

# NUTS & VOLTS

## MAGAZINE



\$3.50  
VOL. 17 NO. 9  
SEPTEMBER 1996

*Exploring Electronics And Technology For The Hobbyist And Professional*

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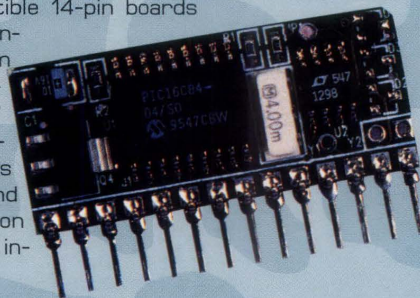




# Micromint Introduces Small, Ultrafast BASIC and C Computing!

There is no debating that the BASIC Stamp<sup>®</sup> I is a great little controller. Unfortunately, it has to sacrifice speed and performance to bring you the convenience of BASIC. Now, Micromint offers Stamp users the best of all worlds: assembly language speed, BASIC and C programmability, and enhanced performance.

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PicStics<sup>™</sup> also have more I/O lines and onboard features. The PicStic<sup>™</sup> 2 has a battery-backed hardware clock/calendar. Most people just call it a real-time clock because it allows you to trigger program events based on a particular time of day or day of the month. PicStic<sup>™</sup> 3 connects you to the analog world through its high-speed, 2-channel, 12-bit A/D converter.

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Price	<b>\$29</b>	<b>\$39</b>	<b>\$39</b>	\$34
BS1 software compatible	yes	yes	yes	yes
Reprogrammable EEPROM	yes	yes	yes	yes
I/O lines	<b>10</b>	<b>9</b>	<b>10</b>	8
Extra features	none	<b>real-time clock</b>	<b>2-channel, 12-bit ADC</b>	none
Programming language	PBASIC compiler; C, assembly lang.	PBASIC compiler; C, assembly lang.	PBASIC compiler; C, assembly lang.	PBASIC interpreter
RAM (variables)	<b>22 bytes</b>	<b>22 bytes</b>	<b>22 bytes</b>	14 bytes
Max. program length	150 inst*	150 inst*	150 inst*	80 inst*
Clock speed	4 MHz	4 MHz	4 MHz	4 MHz
Execution speed	<b>50k inst/s*</b>	<b>50k inst/s*</b>	<b>50k inst/s*</b>	2k inst/s
Max. serial I/O	2400 bps**	2400 bps**	2400 bps**	2400 bps
Packaging	14-pin SIP	14-pin SIP	14-pin SIP	14-pin SIP

\*Maximum program length and execution speed are determined by instruction mix. Overall speed gain is typically at least 15 times while individual instructions may be 100 times faster.

\*\*Comm speed is presently set for compatibility. New compiler versions will allow 9600 bps.

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Does not include PicStic. \$149.00

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## PicStic<sup>™</sup> Most Asked Questions

### 1. Is PicStic BASIC Stamp<sup>®</sup> compatible?

Using the PBASIC compiler, PicStics are 100% BASIC Stamp program compatible, but typically run 15 times faster (7 times faster than BS2) and allow more variables. If you have an existing BS1 program, it can be compiled using the PBASIC compiler and executed exactly as before. The only exception is that because PicStic uses a compiler, interactive features like debug are not compiled with the program.

### 2. I have a BASIC Stamp<sup>®</sup> development system. Can I use it?

No. Parallax BASIC Stamps<sup>®</sup> use an interpreted BASIC with a tokenized BASIC downloader. PicStics use an EEPROM-programmable processor with a compiled PIC assembly language program. So, yes, you'll need a PicStic programmer with either the PicStic C or PBASIC compiler development system.

### 3. How fast is the PicStic ADC?

PicStic uses an LTC1298 12-bit ADC. In a typical application, the ADC can provide 1000 samples per second or more.

### 4. How much current can I draw from PicStic's onboard regulator?

For a 9-V input at 25°C, the 5-V output is typically 100 mA.

### 5. Why does PicStic have two more I/O lines and interrupts too?

PicStic has the same eight general-purpose I/O lines supported in PBASIC, but because PicStic uses an EEPROM PIC16CB4, the two lines required for programming the Stamp aren't required on PicStic. These two I/O lines and the four interrupt sources are available using assembly language (or calls from PBASIC or C).

### 6. What about the 9600 bps or 10 MHz PicStics?

The best part about using PicStic and a compiler is that we can start by being 100% compatible and then add powerful new instructions as they are written. Next versions of the PBASIC compiler will allow 9600 bps, Peek and Poke, and increased clock speeds.



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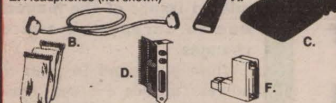
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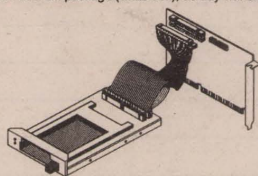
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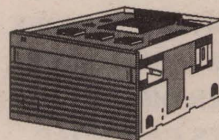
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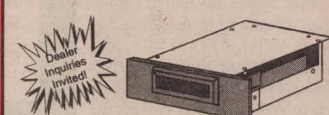
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Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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# reader FeedBack

Dear Nuts & Volts:

I don't usually write to electronic magazines that I have followed since 1945, but someone should give Ronald Reis a pat on the back for such an excellent article on resistors "The Ubiquitous Resistor: All About the Most Widely Used Electronic Component of All Time" July '96.

I was Ham licensed in 1946, radio school USAAF 1944, and am now an extra, but it was a review that really impressed me.

**Harry Tanzer**  
Yucca Valley, CA

Dear Nuts & Volts:

The article entitled "The Ubiquitous Resistor" (July '96, p. 26) incorrectly attributes the invention of the Wheatstone bridge to Charles Wheatstone. In fact, the circuit was invented by Samuel Hunter Christie in 1833. Wheatstone merely encouraged and popularized its use in electrical measurements. Indeed, Wheatstone, in his own writings in the mid-nineteenth century, gave full credit to Christie for the circuit's invention.

**Bill Johnston**  
White Sands, NM

Response:

*Bill is right. Technically, Charles Wheatstone did not "invent" the bridge, which is named in his honor. He "developed" it in 1850.*

**Ronald A. Reis**

Dear Nuts & Volts:

I am an electronic technology instructor at Suburban Technical School in Ronkonkoma, NY and I have found the articles to be a perfect introduction for my students into the hobbyist realm.

There are five instructors teaching five classes during the day. Each class runs 1,200 hours (about 10 months — throughout the year) and covers everything from DC and AC theory, semiconductors and op-amps, communications, digital, DOS, upgrading, and repair of PCs and networks. The four evening classes last 13 months and stress digital technology.

Although we try to allocate a third to a half of our time to laboratory applications and investigation of the lecture part of the course, we are always looking for real applications and fun projects. Your magazine fits the need and the students who have had a

chance to read my copy are motivated to try some of the designs or at least to enjoy the achievement of now being able to understand and to analyze the circuits. For most of these students, this is their first exposure to electronics; they were not brought up with a soldering iron in their hands and a burning desire to make electronic things.

**Roger S. Cohen**  
Holbrook NY

Dear Nuts & Volts:

In a recent Tech Forum column, I inadvertently called an EPROM and Electrically Erasable Read Only Memory (which, if you add Programmable, is the correct name for another device, the EEPROM). An EPROM is actually an Erasable Programmable Read Only Memory. The devices are functionally similar with both being field programmable and erasable; however, an EPROM can only be erased through exposure to ultraviolet light, whereas an EEPROM can be erased (a memory location at a time) while in-circuit. Flash memories belong to this class; however, in this case, the entire device can be "flash" erased at once. Since I use both parts, the error was all too easy to overlook. My apologies for any confusion this may have caused. Aside from the name, the rest of the information was correct.

**Jay Rabkin**  
Pasadena, CA

Dear Nuts & Volts:

As a subscriber, I want to thank you for posting Scott Edward's columns and info on your Web page. I hope that you see fit to expand this coverage to include other writers such as Reis, Weeder, Lancaster, and Lunt.

**Rich Dunlap**

Dear Nuts & Volts:

Haven't seen your magazine in years and when I get my issue I will be subscribing. Glad you have a Web site and find it very interesting. Your magazine was one of the best magazines I would read back when I was very interested in electronics. Now taken over by computers, your magazine is still going to be worth reading every month. Thanks for your hard work and taking the time to give us a Web site to visit.

**Lou Clawges**  
Security Electronics

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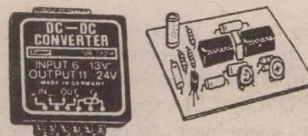
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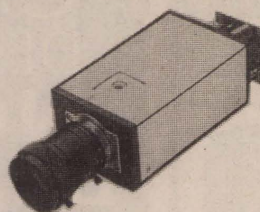
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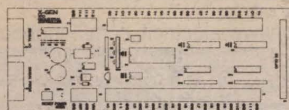
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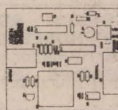
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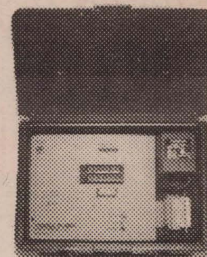
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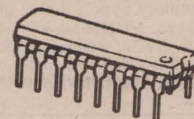
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# PC Power Supply Repair



by TJ Byers

## Repairing a broken PC power supply is a lot simpler than you might think. Nine times out of ten you can do it yourself for under \$10.00.

It's 8:00 a.m., the neighbor's dog barked all night, your coffee tastes like weak tea, and the phone message light blinks frantically. Full of resolve, you flip on your PC's power switch, and ... presto — nothing! No lights, no beep, no fan, nada. Suddenly you realize, it's gonna be a really bad hair day.

While there's nothing I can do about the early hour or the coffee, I can probably help you get your PC back on its feet. The most common case of "Sudden PC Death Syndrome" is a defective power supply. The problem can come from many sources, like heat, power surges, and old age. While it's easy enough to replace a power supply by swapping the old for new, it's not always practical.

A case in point: I have an AST 486SX that died when a truck plowed into the corner power pole and caused a two-hour black out. When the power came back on, my PC didn't. A quick check showed the cause was a fried power supply. Unfortunately, a call to AST revealed, to my horror, that a replacement power supply costs \$150.00. Moreover, because of its unique case design, there's no generic substitute.

Fortunately, it's not difficult to fix PC power supplies. While they may look different on the outside, most PC power supplies use the same electronics on the inside. In this article, I'll show you how easy it is to fix a dead power supply.

### The Basics

The power supply is a large metal box, mounted inside the PC that provides power to the motherboard and various peripherals. It's easily identified by a warning sticker on the case that reads "CAUTION! Hazardous Area" (or a similar high-voltage warning).

On the back of the power supply is an AC connector that plugs the PC into the wall. Often there's another AC connector that's used by some monitors. Most power supplies also have a voltage selector switch that lets it work with 110V or 220V power sources.

A typical PC power supply provides four DC output voltages: +5, +12, -5, and -12 volts. These voltages are available through four different types of connectors (Figure 1; 1-4). The color of the wire identi-

fies the voltage and its use (Table 1).

### Getting Started

A lot of power supply failures are actually simple problems that are easy to fix. Obviously, the place to start is at the beginning — in other words, are you getting power from the wall to the PC? As stupid as it sounds, the first thing to do is look under your desk and see if the PC is plugged into the wall. If it is, move the plug to a different socket (they go bad, too, you know).

That done, pull the power cord from the back of your PC and see if the power is getting that far. You can do this using a VOM or a simple neon lamp circuit tester, like part number 22-102 from Radio Shack.

If there's no power, and you're plugged into a power strip or surge protector, the strip is probably the culprit. To test it, simply remove the PC's plug from the strip and

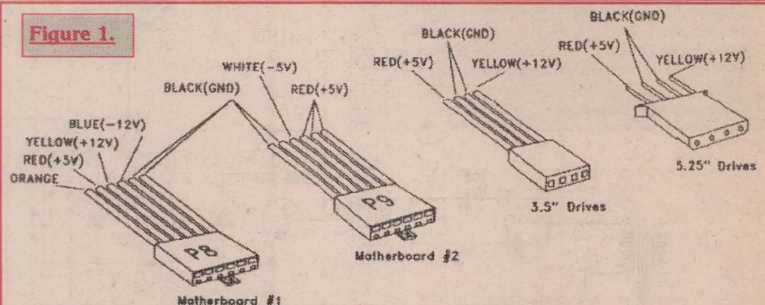
plug it into a wall socket. If the PC starts working, the problem is in the strip. Generally, the problem is a blown fuse or a tripped circuit breaker. You'll find both at the cord end of the strip. The last item you should test before popping the hood is the power cord itself; replacing it with another cord is the fastest and safest method.

### Under The Hood

Still nothing? Now it's time to remove the cover. Most covers are attached by five or six screws on the back. Before going any further, carefully read the instructions in the section called "Safety First."

The next logical place to look is at the power switch. Unfortunately, this may not be possible at this stage of the game. Many power supplies have a built-in power switch which isn't accessible until you dis-

Figure 1.



The 5.25-inch drive connector is the easiest to access for testing. The motherboard connectors P8 and P9 are identical, and can be reversed. They plug into the motherboard with the black leads together on the inside.

