine-chip, four-channel circuit would use up as many as 34 output lines. If you have I/O lines in surplus, or if you are hanging the circuit directly off a 32-bit system bus, then you won't have a problem. But if lines

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

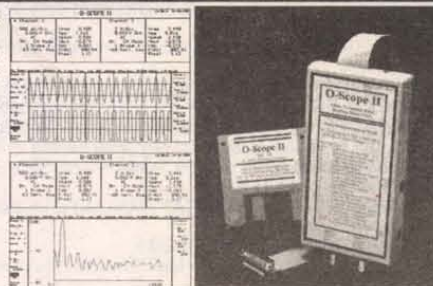
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brought high, and the PWM output, held low until now, begins on the rising edge of CS (Figure 3).

Once the chip is initialized, you need only select the chip, clock in one byte to alter the pulse width, or two to alter the PWM period and pulse width, then bring CS back high for the changes to be registered. The chip contains steering logic to ensure only the appropriate registers get updated. The updated PWM period and pulse width take effect only after the end of the previous total output period. (Figure 4 shows the meanings of all the bits in the three registers.)

## An Improved I2C Master

The last two columns, I've been using essentially the same version of code for the I2C master. That version was feeble, barely smart enough to generate I2C waveforms so I could bootstrap my I2C slave code. Except for checking for the Bus Free condition, it blissfully ignored the outside world as seen through the SDA and

SCL lines. The master pulled off this trick by sending all ones for the second byte of the datagram, thus enabling a slave to jump in and put pulse-width count, and low thereafter. The high-frequency oscillator determines the maximum PWM frequency achievable, and the width of the counter and PWM words determine the resolution.

A four-bit PWM generator requires at a minimum three discrete logic chips — a counter, a comparator, and a register — using the above approach. This isn't counting the high-frequency oscillator, but that can often be shared with other PWM generators in your design. Likewise, an eight-bit PWM requires six chips. If you use an eight-bitter. This is not caused by the slave clock-stretching; last month's slave is fast enough that it releases SCL before the master is done with Tlow. Rather, it's caused by the slave's inability to synchronize any closer to the master's SCL transition than 0 to 4 instruction cycles. This is still well within the timing constraint

of 12 cycles for Tlow, so everything works fine.

The jitter does make the waveform look messier, and datagrams are noticeably harder to trigger on to get a stable display on my 'scope. Last month, if I tweaked the trigger control a bit, I could get a reasonable display without using my external trigger circuit. This month, I found it difficult to get a stable display, even using the START output of my START/STOP detector circuit. (See Sept. '99 for details of this circuit.)

The display was so bad, in fact, I thought the revised master wasn't working. I could get a stable display if I pulled the slave out of the circuit, so I knew the master was transmitting something right but, when it interacted with the slave, it seemed like I was getting continuous START/STOP timing violations (i.e., that SDA was changing state while SCL was high other than during a START or STOP).

I got better results using the SYNCH output of the trigger circuit instead. The START output of the trig-

ger circuit produces a variable-length, negative-going pulse. The exact length of the pulse is determined by the data the master sends. Apparently, the data I was using was giving START conniptions. When I changed over to SYNCH, things cleared up right away. SYNCH produces a pulse the same length as the datagram, independent of the data it carries.

Once I was able to see the datagram clearly on the 'scope, I had to verify that the master was actually receiving the data the slave was transmitting.

As it turned out, the routine get\_byte had a couple major bugs in it. The first was a logical inversion of the incoming bit stream (the same kind of error I made in the slave last month ... sigh), and the second was shifting the i2c\_in buffer one too many times. I cured the first by replacing "btfsc STATUS, Z" with "btfss STATUS, Z." I cured the second bug by moving "rlf i2c\_in" above the clock-stretch check before the low bit of the

```

bsf    W_SDA           ; yes, clean up
bcf    STATUS, RP0     ; (Ports in Bank0)
retlw  arb_OK          ; Return, arbitration won

; ** Get Byte
entry:  SDA = X, SCL = 0
exit:   i2c_in = received byte, W = changed
        bit_count = 0,
        SDA = 1, SCL = 0

get_byte
        movlw 8         ; # of bits to shift
        movwf bit_count
        clrf  i2c_in
        bcf  STATUS, C   ; Clear C to shift in zeros
        bsf  STATUS, RP0 ; (Tris in Bank1)

shift_in
        bsf  W_SCL       ; begin 4.0 us SCL high time
        bcf  STATUS, RP0 ; (Ports in Bank0)
        nop             ; Delay to let SCL settle

        rlf  i2c_in      ; shift bits left for next bit

; ** check for SCL stretch
btfss  R_SCL            ; Did SCL go high?
goto   $-1             ; No, SCL being stretched

        movlw SDA_mask  ; Isolate SDA bit
        andwf PORTA, w
        btfss STATUS, Z  ; SDA = 1 ?
        bsf  i2c_in, 0   ; yes, set LSB
        else, LSB already clear

        bsf  STATUS, RP0 ; (Tris in Bank1)
        bcf  W_SCL       ; begin 4.7 us SCL low time
        nop             ; NOPs pad out 4.7 usec
        nop             ; T_low delay

        decfsz bit_count ; All bits shifted in?
        goto  shift_in  ; no, go shift next bit
        bsf  W_SDA      ; yes, clean up
        bcf  STATUS, RP0 ; (Ports in Bank0)
        return

; ** Give ACK
entry:  I2C Bus data read from Slave has just occurred,
        SDA = 1, SCL = 0
exit:   ACK pulse generated, SDA = 1, SCL = 0

give_ack
        bsf  STATUS, RP0 ; (Tris in Bank1)
        bsf  W_SDA       ; Output ACK pulse
        bsf  W_SCL       ; begin 4.0 us SCL high time

```

```

        bcf  STATUS, RP0 ; (Ports in Bank0)

; ** check for SCL stretch
btfss  R_SCL            ; Did SCL go high?
goto   $-1             ; No, SCL being stretched

        bsf  STATUS, RP0 ; (Tris in Bank1)
        nop             ; Hard-coded to pad out 4.0 usec delay

        bsf  W_SCL       ; begin 4.7 us SCL low time
        bcf  W_SDA       ; clean up
        nop             ; NOPs pad out 4.7 usec delay

        nop
        nop
        nop
        bcf  STATUS, RP0 ; (Ports in Bank0)
        return

; ** Get ACK -> this versions ignores any returned ACK
entry:  I2C Bus address or data write has just occurred,
        SDA = 1, SCL = 0
exit:   W = ACK status, SDA = 1, SCL = 0

get_ack
        bsf  STATUS, RP0 ; (Tris in Bank1)
        bsf  W_SCL       ; begin 4.0 us SCL high time
        bcf  STATUS, RP0 ; (Ports in Bank0)
        nop

; ** check for SCL stretch
btfss  R_SCL            ; Did SCL go high?
goto   $-1             ; No, SCL being stretched
movlw  SDA_mask         ; Isolate SDA bit
andwf  PORTA, w

; ** Commented out to ignore ACK for initial timing tests
btfsc  STATUS, Z        ; SDA = 0 ?
retlw  no_ack           ; no, signal No ACK
        nop             ; NOPs to pad out 4.0 usec delay

        bsf  STATUS, RP0 ; (Tris in Bank1)
        bcf  W_SCL       ; begin 4.7 us SCL low time
        bsf  W_SDA       ; clean up
        bcf  STATUS, RP0 ; (Ports in Bank0)
        retlw ack       ; Signal ACK

end

```

## Listing 1 continued



## Byte 1: Control Register

7	6	5	4	3	2	1	0
0	0	0	0	0	0	PC	CD

CR7-CR2 Unused; "don't care"

**CR1 (PC)** Power Control Bit. If bit is "0", chip remains in active state. If bit is "1", internal clocking, voltage comparator (VT) circuit, and voltage ref. are disabled, putting chip in low power mode. Active mode reentered by clearing PC and clocking in 24-bit initialization.

**CR0 (CD)** Clock Divider Bit. If bit is "0", chip will divide CLK input by one. If bit is "1" CLK input divided by two.

## Byte 2: Frequency Data Register

7	6	5	4	3	2	1	0
PWM Frequency Register							

**M7-M0** This register holds the byte that determines the total period of output PWM:

$$\text{PWM Output Period} = (M+1)(CD+1)(\text{CLK in period})$$

M = value in frequency register

CD = value of Clock Dividerbit in control register

Example: for M = 5 and CD = 0, the PWM output period will be 6 input clock cycles long.

## Byte 3: Pulse Width Data Register

7	6	5	4	3	2	1	0
Pulse Width Data Register							

**N7-N0** This register holds the byte that determines the pulse width (high duration) of output PWM:

$$\text{PW} = (N+1)(CD+1)(\text{CLK in period})$$

N = value in PW register

CD = value of Clock Dividerbit in control register

Example: for N = 3 and CD = 0, the PWM output will be high for 4 input clock cycles, then low for the remaining cycles. If the frequency register contains 5 as above, the PWM output will be high for 4 CLK cycles and low for 2.

Figure 4: Pulse Width Modulator Data Register

buffer is set or cleared. This ensures that i2c\_in does not get shifted after the last bit is written to the buffer.

To discover these bugs, I used two different bits of debug code in test2 — the main loop. The first debug routine is a six-instruction code snippet that outputs to PortB a running count the times the byte sent doesn't equal the byte received. It assumes the slave always echoes the address byte sent to it (which is what last month's slave does). Putting a logic probe on PB0 will tell you right away if errors are piling up. If you set your logic probe to capture a pulse, you'll be sure of catching even one-time errors.

The second section of debug code, commented out in the listing, is just a simple write of the contents of i2c\_in to PortB. To use it, uncomment the "mowf PORTB" instruction and comment out the above six instructions of debug code. Probing around

the bits of PortB will quickly tell you if the master is receiving the correct data.

The next iteration, I'll work on improving both the master and the slave (though not simultaneously). In particular, I'm keen on writing high-level routines to build datagrams on the master side and to interpret them on the slave side. And, speaking of high-level, here's a book about a very high level of programming, indeed.

## Spiritual Machines?

If you listen to some people, you'd think there is nothing truly new under the sun, that humanity will never rise above its mean genetic heritage, and that light beer will always taste bad. Ray Kurzweil doesn't listen to those people, and a good thing, too, or we perhaps wouldn't have had OCR, music synthesizers, and voice recognition systems as early

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as we did.

Ray Kurzweil is well known as a technologist whose technology works, so when he talks about the future of computing, it pays to listen. And he has a lot to say in my pick for the book of the month, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (Viking Penguin, New York, 1999, ISBN 0-670-88217-8).

*Spiritual Machines* is in the same vein as Hans Moravec's recent book, *Robot: Mere Machine to Transcendent Mind*, (reviewed in these pages in the May '99 issue). Like Moravec, Kurzweil is attempting to predict the future evolution of robotics and artificial intelligence. Kurzweil

puts rather more emphasis on AI than on robotics in his book, as you might expect given his background. He also comes to pretty much the same conclusions as Moravec: 30 years from now, human-level intelligence will be available in the equivalent of desktop personal computers.

I was fascinated by this book. In some ways Kurzweil is bolder than Moravec. He places much more faith in traditional AI approaches, for instance, and he makes his case with all the fervor of Manifest Destiny.

I liked this book, though some of Kurzweil's notions are suspect. In particular, I don't believe his claim that there is an inherent force in the universe that must — of course — lead

first to biological intelligence and inexorably on to machine intelligence. He talks glibly about evolution "speeding up" through what he calls the "law of accelerating returns."

I don't know, but I just get a rash when anyone starts talking about anything in an evolutionary system as being inevitable. I've read too much evolutionary biology (especially the writings of paleontologist Stephen Jay Gould) to see the outcomes of evolutionary processes as anything but contingent on accidents of history. Things didn't have to turn out the way they did, and we are not the pinnacle of the evolutionary ladder. Evolution doesn't work in such a linear fashion.

Still, even with the above caveats,

I recommend this book. I happen to believe that Kurzweil is right about his technological assessments of what's in store the next century, even if I don't agree with his descriptions of how evolution works. It is possible to be right for the wrong reasons (something readers of my code listings will no doubt have already noticed).

## Spirit vs. Brawn

Next time, I'll get to those higher-level routines for I2C and talk more about PWM motor control. I'm contemplating building some big robots this year, and that calls for big motors. Ah, I can almost smell the ozone and solder smoke already ... **NV**



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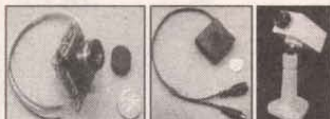
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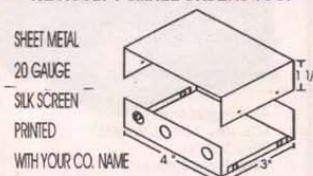
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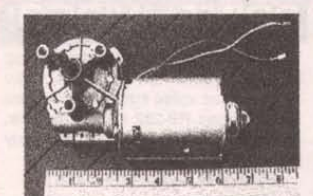
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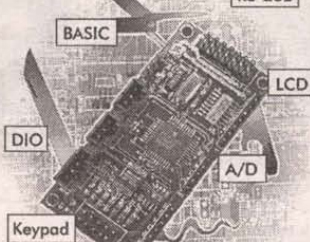
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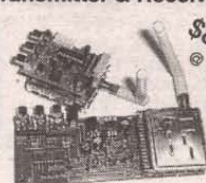


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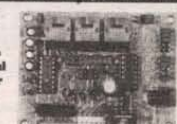
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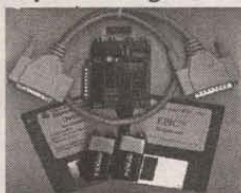
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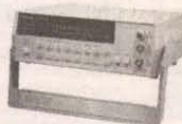


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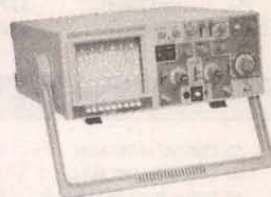


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Continued from page 22

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**MO - WASHINGTON** - Hamfest. Zero Beaters ARC, Dave Neal N0PNG, 314-532-2477 (days) or 314-458-3254 (eve). E-Mail: Dave\_Neal@msc.com Web: <http://zbarc.usmo.com/>

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## JULY 22

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

## JULY 23

**IL - SUGAR GROVE** - Hamfest. Fox River Radio League, Maurice Schietecatte W9CEO, 815-786-2860. E-Mail: w9ceo@arrl.net Web: <http://www.frrl.org/hamfest.html>

## JULY 29-30

**OK - OKLAHOMA CITY** - State Convention. Central OK Radio Amateurs, Harold Miller KB1ZQ, 405-672-7735 or 405-650-9963. E-Mail: n1lpr@swbell.net Web: <http://www.geocities.com/heartland/7332>

## JULY 30

**OH - RANDOLPH** - Hamfest. Portage ARC, Joanne Solak KJ30, 330-274-8240. E-Mail: jsolak@apc.net Web: <http://parc.portage.oh.us>

## AUGUST 2000

### AUGUST 5

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

### AUGUST 12

**IL - QUINCY** - Hamfest. Western Illinois ARC, Jim Funk, N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: <http://www.qsl.net/w9awe>

### AUGUST 13

**IA - AMANA** - Hamfest. Cedar Valley ARC, Wayne Kolosik, K10FE, 319-393-4224. E-Mail: k10fe@usa.net

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

**NJ - BAYVILLE** - Hamfest. Jersey Shore ARS, Bob Murdock W2XNJ, 732-269-6379. E-Mail: jsarsfest@aol.com Web: <http://members.aol.com/jsarsfest/jsarsfest.html>

### AUGUST 20

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

### AUGUST 26-27

**MA - BOXBORO** - NE Division ARRL Convention. Dave WITQ, 978-649-3907

### AUGUST 27

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

**KS - SALINA** - State Convention. Central KS ARC, Ron Tremblay WA0PSF, 785-827-8149. E-Mail: tremblay@midusa.net Web: <http://www.qsl.net/w0ocy>