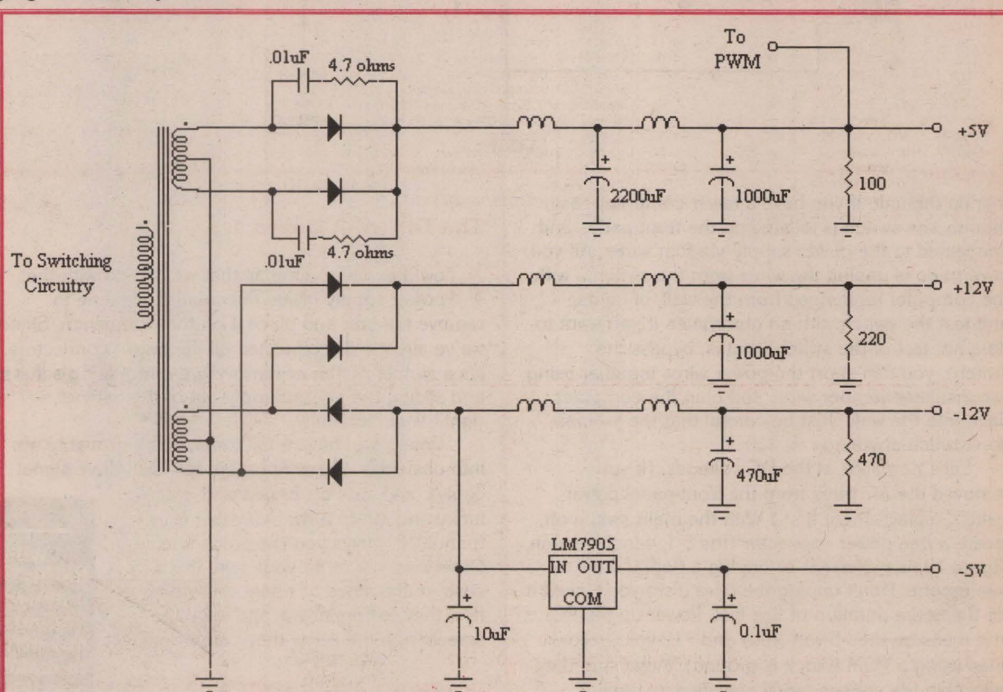


Figure 3. The low-voltage supply provides four output voltages.

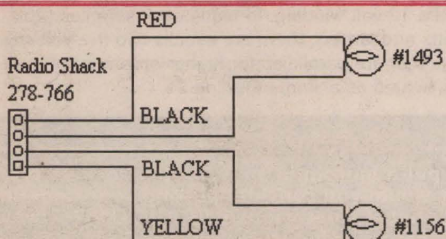
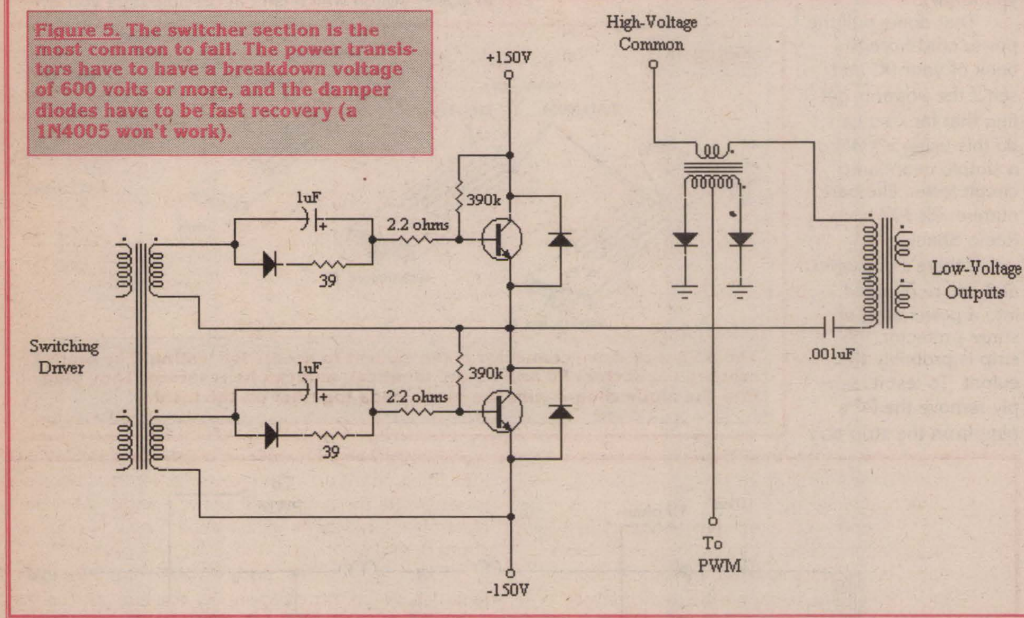
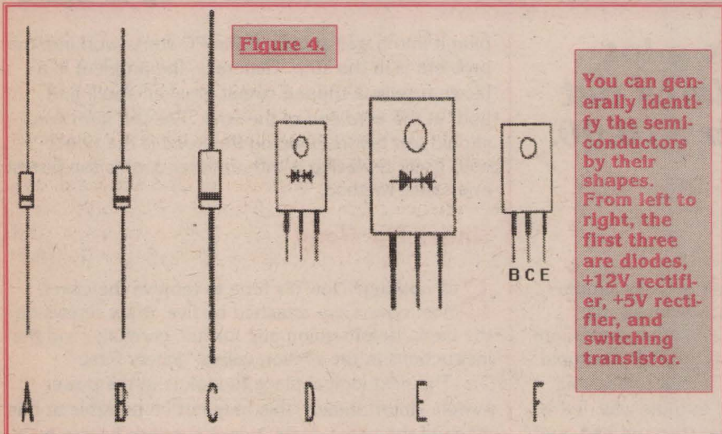


Figure 2. A dummy load can be made from a couple lamps that you can buy at any auto parts store and an extension cable from Radio Shack.



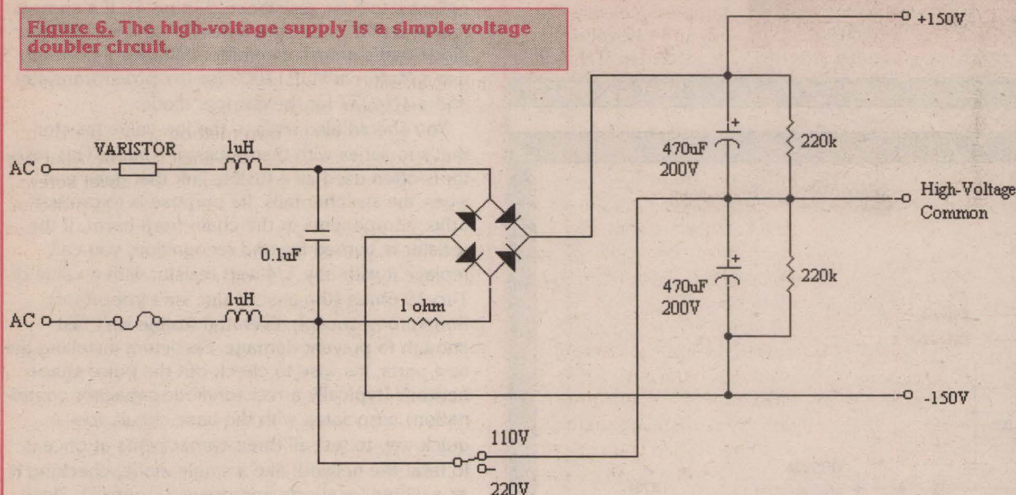
**Table 1. Power Supply Color Codes**

Wire Color	Voltage	Use
Red	+5V	Motherboard, adapter cards, disk drives
White	-5V	Logic circuits (rarely used in modern PCs)
Yellow	+12V	Disk drive motors, RS-232 serial port, fans, adapter cards
Blue	-12V	RS-232 serial port, fans
Orange	n/a	Power OK signal
Black	0V	Ground (GND)





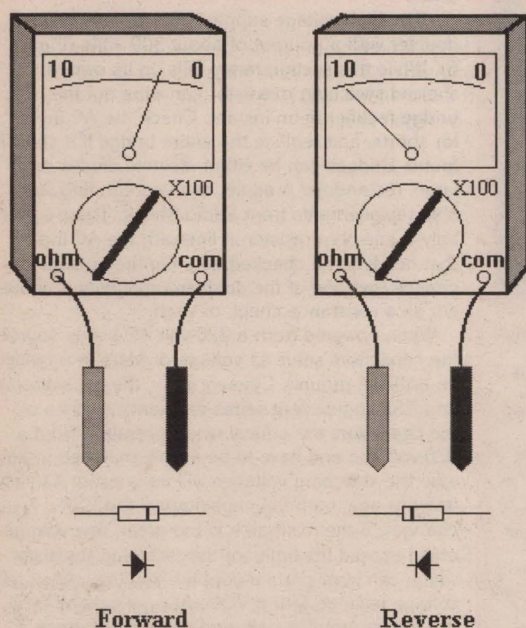
**Figure 6. The high-voltage supply is a simple voltage doubler circuit.**



part, because you have to first locate the affected parts on the circuit board. Use the road map, "How To Find Waldo," to help you in your quest. An ohmmeter is a good way to probe suspected areas for shorted devices. Once the area is located, the real work begins because it's virtually impossible to tell the difference between a shorted diode and a shorted capacitor without removing one or the other. Since the rectifier is the most likely culprit and the easier to remove (the electrolytics are glued in place), I'd start there.

The +5-volt and +12-volt diodes are most likely nestled inside a transistor case mounted on a heat sink. The bigger one (Figure 4e) is the +5-volt rectifier, and the smaller one (Figure 4d) is the +12-volt rectifier. The negative-voltage rectifiers are individual diodes typically in a DO-41 case.

With the suspect rectifier or diodes in hand, do a resistance check of the defective voltage output line again. If the reading is within the normal range, trash the old part or parts and replace with new. (Helpful Hint: If the new diodes come in an axial-lead pack-



**Figure 7. A cheap VOM is the best way to check transistors and diodes. Why? Because the test voltage has to be enough to breach the barrier voltage of a silicon diode, typically 0.7 volts, and a lot of DVMs have a probe voltage of 0.3 volts and less.**

Each winding has a grounded center tap to permit fullwave rectification using just two diodes (full-wave bridge rectifiers need four diodes). The direction of the rectifiers determines the polarity of the output voltage. Common cathodes are positive, and common anodes are negative.

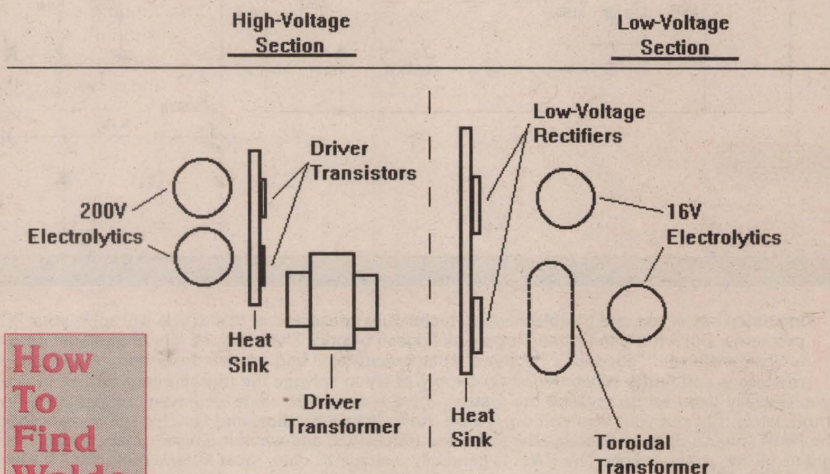
Because of its high-current requirements, the +5-volt rectifier is usually an array of parallel Schottky diodes in a single package (Figure 4) that mounts on a heat sink. The -5-volt output is often derived from the -12-volt rectifier via an IC regulator (typically an LM7905

equivalent) rather than from the five-volt transformer winding. However, I've seen it done both ways.

The output of the rectifiers is filtered first by an inductor, called a choke, then by a heavy-duty electrolytic capacitor. In some designs, the five-volt line is double-filtered to reduce ripple by cascading two L-section filters on the output. Invariably, a bleeder resistor is placed across the output to discharge the capacitors after power off.

The most common cause of low-voltage failure is a shorted rectifier. If one blows, so does its companion, which forces you to replace them as a package deal. Second on the hit list is a shorted capacitor, which usually does less overall damage. Most of the time, the failure is limited to just one output line, but there's no guarantee.

Now comes the tricky



**How To Find Waldo**

age, typically DO-41, solder them on the trace side of the circuit board instead of the component side. It's a lot easier.) If the output still shows a short, yank the electrolytic and check again. If the output is still shorted, make sure you're pulling the right teeth.

Exact replacement parts always cost more than generics, so go with the generic. You can get "universal" replacements from GE, RCA, and Philips ECG. Unfortunately, they're almost as expensive as the original. For the +5-volt rectifier, I recommend the MBR series from General Instruments and Motorola (available from Digi-Key and Allied Electronics, respectively). The +12-volt rectifier is a dual Schottky device that's available from several vendors, and generally sells for a buck or two. The negative voltage rectifiers must be fast recovery diodes, like a 1N4933. Replacement electrolytic capacitors are as close as your local Radio Shack.

When the voltage line has a three-terminal IC voltage regulator, check the resistance between both the input and the output (Figure 4) to ground. If only the output pin is shorted, the output capacitor is bad.

## SOURCES

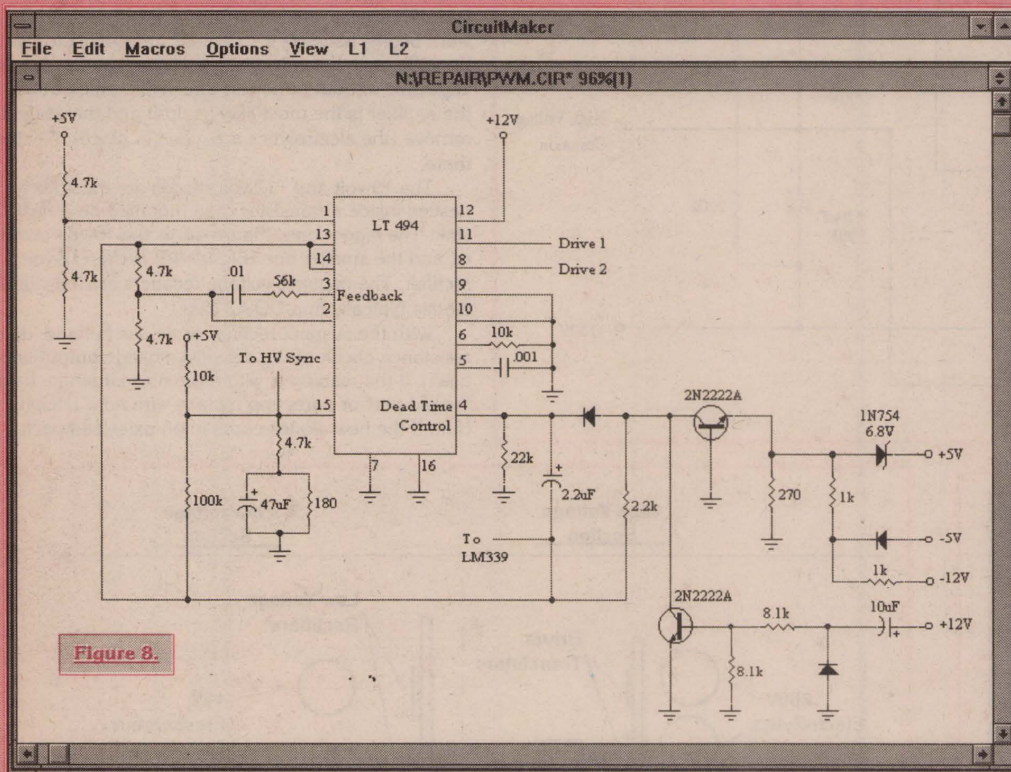
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**Table 2. Output Voltage and Resistance**

Nominal Voltage	Voltage Range	Resistance	Wire Color
+5V	+4.75V to +5.25V	>100 ohms	Red
-5V	-4.75V to -5.25V	>100 ohms	White
+12V	+9V to +15V	>250 ohms	Yellow
-12V	-9V to -15V	>250 ohms	Blue
n/a	0V or +5V	>1000 ohms	Orange
0V	0V	0 ohms	Black



## Still Don't Work, Huh?



**Figure 8.**

Nine times out of ten, the troubleshooting techniques presented in this article will solve your PC power supply problems. But what if the power supply still doesn't work? There can be lots of reasons, ranging from a faulty transformer (good luck finding a replacement) to a bad solder connection. In most situations, I'd cut my losses and find a substitute power supply or try to salvage the motherboard for use in another system. But if you're really dead set on reviving the system, there is one more stage we haven't discussed — the PWM (pulse-width modulator). But put your seat belt on, 'cause this is gonna be short and fast. It's not for everybody.

The PWM (Figure 8) is what drives the switching transistors, and when it doesn't work, nothing works. Consider it the brains of the power supply. The PWM is generally a single IC chip, most likely a Motorola TL 494. But before you replace the chip, let's see if it's working or not. For this you'll need an oscilloscope and a power supply.

The simplest way to test the PWM chip is to grab a disk drive connector and pump +12 volts into its yellow wire from an independent power supply. This can be done using another PC power supply or any other DC source (batteries work, too). Once power is applied to the PWM chip, observe the output waveforms on pins 8 and 11. Both outputs should be active squarewaves. If at first you don't succeed, ground pin 4 and try again. If the scope still shows nothing, replace the LT 494 chip. If the scope shows waveforms, the most likely culprit is the LM339 comparator. The LM339 is cheap, about a buck, and readily available, so it's worth a shot.

My method of replacing an IC is to clip the leads as close as possible to the body of the IC, leaving 14 or so metal pegs standing upright from the main board. Paying attention to direction, slip the replacement IC alongside the pegs and solder the new component in place.

If by now the power supply still doesn't work — chuck it.

If only the input pin is shorted, the rectifiers are bad. If both are shorted, the chance is both the diodes and the IC are shorted. To verify this theory, remove the IC and check the resistance again. If it reads okay, replace the semiconductors. The re-placement for the -5Volt IC voltage regulator is an LM7905.

## High-Voltage Repair

If the new fuse blows when you apply power, there's a problem in the high-voltage section. We know this

## MANUALS

**First Principles of PC Power Supplies**  
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**WARNING: COMPLETELY DISCHARGE  
THE INPUT CAPACITORS BEFORE WORKING  
IN THE HIGH-VOLTAGE SECTION!**

If the fuse has a "mirrored" look to it, you can bet the farm that at least one of the two switching transistors is shorted (Figure 5). Typically they perish as a couple. These transistors are mounted on the heat sink(s) closest to the two largest electrolytic capacitors (see "How To Find Waldo"). With the red probe of a VOM on the collector of the first transistor,

check the collector-to-emitter resistance, then the collector-to-base resistance (Figure 4). If a short is found, replace both the transistor and the damper diode that's across its emitter-collector. I normally use a Motorola MJE13009 for the power transistor and a 1N4937 for the damper diode.

You should also replace the low-value resistor that's in series with the transistor's base. This resistor is often used as a fusible link that goes puff when the switcher fails. Its purpose is to protect other components in the chain from harm. If the resistor is burned beyond recognition, you can replace it with any 1/4-watt resistor with a value of 1 to 10 ohms (the exact value isn't important). Sometimes, though, even the fusible isn't fast enough to prevent damage. So before installing the new parts, it's wise to check out the pulse shaper network (typically a resistor-diode-capacitor combination) associated with the base circuit, too. A quick way to test all three components at once is to treat the network like a single diode, checking it as a whole for shorts and opens (Figure 7). Now repeat the procedure for the second switching transistor.

The high-voltage supply is a simple voltage doubler with an output of about 300 volts (Figure 6). While this section rarely fails on its own, a shorted switching transistor can wipe out the bridge rectifier in an instant. Check the AC input for shorts, and replace the entire bridge if a short is found. Bridges can be either discrete diodes or a large, rectangular module, and you can find suitable replacements from Radio Shack. There's probably a one-ohm resistor in line with the AC input that needs to be checked, too. On the outside chance that one of the doubler capacitors is shorted, do a resistance check of each.

When powered from a 220-volt AC power source, the capacitors serve as voltage dividers to provide an artificial ground. Consequently, the capacitance and ESR (equivalent series resistance) values of the capacitors are critical when operating from a 220-volt line and have to be evenly matched, otherwise the switching voltages will be uneven. As electrolytics age, both the capacitance and ESR changes. If the mismatch is too great, one voltage could exceed the limits of the switching transistor, which can start parts a-poppin'. You can check the voltage balance with a VOM. Always replace both capacitors, not just one, and use a good grade capacitor, like the Panasonic TSU series.

## It's Showtime

If you've made it this far, you probably have a working power supply. But before you apply power, let's make sure we've covered everything.

– You did a final resistance check on the output voltage lines, and all are within the specifications of Table 2, right?

- You checked the resistance across the AC input (with the power switch on) and it measures 1 megohm or better, check?

– You checked the fuse.

– Any broken wires or burned parts?

Good! Then it's showtime. Re-assemble the power supply. Plug the dummy load into one of the disk drive connectors. Apply power.

If both lights light, congratulations! You've got yourself a working power supply, because the power supply itself needs the -5- and -12-volt lines to operate. Consequently, you don't have to test them, unless you're as curious as I would be. Now all you have to do is put everything back together and enjoy a more peaceful day — except for the coffee. Here I suggest ... **NV**



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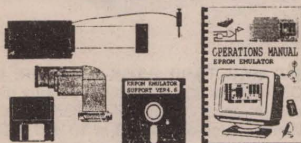
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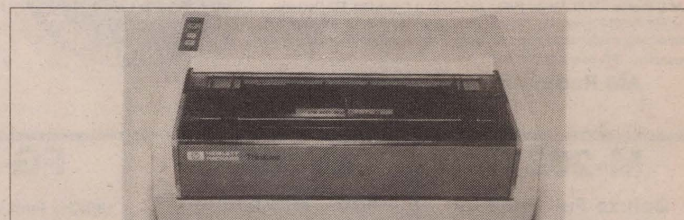
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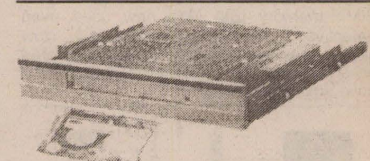
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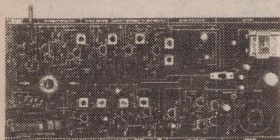
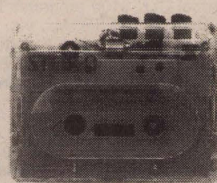
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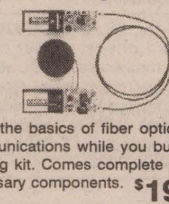
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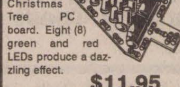
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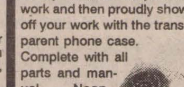
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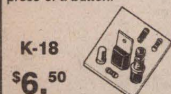


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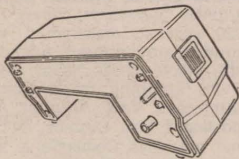
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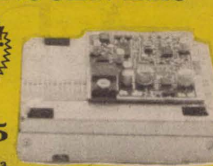
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# A DC Motor PWM Speed Controller

by Lyndon Walker

Some time ago, I was building a project which used a small DC powered water pump. The pump was purchased from a surplus dealer and worked well, but ran a little too fast. I first thought of slowing it down by putting a power resistor in series with the motor leads, but later decided against that approach. My project, an automated plant watering system, used a 7.2V NiCd battery and although it was only on for a few seconds each day, I didn't want to waste power. The circuit I'll describe here was the solution to the problem.

There are many different ways to control a permanent-magnet DC motor, and they each have their advantages. Perhaps the oldest is by inserting a variable resistance in the power supply lead as shown in Figure 1.

Varying the speed this way is quite simple and very easy to do as long as you have a rheostat which can handle the required motor current. If just one speed is needed, the rheostat can be replaced by a single power resistor. Alternately, a group of power resistors connected in series can be used. A selector switch will then choose the desired tap point and so adjust the speed. This method, along with plenty of

oil to cool the resistors, was used for many years to control large motors. In fact, many radio-controlled models still use resistors as speed controllers. Inside the model, a servo motor turns a rotary switch which selects the desired speed.

In all these cases, the resistance will dissipate the unused power as heat, making this a very inefficient method of control. This is especially true if the circuit must run from battery power. However, because of its simplicity and ruggedness, resistance control is very popular.

Pulse-Width Modulation (PWM) is a much more efficient method of controlling motor speed. To do this, a constant stream of pulses at a fixed frequency and voltage is fed to the motor. The frequency is usually chosen so that it's outside the audible range, but low enough that the losses in the switching transistors are minimized.

By varying the length of the pulses, we control the amount of time that the power supply is connected to the motor and thus control its speed. Changing a pulse train in this way — by varying the ON time of the pulses while keeping the pulse period constant — is known as Pulse-Width Modulation.

PWM settings are often specified by the resulting Duty Cycle of the pulse train. The Duty Cycle is simply the percentage of time that the pulse is in an ON state. PWM is therefore considered as one form of Duty Cycle Modulation.

When the switch is in the ON state, the motor is connected to the power source. When it's OFF, there is no current flow from the power source. The switch has a low on-resistance and so it dissipates very little power as heat. Most of the heating in the switch comes as it is changing

between ON and OFF states. By lowering the switching frequency and reducing the state transition time, these switching losses can be minimized. As a result, PWM control is quite power-efficient.

Because PWM requires only a fast switch and a means of controlling it, it has become very popular in computerized motor controls. In fact, judging from comments on the Internet robotics newsgroups, there are many people out there who believe PWM can only be done by programming a microcontroller or computer. Definitely not so. As the circuit in Figure 2 shows, an efficient PWM controller can be built at very low cost with readily available components.