**NY - YONKERS** - Hamfest. Yonkers ARC, John Costa WB2AUL, 914-969-6548. E-Mail: wb2aul@aol.com

## SEPTEMBER 2000

### SEPTEMBER 9-10

**FL - MELBOURNE** - Hamfest. Platinum Coast ARS, Tim Madden K14TG, 407-724-9339. E-Mail: k14tg@hotmail.com

### SEPTEMBER 16

**NY - WHITE PLAINS** - Hudson Division Convention. Westchester Emergency Communications Assn., Thomas Raffaelli WB2NHC, 914-741-6606. E-Mail: wb2nhc@weca.org Web: <http://www.weca.org>

### SEPTEMBER 16-17

**IL - PEORIA** - Hamfest. Peoria Area ARC, Jim Williams N9HHJ, 309-692-3378. E-Mail: jimn9hhu@juno.com Web: <http://www.w9uvi.org>

### SEPTEMBER 17

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

### SEPTEMBER 23

**NY - HAMBURG** - Western NY ARRL Section Convention. Harold Smith K2HC, 716-424-7184. E-Mail: info@buffalohamfest.org Web: <http://www.buffalohamfest.org>

### SEPTEMBER 24

**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: <http://www.metro70cmnetwork.com>

**OH - CLEVELAND** - Hamfest. Hamfest Association of Cleveland, Ron Nichols N8LZA, 1-800-CLE-FEST or 216-999-7388. E-Mail: info@hac.org Web: <http://www.hac.org>

## OCTOBER 2000

### OCTOBER 6-7

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

### OCTOBER 6-7-8

**AZ - SCOTTSDALE** - Southwestern Div. Convention. Scottsdale ARC, Walt Schuknecht N7IZM, 480-947-0338. E-Mail: n7izm@arrl.net

### OCTOBER 15

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

### OCTOBER 21

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

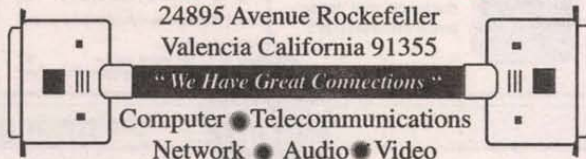
### OCTOBER 29

**NY - LINDENHURST** - Hamfest. GSBARC & SCRC, Lenore Dunlop N2KYP, 516-785-0826. E-Mail: info@gsbarc.org Web: <http://www.gsbarc.org>

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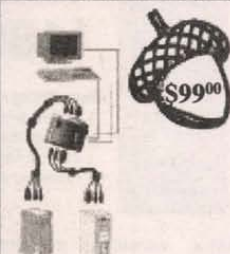


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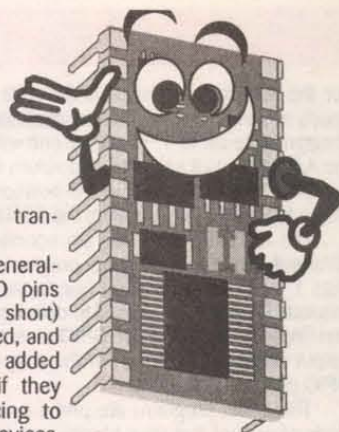
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# STAMP APPLICATIONS

by Lon Glazner



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

### STAMP Net: A Multi-Drop Stamp-Based Network — Part II

**L**ast month, we designed an RS-485 based network, and described a communication protocol, which allowed multiple BASIC Stamp2-SXs (BS2-SX) to communicate together. The communication was a Master-Slave format in which the Master would send a communication string to a specific Slave, causing that Slave to execute a specific program stored in memory. Once the program was executed, the Slave would respond with some data. This network was called STAMP Net.

#### Overview

Our previous design and testing was done on a solderless breadboard, which allowed enough flexibility to prove out the design concept. This month, the STAMP Net design was moved to a set of

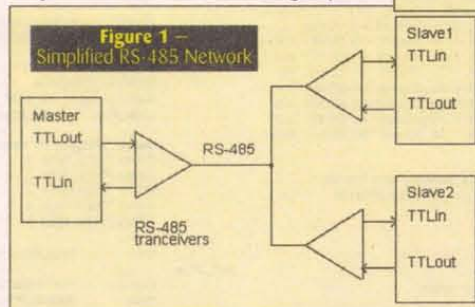
prototype PCBs, and the network communication was tested with cables measuring roughly 200 feet. From the literature I've read on RS-485, a 200-foot cable is small potatoes, as far as cable lengths go. And judging from the lack of trouble that I had getting the system to work, I'd have to agree.

#### Defining the Design

This design was defined pretty well in last month's article. I did decide to add a little code to control a 1A relay, and a pair of general-purpose I/O pins. Even with the addition of this functionality, there is plenty of room left in the BS2-SX to implement more functionality. I would really like to add a PC terminal interface to the design, but that will have to be done some time in the future, when time permits.

As a little refresher from last month, I've included the system block diagram. Figure 1 gives a pretty good conceptual overview how a Master-Slave communication protocol on an RS-485 network is connected. The RS-485 transceivers that were chosen for the design are the MAX487 from Maxim Integrated Circuits.

The changes in the schematic were pretty simple. A relay driver circuit was added. The relay is a 5V variety (drive voltage) which can handle 1A with a 30V potential at its switch connections. A 2N3904 NPN transistor buffers the BS2-SX pin that drives the relay, and a 1N4001 diode was added across the relay's inductor to reduce voltage spikes



and other transients.

Two general-purpose I/O pins (GPIO, for short) were included, and should have added protection if they are interfacing to external devices.

Take a look back at the Sept. '99

Stamp Applications article for more information on protecting I/O pins.

The GPIO pins can be set as inputs or outputs in software. The voltage level at either GPIO1 or GPIO2 will be returned to the Master unit if either pin is set as an input pin. As inputs, these pins could be used to read switches at each STAMP Net node. These same pins could be configured as outputs by a Master unit and be used to drive additional relays, or be used to light LEDs.

#### Reviewing Our Communication Protocol

The communication protocol was based on a generic structure of eight bytes for each communication string. The Master unit sends the address of the

Byte	Number	Description
Address	1	Address of unit message is intended for
Program	2	Program to be executed by receiving unit
Data 1	3	General purpose data byte
Data 2	4	General purpose data byte
Data 3	5	General purpose data byte
Data 4	6	General purpose data byte
Data 5	7	General purpose data byte
Checksum	8	Sum of all bytes in message

Table 1: Command and Response String Definition

STAMP Net node that it was trying to communicate with, and the number of the program that it wishes to have executed. Five generic data bytes and a checksum byte follow the first two bytes. Table 1 can be used as a quick reference for the data string format for STAMP Net.

As of now, there are only two programs that are loaded into the STAMP Net nodes for the Master unit to access through a Slave unit.

The first is the Analog.bsx program, which reads an eight-bit A/D and returns the average, maximum, and minimum measurements out of 128 samples.

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# STAMP APPLICATIONS

For the Master unit to receive the A/D data, it only needs to send a valid communication string with the Program byte set to 1. The Slave unit will interface to the A/D, take 128 samples, and return the results in the Data 1, Data 2, and Data 3 positions, and then return to waiting for data from the RS-485 bus.

The IOControl.bsx program operates a little bit differently than the Analog.bsx program. The value in Data 1 — when it is received from a Master unit that requests Program 2 — is used to determine the direction (input or output) of the GPIO pins, as well as the output voltages (0V or 5V) of the relay pin and any GPIO pins set as outputs.

These two programs are prime examples of the kinds of control that your Master unit can have over a Slave unit. The Master may execute a program in a Slave, and that program can be performed more or less autonomously. Or the Master may send data along with the program request information that reconfigures the Slave unit as in the IOControl.bsx program.

A communication protocol can have multiple timing requirements. I left the timing requirements for STAMP Net very lax. In fact, I extended the

response time allotted for the Slave unit from 500ms to 1.5s since last month's article. I never intended to make STAMP Net a high-speed network, and some of the STAMP Net nodes that I'll be using will be monitoring environmental conditions, so additional time might be necessary.

So what does this all look like electrically? Oscilloscope captures of the Master and Slave communication are shown in Figure 4. Take a look at the data on the Master TX line (MST\_TX), and how it is received on the Slave RX line (SLV\_RX). The receive enable line is also of interest in this oscilloscope capture (MST\_EN and SLV\_EN). It is low to set the MAX487 IC to receive data, and high for the MAX487 to send data to the RS-485 bus (keep in mind that both the Master and Slave control their

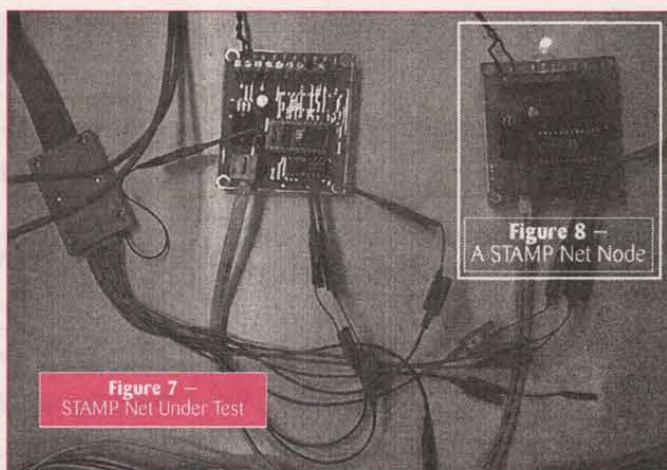


Figure 7 —  
STAMP Net Under Test

Figure 8 —  
A STAMP Net Node

own MAX487). If you're having trouble with a communication protocol, "scoping" the signals like I've done here can detect the most common problems. The top signal, without a label, is scope channel

## Code Listing 1: Master.bsx

```
*****
*Master Program
*The Master program controls communication and data display. For a
*unit designated as a Master unit (address = 0) this program is
*used to poll the various slave units. If a unit is a Slave unit
*(address < 0) then this program is where the unit waits for
*commands.
*($STAMP BS2SX,C:\Parallax\Analog.bsx,C:\Parallax\IOControl.bsx)
*0:Master_Prgm.bsx

*I/O pin designations
AD_CLK      CON      0      *ADC0831 clock pin
AD_Data     CON      1      *ADC0831 data pin
AD_CS       CON      8      *ADC0831 chip select (asserted low)
Relay       CON      9      *Relay control pin (asserted high)
GPIO1       CON     10      *General purpose I/O pin
GPIO2       CON     11      *General purpose I/O pin

*Communication Constants
Data_Out     CON      5      *TTL data out pin
TX_RX        CON      6      *Receive enable (asserted low)
Data_In      CON      7      *TTL data in pin
Baud         CON     45      *38.4kbps, 8N1 true data

*Internally used registers
Addr         var      byte    *Address of unit
Comm_Flag    var      byte    *Flag bits for unit
Mstr         var      byte    *Set for Master unit cleared for Slave
S1           var      byte    *Set if Slave # 1 is present on RS-485 bus
S2           var      byte    *Set if Slave # 2 is present on RS-485 bus
S3           var      byte    *Set if Slave # 3 is present on RS-485 bus
S4           var      byte    *Set if Slave # 4 is present on RS-485 bus
S5           var      byte    *Set if Slave # 5 is present on RS-485 bus
S6           var      byte    *Set if Slave # 6 is present on RS-485 bus
S7           var      byte    *Set if Slave # 7 is present on RS-485 bus

*Communication message string variables bytes(8 total)
Addr_Req     var      byte    *Unit address of message destination
Prgm_Req     var      byte    *Request execution of this program
Data1        var      byte    *Data byte 1
Data2        var      byte    *Data byte 2
Data3        var      byte    *Data byte 3
Data4        var      byte    *Data byte 4
Data5        var      byte    *Data byte 5
Checksum     var      byte    *Sum of previous bytes

*Storage Registers
Put_Addr     var      byte    *Put address location
Get_Addr     var      byte    *Get address location

*Working registers
Loop1        var      byte    *For...Next variable
Work1        var      byte    *General purpose register
Work2        var      byte    *General purpose register
Work3        var      byte    *General purpose register
Work4        var      byte    *General purpose register
WorkBig      var      word    *Word sized general purpose register

*A/D registers
ResultA_D    var      byte    *Result of A to D measurement
MaxA_D       var      byte    *Storage for maximum A to D result
MinA_D       var      byte    *Storage for minimum A to D result
AvgA_D       var      byte    *Storage for avg. A to D result

*Program constants
AD_Samples   CON     128      *Number of samples taken
DirFlag      CON      6      *Flag set to skip direction setting routine

*****
Main_Program:
GET      DirFlag,Work2
If Work2 = 10 Then Get_Address

Comm_Flag = $00000000
Outs     = $0000000100100000
Dins     = $0000001101100011
*Set output pin values
*Set pin direction values

Get_Address:
Addr      = (INL&$0011100)/4
If Addr < 0 then No_Master
Mstr = 1

No_Master:
Pause      2000

*Addr and Comm Flag Debug statements
Debug      *Address = *, BIN8 Addr,CR
Debug      *Comm Flag = *, BIN8 Comm_Flag,CR

If Mstr = 1 then Master_Program
Goto      Slave_Program

*****
Master_Program:
Pause      1000
Addr_Req   = 1
Prgm_Req   = 2
Data1      = $11100100
Checksum   = Addr_Req+Prgm_Req+Data1+Data2+Data3+Data4+Data5
HIGH       Data_Out
HIGH       TX_RX
SEROUT     Data_Out,Baud,[Addr_Req,Prgm_Req,Data1,Data2,Data3,Data4,Data5,Checksum]
PAUSE      1
LOW        TX_RX
Data_In,Baud,1500,No_Data,[Work1,Work2,Data1,Data2,Data3,Data4,Data5,Checksum]
Work4      = Work1+Work2+Data1+Data2+Data3+Data4+Data5
If Work4 < Checksum Then Bad_Data

Comm_Flag = 1
Work3 = $00000001
Work3 = Work3 << Addr_Req
Comm_Flag = Comm_Flag+Work3
Debug      *Address of Sender = *,DEC Addr_Req,CR
Debug      *Data byte 1 = *,DEC Data1,CR
Debug      *Data byte 2 = *,DEC Data2,CR
Debug      *Data byte 3 = *,DEC Data3,CR
Debug      *Data byte 4 = *,DEC Data4,CR
Debug      *Data byte 5 = *,DEC Data5,CR

Goto      Done_Polling

Bad_Data:
Debug      *Checksum Invalid Addr: *,DEC Addr_Req,CR
Goto      Master_Program

No_Data:
Debug      *No Data Returned Addr: *,DEC Addr_Req,CR
Goto      Master_Program

Done_Polling:
Debug      *Comm_Flag = *, BIN8 Comm_Flag,CR
Pause      3000
Goto      Master_Program

*****
Slave_Program:
Debug      *Slave Program *,CR
LOW        TX_RX
SERIN      Data_In,Baud,[Addr_Req,Prgm_Req,Data1,Data2,Data3,Data4,Data5,Checksum]
If Addr_Req < Addr Then Bad_Address
Work4      = Addr_Req+Prgm_Req+Data1+Data2+Data3+Data4+Data5
If Work4 < Checksum Then Bad_Sum

PUT        0,Data1
PUT        1,Data2
PUT        2,Data3
PUT        3,Data4
PUT        4,Data5
RUN        Prgm_Req
*Execute requested program

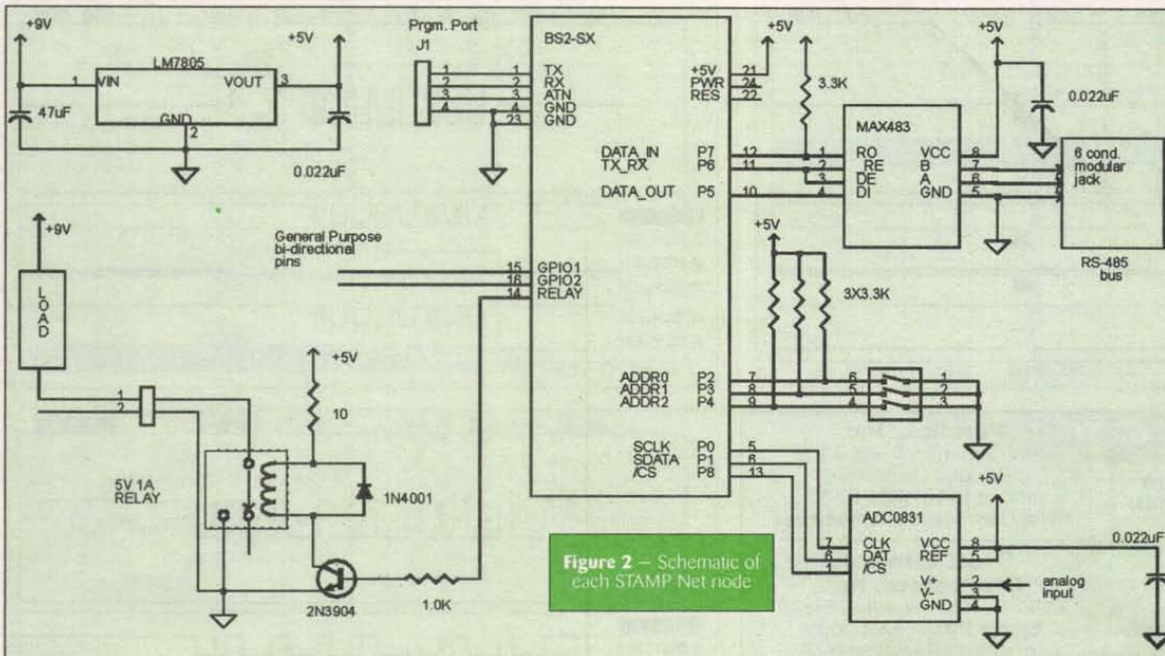
Bad_Sum:
Debug      *Checksum Invalid: *,cr
Goto      Slave_Program

Bad_Address:
Debug      *Wrong Address: *,DEC Addr_Req,cr
Goto      Slave_Program

Goto      Get_Address

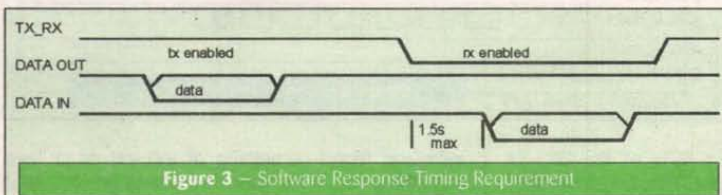
END
```





allowed me to skip the I/O direction setting lines of the code if the IOControl.bsx program had been executed. This prevents the Slave unit from resetting the direction of the GPIO pins, or their output voltage levels when the Slave returns to the main program after IOControl.bsx is executed.