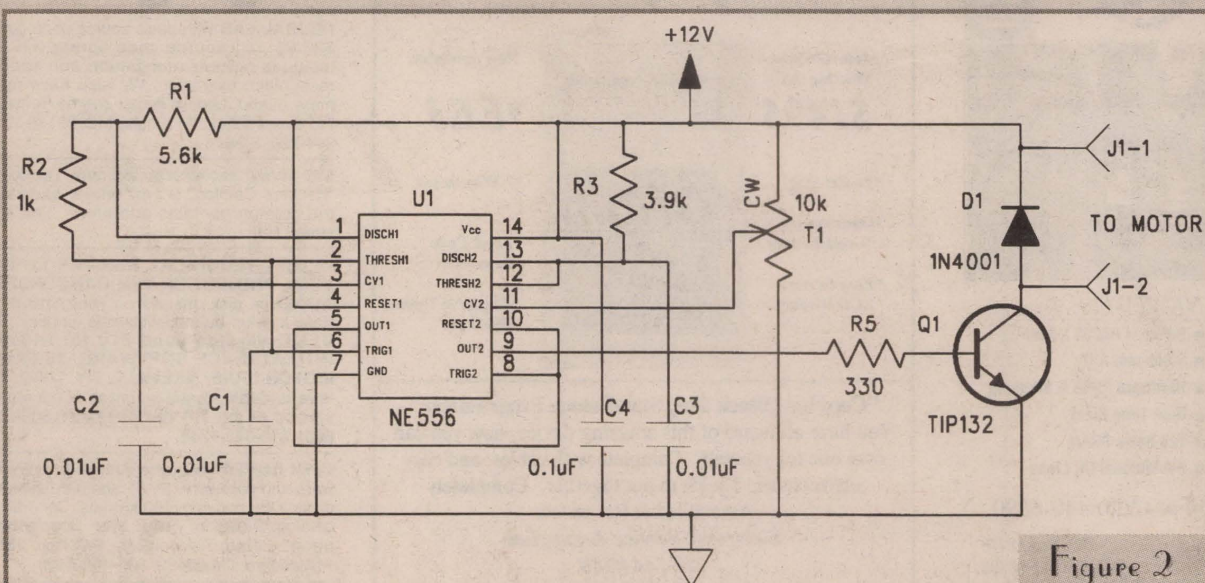
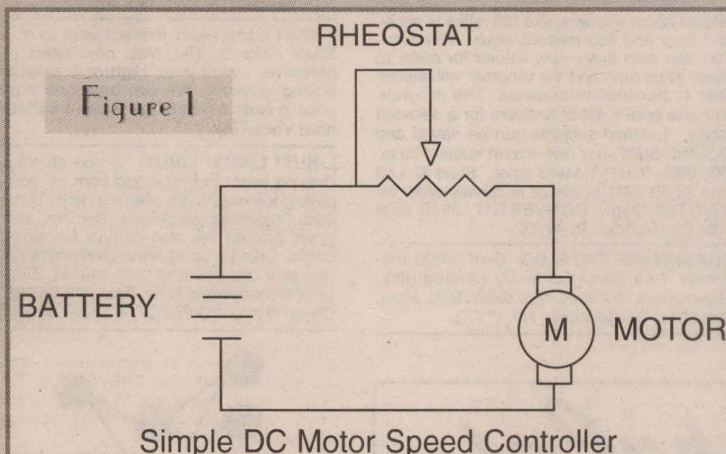
The central feature of this circuit is the NE556. This is a dual version of the popular NE555 or LM555 Timer IC. Each section of the '556 is configured differently. This makes it easy to modify the circuit. The first half (denoted on the schematic by legends ending in "1"), operates as a free running multivibrator. It generates short pulses at a fixed 19 KHz rate. These pulses are then used to trigger the second half of the IC which is configured as a monostable multivibrator.

The monostable outputs a single pulse for each trigger pulse input. The length of the output pulse is controlled by T1, the variable resistor at pin 11, and is adjustable up to a maximum slightly less than the period of the trigger pulses. In this way, we create a train of 20 KHz pulses whose duty cycle we can control over a range of about 0 to 90%. At higher voltages, the limits are about 5% to 90%.

Pin 9 outputs the PWM pulses which control the TIP132 power transistor. This transistor is used as a "low side" switch which closes the motor circuit. The diode D1 suppresses the inductive kickback from the motor when Q1 switches off.

The circuit can be constructed on ordinary perf-board using wire-wrap or point-to-point techniques. Try to mount capacitor C4 as close to pin 14 of the 556 as possible. It is used for power supply decoupling and long wire lengths will diminish its effectiveness. Most component tolerances are not critical, but if you decide to substitute another transistor for Q1, be sure it can handle the motor current. The TIP120 available from Radio Shack is a good choice. The TIP132 shown easily handles 3A with a small heatsink. You can also use one of the excellent International Rectifier IRFZ series of HEXFETs as long as the power supply is at least 12V. These HEXFETs switch rapidly and are available in a wide range of current ratings.

The circuit performs quite well over a supply voltage range of 5-12 VDC, so a regulator is not necessary. This makes it ideal for operation directly off the NiCd batteries often used to power hobby robots. The parts are inexpensive and available at Radio Shack or most of the surplus vendors which advertise in this or other magazines. This controller is an ideal small project for those rainy evenings. NV





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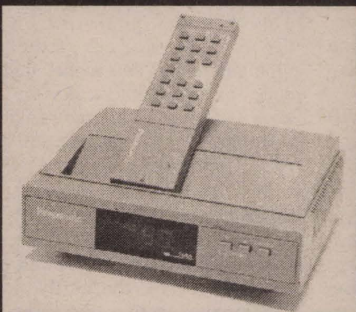


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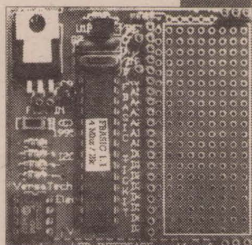
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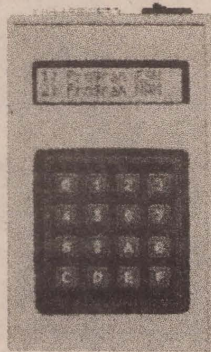
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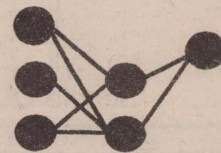
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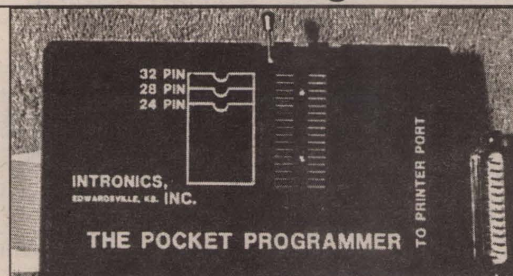
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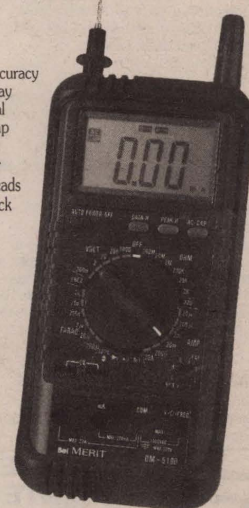
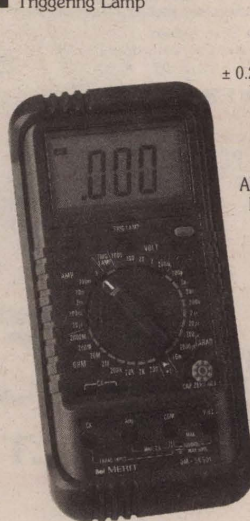
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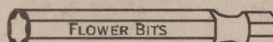
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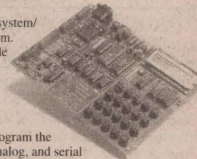
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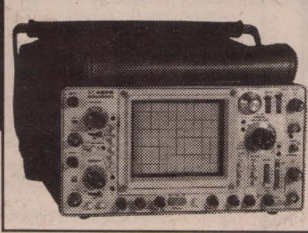
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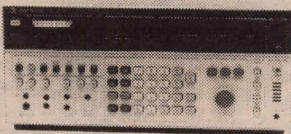
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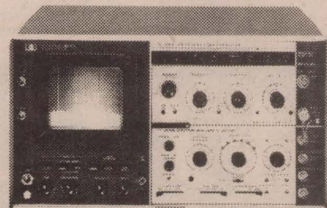
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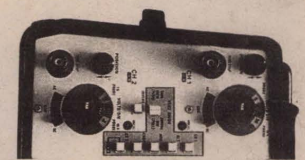
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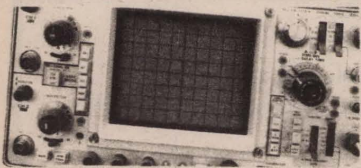
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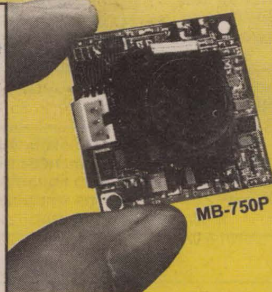
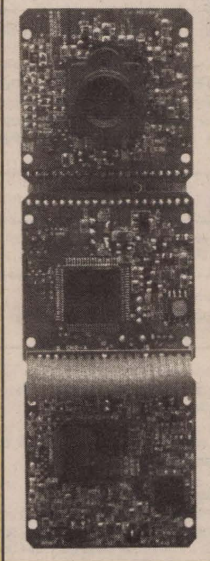
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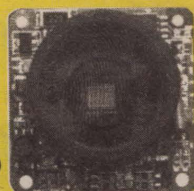


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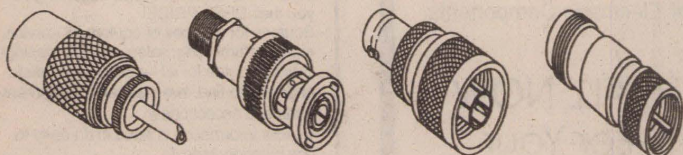




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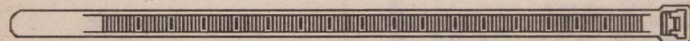
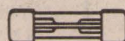
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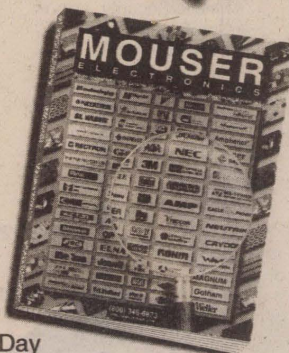
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*This article will explore the mysteries of Gerber photoplotting files and Excellon drill files used in PCB manufacture. We'll look at strategies for getting the best results from the popular EASYTRAX and AUTOTRAX PCB CAD software, including the use of a free DOS program to take the drudgery out of producing flawless files.*

## Background

You can think of a printed circuit board (PCB) layout as consisting of two kinds of objects: tracks and pads. Tracks are solid lines of a particular width; pads are filled circles, rectangles, or other shapes. In the olden days, PCBs were laid out by draftsmen using black tape for the tracks and die-cut shapes for the pads. The layout would be photographed onto large pieces of film.

When computers came along, the drafting process was automated. However, the pen plotters used for regular drafting weren't entirely suitable for PCBs. For one thing, pens can not reproduce the full range of track widths required by PCB designers—at least not in a single stroke. And pens are very inefficient at making solid, filled objects like PCB pads. They have to spend time coloring in these shapes. Finally, a plot still has to be photographed onto film for use in the rest of the PCB process.

The problem was solved when it occurred to someone to replace a plotter's pen and paper with a light source and film. The light could be moved over the film and turned on and off to selectively leave images behind. Further, by making the light in the form of a tiny projector, the shape of the film images could be controlled. So, to make a track, the projector would load up a circular slide or "aperture" of the appropriate size and move across the film with its light continuously turned on. To make a pad, the projector would load up an aperture of the desired pad shape, move to the pad position, and flash its light.

A pioneer in this field was a company called Gerber Scientific, and the Gerber name remains associated with computer file format for the instructions that were used to control this kind of light plotter. The instructions themselves are set down in an Electronics Industry Association (EIA) standard, called RS274D.

## Aperture Files

The idea behind the Gerber format is practical enough, but there was a complication: Not every photoplotter had the same set of apertures. And there was no universally agreed-upon correspondence of a particular Gerber code to a particular aperture shape and size. There couldn't be. We're talking about hundreds of commonly used combinations of aperture shape and size mapped to a relatively small number of codes (as few as 24).

So, the idea was to create two files: the first contained the plotting data, referring to apertures by a series of codes; the second contained the shape and size information for each code. For example, the plot file might say, in effect, 'move to XY coordinate so-and-so, then flash aperture D23.' The aperture file would specify the size and shape of aperture D23. Here's where the fun begins: What if the aperture specified for D23 doesn't match what the PCB designer had in mind? Uh-huh, disaster!

Still harkening back to the old days, it was common practice to set up PCB designs according to apertures that your board shop had on hand. You'll see words to this effect in the instruction manuals of many older PCB CAD packages.

## Gerber in the Modern Era

This stuff about mechanical plotters sounds quaint nowadays. You'd be hard pressed to find a board shop that uses one anymore. Mechanical plotters have long since been replaced by computerized raster photoplotters that are like laser printers on steroids (or, more accurately, like the photo-typesetters used in publishing). But they still use the Gerber file format.

Gerber has survived because of the inherent conservatism of business ("if it works, don't fix it") and because of the format's versatility. A Gerber file is a text file that can be viewed and modified with a text editor or word processor. And it's relatively easy to buy or write programs that extract data from Gerber files for other manufacturing processes. So Gerber lives on. There is an improved version of the Gerber format, referred to as Gerber-X or RS274X, in which the

aperture file becomes part of the plot file. If you own software that generates this kind of file, use it and skip the rest of this article. But the vast majority of inexpensive CAD packages, like AUTOTRAX and EASYTRAX, are stuck in the Gerber-D time warp. So we still have to cope with separate plot and aperture files.

## Plot File Format

A Gerber plot file is a plain-text file. If you open it with a text editor (like DOS EDIT or Windows Notepad) or word-processing program, you will see normal, printable letters-and-numbers text. The file is divided into 512-byte blocks consisting of 510 characters of data, followed by a carriage return and line feed.

Blocks are divided into records. Records may vary

in length. The end of a record is marked with the asterisk character (\*). A block contains as many complete records as will fit within its 510-character straightjacket; if there are unused characters, the end of the block gets padded with spaces.

Records are instructions to the photoplotter. For example, the record X200Y245\* means move to the location with XY coordinates 200, 245. Dimensions are usually expressed in thousandths of an inch, referred to as "mils." Other examples of records:

D01\* Light on  
D02\* Light off  
D03\* Flash light  
D23\* Switch to aperture D23

Modern photoplotters typically allow a range of aperture codes from D10 to D269.

The last two blocks of a Gerber file are special. The second-to-last block ends with the record M02\*. The last block contains the backspace control character (ASCII 8), followed by 509 spaces, and ending with a carriage return and line feed.

Figure 1 contains a fragment of a PCB layout; Table 1 is the corresponding Gerber plot file.

Each Gerber file describes only one layer of the PCB, so you need a file for each layer used in the final PCB. For example, a two-sided board would require at least two Gerber files, one for top-layer copper, and one for bottom. But it could require more for such things as solder mask, parts-placement overlay, etc. To avoid confusion, there's general agreement on the DOS file extensions for each of the possible layers:

Top Layer	.GTL
Mid Layer 1	.GM1
Mid Layer 2	.GM2
Mid Layer 3	.GM3
Mid Layer 4	.GM4
Bottom Layer	.GBL
Top Overlay	.GTO
Bottom Overlay	.GBO
Power Plane	.GPW
Ground Plane	.GGD
Top Solder Mask	.GTS
Bottom Solder Mask	.GBS
Top Paste Mask	.GTP
Bottom Paste Mask	.GBP
Pad Master	.GPM
Keep Out Layer	.GKO
Drill Drawing	.GDD
Drill Guide	.GDG

## Aperture File Format

The aperture file tells the photoplotter the size and shape of a pattern to be flashed (e.g., a pad) or dragged across the film (e.g., a track) for plotting. Aperture files are ordinary text files with entries as

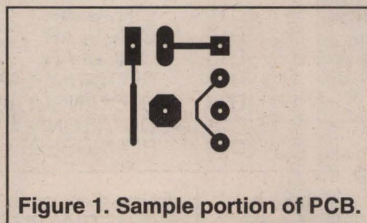


Figure 1. Sample portion of PCB.



shown in the ENTRIES sidebar.

The entries are separated by one or more spaces, and each line ends with a carriage return and linefeed. Table 2 is the aperture file from the Gerber file of Table 1. The meanings and usages of the entries are as follows:

**D code.** Just what it says: the D-code number, D10 through D269, assigned to this aperture in the Gerber plot file. (You should be aware that older photoplotters supported just 24 D codes mapped to fixed aperture numbers. This arrangement has gone the way of the Dodo.)

**Shape.** A word describing the shape of the aperture. There are quite a few recognized shape names, but not all shapes are supported by every photoplotter/board house. Here's a sampling of shapes used in aperture files:

CIRCULAR  
OCTAGONAL  
OVAL  
SQUARE  
RECTANGULAR  
ROUNDRECT  
CROSSHAIR  
MOIRE  
LINE  
ANNULUS  
THERMAL

Some pads can be described by more than one combination of shape and size specifications. A rectangular pad with identical X and Y dimensions is obviously a square, for instance. And some shapes are automatically converted to others by software or personnel at the board house. Although some systems allow a shape name of "LINE," circular apertures are generally used for both pads and line drawing.

**X size and Y size.** These are the aperture's dimensions in the X and Y coordinate system of the board. The sizes are usually expressed in mils, but may also be expressed in decimal inches. Note that if a board uses the same pad twice, but rotated 90 degrees, its aperture file will contain two entries for that pad with the X and Y size entries swapped.

**Hole.** Size of hole to drill in a given pad (usually mils, but may be decimal inches). This entry is frequently set to 0 (no hole) so that the hole sizes can be specified on a case-by-case basis through the drill and tool files (discussed later). The reason is that many

## ENTRIES

Format:	D code	Shape	X size	Y size	Hole	Use
Example:	D11	CIRCULAR	70	70	0	MULTI

and tool-movement instructions. We won't go into it in detail, because there are several formats, and frankly, drill files almost never cause problems! It is worth the time to look at the companion tool files, though, because you may want to edit them.

Tool files (DOS file extension .TOL) are normal text files. Their contents can be as simple as a tool number, T01 through Tn (where n is the largest tool number used in the job) followed by the size of the hole to be drilled. Optionally, they may contain other information generated by your CAD program, including the number of holes drilled by a given tool, and even the total distance the tool will travel in moving from hole to hole of the PCB. The board house doesn't necessarily need this information, but may want it to factor into price quotes or job planning as this information can help in formulating an estimate of how long the board will take to drill. Here's a tool file from a PCB prototype I recently had made:

T01	.125
T02	.032
T03	.035
T04	.040
T05	.024

The drill sizes are in inches, so T01 is a 1/8" (0.125") bit, T01 is 0.032" (32-mil) bit, and so on.

Some board houses, particularly those specializing in fast turnaround, try to limit the number of tool changes. They usually do this by charging extra for drills not on their standard drill list. For example, I sent the board whose tool list appears above to AP Circuits, the Canadian prototyping house (Sources). Their standard drills in the range required by my prototype are: 0.028, 0.035, 0.042, and 0.125. To avoid the nonstandard drilling charge, I edited the tool file to map my "nonstandard" drills to AP's standard ones:

T01	.125
T02	.035
T03	.035
T04	.042
T05	.028

to the tool file. If you make a drill size larger, you have to ensure that it won't be too large for the smallest pad in which it will be drilled. Most board houses recommend a minimum of 10 mils (0.01") of copper margin around a hole. When the pad is round, this copper is called the annular ring. To determine the annular ring for a given combination of pad and hole, calculate (pad-hole)/2. So if the pad is 62 mils and the hole is 35 mils, the annular ring is (62-35)/2 = 27/2 = 13.5 mils.

## Generating Gerber Files in -TRAX Software

EASYTRAX is a free, DOS-based software package for generating PCB artwork; AUTOTRAX is its popular commercial counterpart. (EASYTRAX is available for downloading from the *Nuts & Volts* library on the Internet; go to [www.nutsvolts.com](http://www.nutsvolts.com) and select the library option.)

These programs are of quite high quality, as they represented the state of the PCB-CAD art for personal computers at a time when a '286 processor was considered fast. But one area in which they really show their age is the generation of Gerber files. When these programs were current, the list of apertures available from your friendly photoplotter determined what shapes and sizes you could use in designing a PCB.

This expectation is hardwired into the way that the companion TRAXPLOT program generates Gerber files. The program combs through your aperture list, and tries to match the shapes used in your design to shapes available. You can set a "match tolerance" to allow the program to pick apertures that are close enough. Or you can override the program's match and select the apertures yourself. The program makes the outdated distinction between apertures coded for flash and stroke uses, and won't select an aperture for an "unauthorized" use without your permission.

All of this was necessary back when you had a limited set of apertures to work with. But with modern photoplotters, the opposite approach makes more sense: Use the shapes and sizes you need in your

Table 1. Gerber File for Figure 1 (spaces at end of file removed)

```
X0Y0*D11*X1725Y2700*D01*X1725Y2700*X1725Y2875*D02*X1825Y3000*D01*X1825Y3000*X2000Y3000*D12*D02*X2000Y2900*D01*X2000Y2900*X1925Y2825*D02*X1925Y2825*D01*X1925Y2825*X1925Y2775*D02*X1925Y2775*D01*X1925Y2775*X2000Y2700*D02*X1725Y2875*D01*X1725Y2875*X1725Y3000*D13*D02*X2000Y2900*D03*X2000Y2800*D03*X2000Y2700*D03*D14*X1725Y3000*D03*D15*X2000Y3000*D03*D16*X1825Y2800*D03*D17*X1825Y3000*D03*D02*M02*
```

board designers specify more than one hole size for pads of the same size, depending on the size of the wire or component lead that will be soldered to a particular pad.

**Use.** This entry can be used to direct the use of a particular aperture for flashing pads (FLASH), drawing lines (LINE), or both (MULTI). If there's no entry, the default is MULTI.

## Drill and Tool Files

The situation with drill files (several formats; Excellon is the most common) and their companion tool files is similar to that of Gerber plot and aperture files. The main difference is that the drills still do physically change bits for each size of hole drilled, while the photoplotter just simulates the change of apertures.

The drill file (DOS file extension of .DRL or .NCD for numerically controlled drill) looks a lot like the Gerber plot file; it's a series of X and Y coordinates

Why edit the tool file rather than make the changes in the CAD program? Well, the board will eventually be manufactured, and those hole sizes are required for the components to fit properly. But on a quick, cheap prototype I can tolerate some slop. Editing the tool file makes the change completely temporary — when the board goes into production it will do so with the original, unmodified tool file.

Another reason for editing the tool file is to accommodate variations in procedure from one board shop to another. Some shops use the exact drill bits listed in your tool file. If the board is made with plated-through holes, the actual size of the holes will be several mils smaller than the drill due to the thickness of the plating. Other shops look at those drills as finished hole sizes. If the holes will be plated, they're drilled slightly oversize so that after plating they're the size you specify. You may want to consult your shop and find out which form of reckoning they use, and adjust your tool file accordingly.

Some caution is required when you make changes

Table 2. TRAXAN-Generated Aperture File for Figure 1

D	Shape	X	Y	H
D10	CIRCULAR	5	5	0
D11	CIRCULAR	20	20	0
D12	CIRCULAR	10	10	0
D13	CIRCULAR	62	62	0
D14	RECTANGULAR	50	120	0
D15	RECTANGULAR	62	62	0
D16	OCTAGONAL	100	100	0
D17	ROUNDRECT	50	120	0

design, then compile an aperture list to match. When you run TRAXPLOT to create your Gerber files, just select your "perfect" aperture file, and run the process with 0 match tolerance. Since all of the apertures are there, the program will breeze through the matching process.

There are at least three ways to compile a perfect aperture list.

(1) Run TRAXPLOT once to find out what apertures you need, write them down, and manually type up a text file in the aperture format shown above.

(2) Open the -TRAX .PCB file with a text editor, read the database entries, mentally convert them to apertures, and manually type up an aperture file.

(3) Use my TRAXAN program to read your .PCB file and generate an aperture file.

To write TRAXAN, I had to figure out the format of the .PCB files generated by EASYTRAX and

# Understanding Gerber Files for Flawless PCB Output



**Table 3. AUTOTRAX Native .PCB file for Figure 1**

```
PCB FILE 4
FT
1725 2700 1725 2875 20 6 1
FT
1725 2875 1725 3000 10 6 1
FT
1925 2775 1925 2825 10 6 1
FT
1925 2775 2000 2700 10 6 1
FT
1925 2825 2000 2900 10 6 1
FT
1825 3000 2000 3000 20 6 1
FP
1825 2800 100 100 3 40 1 13
0
FP
1725 3000 50 120 2 30 1 13
0
FP
1825 3000 50 120 4 30 1 13
0
FP
2000 2700 62 62 1 30 1 13
0
FP
2000 2800 62 62 1 30 1 13
0
FP
2000 2900 62 62 1 30 1 13
0
FP
2000 3000 62 62 2 30 1 13
0
ENDPCB
```

**AUTOTRAX.**  
Fortunately, the format turned out to be an extremely simple structured text document that you can actually sight-read. Table 3 shows the .PCB file for Figure 1.

Let's look at how the -TRAX programs store the details that make up a track. They identify a track entry with the abbreviation FT or CT on a line by itself; FTs are 'free' tracks — those not associated with a predefined component — while CTs are 'component' tracks — usually part-placement outlines. The next line sets down the characteristics that define the track:

Start X Start Y  
End X End Y  
Width Layer ?

Here's an example track entry:

```
FT
1750 1700 1825 1700 8 6 1
```

That entry defines an 8-mil wide track that goes from XY coordinates 1750,1700 to 1825,1700 on the bottom PCB layer (layer 6). I never did determine what the ? entry is for, but I didn't try very hard, since all we need to know for our aperture file is the width!

The format for pads is similar. The program identifies a pad as free (FP) or component (CP), then specifies the information as shown in the LOCATIONS sidebar.

Here's an example pad entry:

#### LOCATIONS

X Location Y Location X Size Y Size Shape Hole Size ? Layer

CP  
1000 2000 60 80 4 30 1 13

That entry defines a type-4 (rounded-rectangular) component pad at XY coordinates 1000, 2000 with dimensions of 60 mils in the X direction and 80 in the Y. The pad has a 30-mil hole and is intended to be plotted on all copper layers (13). The layers are numbered as you might expect, from top (1) to bottom (6), with the number 13 used to mean multilayer. The pad shapes are numbered as follows:

1. Round
2. Rectangular or Square
3. Octagonal
4. Rounded Rectangular
5. Crosshair Target
6. Moire (concentric circular) target

So, you can see how it would be possible, if a bit tedious, to read the .PCB files and manually compile an aperture list. For tracks, you would look at the width entry and place a correspondingly sized circular aperture in the file. For pads, you'd convert the shape number to the appropriate shape-descriptive word (ROUND, RECTANGULAR, etc.) and enter the XY dimensions. You would, of course, avoid duplicate definitions; one aperture entry can be used for an unlimited number of pads or tracks. You'd also avoid giving two different apertures the same D code, since the format prohibits redefining the codes.

I wrote the TRAXAN program to automate this process. To use it, you just type "TRAXAN pathname" at the DOS prompt, where pathname is the drive, file name, and extension of your board, such as C:\PCBS\MY\_BOARD.PCB. The program reads all of the pad and track entries in the PCB file and prepares an aperture file, which it saves to the same path as the PCB file, but with the extension .APT. In the example above, the output file would be C:\PCBS\MY\_BOARD.APT.

By default, the dimensions in a TRAXAN-generated aperture file are in mils. You may change this to decimal inches by adding a slash (/) after the pathname: "TRAXAN pathname.PCB /." Note that this must be a forward slash (/) as DOS uses the backslash (\) as a separator for parts of a pathname. However, to prepare files for TRAXPLOT, omit the slash.