I also removed the part of the Master.bsx routine which polled each Slave on the STAMP Net. This function will be replaced later by a user interface, and a more in-depth polling routine. I have added the new versions of the programs here for anyone that may wish to see them. For these programs, the Slave address and Program request byte should be entered into the Master part of the Master.bsx program. This makes testing new programs a little simpler.



A1-A2, which is the differential voltage as seen by the MAX487.

### Zooming in on the Master unit transmission

There are a few differences between the Master.bsx and Analog.bsx programs from last month. I added a couple of lines of code which

gives us some additional insight into what's really going on. It is also nice to get a close-up of the Slave unit response, as shown in Figure 6.

## The Software

## In Closing

At this point, I've got a pretty good head of steam going on the STAMP Net project. The PCBs are designed and look like they'll work for the final application, which is a workshop alarm. Although, I've got to say, there is still a lot of software to write. The three programs listed here need to be refined, and I'm sure I've got a little learning to do. But, with the BS2-SX, I have plenty of room for code, and the Parallax technical support is only an E-Mail away.

## Code Listing 2: Analog.bsx

```

Analog.bsc
'This is program 1 for the STAMP Net design. If this program
'is requested then 128 analog measurements are taken with the
'ADC0831 analog to digital converter. The maximum, minimum,
'and average result are returned to the Master unit.

'I/O pin designations
AD_Clk      CON      0      'ADC0831 clock pin
AD_Dat      CON      1      'ADC0831 data pin
AD_CS       CON      8      'ADC0831 chip select (asserted low)
Relay       CON      9      'Relay control pin (asserted high)
GPIO1       CON      10     'General purpose I/O pin
GPIO2       CON      11     'General purpose I/O pin

'Communication Constants
Data_Out     CON      5      'TTL data out pin
TX_RX        CON      6      'Receive enable(asserted low)
Data_In      CON      7      'TTL data in pin
Baud1        CON      45     '38.4kbps, 8N1 true data

'Internally used registers
Addr         var      byte   'Address of unit
Comm_Flag    var      byte   'flag bits for unit
Mstr         var      byte   'Set for Master unit cleared for Slave
S1           var      byte   'Set if Slave # 1 is present on RS-485 bus
S2           var      byte   'Set if Slave # 2 is present on RS-485 bus
S3           var      byte   'Set if Slave # 3 is present on RS-485 bus
S4           var      byte   'Set if Slave # 4 is present on RS-485 bus
S5           var      byte   'Set if Slave # 5 is present on RS-485 bus
S6           var      byte   'Set if Slave # 6 is present on RS-485 bus
S7           var      byte   'Set if Slave # 7 is present on RS-485 bus

'Communication message string variables bytes(8 total)
Addr_Req     var      byte   'Unit address of message destination
Prgm_Req     var      byte   'Request execution of this program
Dat1         var      byte   'Data byte 1
Dat2         var      byte   'Data byte 2
Dat3         var      byte   'Data byte 3
Dat4         var      byte   'Data byte 4
Dat5         var      byte   'Data byte 5
Checksum     var      byte   'Sum of previous bytes

'Storage Registers
Put_Addr     var      byte   'Put address location
Get_Addr     var      byte   'Get address location

'Working registers
Loop1        var      byte   'For...Next variable
Work1        var      byte   'General purpose register
Work2        var      byte   'General purpose register
Work3        var      byte   'General purpose register
Work4        var      byte   'General purpose register
WorkBig      var      word   'Word sized general purpose register

```

```

A/D registers
ResultA_D var byte 'Result of A to D measurement
MaxA_D var byte 'Storage for maximum A to D result
MinA_D var byte 'Storage for minimum A to D result
AvgA_D var byte 'Storage for avg. A to D result

'Program constants
AD_Samples CON 128 'Number of samples taken
DirFlag CON 6 'Flag set to skip direction setting routine

*****
Main_Program:

GET DirFlag,Work2
If Work2 = 10 Then Get_Address

Comm_Flag = %00000000
Outs = %0000000100100000 'Set output pin values
Dirs = %00000001101100011 'Set pin direction values

Get_Address:
Addr = (INLA%0011100)/4 'Get unit address from P4-2

WorkBig = 0 'Clear average storage register
MinA_D = 255 'Set minimum to max output
MaxA_D = 0 'Set maximum to min output

Measure_Analog:
For Loop1 = 1 to AD_Samples
    LCW AD_CS
    PULSCUT AD_Clk,10
    SHIFTPIN AD_Dat,AD_Clk,msbpost,[ResultA_D]
    HIGH AD_CS
    WorkBig = Workbig + ResultA_D
    If ResultA_D < MaxA_D Then Test_Min
        MaxA_D = ResultA_D
Test_Min:
    If ResultA_D > MinA_D Then Keep_Sampling
        MinA_D = ResultA_D
Keep_Sampling:
    Next
    AvgA_D = WorkBig/AD_Samples

Debug 'Average Storage = *,DEC WorkBig,cr
Debug 'Minimum A to D = *,DEC MinA_D,cr
Debug 'Maximum A to D = *,DEC MaxA_D,cr

Checksum = MaxA_D+MinA_D+AvgA_D
HIGH Data_Out 'Set output high
HIGH TX_RX 'Enable transmission on RS-485
SERCUT Data_Out,[Baud,[500,$00,MaxA_D,MinA_D,AvgA_D,$00,$00,Checksum]
PAUSE 1
LOW TX_RX 'Enable receiver on RS-485

RUN 0 'Return to main program
END

```



# STAMP APPLICATIONS

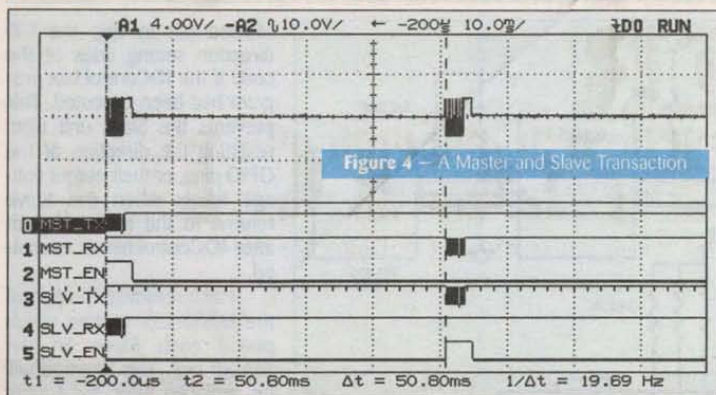


Figure 4 - A Master and Slave Transaction

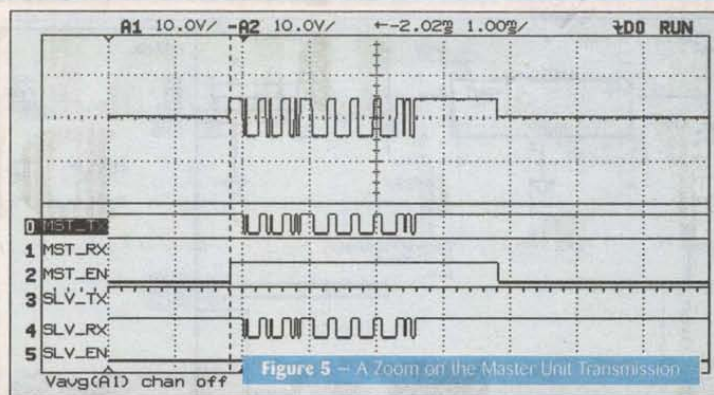


Figure 5 - A Zoom on the Master Unit Transmission

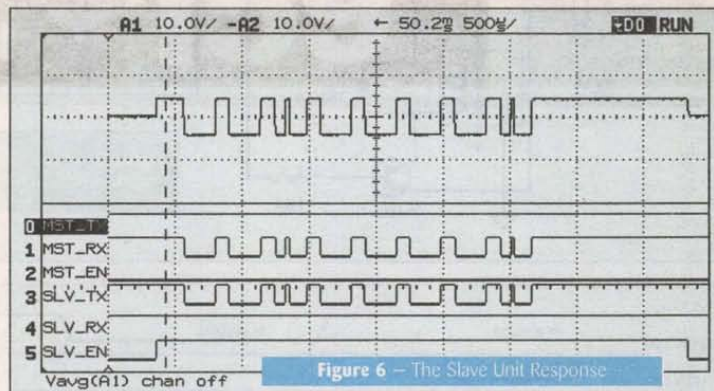


Figure 6 - The Slave Unit Response

## RESOURCES

For more information on the BASIC Stamp, contact:

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The RS-485 network went together without much trouble, and termination resistors were avoided (thanks to short cable requirements). This is not always the case. I think I stacked the deck in my favor by taking a realistic approach to what I wanted my network to do. The generic STAMP Net communication protocol prevented me from getting bogged down in timing issues, or overly elaborate code requirements. Keeping cables short (no run over 200

feet long) kept expenses down, and electrical reflections under control.

Probably the best news is that I've got about 80% of the BS2-SX resources still available for use. That could translate into a pretty cool user interface. We'll just have to wait and see.

But that's it for STAMP Net in this forum. I hope

everyone found something of interest or at least something useful for your own Stamp project. Next month, we'll take a step back to the past with a BASIC Stamp 1 and a 12-bit A/D interface. See you then. **NV**

### Code Listing 3: IOControl.bsx

```
'IOControl
'The IOControl program sets the pin direction and output levels of the Relay,
'GPIO1, and GPIO2 pins. The pin direction and voltage level are determined
'by the value in Dat1 sent by the Master unit.

'The values are defined as,
Dat1,2 GPIO1 direction 1 = output
Dat1,3 GPIO2 direction 1 = output
Dat1,5 Relay voltage level
Dat1,6 GPIO1 voltage level
Dat1,7 GPIO2 voltage level

'I/O pin designations
AD_Clk CON 0
AD_Dat CON 1
AD_CS CON 8
Relay CON 9
GPIO1 CON 10
GPIO2 CON 11

'Communication Constants
Data_Out CON 5
TX_RX CON 6
Data_In CON 7
Baud CON 45

'Internally used registers
Addr var byte
Comm_Flag var byte
Mstr var byte
S1 var byte
S2 var byte
S3 var byte
S4 var byte
S5 var byte
S6 var byte
S7 var byte

'Address of unit
'Flag bits for unit
'Set for Master unit cleared for Slave
'Set if Slave # 1 is present on RS-485 bus
'Set if Slave # 2 is present on RS-485 bus
'Set if Slave # 3 is present on RS-485 bus
'Set if Slave # 4 is present on RS-485 bus
'Set if Slave # 5 is present on RS-485 bus
'Set if Slave # 6 is present on RS-485 bus
'Set if Slave # 7 is present on RS-485 bus

'Unit address of message destination
'Request execution of this program
'Data byte 1
'Data byte 2
'Data byte 3
'Data byte 4
'Data byte 5
'Sum of previous bytes

'Put address location
'Get address location

'For...Next variable
'General purpose register

Work2 var byte
Work3 var byte
Work4 var byte
WorkBig var word

'A/D registers
ResultA_D var byte
MaxA_D var byte
MinA_D var byte
AvgA_D var byte

'Program constants
AD_Samples CON 128
DirFlag CON 6

'Number of samples taken
'Flag set to skip direction setting routine

Main_Program:
GET DirFlag,Work2
IF Work2 = 10 Then Get_Address

Comm_Flag = %00000000
Outs = %0000000100100000
Dirc = %0000001101100011

'Set output pin values
'Set pin direction values

Get_Address:
Addr = (INL%0011100)/4

'Get unit address from P4-2

'Set I/O Direction
GET 0,Work1
Work1.NIB0 = Work1.NIB0%1100
Work2.NIB0 = DIRC%0011
DIRC = Work2.NIB0+Work1.NIB0
DEBUG "DIRC = ",BIN4 DIRC,CR

'Set output levels
GET 0,Work1
Work1.NIB1 = Work1.NIB1%1110
OUTC = Work1.NIB1
DEBUG "OUTC = ",BIN4 OUTC,CR

'Dat1 from Master stored in RAM0
'High nibble has voltage levels
'Set output levels
'Display output register

Dat1 = 0
IF DIRC = %1111 Then No_Inputs
Dat1 = INC%1100
DEBUG "INC = ",BIN4 INC,CR

'Send data to Master

Checksum = Dat1
HIGH Data_Out
HIGH TX_RX
SEROUT Data_Out,Baud,[%00,$00,Dat1,$00,$00,$00,Checksum]
PAUSE 1
LOW TX_RX

'Enable receiver on RS-485

PUT DirFlag,10
RUN 0

'Return to main program

END
```





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# TECH FORUM

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

## QUESTIONS

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

I enjoy listening to AM broadcast band DX on my portable AM/FM radio. Is there a simple way I can add an analog S-meter to it for AM reception only?

**12991 Marvin Rosen**  
Baltimore, MD

I need to locate a source for Signetics 95H90 and 9582 prescaler ICs for my frequency counter, or a suitable substitute.

**12992 Philip D. Greenway**  
Fayetteville, GA

I really enjoyed Evert Fruitman's article "Automatic Night LED" in the Oct. '99 issue of *Nuts & Volts*.

All my flashlights seem to grow feet and walk off and hide just when I need them.

What I would like to find is a circuit that has both a flashing LED, and piezoelectric beeper. Both activated approximately once every 30 seconds.

The LED for finding the flashlight at night, and the beeper for daylight hiding flashlights.

Perhaps two models: 1. High power, but low parts count, and therefore cheap. 2. One with the absolute lowest power drain. This one would require more parts (?) and therefore cost more.

**12993 Stuart B. Wahlberg**  
Blythe, CA

I have an RCA VCR model No. VKP925T. When I try to play a cassette, the entire screen is filled with neat columns and rows of the same cipher. Any help with this problem would be appreciated.

**12994 Mark Weinstein**  
Wantagh, NY

I have recently come into possession of a Webster-Chicago wire recorder transport mechanism, model 79-1, SN 730. Unfortunately, there was no electronics attached to it.