After running TRAXAN, use the TRAXPLOT program to generate your Gerber files as usual. Remember to specify the TRAXAN-generated aperture file, instead of TRAXPLOT's default STANDARD.APT. For all of the entries having to do with matching apertures to shapes, accept the program's defaults. Since the TRAXAN-generated aperture file will have an exact match for every shape used in your

design, the matching stuff will never come into play.

One note regarding TRAXAN: This program generates aperture files that make TRAXPLOT happy. Using the slash character (/), you can get it to output aperture files for certain other programs, like Gerber file printing and viewing utilities. But TRAXAN aperture files won't please every program you encounter. I found that GCPREVUE, a free Gerber viewer found on the AP Circuits web site, wants a more elaborate aperture file. You can manually edit the TRAXAN aperture files, or modify the TRAXAN.BAS program to generate this format.

TRAXAN is available free from the *Nuts & Volts* library on the Internet in both executable (.EXE) and source (.BAS) formats. The files are combined into a single file, TRAXAN.ZIP, requiring PKUNZIP to unpack. TRAXAN is unsupported freeware — I've thrown it into the public domain for people to use, modify, and distribute without restriction. I've used the program to generate my own aperture files with complete success. However, TRAXAN was written quickly as a brute-force tool, so there's no support or documentation for it.

#### Summary

Working with Gerber files is easy, once you understand the relationship between plot files and aperture files. Despite changes in photoplotting technology, you can still produce excellent results with older PCB CAD software. **NV**

#### Sources

Inexpensive PCB prototyping: **AP Circuits**, #3-1112 40th Ave. N.E., Calgary, Alberta, Canada T2E 5T8; phone 403-250-3406. In addition to fast-turnaround, low-cost PCB prototyping services, APC offers an excellent collection of free- and shareware programs for PCB CAD, and documentation for novice PCB designers. Sign onto their dial-up BBS at 403-291-9342 or access their Internet web site at <http://www.apcircuits.com>  
**AUTOTRAX PCB CAD program: Protel Technology, Inc.**, 4675 Stevens Creek Blvd. Suite 200, Santa Clara, CA 95051; Sales toll-free: 1-800-544-4186; Callers outside the US/Canada: 408-243-8143; Fax: 408-243-8544.

**TRAXAN program:** Go to the *Nuts & Volts* web site (<http://www.nutsvolts.com>). Press the button to navigate to the library, and download the file TRAXAN.ZIP. This compressed archive file contains both an executable version of TRAXAN (TRAXAN.EXE) and the QuickBASIC source code (TRAXAN.BAS). TRAXAN is unsupported freeware.

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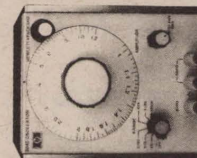
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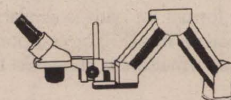


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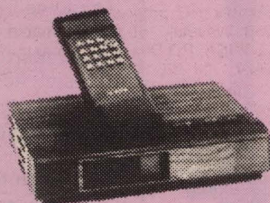
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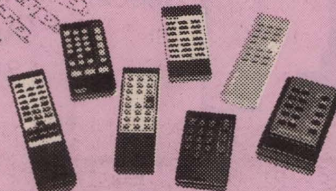
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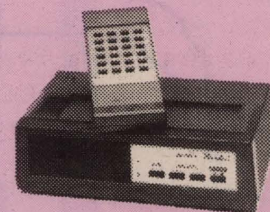
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# Flame Speaker:

## An Experiment in Plasma Acoustics

by John Iovine

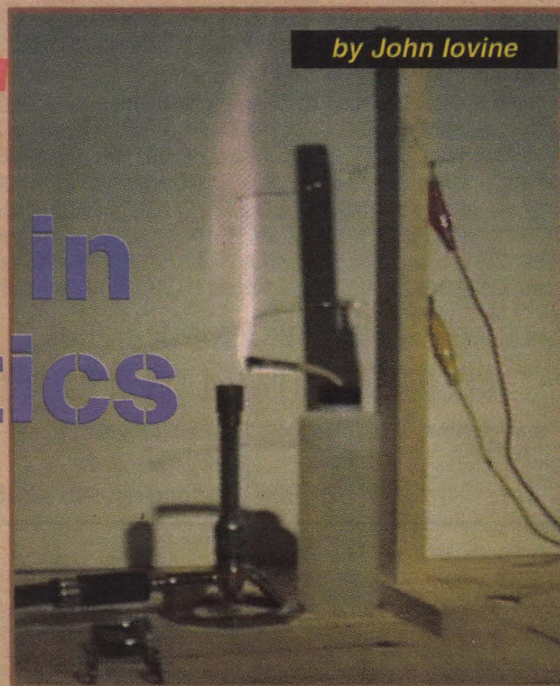
About 25 years ago, I read an interesting article on three researchers — W. Babcock, K.L. Baker, and A.G. Cattaneo — who discovered an interesting phenomenon of plasma acoustics while working at the United Technology Center in California.

The researchers were able to use a high-

temperature gaseous flame from a propane or butane torch that is seeded with potassium nitrate.

### Function

Any audio sound source may be used, but I recommend using music because it has more high-frequency components in it than speech (see Figure 1).



into two electrodes positioned into the flame.

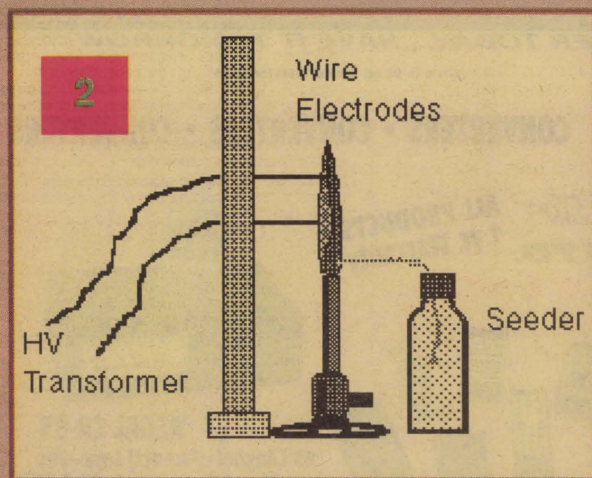
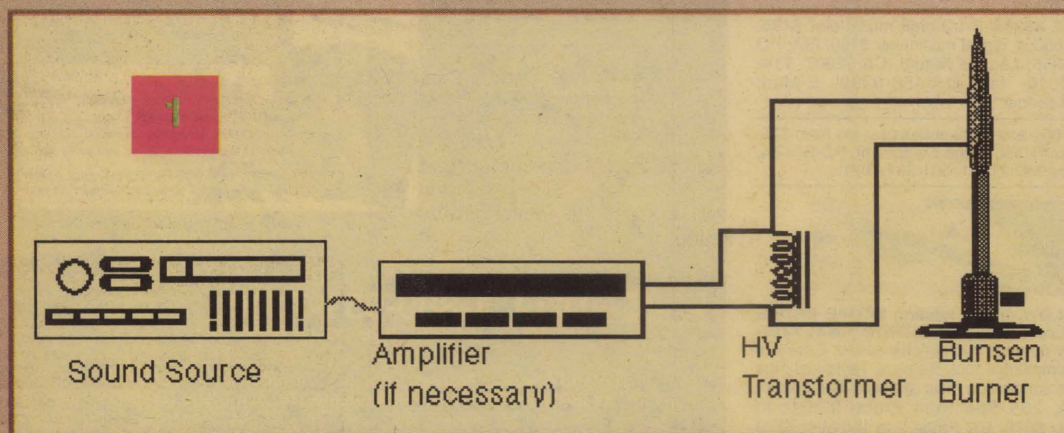
The flame is seeded with a water solution of potassium nitrate to induce low-temperature ionization.

### How it works

A water solution of potassium nitrate is fed into the flame by a alcohol lamp wick placed at the bottom of the flame. The potassium nitrate ionizes easily, by thermal ionization, inside the flame. Ionization creates free electrons and positive potassium ions. When you supply a high-voltage electrical signal, the positive ions move toward the negative electrode, and electrons move toward the positive electrode. In the case of an audio signal, the electrical signal fluctuates (switching back and forth rapidly),

causing the flame to vibrate.

Flames, like a liquid, exhibit a surface tension. A gaseous membrane is created by a difference in density and high temperature of the torch flame to the ambient air. The membrane acts as a diaphragm to compress and rarify the air, and produce sound waves as the flame vibrates.

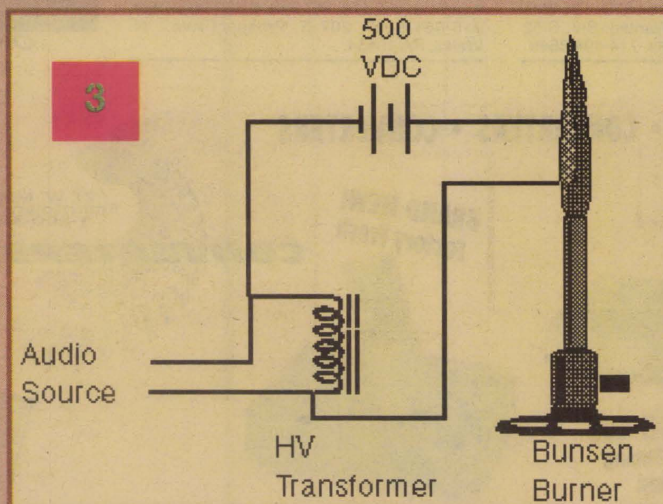


temperature plasma as a speaker. They discovered that the response of the plasma speaker is better at higher audio frequencies than at low audio frequencies. This drawback, they theorized, may be a result of the small size plasma, rather than an intrinsic limitation.

Rather than trying to create a high-temperature plasma, we can use a lower

The audio source (radio, tape, or CD player) must supply 10 or more watts of power to the HV transformer to be heard. If necessary, feed the audio sound through a power amplifier. The more power, the greater the volume. From the amplifier, the audio is fed into a step-up transformer.

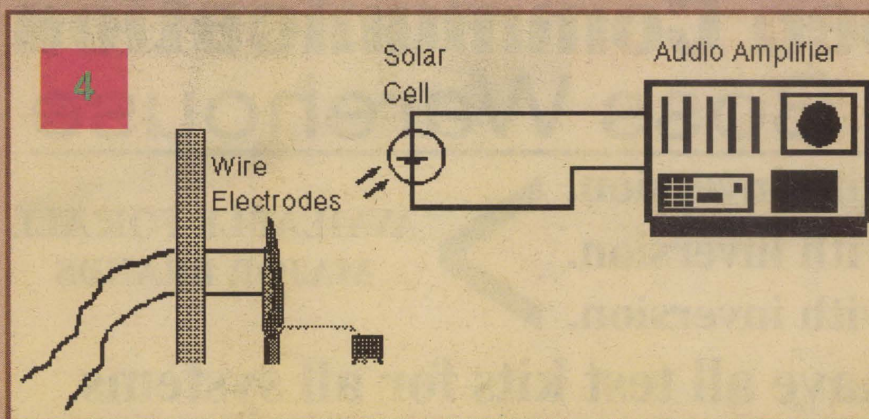
The output of the step-up transformer is fed



### Experimenting with plasma acoustics

Figure 2 illustrates a simple set-up for you to begin experimenting. The seeder I used was fashioned from a plastic bottle I had lying around, but just about any container will work.



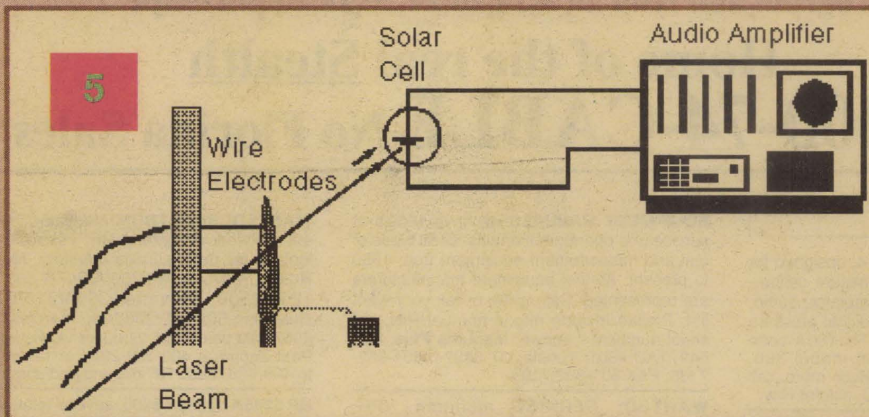


Remember to turn off all equipment before adjusting or touching the electrodes. They are connected to a high-voltage transformer and are quite capable of shocking you.

### Improving the design

The experiment can be improved by using a larger and hotter flame. Anything that would do so would increase the quality of the sound. If possible, use nichrome or tungsten wire for electrodes. These wires will last longer in a high-temperature flame.

Supplying a 500 DC bias to the circuit will improve the quality of sound (Figure 3). This allows the sound signal to travel on top of the DC bias. It

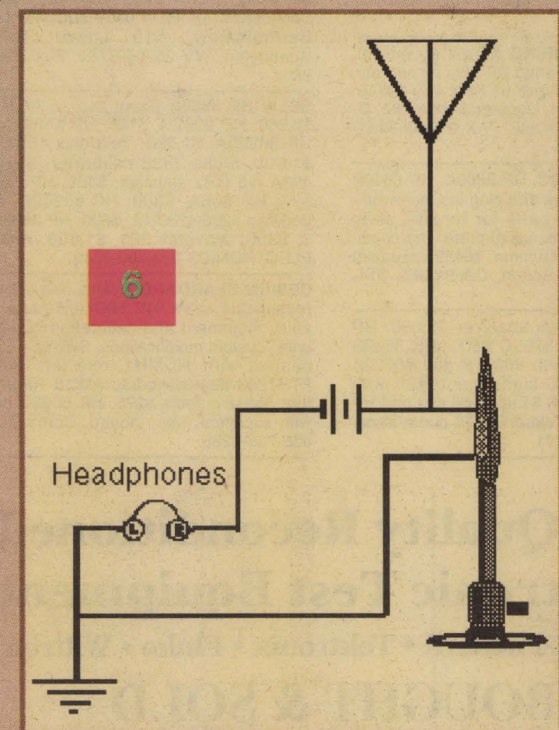


reduces the polarity fluctuation of the audio signal inside the flame and improves the fidelity of the sound.