Where can I find either the electronics package or complete plans to build it? I would also need the wire which the recorder uses.

**12995 Mark Weinstein**  
Wantagh, NY

I would like to figure out how to

make my door locks keyless. They are already electric, so some sort of transmitter is all that would be necessary, but I'm not sure how to do this.

**12996 Nathan Wilson**  
Ogden, UT

I am investigating using a PC to operate different peripherals. The main difficulty that prevents Turbo C from being used to implement many programs is its dependence on the system clock, 18.2 ticks per second, much too slow for many applications.

However, looking at a book describing Microsoft C v6.0, I was surprised to learn that it was able to measure events much quicker, 450,000 ticks per second. At this rate, a C program could be used for many real-time applications.

Does the speed of response for a C program depend on the particular compiler being Visual C, Ansi C, etc.?

**12997 Thomas Ng**  
San Jose, CA

I have a student who needs help with a VICA project. He wants to build a Tesla coil that operates from 12V (two six-volt lantern batteries).

We know we can use a 555-timer circuit to generate the pulses we need, but also need an efficient way to boost the voltage out of the pulser circuit to 25V-50KV.

I have some flyback transformers, but am not sure if that would be the proper way to get the job done.

**12998 David Mixer**  
Leander, TX

Can someone suggest a source of information on fusible resistors?

What are they? How are they constructed and tested? How are they specified?

**12999 Wendell Coutts**  
Nashville, TN

I read the article on "Reviving NiCad Powered Devices" and have a question.

Thirty years ago, I used to build power supplies for reclaiming gold by electroplating and the major problem was "dendrites" growing between the plates and having them short out. We then switched to "periodic

reverse" plating in which for gold it was about 90% plating followed by 10% deplating. This seemed to have a smoothing effect and there were no complaints about shorts, then they switched over to them completely.

It would be interesting to know if a NiCad charger could be built using this technique to eliminate this problem and, of course, incorporate the other features that he mentioned about charging current.

**129910 Charles Andrew**  
via Internet

I need information on how to use the Intel "Prompt 48" microcomputer design aid. Schematics would be helpful, but the user manual will suffice.

**129911 Bill Kotaska**  
St. Louis, MO

I read enthusiastically *Nuts & Volts* articles on NC routers because I was building one. It is complete now, but has a serious motor noise problem.

I am using a 14,000 RPM 120V .5A AC-DC motor and it throws horrible garbage on the logic board even though everything is disconnected except the power cords. I even isolated them with an unplugged, uninterruptible power supply, so it must be radiated. It looks like about 60 MHz on a scope, but is all over the nearby FM radio band.

How can I quiet it down so the logic board will stop getting lost?

**129912 Jim Soquel**  
via Internet

I was posed the following question regarding stranded versus solid wire.

Supposedly, stranded wire of a particular gauge is rated to carry more current than a solid wire of similar gauge (at DC or power line frequencies where skin effect is negligible). I was unable to explain why, as this definitely is not within my area of expertise.

First, making it clear that I didn't know what I was talking about, I did speculate that the stranded wire would have more surface area, thus more heat dissipation ability, but it seems that would be a factor only in

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
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- The question number and a short summary of the original question will be printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

## QUESTION INFO

### TO BE CONSIDERED FOR PUBLICATION

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

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

### INFORMATION/RESTRICTIONS

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

### HELPFUL HINTS

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

the case of uninsulated wire. This brings up three questions:

1. Is it true that stranded wire has higher current carrying capability?
2. If the answer to question #1 is yes, why is this?
3. Does stranded wire of a particular gauge have more, less, or the same metallic cross-sectional area as its solid wire counterpart of a similar gauge?

**129913 David J. Mehrl**  
Lubbock, TX



I have an EEPROM reader and writer card that plugs into an eight-bit ISA slot on the motherboard of my desktop.

Often I have to reprogram an EEPROM at a job site, but this requires me to go back to the shop to rewrite the EEPROM, then back to the job.

Does anyone know a way to hook this ISA card to a laptop so that I can program the EEPROM in the field? It's an old laptop, so I do not mind making any necessary modifications to it. I'll also have access to 110V, if necessary.

**129914** Dean Thompson  
Phoenix Electronics  
DBT4251@aol.com

I have an older, color Mac scanner. Is it possible to convert it to PC?

**129915** Jordan P. Barrette  
via Internet

## ANSWERS

### ANSWER TO #109914 - OCT. 1999

I am seeking information on how to build a battery load tester.

The testing of lead acid or any other type battery consists of more than simply measuring the terminal voltage. All batteries experience failure in several ways.

Lead acid typically will fail from either high impedance, basically the internal cells will become insulators. This is evident when applying charging voltage to the cell(s) and the terminal voltage = the charging voltage, and very low or no current flow from the charging circuit into the cell(s). Sometimes applying a much higher charging voltage will cause the cell(s) to accept current, and they may rejuvenate.

### ANSWERS TO #109915 - OCT. 1999

I recently bought a Leviton DHC X-10 Inductive Dimmer Switch. I tried it on my ceiling fan and it worked, but caused an annoying hum. I want to replace the triac inside of it with a Teccor "Alternistor." Would this improve the hum? Is it safe to attempt this kind of modification?

**#1** The hum in the fan is caused by the core of the motor vibrating due to the time varying magnetic fields. It could be that the core laminations are somewhat loose, or it could be that the motor is not well-isolated mechanically from the housing.

Vibration is also probably being transmitted to the ceiling, which makes an excellent sound board. Due to the inductive nature of a motor and transformer (or relay for that matter), usually a controller designed for fan use should be used.

As with any SCR or TRIAC controller, there are different control methods. The simplest is to turn on the load at some non-zero point in the AC sine wave. This effectively changes the average voltage (since the current is actually only on for a portion of the sine wave). Earlier fan controllers used tapped inductors to control the current. This provided a uniform, but reduced amplitude sine wave for the motor.

SCR controllers are used extensively in high power variable DC power supplies. Since the chopped AC is rectified and followed with a matched filter network, the fractional sine wave input is not a problem.

As for the alternistor, substituting it for a pair of SCRs or TRIAC would have no effect on the hum. These devices all operate basically the same way, though the statement that the alternistor is better for highly inductive loads suggest it will not self-destruct as easily from the transients produced when switching an inductive load.

AC or DC, interrupting the current flow through an inductor (as when opening a switch, or turning off an SCR) can still produce transients capable of destroying semiconductors.

As to whether you would want to undertake a component exchange, as long as you know that the devices are interchangeable (voltage and current ratings similar and

the available drive signal is adequate). And you are comfortable making such modifications, go ahead. But since it won't affect the objectionable hum, why bother. As a side note, some fans simply produce more audible noise than others.

**Rick Nelson**  
Newport News, VA

**#2** The problem with the triac dimmer control on an inductive load is the delay in turning on the device for a portion of the AC power cycle to effect the dimming or speed control.

This delay in turning the device on causes a square edge on the leading edge of each cycle. The inductive motor does not like this rapidly rising edge. It causes the accompanying hum in the motor. All triacs typically turn off when the trailing edge of the AC sine wave nears zero volts (typically 1-2 volts depending on the holding current of the particular device).

This trailing edge shut-off of the device typically will not cause the hum in the motor. It is caused by the rapidly rising edge on the front of the cycle when the triac is abruptly turned on when the adjusted threshold voltage is reached.

These type devices all work the same with the rapidly rising turn on voltage, and turn off being near the zero crossing when the load current drops below the holding current.

The device you mention, if it's only improvement, is its better turn off characteristics. I would think it would make little difference in the hum from the fan. The only thing that should effect that is to slow the turn on rising edge. But in so doing, you will create additional heat in the device because the turn on not being instantaneous will have load current flowing across the device while it is slowly turning on.

I am wondering if a non-polarized capacitor across the motor, and maybe an inductor in series might smooth the abruptly rising edge, and dampen the hum. Guess you would call that a filter ...

**Ed Pruitt**  
Keller, TX

Doing this, you must monitor the voltage and current closely, and provide a constant current source that will limit the maximum current. This can be as simple as a light bulb in series with one of the terminals. Also, monitor the battery or individual cells for excessive heating. Even a small current across a high impedance cell can cause excessive heating if the charging voltage is well above the

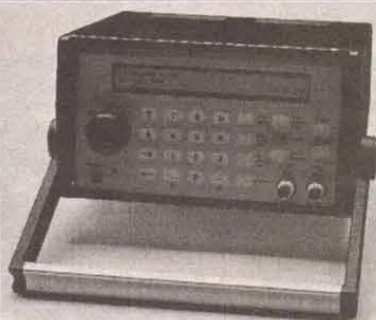
rated voltage of the battery or cell.

A high impedance cell with a high voltage drop across it and minimal current flow can produce excessive heat. ( $P = E \times I$ )

The second typical failure is the LOW charge capacity. (I charge it all week, and it goes dead in 15 seconds.) Again, measuring the open circuit terminal voltage, it will show full rated voltage. But apply a typical

load of say 1/10 the amp hour rating and measure the time for the cell voltage to reach about 1.75V/cell or about 10 volts for a 12-volt battery. The time should be somewhere near 10 hours. (x amp hours discharged at 1/10 x rate = 10 hours.) Anything less than this indicates a battery that is low in capacity compared to rated capacity.

The only drawback is you need to



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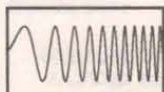
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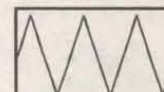
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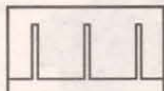
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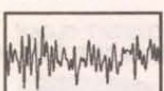
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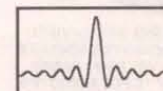
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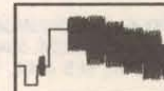
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monitor the battery for 10 hours. Obviously, discharge rates approaching the one-hour rate [i.e., 7 amp load for a 7 amp-hour] the battery should hold for one hour.

Many batteries like the ones you mention are generally designed for lower discharge rates typically 1/10 of the amp rating for one-hour rate. This has to do with the internal connections to and between cells.

Higher currents cause excessive internal voltage drop, and cause heating. In most cases, a quick test will fail to disclose a low capacity battery.

The third failure mode is shorted cells. This will cause the open terminal voltage to be lower than the rated voltage, by two volts per cell. So, if a 12-volt battery has one shorted cell, its terminal voltage will indicate 10 volts.

The confusing part of this is the charge state of the battery. It could be virtually fully discharged, and all cells okay, and read 10 volts. This test should be performed with a typical charging circuit applied to the battery.

If the example 12-volt battery reads 10 volts while being charged, it likely has shorted cells. Shorted cells cause the charge current to increase unless some type of constant current charger is being used.

So a simple push-button tester with LEDs to indicate good, bad etc., is going to be something like the auto stores are using. It is a microprocessor controlled testing sequence to test for all failure modes. They are built for specific battery groups like the typical automotive 12-volt battery.

A fairly simple circuit would have a voltmeter, a load to discharge the battery over time, and a charging circuit to make sure the battery is as fully charged as it can be prior to testing the terminal voltage, then the discharge time using the load, all the time monitoring the voltage, and current into and out of the battery.

Usually when I have a battery of questionable quality, I charge it for 10-14 hours at 1/10 at its amp-hour rating, and then discharge it into a typical load, and see how long before it fails. I do this after I have determined it is not high impedance or has shorted cells.

Ed Pruitt  
Keller, TX

## ANSWER TO #11996 - NOV. 1999

Does anyone know of a product that can block Caller ID in Australia?

There is no way for a customer to stop Caller ID signals from going out, they are generated by the phone

company at the switching center.

The telcos in the USA are required to not send the data if the customer requests, either on a per-call basis or on all calls. The only exception is when calling toll-free numbers and emergency services. The Australian phone company probably does the same, check with them.

Mark Phillips  
Kings Park, NY

## ANSWER TO #11991 - NOV. 1999

Does anyone know of a good reference book or information on troubleshooting strobe lights that work off of the 12-volt system in a vehicle?

Try this website for strobe-related questions: <http://repairfaq.physik.tu-berlin.de/repairfaq/strobfaq.htm>.

Twelve-volt strobe systems, much like 12-volt capacitive discharge ignition systems use a DC-to-DC converter to increase the 12 volts to somewhere around 300 volts.

This voltage is stored across a capacitor designed with minimal internal inductance. A much smaller capacitor, perhaps 0.1uF, is also connected to this voltage through a resistor to limit its charge rate.

A diac is then generally used, in series with a trigger transformer

with the smaller capacitor as its power source, to ionize the gas in the flash tube. A fine wire wrapped around the flash tube or a conductive paint stripe on it is usually used for this.

Once the gas is ionized, it becomes conductive and the energy in the larger capacitor is given up in the ensuing flash. The flash rate is determined by the rate at which the smaller capacitor charges to the diac breakdown voltage, which is usually about 22 volts.

In the case of a triggered strobe — as would be used in photography — the diac is replaced with a switch. A diac is basically just a SCR that conducts when a given voltage is reached. Some circuits use a neon bulb in its place.

Klaus  
via Internet

## ANSWER TO #11998 - NOV. 1999

I want to experiment with varying light intensities using ordinary household light bulbs.

I need to automatically and very slowly, cycle voltage up and down between 60 VAC (or so), and 120 VAC, taking as much as 20 minutes to go all the way up and as much as 30 minutes to go all the way down.

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## TECH FORUM

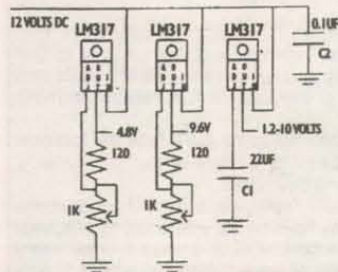
be found at Jameco, 1-800-831-4242. They offer an electronic kit, part number 127589 is a slow on, slow off dimmer that has two modes of operation. Dims are two seconds to one hour, and a timer dimmer independent adjustment one second to 30 minutes. See page 79 of their new catalog #993.

Joseph Kish  
Clackamas, OR

### ANSWER TO #11992 - NOV. 1999

I have a robotics project that has a 12-volt system. I need to reduce the voltage to 4.8 and 9.6 volts to run servos and accessories. Also, I need to reduce the main drive motor voltage to three volts, then increase to 12 volts over five seconds.

You left out an important piece of information: The current required by your circuits. If the current draw is less than 1.5 amps, these circuits will do:



The rate of voltage rise is determined by the value of C1. Smaller is faster. You will lose about two volts in the LM317, so the maximum output is 10 volts with 12 volts input.

Russell Kincaid  
Milford, NH

### ANSWERS TO #11994 - NOV. 1999

I need a source and supplier for electronic radio tubes. I repair and restore old radios and the tubes are difficult to find.

#1 Although solid-state devices currently dominate today's electronics, vacuum tubes are still being used to build guitar amplifiers and by audiophiles in their high-quality audio component systems. Tubes are also still being used in audio recording studios, in specialized types of audio processing equipment.

As the demand for tubes being used in these applications continues, it has forced prices upward. For an excellent article about this, go to [www.spectrum.ieee.org/select/0898/tube.html#sb2](http://www.spectrum.ieee.org/select/0898/tube.html#sb2)

One of the best sources for tubes and other old radio parts is **Antique Electronic Supply** in Tempe, AZ. They have a nice catalog which lists over 70 pages of tubes, sockets, speakers, grill cloth, books, knobs, and other hard-to-find parts; 1-800-706-6789. They also list many old (tested) tubes, as well as "new, old stock" (NOS) tubes. Their catalog is also a helpful source of information about the parts, which ones might most appropriately be used, etc. They can furnish copies of old radio schematic diagrams for \$6.50 each. Their web site is located at [www.tubesandmore.com](http://www.tubesandmore.com)

Another good source for tubes is **RF Parts Company**, 1-800-737-2787 or 1-800-RFPARTS. Their web site is located at [www.rfparts.com](http://www.rfparts.com). They have a minimum order of \$25.00, but their prices are good. Their online catalog lists a large assortment of receiving tubes, as well as tube sockets and other parts.

The major manufacturers of tubes are now in Russia (Svetlana and Sovtek), China, Yugoslavia, the Czech Republic, and in Eastern Europe. During the recent war in Kosovo, one of the Yugoslavia tube factories was damaged by the bombing, so it may be some time before they resume tube production. A web search for Svetlana will take you to a page with a multitude of related links. [www.svetlana.com/docs/relatedsites.html](http://www.svetlana.com/docs/relatedsites.html)

The quality of tubes made in China has been questioned by many, and you should be aware that many private label tubes currently being sold are made in China.

Continued on next page

### ANSWER TO #9996 - SEPT. 1999

I have a NEC model #DX-1000U VCR that has encountered a micro-processor failure. Can you direct me to someone who can supply me with old NEC parts?

You're going to have to hit the hamfests, swap meets, garage sales, rummage sales, Goodwill, Salvation Army, and probably several local radio/TV/VCR shops to find that VCR, or one that has that CPU in it.

If you're really desperate, and you have Internet access, you can go to sites like E-bay and such, and post that you are looking for a NEC DX-1000U.

Please note: A lot of these places will want to sell you the whole VCR. But, if it is working, and in better shape. I would just keep the other VCR as spare parts.

Terry Baker  
Lindstrom, MN

### ANSWER TO #11993 - NOV. 1999

I need hook-up schematics of E-Lab's serial-to-parallel interface (EDE 1400) and parallel/serial transceiver (EDE 300).

A prime choice may be to check the manufacturer's website or to contact them directly. They will probably be able to give you the data (for free), they are:

**E-Lab Digital Engineering, Inc.**, 1932 Hwy 20, P.O. Box 246, Lawton, IA 51030-0246. E-Mail: [elab@netins.net](mailto:elab@netins.net) Web: [www.netins.net/showcase/elab](http://www.netins.net/showcase/elab) Voice: 712-944-5344 fax 712-944-5501.

Thomas Ng  
San Jose, CA

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11666A, Reference Bridge, 0.4-18GHz	\$800
11721A, Frequency Doubler	\$600
11975A, Amplifier, 2-8GHz	\$2000
16508, 80 Channel Logic Analyzer	\$2000
16500A, Logic Analyzer Mainframe	\$750
214B, 10MHz Pulse Generator	\$1000
3312A, Function Generator, 1Hz-13MHz	\$700
3325A, Synthesizer/Function Generator	\$1000
3325A01/02, Synthesizer/Function Generator	\$1500
3335A, Frequency Synthesizer, 200Hz-81MHz	\$4000
w/Opt. 01	\$800
3456A, Digital Multimeter, 6.5 Digits	\$300
3468A, 5.5 Digit Multimeter	\$375
3468B, 3.5 to 5.5 Digit Multimeter	\$700
3478A, Digital Multimeter	\$400
3488A, Switch Control	\$600
3551A, Transmission Test Set	\$5000
3562A, Dynamic Signal Analyzer	\$1500
35677A, S-Parameter Test Set	\$1000
3575A, Phase Gain Meter 1Hz-13MHz	\$6000
3577A, Network Analyzer, 5Hz-200MHz	\$800
3581C, Selective Voltmeter	\$1500
3582A, Spectrum Analyzer, 0.02Hz-25.5KHz	\$4750
3585A, Spectrum Analyzer, 20Hz-40.1MHz	\$1800
3852A, Data Acquisition/Control Unit	\$300
4342A, Q-Meter	\$700
435B, Power Meter	\$2750
436A, Power Meter w/Opt. 022	\$1100
438A, Power Meter	\$800
4935A, Transmission Impairment Test Set	\$1000
w/Opt. 003	\$2500
5316B, Universal Counter	\$2500
5328B, Universal Counter	\$1000
5340A, Frequency Counter w/Opt. 01/02/011	\$1000
5342A, Microwave Frequency Counter, 10Hz-18GHz	\$900
54100A, Digitizing Oscilloscope	\$1700
54100D, 1GHz Digital Oscilloscope	\$2700
54110D, 1GHz Color Digitizing Oscilloscope	\$2500
54201D, Digitizing Oscilloscope	\$2650
6011A, Autorange Power Supply, 20V/120A, 1000 Watt	\$1200
6012B, DC Power Supply, 0-60V/0-50A/1000 Watt	\$2250
6034A, DC Power Supply, 0-60V/0-10A, 200 Watt	\$1000
6274B, DC Power Supply, 0-60V, 0-15A	\$1250
6475C, DC Power Supply, 0-110V, 0-100A	\$3500
6632A, DC Power Supply, 0-20V, 0-5A, 100 Watt	\$1000
7035B, X-Y Recorder	\$250
778D, Dual Directional Coupler	\$400
8013B, Pulse Generator	\$500
8082A, Dual Pulse Generator, 250MHz	\$1200
8112A, 50MHz Pulse Generator	\$3300
8116A, 50MHz Programmable Pulse/Function Generator	\$3000
8165A/002, Programmable Signal Source w/AM	\$1500
8341A, Synthesized Sweeper, 0.01-20GHz	\$13,000
w/Opt. 02	\$14,500
8341B, Synthesized Sweeper, 0.01-20GHz	\$2500
8347A, RF Amplifier, 100kHz-3GHz	\$4000
8349B, Microwave Amplifier, 2-20GHz	\$1000
8350A, Sweep Oscillator Mainframe	\$1250
8350B, Sweep Oscillator Plug-In, .01-2.4GHz w/Opt. 02	\$5000
8352A, RF Plug-In, .01-8.4GHz w/Opt. 02 & 04	\$1750
8354A, Oscillator Plug-In, 5.9-12.4GHz	\$600
8495H, Programmable Attenuator (unused)	\$1000
8501A, Storage Normalizer	\$1200
85021B, Directional Bridge	\$13,000
8510B, Network Analyzer w/Opt. 010	\$5500
8511A, Harmonic Frequency Converter, 45MHz-26.5GHz	\$800
8548B, RF Spectrum Analyzer Plug-In, 500KHz-1250MHz	\$4500
8569A, Spectrum Analyzer, .01-22GHz	\$1250
8622B, Sweep Oscillator Plug-In, .01-2.4GHz w/Opt. 04, Rear Output and 8620C Mainframe	\$1150
86290A, RF Plug-In, 2.0-18GHz	\$1550
86290C, RF Plug-In, 2.0-18GHz	\$700
8640A, Signal Generator, 0.5-512MHz	\$2100
8640B, Signal Generator, Opt. 002, 5-1024MHz	\$2200
8640C, Signal Generator, Opt. 1, 2	\$450
8654A, Signal Generator, 10KHz-990MHz	\$1700
8656B, Signal Generator, 0.1-990MHz w/Opt. 02	\$2250
8660C, Synth. Signal Generator w/Opt. 1 & 100	\$800
86603A, RF Plug-In, 1-2600MHz	\$950
86603A, RF Plug-In, 1-2600MHz w/Opt. 02	\$13,000
8662A, Synthesized Signal Generator, 10KHz-1280MHz	\$27,500
8671B, Synthesized CW Generator	\$3500
8672A, Synth. Signal Gen., 2.0-18.0GHz	\$4500
8672A, Synth. Signal Gen., 2GHz-18GHz, w/Opt. 08	\$1350
8748A, S-Parameter Test Set w/Opt. 025	

8756A, Scalar Network Analyzer	\$1500
8757A, Scalar Network Analyzer, 10MHz-60GHz	\$4000
8970A, Noise Figure Meter	\$4500

### TEKTRONIX

11A32, Two Channel Amplifier Plug-In, DC-400MHz	\$1250
11A34, Four Channel Amplifier Plug-In, DC-300MHz	\$1500
11A52, 600MHz Two Channel Vertical Amplifier	\$700
1503, TDR Cable Tester w/Opt. 04 Recorder	\$1550
1503B, TDR Cable Tester w/Opt. 04	\$2450
2215, 60MHz Oscilloscope	\$500
2236, 100MHz Oscilloscope w/Counter/Timer/DM	\$700
2246, 100MHz Oscilloscope	\$1600
2247A, 100MHz Oscilloscope w/Counter/Timer/Volmeter	\$2500
2337, 100MHz Oscilloscope w/DM	\$1650
2430A, 150MHz Digital Oscilloscope	\$2350
2430R, 150MHz Digital Storage Oscilloscope	\$1800
2432A, 300MHz Digital Storage Oscilloscope	\$3000
2445, Four Channel 150MHz Oscilloscope	\$1500
2465, Four Channel 300MHz Oscilloscope	\$2000
2465A DV, Four Channel 300MHz Oscilloscope	\$3850
2465CTS, Four Channel 300MHz Oscilloscope w/CC/TWR	\$2500
2467, Four Channel 350MHz Oscilloscope	\$3000
2467B, Four Channel 400MHz Oscilloscope	\$4500

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475A, 250MHz Oscilloscope	\$800
492P, Programmable Spectrum Analyzer, 50KHz-21GHz w/Opt. 1/2/3	\$7000
577D2, Curve Tracer, Non-storage w/177 Fixture	\$1750
7D20, Programmable Digitizer	\$400
7L5L3, Spectrum Analyzer, 20Hz-SMHz w/Opt. 025 Tracking Generator	\$1850
7L12, Spectrum Analyzer, 100KHz-1.8GHz	\$1500
7L18, Spectrum Analyzer Plug-In, 1.5-18GHz	\$2500
Capable of 60GHz with Mixers	\$450
7S12, TDR/Sampler	\$450
7M5003, Three Slot Power Mainframe	\$450
7M5006, Six Slot Power Mainframe	\$550

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Datron 1061A, 6.5 Digit Autocal Multimeter, DC Only	\$700
Datron 1062, 6.5 Digit Autocal Multimeter, DC/AC/Ohms	\$900
EIP 545A, Microwave Frequency Counter	\$800
EIP 548A, Frequency Counter, 10Hz-26.5GHz	\$2000
EIP 548B, Frequency Counter, 10Hz-26.5GHz	\$3250
EIP 578, Source Locking Frequency Counter	\$2500
Fluke 1100B, Voltage Calibrator w/Opt. 03 & 05	\$2500
Fluke 5200A, AC Voltage Calibrator w/5205A Amp	\$1850
Fluke 7261A, Universal Counter/Timer, 0Hz-125MHz	\$350
Fluke 8010A, Digital Multimeter	\$175
Fluke 8012A, Digital Multimeter	\$175
Fluke 8050A, Digital Multimeter	\$250
Fluke 8502A, Digital Multimeter, DC Only	\$225
Fluke 8520A, Digital Multimeter	\$350
Fluke 8600A, Digital Multimeter	\$65
Fluke 8810A, Digital Multimeter	\$250
Fluke 8840A, Digital Voltmeter w/Opt. 059	\$600
Keithley 195A, Digital Multimeter	\$700
LeCroy 7200, Precision 400MHz Digital Oscilloscope w/ (2) 7242B Plug-Ins	\$7000
LeCroy 9450, 350MHz High Performance Digital Oscilloscope	\$3250
Marconi 2019A, Signal Gen., 80KHz-1040MHz	\$2200
Polaroid 1105E-FT, Signal Generator, 0.8-2.4GHz	\$400
PSY 500, Frequency Synthesizer, 1-500MHz	\$450
Stromm Donner 6530, Frequency Counter 10Hz-26.5GHz	\$1000
Trans. Devices DLR400-15-2500A, Dynamic Load	\$1500
Trans. Devices DLPV 130-110-1000	\$950
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Wavetek 178, Automatic Synthesizer	\$1700
Wavetek 852, Dual Hi/Lo Filter	\$1000
Wavetek 2001A, Sweep Generator, 1-1400MHz	\$450
Wavetek 2500A, Signal Generator, 2-11MHz	\$2250
Wavetek 3000-200, Signal Generator	\$900
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Wavetek 8501, Peak Power Meter	\$2000
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HP 141T, Spectrum Analyzer w/8552AB/8553B, 1KHz-110MHz.....	\$1,000	HP 8640B, Signal Generator, 5-105MHz, Opt. 001 or 003.....	\$700
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HP 141T, Spectrum Analyzer w/8552AB/8553B, 1KHz-110MHz.....	\$1,000	HP 8660D, RF Signal Generator, 5.4-18GHz.....	\$1,700
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HP 415E, SWR Meter.....	\$100	HP 8901A, Modulation Analyzer.....	SPECIAL \$650
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HP 3314A, Function Generator, Opt. 001.....	SPECIAL \$950	Rockland 5100, Synthesizer, DC-2MHz, .001 Hz Resolution.....	\$325
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HP 3400A, RF Voltmeter, 50V-3V, 1.2GHz.....	\$200	Sencore SC81, Scope (100MHz) w/New Probes, Dual Trace.....	\$950
HP 3455A, DMM 4-1/2 Digit.....	\$250	Sencore SC81, Scope (100MHz) w/p Probes, Dual Trace.....	\$400
HP 3456A, DMM 4-1/2 Digit.....	\$250	Sencore TVAS92, TV Video Analyzer.....	\$1,100
HP 3456A, DMM 4-1/2 Digit, AC/Battery, 5 Function.....	\$175	Sencore VGS1, Universal Video Generator.....	\$1,200
HP 3488A, Switch Counter.....	\$450	Sorenson DCR-80-5A, Power Supply, 80V @ 5A (metered).....	\$375
HP 3551A, Portable Transmission Test Set.....	\$550	Tek 7514, Plug-in Sampling Plug-in, DC-1GHz.....	\$425
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HP 3580A, Spectrum Analyzer, 5Hz-50KHz, LED Readout.....	\$650	Tek AM502, Plug-in Differential Amp.....	\$225
HP 3580A, Spectrum Analyzer, 5Hz-50KHz, Mechanical.....	\$500	Tek DC503, Plug-in Counter Universal, 100MHz.....	\$150
HP 3582A, Spectrum Analyzer, 0.2-25.5KHz.....	\$1,800	Tek DC509, Plug-in Counter, 135MHz, UNISED.....	\$375
HP 3585A, Spectrum Analyzer, 20Hz-40MHz.....	SPECIAL \$2,800	Tek DM502, Plug-in DMM.....	\$125
HP 3702B, IF/BPF Receiver w/3705 DFT Phase Detector.....	\$475	Tek DM502A, Plug-in DMM.....	\$125
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HP 3770A, Amplitude/Delay Distortion Analyzer.....	\$300	Tek DM504, Plug-in Function Generator, .001-40MHz.....	\$375
HP 3770B, Primary MPX Analyzer.....	\$500	Tek PG501, Plug-in Pulse Generator, 5Hz-50MHz.....	\$175
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HP 4597A, LAN Protocol Analyzer.....	\$175	Tek T922, Scope (15MHz), Dual Trace, NICE!.....	\$175
HP 5314A, Counter, 100MHz, Opt. 002, w/Manual, NICE!.....	\$750	Tek TM503, Power Module, 3 Slot.....	\$125
HP 5314A, Counter, 100MHz, Opt. 001 (basic), NICE!.....	\$425	Tek TM504, Power Module, 4 Slot.....	\$150
HP 5315B, Counter, 100MHz, Opt. 001, w/Manual, NICE!.....	\$275	Tek TM506, Power Module, 6 Slot.....	\$200
HP 5315B, Counter, 1GHz, Opt. 001003, w/Manual.....	\$425	Tek TR503, Plug-in Tracking Generator, 100KHz-1.8GHz.....	\$375
HP 5316A, Counter, 100MHz, HPB.....	\$350	Tek T213, Scope (60MHz), Dual Trace.....	\$375
HP 5328A, Counter, 100MHz w/DMM Opt. 021.....	\$200	Tek T215, Scope (60MHz) Dual Trace.....	\$450
HP 5328A, Counter, 500MHz.....	\$250	Tek T235, Scope (100MHz) Dual Trace.....	\$650
HP 5334A, Counter, 100MHz, Opt. 010 Over.....	\$500	Tek T236, Scope (100MHz) w/Counter/Timer/DMM.....	\$850
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HP 6104A, Power Supply, 0-20, 20-40V @ 2A, 1A.....	\$150	Tek T445A, Scope (150MHz), 4-Channel Cursor Readout.....	\$1,400
HP 6112A, Power Supply, 40V @ 5A (metered).....	\$150	Tek T465, Scope (300MHz), 4-Channel Cursor Readout.....	\$1,400
HP 6116A, Power Supply, 0-100V @ 200MA.....	\$175	Tek 453, Scope (60MHz), Dual Trace.....	\$175
HP 6177C, DC Current Source to 100V@500MA.....	\$250	Tek 455, Scope (100MHz), Dual Trace.....	\$425
HP 6202B, Power Supply, 40V @ 75A (metered).....	\$150	Tek 455B, Scope (100MHz), Dual Trace.....	\$475
HP 6203B, Power Supply, 7.5V @ 3A (metered).....	\$185	Tek 456, Scope (100MHz storage), Dual Trace.....	\$575
HP 6205B, Power Supply (dual), 0-40V @ 3A, 0-20V @ 8A (metered).....	\$175	Tek 475, Scope (200MHz), Dual Trace.....	\$475
HP 6206B, Power Supply, 0-60V @ 1A (metered).....	\$200	Tek 485, Scope (250MHz), Dual Trace.....	\$625
HP 6212A, Power Supply, CV/CV, 0-100V @ 100MA.....	\$125	Tek 485, Scope (250MHz), Dual Trace.....	\$700
HP 6213A, Power Supply, CV/CV, 0-10V @ 1A.....	\$75	Tek 520A, NTSC Vectorscope.....	\$400
HP 6217A, Power Supply, CV/CV, 0-50V @ 200MA.....	\$100	Tek 576, Curve Tracer.....	SPECIAL \$1,400
HP 6218A, Power Supply, CV/CV, 0-50V @ 200MA.....	\$125	Tek 7104, Scope (1GHz) w/7A29, 7A28, 7B10 & 7B15.....	\$1,200
HP 6227B, Dual Tracking PS 0-25V @ 2A.....	\$375	Tek 7904, Scope (dual beam) w/7A24, 7A26, 7B80 & 7B81.....	\$750
HP 6260B, Power Supply, 10V @ 100A (metered).....	\$300	Tek 7904A, Scope w/7A24, 7A26, 7B80 & 7B85.....	\$825
HP 6264B, Power Supply, 0-20V @ 20A.....	\$225	Tek 7904A, Scope (500MHz) Frame.....	\$425
HP 6265B, Power Supply, 40V @ 3A (metered).....	\$200	Wavetek 145, Pulse/Function Generator, .0001-20MHz.....	\$300
HP 6266A, Power Supply, 40V @ 6A (metered).....	\$200	Wavetek 157, Programmable Waveform Synthesizer.....	\$425
HP 6266B, Power Supply, 0-40V @ 5A.....	\$175	Wavetek 185S, CATV Sweep/Transmitter.....	\$750
HP 6269A, Power Supply, 0-40V @ 1.5A (metered).....	\$275	Wavetek 286, Synthesized Function Generator, 20Hz-20MHz (unused).....	\$800
HP 6294A, Power Supply, 0-60V @ 1A (metered).....	\$275	Wavetek 442, Dual HiLo Filter, 1Hz-10KHz.....	\$400
New in box w/Manual.....	\$275		
HP 8011A, Pulse Generator, 1Hz-20MHz.....	\$175		