### Other experiments

A solar cell or photo-transistor that is connected to an audio amplifier will output the sound signal fed into the flame when the light from the flame is directed onto the photocell by a lens (see Figure 4).

Another possibility is to direct a laser beam between the electrodes in the flame. This may be low cost to modulate a laser with information (see Figure 5). In the 1920s, Lee DeForest replaced a radio crystal detector with a flame (see Figure 6). **NV**



Images Co. This is a three-wire device. The two outside wires are the primary wires where the audio signal is fed. The center wire from the transformer is the high voltage out. The high voltage out is connected to one of the electrodes placed into the flame. The second electrode is connected to either one (but not both) of the primary wires. Be careful when operating the circuit; the

I drilled a hole in the top of the plastic bottle and fed the lamp wick through it. An alcohol lamp wick is used to continuously supply the potassium nitrate into the flame. The potassium nitrate strength isn't critical, dump a spoonful into any quantity of water and it will work fine.

The step-up transformer is a high-voltage transformer from

audio signal from the amplifier is stepped-up by the transformer and is capable of shocking you.

When running the plasma speaker, you'll notice a glow emanating from the tip of the electrodes. The glow keeps in step with the volume of the sound. If the electrodes start arcing, either move the electrodes further apart or turn down the volume on the amplifier.

### Parts list:

Bunsen Burner or Butane torch — Local Supplier

HV transformer \$19.95  
Potassium Nitrate, 1/2 oz., packed in water \$6.00  
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<http://www.bellelect.com>



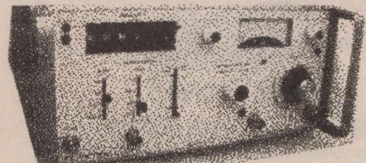
# BELL Electronics



**FEITEK PROVIDES** repair, calibration and certification on many makes of test equipment. We also have a large selection of used equipment. Send large SASE envelope for list. VISA and MasterCard accepted. Feitek Inc., 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

**LOW PRICES.** Tek 434 oscilloscope \$200. Tek 7623 mainframe \$200. Tek plug-ins 7B92A \$250. 7A24 \$200. 7A19, 7A26, 7B85, 7D14 \$150 ea. HP 5004 signature analyzer \$150. HP 11710B down converter \$150. HP 8750A storage normalizer \$150. HP 1615 logic analyzer w/opt. 001 \$150, and more. Call 908-681-2032.

**ANALOG 5100 VARIABLE AF ELECTRONIC FILTERS:** Highpass or lowpass, adjustable from 2Hz to 200KHz, unused condition, quantities available. \$95 each PPD CONUS. Call/Fax/E-Mail Brian at Kentronix, 908-681-3229, 908-681-3312 Fax, brian@kentronix.com E-Mail, PO Box 2444, Farmingdale, NJ 07727



**WAVETEK 3000-200 RF** synthesized generator & deviation meter, AM, FM, CW, & DC (for up to 100KHz sweep, or burst modulation), 1 to 512 MHz, +13 to -137 dBm, six digits, .001% stability. \$750. Gary N62D, 408-385-0301 VISA/MC.

**WANTED! TEST** equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. 1-800-432-3424.

**INSTRUMENT RECORDER,** Hewlett Packard 3964A, opt. 001, 002, 003, 004, 007, 26, 91, 146; as new condition \$500. Psitech Plus 707-745-4804.

## SECURITY

**SMART CARD PROGRAMMER.** Read and write your own smartcards. Works with ISO7816-3 standard microprocessor smartcards. Develop your application today. Not sold for any illegal use. All sales are final. \$2,500 + shipping. Blank smartcards \$50/ea. SmartCard Technologies 419-537-0474.



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**TD-53 ADVANCED** Transmitter Bug Detector, \$230. Tap trap \$65. (New, 1/2 price) 904-877-8582.

**MYOTRON "CHECKMATE"** one millisecond immobilize assailants up to one hour. 20,000 watts, over 1/4 million volts, scrambles brain signals with no after effects, yet non-lethal. (Retail \$399.95) special \$249.95 lifetime warranty. (Video) more info. Call **Total Security** 770-486-1365.

**SPY CATALOG** on disk. Sources, information, complete descriptions of products, \$15 postpaid. Jeff Montgolf, 64 Muncher Rd., Empire, AL 35063.

<http://www.hackerscatalog.com> Telecode's "Hackers Catalog" is now online. Everything the catalog contains and more. You ain't surfed yet!

**MAGNETIC "STRIPE" CARD WRITER/READER.** Read and write all 3 tracks of data. Not sold for any illegal use. All sales are final. \$2,500 + shipping. Blank cards \$25/ea. SmartCard Technologies 419-537-0474.

**SPY EMPORIUM** privacy security. Professional recorders, parabolic mic., wire-less covert video, bugging/phone tap detectors, scramblers, locksmith tools, etc. FOR CATALOG, SEND \$5 to Security Trade, 6065 Hillcroft, Suite 413, Houston, TX 77081. 713-774-1000, FAX 713-774-6222.

**PAGER OWNER!** Use your pager as a security monitor to monitor your burglar alarm and telephone answering machine using Pageout automatic paging system \$99.99. Other systems available. Call 410-483-6211. <http://www.worldprofit.com/maateez.htm>

**MILITARY COMPONENTS** wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-842-5953, FAX: 818-845-3613.

**ALARM CONTROL** panels, power supplies, contacts, motion detectors, sirens, strobes, metal enclosures, timers, water gas and temperature sensors. Send \$2 for catalog: HES Electronics, PO Box 183, Brick, NJ 08723.

## SATELLITE EQUIPMENT

**MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES** 818-842-3539, FAX 818-845-3613.

**MAGNETIC "STRIPE" CARD WRITER/READER.** Read and write all 3 tracks of data. Not sold for any illegal use. All sales are final. \$2,500 + shipping. Blank cards \$25/ea. SmartCard Technologies 419-537-0474.

**LPTV TRANSMITTERS.** Broadcast TV to little communities, from satellite dishes. Write: Electronica Sonora/Eduardo Robles, 252 Grand Ave., Nogales, AZ 85621-2637. Call: tel/fax: (62) 150199- (MEX).

**SATELLITE HACKERS BIBLE.** Covering: Satellite data communications, radioteletype, SCPC, weather facsimile (Wefax), frequencies. BMAC, stock market quote receivers schematics, and more! Includes: 250+ IBM-PC software files. \$56.95. VISA/MC 520-782-2316. TELECODE, Box 6426-NV, Yuma, AZ 85366-6426.

# RAINBOW KITS

**THE SUPER SENSITIVE BIONIC EAR**

LOOK FOR OUR FULL CATALOG ON OUR WEBB PAGE: [www.rainbowkits.com](http://www.rainbowkits.com)

COMES COMPLETELY BUILT

12" PARABOLIC REFLECTOR

**The "ZAPPER II"**

- Complete with**
- Professional headset
  - Ultra sensitive microphone
  - 12" parabolic reflector.
  - Individual volume controls for each ear.
  - Auto Safety Circuit shuts sound off at 95 decibels for your ear protection.
  - On /Off & master volume control
  - The Bionic Ear increases sound by up to 30 decibel.
  - Hear & pinpoint sounds of wild birds and animals, great for hunters, Search & Rescue teams, sports events and Law Enforcement.
  - Hear mere whispers at incredible distances.
  - Record those sounds with your own recorder.

BE-1 BUILT **\$149<sup>95</sup>**

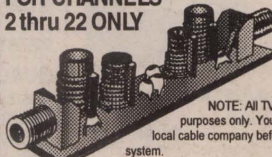
With it's new and improved design it will not only test your radar detector...BUT it's tuned to the amateur radio band.

- While your out on American highways personally test yours and your fellow travelers radar detectors.

The "ZAPPER II" is a 10.450 GHz to 10.550 Transmitter

KIT **\$39<sup>95</sup>** BUILT **\$49<sup>95</sup>**

## TV NOTCH FILTERS FOR CHANNELS 2 thru 22 ONLY



NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF-222

Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels 2 thru 22 only.

KIT **\$14.95**



## WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike, 6 to 12v DC. SIZE: 1.25" x 1"

WM-2 KIT **\$14.95**



## STROBE LIGHT

Do you need an attention getter, warning light, or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC. Size 3.5"x1.9"

ST-1 KIT **\$11.95**



## SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to 12v DC. SIZE: 1.75"x1"

AA-1 BUILT **\$29.95** KIT **\$10.95**



## MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWM5 KIT **\$34.95**

## Record every number dialed on your phone

Okay. Caller ID's tell you what number is calling you. But what about the calls made from your phone? Now, return from work or vacation and know the answer. The new DTMF Recorder electronically logs and saves every number dialed. This is the same high-tech magic used by detectives and government spies. Now yours. Does your wife or husband make expensive long distance calls and then deny it? Does your son or daughter call that low-life you forbade them to talk to? Now know.

- Decodes digits 0 thru 9, \*, A, B, C, on a 2 line 16 character LCD display.
- Clicks into your phone or extension in seconds, with no special wiring or hassles, or jack it to the incoming service panel in your garage.
- Records all numbers dialed, including local numbers that don't appear on your bill.
- Records credit card numbers entered through your phone key-pad.
- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn more of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price.

Power requirement 9v DC. SIZE: 3.5" x 4" x 1" BLACK ANODIZED ALUMINUM CABINET  
DIS-1 KIT **\$119<sup>95</sup>** BUILT **\$159<sup>95</sup>**



## Read the code from any INFRARED Device



- Complete with Software for any 80386 or 80486 base machine, with DOS 3.3 or higher.
- Sampled data can be saved to disk for instant comparison & analysis.
- Zoom in on and view any 8 millisecond portion.

TIR-1 KIT **\$89.95**



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Camera with its Power Supply

### B/W VIDEO CAMERA WITH STAND

This little camera looks like a toy, but don't let looks deceive you! It has great quality and durability built into the metal housing. Measures only 88mm long including lens, 32mm wide and 26mm high. Ready to plug into any VCR. Has 1VP-P 75 Ohm output. Operates on 12 VDC @ 1.5W, 0.2 Ls (F=2.5), weight = 95 grams. Includes camera, plastic adjustable stand, and power adapter.

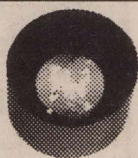
**96V003 \$195.00 each**



### TVRO PARTS BOARD

These are motherboards from block-conversion-type satellite TV receivers. The tuners and PROMs have been removed, but there are hundreds of useful RF and digital parts left, including the 70MHz IF strip.

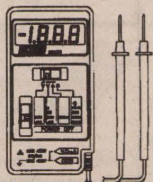
**94V005 \$9.95 each**



### TOMINON HIGH POWER LENS

1:4.5, f=230mm (9"), weight 4 lbs. Six coated glass lenses, symmetric, in black aluminum case, 3-5/8" dia. by 4-3/16" long. All aberrations are corrected well for a 50 degree angle of view, and especially well for macro projection. Scale range is from 1:10 through 1:1 to 10:1. Make a telescope with our "Precision Objective Lens" (92L031) and instruction sheet. Other applications include: high quality image projection at macro scales, or portrait photography in formats up to 6" x 9". Originally cost over \$350.00. Unused.

**92L034 \$29.95 each**



### POCKET MULTIMETER

Measures: Volts AC to 450 Volts, Volts DC in four ranges from 2 to 450 Volts. Measures: Amps DC to 200 mA. Measures: Ohms in four ranges from 0 to 20000K Ohms. Comes with test probes attached and full set of instructions.

**96Z004 \$14.95 each**

### SUPER-POWERFUL MAGNET ASSEMBLY

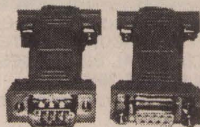
Two magnets approx 1.75" x 2.25" mounted in a metal frame. Strength is approx. 1300 Gauss each. These magnets are epoxied in place and are not easily removed. Makes excellent clamping/holding assembly.

**92N001 \$15.95 Pair**

### DELUXE TOOL CASE

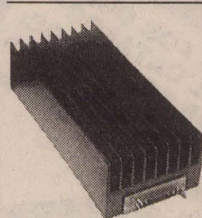
Features include carrying strap and pockets for individual hand tools. Adjustable, foam-covered dividers allow for convenient partitioning of this sturdy foam-lined case. Measurements: 6" x 12" x 18".

**96U007 \$59.95 each**



### 9-PIN GENDER CHANGERS

Male - male - 96C007  
Female - Female - 96C008  
Your Choice - \$3.95 each



### UHF LINEAR AMPLIFIER

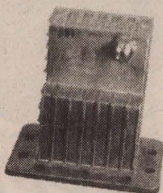
For 870-895MHz, 45W output. 1 Watt input. VCC 20 to 30 VDC @ 6 A. Class A, low intermodulation distortion. New, with spec sheets.

**96A003 \$149.00**

### MINIATURE C-BAND LNB

Low-noise block converter. Better than 40°K noise temperature. Spec sheet included.