## Lowest Dealer Price Available

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Refurb. Panasonic 145	\$45	\$40	\$35
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Oak Sigma 99 Channel	\$45	\$40	\$35
75 Channel Converter	\$18	\$18	\$18
Zenith ST1600 w/Remote	\$75	\$70	\$65

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## TECH FORUM

The audio amplifier tubes being used in guitar amps are in rather heavy demand, and this has driven the price of them up considerably. There are a lot of dealers for these tubes to be found on the Internet. For example, **Mojo Musical Supply** [www.mojotone.com/catindex.html](http://www.mojotone.com/catindex.html) lists a number of tubes, transformers, and other parts needed to build and repair tube-type guitar amps. A lot of these same parts can be useful in the repair of old radio equipment, as well.

You should also visit any local hamfest, as many radio amateurs are also interested in old radio equipment, and you'll almost certainly be able to find an assortment of tubes (NOS and used) at any hamfest. Often, you'll find some nice old radio equipment for sale in the flea market division of most hamfests.

The American Radio League's monthly magazine *QST*, lists the location of hamfests all over the country every month, and there are usually several classified ads listing collectors who sell and buy tubes.

Other vendors of tubes include <http://st6.yahoo.com/thetubestore/index.html>. This site is in Canada, but they have an extensive listing of tubes, which includes JAN/Philips military spec tubes, NOS, and various other manufacturers. They include a brief description of each tube type, where it was made, and some of the features/virtues of each particular tube. They apparently deliver tubes internationally, as well as to the US and Canada.

Another vendor of tubes and parts, [www.vibroworld.com/parts/tech2.html](http://www.vibroworld.com/parts/tech2.html). This site features "Tube Talk." Some interesting information about tubes in general. They are also dealers for Ruby Tubes Brand, a line of tubes that are made in China, Russia, Yugoslavia, and the Czech Republic. These tubes are selected and tested, and come with a six-month warranty. Ruby Tubes seem to have a better reputation than most Chinese tubes, in general. This company also stocks tube sockets, shields, and other hardware for guitar amps.

Dwight Johnson  
Booneville, MS

### #2

A check of the World Wide Web turned up these sites:  
Electronic Tubes Online Shopping <http://www.hfin.com/shop/>  
Richardson Electronics <http://www.rell.com/>  
Radio Electric Supply <http://www.mindspring.com/>  
Also, my EEM catalog lists these suppliers:  
BTC Electronic Components, Raleigh, NC; 919-878-5200.  
Dearborn/LP, Wheeling, IL; 1-800-323-0198.  
EEV, Inc., Elmsford, NY; 1-800-DIALEEV.  
Penta Laboratories Div., Chatsworth, CA; 1-800-421-4219.  
Richardson Electronics Limited, Lafox, IL; 1-800-348-5580.

Russell Kincaid  
Milford, NH

#3 A good supplier of tubes that I have used in the past is **Tube World**, 2717 Superior Ave., Sheboygan, WI 53081; 920-208-0353 voice/fax.

A few others include: **ESRC**, 1599 S.W. 30th Ave., Unit 4, Boynton Beach, FL 33426; 561-737-8044 voice.

**Vacuum Tubes, Inc.**, 3246 Floridale Ln., Cincinnati, OH 45239-6203; 513-385-3855 fax.

The Tube Store, 877-570-0979 voice.

John M. Hoyt  
Easley, SC

#4 Alltronic, 2300-D Zanker Rd., San Jose, CA 95131-1114. [www.alltronic.com](http://www.alltronic.com) 408-943-9773 fax 408-943-9776.

This company generally has a nice selection of new and used vacuum tubes. If you check through the classifieds section of this magazine, you are likely to find several other sources.

Robert Turner  
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## Newsbytes

*Continued from page 11*

Day, Halloween, Valentine's Day, Thanksgiving, Independence Day, and all of the major holidays.

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The Twinkle Bulbs 3.5 CD-ROM costs \$24.95 and is available online from Barefoot Productions at <http://www.barefootinc.com>

A \$1.00 donation from each sale will be made to the Make-A-Wish Foundation. Network and site licenses are available.

For more information, contact Barefoot Productions, 1101 W. Enclave Circle, Louisville, CO 80027; 303-665-7843, E-Mail: [info@barefootinc.com](mailto:info@barefootinc.com)

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The disposable phone is a telephone with power controls, antenna, and a microphone-speaker unit. Disposable, recyclable alkaline batteries power it. Because the disposable phone is an inexpensive way to provide telephone service, it has almost limitless applications in today's busy and active world.

The disposable phone is ideal for anyone who needs quick, affordable phone service — from busy convention go'ers to traveling vacationers to working people on-the-go. This unique product also

has applications for outdoor sportsmen such as hunters, anglers, boaters, and rafters, and for use in unexpected emergencies such as injuries or fire.

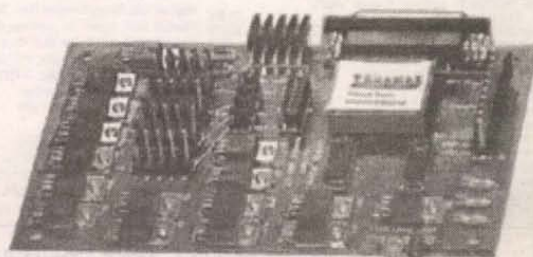
This product is currently in patent pending status and is available for outright sale or licensing arrangements. An exclusive licensing arrangement is available and details can be obtained by contacting the law offices of Fredric D. Abramson, 301-840-9733, fax 301-869-5636. E-Mail: [FDAbramson@compuserve.com](mailto:FDAbramson@compuserve.com).

*Continued on page 86*

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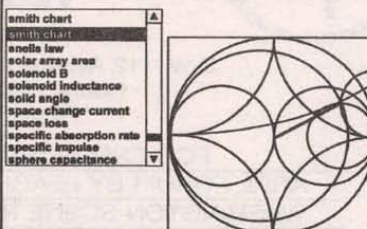


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## Newsbytes

Continued from page 85

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## NEW BOOK AND CD-ROM DEMISTIFY DIGITAL FREQUENCY SYNTHESIS

LLH Technology Publishing announces the publication of *Digital Frequency Synthesis Demystified*, a new book/CD-ROM package that focuses on the latest techniques in digital frequency synthesis, including direct digital synthesis (DDS) and fractional-N PLLs.

Written by Bar-Giora Goldberg, a noted expert in the frequency synthesis field, the book covers synthesis parameters and techniques, system analysis, DDS architecture, PLL synthesis, compression algorithms, and the latest IC synthesizers. Goldberg said, "I'm not aware of any other text that addresses the latest design issues in this exciting and fast-paced technology."

Frequency synthesis is used in cellular telephony, military radios, CB radios, consumer electronics, and other applications too numerous to mention. Recent advances in direct digital synthesis and PLL have made digital approaches extremely popular, and designers

need to access the most current information possible.

LLH's president Carol Lewis describes the book and CD-ROM in this way: "Designers involved in the latest wave of devices making use of DDS will particularly appreciate this text. In addition to the excellent tutorial information in the book, the accompanying CD-ROM contains a variety of software tools and accessories to help designers understand and make use of the latest techniques in this exciting field."

*Digital Frequency Synthesis Demystified* is the newest volume in LLH's "Demystified" series for electronics engineers, which also includes the best-selling *Video Demystified*, now in its second edition. The new book/CD-ROM package sells for \$49.95. It is available at bookstores and over the web at [amazon.com](http://amazon.com). Contact LLH Technology Publishing at 540-567-2000; fax 540-567-2539; Web: [www.LLH-Publishing.com](http://www.LLH-Publishing.com).

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# A Headset Junction Box

by Gerald Roylance

**Have the convenience of a headset on your computer without the inconvenience of having to plug and unplug the speakers and microphone at the back of your computer.**

## Introduction

The audio card on my computer is a wonderful device, and I use it almost every day. Usually, the sound card output drives my speakers, but occasionally I want it to drive a headset with a boom microphone. The headset provides better fidelity with less background noise, and the boom mike is better for recording and speech recognition software. Headsets are more prevalent; two years ago I did not have any, but now I have four — three of which came bundled with software packages.

Unfortunately, using a headset means I have to unplug the speakers and microphone at the back of

*The back of my computer is almost inaccessible, so I wanted an easier method of switching the speakers and headset.*

my computer, and then plug in the headset. Of course, the back of my computer is almost inaccessible, so I wanted an easier method of switching the speakers and headset. A box, some wire, and six jacks made a headset junction box (see Photo A) that makes the task trivial.

To appreciate how inaccessible a computer back plate can be, consider the number of connections on the back of my computer (see Photo B). First are the obligatory power, video, keyboard, and mouse cables. Add to that a SCSI cable for my scanner and a USB cable to a separate hub.

For communication with other computers, my computer has a telephone line and an ethernet cable. A parallel port cable connects the printer, and some exotic devices share a serial port cable. My PROM burner requires its own cable and ISA slot. The picture quality is not great, but there is an antenna cable for the TV tuner and

a patch cord for TV sound (there are additional jacks for a VCR, but I have not used them yet). There would be more cables, but I have run out of ISA and PCI slots on

the motherboard, so my DDS synthesizer gathers dust on the workbench. Finally, there are the sound card speaker and microphone cables, which are what this article is all about. It is a mess back there, and I avoid touching the cables lest something break.

The headset and microphone jacks should be convenient. My VCR got this right — it has convenient "Audio-Visual" inputs on its front panel so you can connect a camcorder without pulling the VCR off the shelf. The headset jacks should reside on the front of the computer or the front of my monitor instead of the jungle at the back of my computer, and the headset junction box lets me put them there.

## Design

A simple solution is to extend the sound card jacks to a better

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Plug end-to-end.  
Stack 32 modules on the same RS-232 cable.



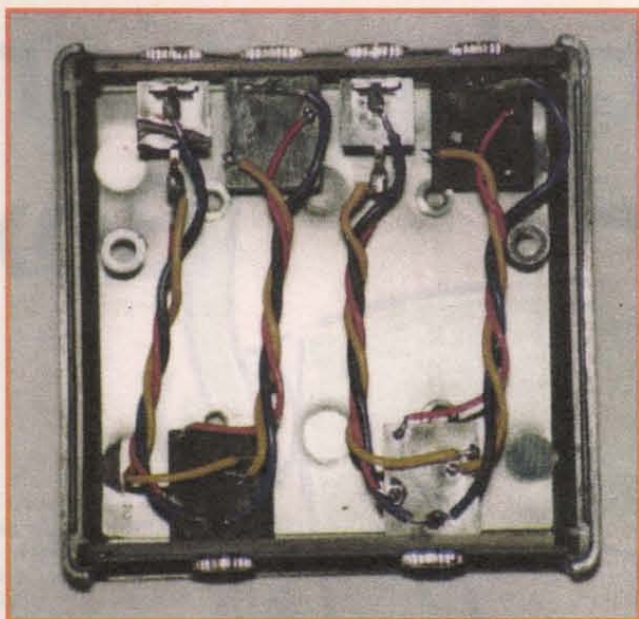


PHOTO A: Internal Wiring

PHOTO B: Rat's Nest

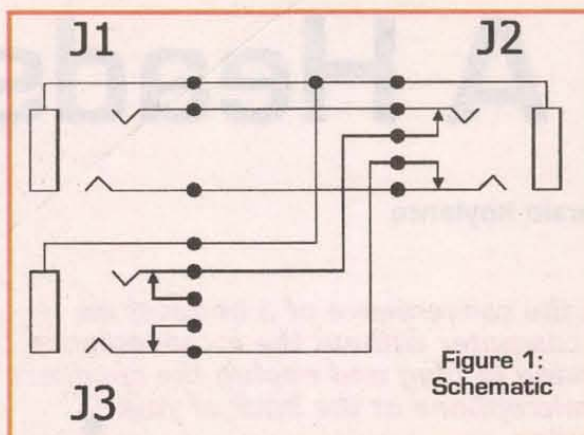


Figure 1:  
Schematic

location. When one wanted to use a headset, he could unplug his speakers and microphone and then plug in the headset. A slightly more clever arrangement avoids unplugging the original speakers and microphone – plugging in the headset would automatically disconnect the speakers. Many stereo receivers disconnect the speakers when the listener connects a headset.

Figure 1 shows the schematic for one circuit. The junction box uses two of these circuits: one for the speakers and one for the microphone. The basic idea is J1 (Sound Card) and J3 (Transducer – either the speaker or the microphone) are on the back of the junction box. J2 (Alternate Transducer) is on the front panel. Normally, the J1 connects to J3, so the sound card will interact with the usual transducer (speaker or microphone). Plugging an alternate transducer (speaker or microphone) into J2 not only connects the alternate transducer to the sound card, but it also disconnects the transducer at J3. The normally closed switches on J2 perform this feat.

Although a microphone is a monaural device, it still requires a stereo (three-wire) jack. The third wire supplies power for microphones with preamplifiers. The preamplifier boosts the signal level and minimizes the effect of electrical noise.

### Construction

If you can, wire the box with shielded cable to minimize the electrostatic coupling between the two sides. Old sound card cables are a good source. I did not have any suitable cable in my junk box, so I twisted the wires together to minimize the magnetic coupling between the two circuits. Also, note that the wires go from J1 to J2 to J3 even though J1 and J3 are next to each

By the way, the terminals on a three-wire telephone plug (or jack) are the tip, ring, and sleeve. Just behind the plug tip is the ring, and the rest of the plug is the sleeve. The 3.5-mm plugs and jacks of a sound card are miniature versions of the original telephone connectors. The two wires of a telephone pair are tip and ring because they connected to the tip and ring terminals of the standard 0.25-inch telephone connector. Telephone switchboard operators used the connectors to complete calls.

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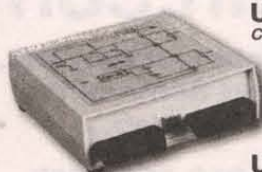
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other. Each signal ground connection (sleeve) takes the long way around to minimize magnetic coupling.

I built the junction box in a plastic box to avoid connecting the signal grounds together (as explained above) and to keep the speaker and microphone circuits isolated. You can use almost any plastic case (Hammond Manufacturing generously donated the one I used). Do not use a metal box unless you also use isolated connectors. If the speaker and microphone grounds are connected together, then some of the speaker current will flow in the microphone ground lead, and that will impress a noise voltage on the microphone input.

The back panel jacks are spaced 0.5 inch apart. The front jacks are on one-inch centers. The holes are 15/64 inch for a tight fit.

Watch out! The diagrams that come with the RadioShack 274-249 3.5-mm jacks have problems. I blindly trusted the package data when I wired everything up. Later testing revealed that tip and ring were swapped, and the reason was the pinout diagrams on the blister pack were inconsistent. Time to pull out the soldering iron and make a few changes ...

## Usage

Connecting the headset junction

box is easy. I used two shielded stereo patch cords (RadioShack 42-2387) to go from my sound card to the J1 jacks on the junction box. The microphone cable should be shielded because the signals are low-level and high impedance, but the speaker cable does not require shielding for its high-level and low impedance signals. My speakers and area microphone plug into the J3 jacks on the back of the junction box. The junction box sits next to my monitor for convenient access (see Photo C).

To use a headset, I need only plug it into the appropriate jacks. Photo D shows the box with a headset plugged in; the box is pulled out to show all the connections.

One thing I do not like about the patch cords that go from the computer to the junction box is that both ends are male. When one end of the cable is connected, the other end is live and exposed. Accidentally shorting the speaker output to ground could damage the sound card, so be careful with the patch cords.

I like the arrangement because it is easy to connect the headset, and the headset has better sound quality than my speakers. Of course, the headset has better frequency response than my cheap speak-

ers, and also blocks out the dull roar of my computer fan. A headset mike is also more convenient than one located on a desk. Good luck. **NV**



PHOTO C:

Junction Box Sitting Next to Monitor

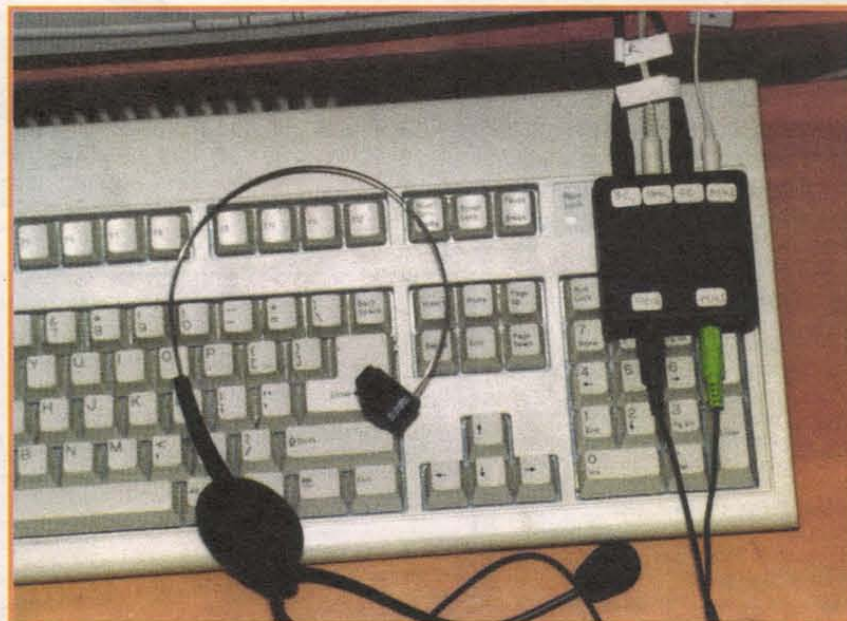


PHOTO D:

Connection of Cables and Headset

## Parts

Plastic case, Hammond Manufacturing 1593KBK.  
For each circuit (two circuits required: one for the microphone and one for the speaker)

**J1** 3.5-mm Stereo Phone Jack, RadioShack 274-249

**J2, J3** 3.5-mm Stereo Phone Jack with NC switches, RadioShack 274-246A

J3 could be the same as J1. I used a jack with NC switches so I could terminate the microphone input when J2 and J3 are unmated. The termination would minimize noise pickup on an open line, but I have not added the resistors yet.

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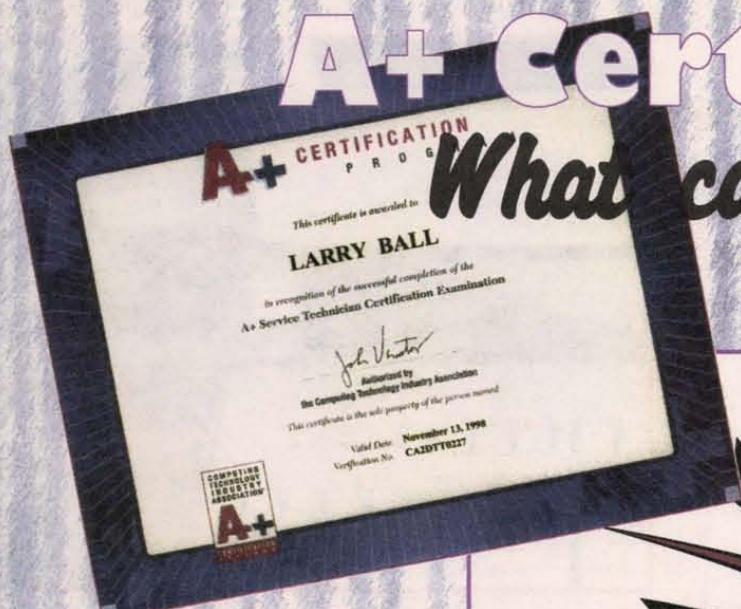
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# A+ Certification —

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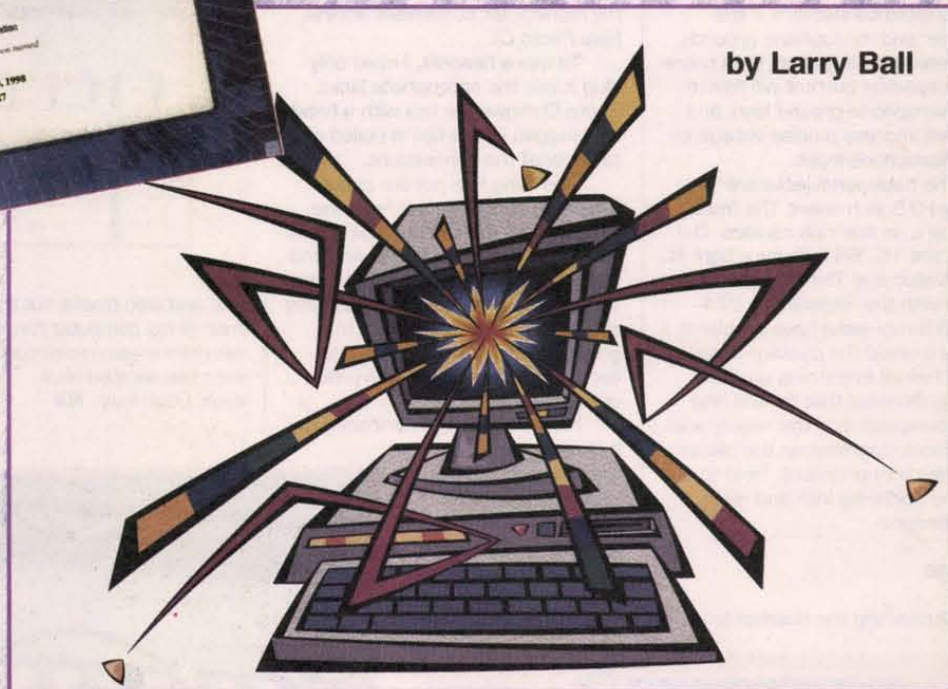


by Larry Ball

You've probably heard of the A+ certification for computer technicians. **But what can it do for you?**

It can be your ticket to better pay, better jobs, and more promotions.

You needn't look any further than your local want ads to see that A+ certification is fast becoming a requirement to "get your foot in the door" when it comes to PC-related jobs.



There are even some high paying computer network support jobs which require A+ certification (as well as other certifications).

A+ certification is supported by a virtual "Who's Who" of major hardware and software manufacturers and dealers. When Microsoft, Intel, Compaq, Hayes, Hewlett Packard, IBM, Tandy, CompUSA, Packard Bell, Digital Equipment Corporation, and over a dozen other companies support a certification, you know it has credibility! In fact, some of these companies refuse to hire technicians for certain positions if they lack A+ certification. This seems to be the trend in the computer industry. More and more companies are requiring it for their employees.

The testing program is sponsored by the Computing Technology Industry Association (CompTIA). It's administered by Sylvan Prometric and anyone can take it. So let's take a closer look at what it takes for you to join the over 100,000 technicians who have already earned the A+ certification.

### The Test

The A+ test consists of two examinations: The core objectives and the DOS/Windows objectives. They can be taken separately or together, but must be taken within 90 days of each other.

The tests reflect the knowledge that a person with six months experience in

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## Sample Questions A+ Core Examination

One reason for an incorrect time/date setting could be

- A. low power supply voltage
- B. low CMOS battery
- C. low disk space
- D. a bad UPS

Correct answer: B

Which type of connector is used for a parallel connection on a printer?

- A. Centronics (36-pin) D-Shell
- B. 25-pin (DB-25) male
- C. 25-pin (DB-25) female
- D. 9-pin (DB-9) male

Correct answer: A

Which statement is true regarding SCSI termination?

- A. Only drives must be terminated.
- B. Only adapters must be terminated.
- C. No termination is necessary.
- D. Both ends of the chain must be terminated.

Correct answer: D

External modems are usually connected to a(n)

- A. SCSI port
- B. LPT port
- C. serial port
- D. parallel port

Correct answer: C

The major advantage of using Flash ROM is

- A. you can upgrade BIOS without replacing the chip
- B. you do not have to re-load the operating system
- C. hard drives are protected
- D. memory capacity is increased

Correct answer: A

A 10BaseT cable is normally connected to a computer with a(n)

- A. BNC connector
- B. TX connector
- C. RJ-11 connector
- D. RJ-45 connector

Correct answer: D

**Figure 1** — These questions are typical of what you might find on the A+ Certification Core examination. This information is from the CompTIA web site and is copyright 1999 by CompTIA.

the computer service field should have. Some of the questions are about basics (like recognizing the components on a motherboard), but most are very specific. Figures 1 and 2 contain sample A+ exam questions. These questions are from the compTIA web site and are similar to what you might see on the tests.

Unless you're a working computer technician with a broad understanding of PC hardware and software, it's wise to study. Of course, novices will need to study more than experienced technicians. You're expected to be familiar with general concepts, as well as specific details. The test's goal is to find out if you have the "hands on" knowledge needed to repair and maintain PC hardware and software.

When taking the examinations, you can expect to be tested on IRQs, displays, operating systems, storage media, printers, modems, expansion busses, installing and upgrading (both hardware and software), problem diagnosis, preventive maintenance, interaction with customers and safety, as well as other areas.

See Figure 3 for an idea of the content of the A+ examinations. Visit CompTIA's web site ([www.comptia.org](http://www.comptia.org)) or request their "candidate information" brochure to learn more about the specific information covered in the tests and to obtain more information on how to sign up. Unlike many tests, the A+ certification examinations aren't taken with a pencil and paper. They're taken on a computer.

You should arrive 15 minutes early so that you can identify yourself to the test administrator, then you'll have an opportunity to learn how the use the

computer-based testing system before the actual test begins. Take advantage of this opportunity. Don't waste your valuable test time learning how the testing program works. One advantage of this format is that as soon as you finish the test, you receive your final score!

The Core examination has 69

## Sample Questions A+ DOS/Windows Examination

Which two files make up the Registry in Windows 95?

- A. CONFIG.SYS and AUTOEXEC.BAT
- B. COMMAND.COM and CONFIG.SYS
- C. MSDOS.SYS and IO.SYS
- D. USER.DAT and SYSTEM.DAT

Correct answer: D

Which file starts programs automatically when Windows 3.1 starts?

- A. WIN.INI
- B. SETUP.INI
- C. SYSTEM.INI
- D. SYSTEM.DAT

Correct answer: A

A(n) \_\_\_\_\_ partition must exist on the hard drive in order to install Windows 95.

- A. CDFS
- B. HPFS
- C. FAT
- D. NTFS

Correct answer: C

The memory addresses from 0 to 640KB are known as

- A. common memory
- B. high memory
- C. expanded memory
- D. conventional memory

Correct answer: D

Which protocol does the Internet use?

- A. DLC
- B. IPX/SPX
- C. TCP/IP
- D. NetBEUI

Correct answer: C

What is one way to recover from the error message "No operating system found" when starting Windows 95?

- A. Insert a CD-ROM with the system files and run the SYS command.
- B. Reboot on a floppy with system files and use the FORMAT C: /F command.
- C. Insert the Windows 95 CD-ROM and use the FORMAT C: /F command.
- D. Reboot on a floppy with system files and use the SYS C: command.

Correct answer: D

**Figure 2** — These questions are typical of what you might find on the A+ Certification DOS/Windows examination. This information is from the CompTIA web site and is copyright 1999 by CompTIA.

## Preparing for the Test

How much you'll need to study for the A+ certification test depends on your level of PC hardware and software expertise. Even if you think you have the test "in the bag," studying will broaden your knowledge and make you a better technician.

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A multitude of companies sell A+ training via mail order, and their formats vary significantly. We'll look at some of them so that you can get a better idea of what's available. There are many considerations when purchasing such materials, but price, quality, and format seem to be the most obvious ones.

### Price

The price of A+ training varies from less than \$100.00 to well over \$2,000.00. At the low end of the scale is the \$85.00 "A+ Certification Kit" published by Sybex and available in local bookstores and through the mail. It consists of two books and two CDs. At the high end of the scale is a complete PC servicing course available from NRI for \$2,100.00. It includes books, software, full subject matter support, a digital multi-meter, and Pentium II computer.

Most A+ self-study kits fall in the \$400.00 to \$800.00 range with the majority near \$600.00. For the budget-minded, Marcraft and Mindworks offer self-study kits for less than \$200.00.

### Quality

When shopping via mail order, quality is the most difficult factor to judge. No matter how well a brochure is written or how specific a salesman is, you can't see the actual study materials

until you've purchased them. Some training vendors have found ways around this problem.

Mindworks and Forefront will allow you to download a free sample of their training software from their web sites.

Micro2000 will send you a demo CD and Marcraft will mail you a sample chapter from their primary training text and lab manual. If you're serious about getting training, you should get these samples. There's no substitute for seeing what you'll be paying for. Some vendors' web sites include free samples of training software and practice test questions.

Visit the web sites listed in the addresses sidebar to see what they're currently offering.

### Format

While quality is the most difficult factor to ascertain when shopping mail order, format is the most confusing. Each company has a different product which (hopefully) consists of different parts. Some vendors sell training in book form only, while others may sell only practice questions on floppy disks. Training packages may consist of books, software, videos, sophisticated test equipment, subject matter technical support, or even a new computer. This makes an "apples-to-apples" comparison impossible. You'll need to narrow the comparison criteria.

The first question you should ask yourself is "what kind of training do I need?" If you lack hardware experience, you should purchase a course which includes hands-on hardware training. It's possible to pass the A+ test without ever having touched the inside of a computer, but a lack of such experience will prove to be an embarrassment on the job.

Once you've decided whether or not you need hardware training, your next format choices will be between computer-based and/or textbook-based

### Skills Tested in Core Examination

Installation, Configuration and Upgrading  
Diagnosing and Troubleshooting  
Safety and Preventive Maintenance  
Motherboards, Processors, Memory  
Printers  
Portable Systems  
Basic Networking  
Customer Satisfaction

### Approximate % of Representation

30%  
20%  
10%  
10%  
10%  
5%  
5%  
10%

Note: The customer satisfaction portion of the test will be scored but will not impact the final pass/fail core of the Core examination.

### Skills Tested in DOS/Windows Examination

Function, Structure, Operation, and File Management  
Memory Management  
Installation, Configuration and Upgrading  
Diagnosing and Troubleshooting  
Networks

### Approximate % of Representation

30%  
10%  
30%  
20%  
10%

Note: Approximately 75% of the test items will relate to Windows 95 and approximately 25% will relate to DOS and Windows 3.x.

**Figure 3 — The A+ examinations cover some areas much more thoroughly than others, you should study accordingly.**

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training. Each one has advantages and disadvantages.

Computer-based training can be interactive and can simulate what happens when you execute certain software commands (or may even simulate software failures). Some companies provide software which links the answers on their practice test to their training text so that you can immediately find more information about questions you don't fully understand. Computer-based training might also include digital videos. Finally, only computer-based training can simulate the actual test conditions you'll encounter when you take the A+ certification test.

Computer-based training has many advantages, but it has one disadvantage. Given a choice, many (if not most) people prefer reading hard copy text rather than computer text.

Some of these programs include 1,000 pages (or even several thousand

pages) of text and graphics. Also, unless your computer is a laptop, books are more portable. Ideally, you should buy a training program which includes both written text and computer software. Most vendors offer such training packages. Marcraft includes their entire training program in both text and software format. That's the best of both worlds.

Another point which needs to be made about format is the number of practice test questions. It's impossible to gauge your learning progress if you inadvertently memorize the answers to the practice questions. You'll want as many practice questions as possible.

With all the different training formats available, some vendors have chosen to compare their products to other companies' products by using comparison charts. Comparison charts can be helpful, but they're also deceptive. Remember: The reason for the chart's existence isn't to help you compare products, it's to make the vendors' product look good. Take a close look at the categories and use your own judgement. Ask yourself "Are these categories important or are they marketing hype?" Most vendors' comparison charts contain both useful and useless comparisons. Read them carefully.

### Get the Latest Information

Like everyone else in the computer field, training vendors are constantly updating and improving their products. The pace of change in the A+ training field is dizzying. For the most current information and prices, contact the companies listed in the sidebar.

### How to Register

To register for the test, contact Sylvan Prometric at 1-800-776-4276, or if you have questions, call CompTIA at 630-268-1818. The cost of taking both portions of the test varies, but for most individuals in North America it's \$256.00. Several discounts are available; visit CompTIA's web site or call them to see if you qualify. NV

## They Wrote The Book

The A+ Certification Exam Guide was developed by IBM, the company which set the standard for Personal Computing. It consists of two large volumes and a CD-ROM disk.

If your goal is to become a certified Computer Service Technician, the Guide is the only reference you should need to successfully prepare for the certifying exam. Over 2,000 pages, it is thorough, yet not cumbersome to use. And once you become a certified Technician, it is still useful as a reference.

The A+ Certification Exam Guide was written by training-education specialists with the experience necessary to guide you through the information that is key to passing the exam. Difficult concepts are clearly explained, and topics and skills stressed on the exam are pointed out. In addition, the volumes include helpful graphics, diagrams, tables and charts.

The CD-ROM disk, which is part of the two volume set, not only contains the entire contents of both volumes, but also, hundreds of very useful sample test questions. There are also Self-Assessment sections at the end of each chapter in the Guide.

This 2-volume set is also a tremendous reference work for anybody who wants to know how PCs work or what to do when they don't work.

The A+ Certification Exam is sponsored by CompTIA.

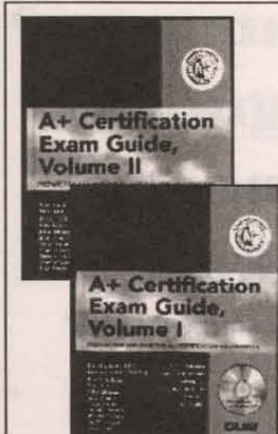
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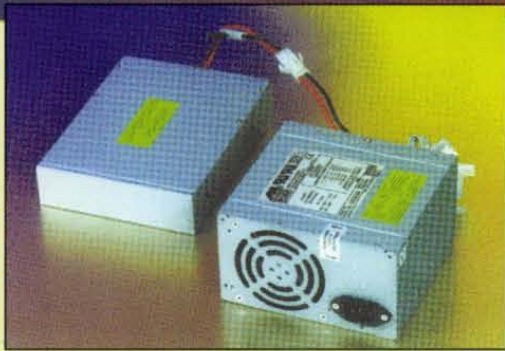


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# New Product News



## BUILT-IN UPS MPS1058 SERIES

**M**agnum's new MPS1058 series of built-in UPS offer full protection against line voltage failures and interruptions.

Housed in standard ATX and PS/2 cases, they directly replace a conventional switching power supply at the heart of a computer or other power sensitive equipment.

The unit functions as a normal power supply when AC power is present and as a true on-line UPS during periods of power failure.

Energy is stored for back-up operation within a small battery pack mounted in a spare disk drive slot or other suitable location within the host system.

Principal advantages over conventional forms of UPS include low cost, high efficiency, high reliability, environmental friendliness, enhanced system security, and the elimination of external cabinets and interconnections.

MPS1058 offers 200W of output power and is capable of operating in industrial and other hostile environments.

All units are fully safety approved and incorporate power factor correction circuitry to comply with current standards.

For more information, contact:

**ACUTECH**  
215 SALEM ST., P.O. BOX 2649, DEPT. NV  
WOBURN, MA 01888-1249  
781-937-0011 FAX: 781-937-3499

## SS9600 SPREAD SPECTRUM DATA TRANSCEIVER



**R**F Neulink, a division of RF Industries announces the introduction of its new SS9600 Spread Spectrum Data Transceiver.

This unit features a full transceiver with a built-in modem and can be used in point-to-point systems, as well as a point to multi-point. Capable of 9600bps over the air rate, this unique small package is a true frequency hopper and large systems with as many as 238 units can be configured. Operating in the 2.4 GHz band, no license is required.

This is a true plug and play radio modem for most small system point-to-point control systems. Built-in self-adjusting

power control insures excellent communications.

Low introductory pricing, plus a one-year warranty, including technical assistance, make this an excellent solution for reliable communications.

For more information, contact:

**RF NEULINK**  
7610 MIRAMAR RD., DEPT. NV  
SAN DIEGO, CA 92126  
858-549-6340 FAX: 858-549-6345  
1-800-233-1728  
E-MAIL: rfneulink@rfindustries.com  
WEB: www.rfneulink.com

## AT-11MP AUTOTUNER

**L**DG Electronics, Inc. announces the AT-11MP, a new model in their Autotuner line of products.

The MP features a dual cross needle meter, providing forward/reflected power and SWR indications. Additionally, an optional remote head is available to allow the tuner to be remotely mounted and still have control over the functions and visual indications of its status.

The MP also features an interface for the ICOM IC-706 radio. While it will operate with any HF radio, the AT-11MP will use the built-in tune button on the IC-706 faceplate and will tune when pressed.

The AT-11MP operates 1.8 to 30 MHz at 5 to 150 watts continuous. The tuning circuit features a switched "L network" and is micro-processor controlled via a Motorola 68HC11. Power requirements are 11 to 14 VDC with a current consumption of 15 to 500mA



(250mA average). The AT-11MP will tune practically any coax feed antenna.

The AT-11MP is available assembled or in kit form: fully assembled and tested, \$239.00; kit with enclosures, \$199.00; and kit without enclosures, \$169.00. The optional remote head assembled and tested price is \$39.00, the kit price is \$29.00. A Balun impedance matching transformer is available to allow the tuner to tune end-feed, long wire, and random length antennas: \$25.00 kit and \$30.00 assembled.

For more information, contact:

**LDG ELECTRONICS, INC.**  
1445 PARRAN RD., DEPT. NV  
ST. LEONARD, MD 20685  
410-586-2177 FAX: 410-586-8475  
E-MAIL: ldg@ldgelectronics.com  
WEB: http://www.ldgelectronics.com

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**Nuts & Volts Magazine**  
**New Product News**

430 Princeland Court,  
Corona, CA 92879  
or E-Mail to

**newproducts@nutsvolts.com**

## NEW HAMWHIP ANTENNAS

**L**DG Electronics, Inc., announces the addition of the hamwhip line of single band mobile ham radio antennas to their line of amateur radio products.

These quality antennas feature aluminum and fiberglass construction and fit on a standard 3/8" antenna mount. The antennas are resonant for each amateur band from 6 to 75 meters, including WARC bands, and are "in-band" tunable for the lowest SWR on your favorite frequency.

These mobile antennas are a perfect match to LDG's AT-11 line of automatic antenna tuners, allowing multiple-band operation from one antenna, a boon to mobile operators.

The hamwhip antennas measure eight feet in length, handle 600 watts (nominal), and are black in color. The external fittings are chrome-plated brass and each antenna withstands the effects of many years of sun and road salts.

Each hamwhip antenna retails for \$22.95 plus shipping.

For more information, contact:

**LDG ELECTRONICS, INC.**  
1445 PARRAN RD., DEPT. NV  
ST. LEONARD, MD 20685  
410-586-2177 FAX: 410-586-8475  
E-MAIL: ldg@ldgelectronics.com  
WEB: http://www.ldgelectronics.com

## K8009 CLOCK KIT

**V**elleman's K8009 15-in-1 LED clock kit is not just a clock! This project also displays date and temperature, has a built-in chronograph with lap time, counts down to a pre-set date, keeps the score of a two-team game, generates random numbers, throws two dice, counts up or down, includes a chime function, and is equipped with a time or temperature alarm with relay output.

It supports both European and US readout formats for time, date, and temperature.

All options are selectable from a distance with the included RF key chain remote. Wired control is also possible.

The K8009 has an easy to understand menu structure, backup battery facility, and a matching enclosure can be ordered separately.

For more information, contact:

**VELLEMAN**  
7415 WHITEHALL ST. STE. 119, DEPT. NV  
FT. WORTH, TX 76118  
817-284-7785 FAX: 817-284-7712  
E-MAIL: velleman@earthlink.net  
WEB: www.velleman.be



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- 3-1/4 Digit LCD Display:** Reads up to 2060. Easy to read display
- Function Dial:** Easy to use to select measurement type or turn unit off
- 4 Jack Plugs:** Safety design with different capacities for different functions
- Diode, Continuity Check Push-Button:** For toggling between diode check and continuity check
- Low Battery Indicator:** Advises you when it's time to change battery
- Extra Long 44" Test Leads:** Helps get to hard to reach places
- Screw-On Alligator Clips:** Convert one or both probe tips to alligator clips
- Fuse-Protected Circuitry:** Built-in fuses make one hand operation easier
- Shock Absorbing Rubber Carrying Case:** with convenient probe storage clips and hanging tab. Helps protect the DMM from damage if accidentally dropped

**Measures:**  
 DC Volts: up to 1000V  
 AC Volts: up to 750V  
 AMPS: up to 20 Amps (AC & DC)  
 Resistance: up to 30M ohm  
 Continuity Check: with audible signal (signal sounds if resistance is less than 20 ohms. Display reads actual resistance)  
 Frequency: (1KHz to 300KHz) displays both digital and bar graph reading  
 Transistor hFE Test: Display shows approximate hFE value based on test condition of 10uA base current and Vce of approx. 3V  
 Temperature Test: Measures from 0° to 1832° F (probe supplied)  
 Diode Test: Tests if diodes are shorted or open

**Specifications**  
**Accuracy**  
 Vdc:  $\pm 1.0\%$  reading  $\pm 5$  digits  
 Vac:  $\pm 1.5\%$  reading  $\pm 8$  digits  
 Adc:  $\pm 1.2\%$  reading  $\pm 5$  digits  
 Aac:  $\pm 1.5\%$  reading  $\pm 5$  digits  
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**Requires two AAA batteries sold separately**

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- Frequency Range: 100KHz to 2.060MHz
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 VM1035A 42mmx42mmx25mm, Standard lens with audio, 12V with back light compensation \$59.00 any qty.  
 VMCB21 44mmx38.5mmx28mm, with 6 infra-red LEDs, 12V \$49.00 any qty.  
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Detailed Specs on the Web

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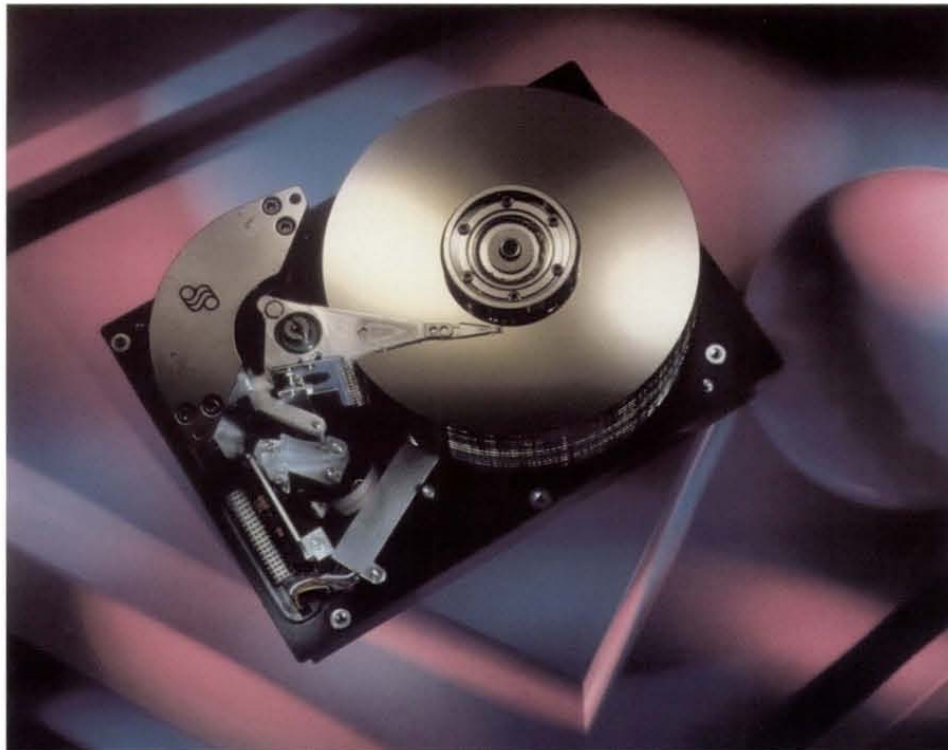
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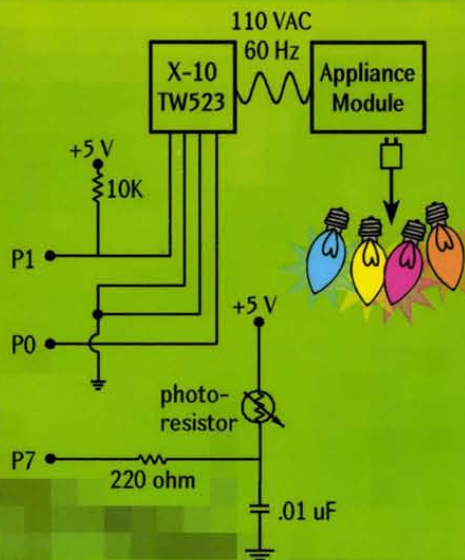
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# Wishing you the best and brightest of holidays!

Parallax wishes you a happy and healthy set of holidays. We thank you for your support during the past year, and look forward to serving you throughout the next year.

Interested in automating your Christmas tree lights with photoresistor activation? Here's a simple project you can build with your BASIC Stamp II, two X-10 modules (one transmitter, and one lamp unit with brightness), a photoresistor and a couple of resistors and capacitors.



The BASIC Stamp II's XOUT command may be used to fade, and turn the lights on or off at specified times. The photoresistor's resistor/capacitor circuit charge time is determined by the RCTIME command.

Complete code and schematics available from our homepage at [www.parallaxinc.com](http://www.parallaxinc.com).



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