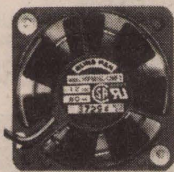
**94G001 \$49.95**



### SUPER BRIGHT LIGHT BAR

Twenty very bright red LEDs mounted in a plastic reflector/lens housing. Measures 16.5" long by 1.2" wide. 12VDC @ 400mA operation. From auto brake light.

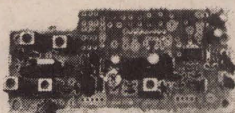
**96L001 \$4.95 each**



### 12VDC FAN

Measures 2" sq. x 0.625" thick. These are new!

**96F003 \$4.95 each**



### 6 METER FSK RECEIVER

Crystal controlled on 50.675 receive frequency. Super het with 10.7MHz IF. Three ICs and one transistor. Not a kit! New, with schematics and spec sheet for major components.

**92A067 \$9.95 each**

### SIGNAMAIL™

This transmitter/receiver pair is designed to alert you when your mail comes. The transmitter is activated by a tilt switch and broadcasts a

#### TRANSMITTER



#### RECEIVER



coded tone that turns on a light and plays a tune in the receiver. These units have dozens of other uses such as perimeter or driveway alarms, gate warning, game trails, etc. The internal tilt switch is easily bypassed for remote switching. Documentation included.

**95Z012 \$14.95/Set**



### FM WIRELESS MIKE KIT

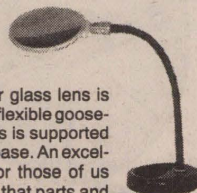
Powerful two-stage, wireless mike kit transmits over half mile (up to 1Km in the open). Tunable to the upper part of FM broadcast band. Circuit requires the ability to tweak RF circuits by stretching or compressing coils. With mike and 9V battery clip. Operates from 6-12VDC. 2.75" x 0.625" x 0.5". Sold for educational purposes only.

**Kit 32 \$10.95 each**

### GOOSE NECK MAGNIFIER

The 4.5" diameter glass lens is mounted on a 13" flexible gooseneck and all of this is supported by a heavy metal base. An excellent investment for those of us who have noticed that parts and the numbers on them keep getting smaller and smaller.

**MC205 \$14.50 each**



### FIVE POUNDS OF FAMOUS BRAND SOLDER

0.125" diameter, 29% Tin, 61% Lead, solid core.

**92Z012 5 Lb. Spool - \$19.95**

### QUACK MEDICINE KIT

Contains all parts and instructions necessary to build a "muscle stimulator." Runs on a 9V battery (not included). Produces a 90V pulse with approximately one second repeat rate. We suggest our Gray Project Box (92U062) for this kit. Sneak one into Biology Lab and make a dead frog's leg kick.

**94U002 Only \$9.95 each**

### DUKE'S DELIGHT

Five pounds of assorted electronic hardware - fasteners, nuts, bolts, screws, brackets, springs, standoffs, arms, gears, pulleys, and indescribable metal stuff scrounged from Silicon Valley's surplus to complement your hardware hoard.

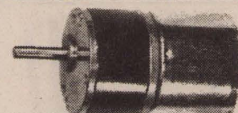
**92Z009 5 Lbs for \$4.95**

### PHONE LINE MANAGER

#### Better than Caller ID!

This device detects an incoming call. If you subscribe to caller ID, the unit will automatically receive and display the caller's telephone number. If not, the unit will ask the caller to enter their telephone or personal ID number. The device will then display and compare this telephone or personal ID number to a memory bank of numbers that you've installed. If the system finds a match your phone will ring. If the system does NOT find a match, the caller will be directed to leave a message. All messages are digitally recorded. No tape or answering machine necessary. New, in factory cartons, with documentation.

**96U001 \$59.95 each**



### REVERSIBLE DC GEAR MOTOR

Usable voltage range approx. 12 to 28 VDC. Good to several hundred RPM. Measures 1.375" dia. by 2" long. Soho Part No. E-119-525.

**96M001 \$6.95 each**



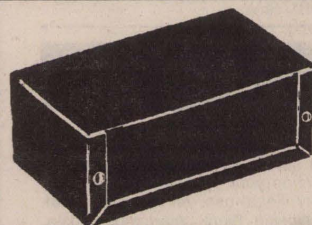
### 6-FT. IEC LINE CORD

Recycled. **95W011 Special \$1.00 each**

### TOROID CORE ASSORTMENT

WOW! May contain tape wound, powdered metal, ferrite material cores, different sizes.

**92N016 20 for \$4.95**



### TITE-FIT BOX CHASSIS

An orthodox box that has many uses and is engineered to deserve its name of Tite-Fit. Screw fastening. All screw fasteners are punched and tapped. Self tapping screws are not used. Available in Plain Aluminum.

Model #	W"	D"	H"	Price
TF770	2-3/4	2-1/8	1-5/8	\$3.40
TF771	2-3/4	2-1/8	2-3/4	3.84
TF772	3-1/4	2-1/8	1-1/8	3.40
TF773	3-1/2	2-1/8	1-5/8	3.66
TF774	4	2-1/8	1-5/8	3.84
TF775	4	2-1/4	2-1/4	4.62
TF776	4	2	2-3/4	4.63
TF777	4-1/4	2-1/4	1-1/2	3.84
TF778	5	2-1/4	2-1/4	4.96
TF779	5	4	3	6.92
TF780	5-1/4	3	2-1/8	5.47
TF781	6	5	4	9.68
TF783	8	8	3-1/2	11.92
TF784	10	6	3-1/2	14.10
TF785	10	2	1-5/8	6.25
TF786	12	2-1/2	2-1/4	8.67
TF787	12	7	4	19.59
TF788	17	5	4	21.51



# ALLTRONICS

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Don Lancaster's

# RESOURCE BIN

number fifty six

## Creating your own web home page.

**O**ur usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) [www.tinaja.com](http://www.tinaja.com) — This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* columns. Along with some new "rich text" global search features.

The site is still under construction, but I fully intend to move thousands of my files here. So, definitely come visit. But bear with me for a while till things really get into gear.

You will get the best results if you have both *Netscape Gold* and *Acrobat Amber 3.0*. You download these from [www.netscape.com](http://www.netscape.com) or [www.adobe.com](http://www.adobe.com)

### Your Own Web Site

Last month, we looked into all the fundamentals of getting online. After you have your ISP and host software in place, and after you have surfed the net for a month, the chances are you might want to start up your own personal web home page.

Before you begin, though, take time to write down *all* the *exact* goals you want your site to accomplish. It *is* reasonable for a site to make others aware of you. Or to provide info on your products. It *is* reasonable for the site to focus on one topic.

But it *is not* reasonable to expect a site to generate scads of direct cash sales. It *is not* reasonable to expect thousands of daily visitors to your site. Unless you have an exceptional sole-source something to offer.

By far, your three most important features that you can offer on your site are *content, content, and content*.

Beyond lots of content, you should also *secondarily* aim to be a *gateway site* that provides great heaping bunches of well-annotated and working links to other quality web locations.

Your first and foremost rule is to study *hundreds* of existing sites to find out what does and does not work. I am not that convinced that presenting lots of highly personal information online is such a good idea.

For instance, if you are female, your personal content *will* be treated as a porno site. At least by many viewers. If you must present a resume online, better to have a short summary plus a "click here for full E-Mail version."

And spare us the drivel. I couldn't care less about your parakeet.

Unless, of course, you've trained him to program in PostScript while he quests Mount Graham tinajas.

Note also that properly maintaining a useful web site demands

### NEXT TIME: Don reviews fundamental resources for electronic servicing.

an *absolute minimum* of 20 hours of work per week. Sometimes *much* more.

You should find two types of sites: *registered* and *non-registered*.

A non-registered site is more or less free and is simply some space your ISP leases to you. If your ISP is *aaron*, your home page site address will be [www.aaron/~your-site](http://www.aaron/~your-site)

Being free is all a non-registered site is worth. Others can freely use your domain name. Getting your site indexed may be tricky. Your address is a free ad for your ISP. And if your ISP goes belly up (or you seek a better one elsewhere) you'll have to rename and repromote your site.

Instead, a registered site costs you \$50.00 per year. This gives you exclusive use of the domain name. Your name ends in *.com* when you

are a for-profit venture. Or ends in *.org* if not.

To find out if a domain name is still available, go to [www.internic.net](http://www.internic.net) and use their *whois* feature. My first two choices of *synergetics* and *guru* were not available. So *tinaja*, of course, was the next logical choice.

To register your domain, you once again should contact [www.internic.net](http://www.internic.net) — Then follow their online instructions. Note that registration can *not* be done by mail or fax. It *must* be done online.

Next comes the home page design. While you can hire others to do this, it is fairly easy to do yourself. You also get *exactly* what you want *exactly* how you want it this way.

There are all sorts of web designer tools. Adobe's new and free beta *Web Presenter* is fairly handy, along with their *Page Mill*. But all you really need is a free copy of Netscape's *Navigator Gold*. Netscape is all I ever use.

You may have heard of HTML. It is ludicrously absurd to call HTML a language. At best this is a *crayon*. A mesmerizing awful atrocity that goes out of its way to *prevent* your end user from seeing what you really want to show in exactly those forms and fonts you wish to show them.

Adobe's great *Acrobat Amber 3.0* is infinitely superior to HTML. On all counts. It quickly and attractively lets you show *any* text and graphics and photos *any* way you want.

When it is properly installed into Netscape, you can instantly view files without needing a special download or changing the program in use.

That anti-aliasing Adobe calls *text smoothing* makes all text ridiculously more legible. Their magnifier feature can instantly blow up schematics and such for greater detail.

Thus, a key web rule: *Use an absolute minimum of HTML on your site!* Favor Acrobat Amber instead.

Uh, you probably should pick up a book on HTML somewhere along the way. Jeff Duntmann has lots of them at his *Coriolis Books*.

### Steal The Plans

Your simplest way to build a web page is to *steal the plans*. Find a page you like on the web and select the *edit* feature of *Netscape Gold*. Which will rapidly transfer copies of all files you'll need to duplicate the site.

Replace their text copy with yours. Then change the sizes and shapes of the graphics by using suitable editors. Grab the wallpaper into a GIF or JPEG editor and shift the color and density around. Mix and match the tools from several dif-

new from  
**DON LANCASTER**

### ACTIVE FILTER COOKBOOK

The sixteenth (!) printing of Don's bible on analog op-amp lowpass, bandpass, and highpass active filters. De-mystified instant designs. **\$28.50**

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# RESOURCE BIN

## SOME INTERNET START-UP RESOURCES

<b>Adobe Acrobat</b> 1585 Charleston Rd Mountain View CA 94039 (800) 833-6687	<b>Inter@ctive Week</b> 100 Q Roosevelt Blvd #508 Garden City, NY 11530 (516) 229-3700	<b>InterNIC Registration Svcs</b> 505 Huntmar Park Dr Hemond VA 22070 (703) 742-4777	<b>Netscape Gold</b> 501 E Middlefield Rd Mountain View CA 94043 (415) 528-3777	<b>WEBSmith</b> Po Box 55549 Seattle WA 98155 (206) 782-7733
<b>Boardwatch</b> 8500 W Bowles Ave #210 Littleton CO 80123 (303) 973-6038	<b>Internet Life</b> One Park Avenue New York NY 11016 (212) 503-3500	<b>LDS/WEB Trac</b> 571 Central Avenue Murray Hill NJ 07974 (800) ASK-LDSI	<b>Nuts &amp; Volts</b> 430 Princeland Court Corona, CA 91719 (909) 371-8497	<b>WEB Week</b> 20 Ketchum Street Westport CT 06880 (708) 564-1385
<b>Coriolis Books</b> 7339 E. Acoma Drive #7 Scottsdale AZ 85260 (520) 483-0192	<b>Internet World</b> 20 Ketchum Street Westport CT 06880 (203) 341-2872	<b>The Net</b> 1350 Old Bayshore #210 Burlingame CA 94010 (415) 696-1688	<b>Synergetics</b> Box 809 Thatcher AZ 85552 (520) 428-4073	<b>Wired</b> 544 2nd St 3rd Fl San Francisco CA 94107 (415) 904-0664
<b>Gale Research</b> 835 Penobscot Blvd Detroit MI 48226 (313) 961-2242	<b>Internet Yellow Pages</b> 2600 Tenth Street Berkeley CA 94710 (800) 227-0900	<b>NetGuide</b> 600 Community Drive Manhasset NY 11030 (516) 562-5000	<b>WEB Techniques</b> 800 Harrison Street San Francisco CA 94107 (303) 661-1885	<b>Yahoo Corp</b> 635 Vaqueros Avenue Sunnyvale CA 94086 (408) 328-3300

ferent sites.

Finally, get into an editor and view the actual HTML text. Then eliminate anything obviously proprietary. As a final test, do make *certain* your final appearance of the site does not look even *remotely* like the original.

There are also lots of web designer programs out there that include ready-to-use templates. Buttons, doodads, rules, and Java applets can be found on hundreds of web sites.

### Speed, Not Glitz

A few site webmasters appreciate how infuriating it is to mope around waiting for a humongous and totally useless image to download. A bored or impatient visitor is a gone one.

If you must use images, compress them with Acrobat or JPEG. *Never* use GIF! Keep the images small.

I invite you to compare the access speed of my [www.tinaja.com](http://www.tinaja.com) against anything else on the web. To run at this speed, I first use few and small graphics on the HTML side.

On the Acrobat side, I use Adobe's new Amber 3.0, which offers dense compression, web-friendly file order re-arrangement, and (eventually when the ISP gets around to it) faster page file block downloads.

### Measuring Visits

How can you tell how many people are visiting your site?

You may have heard the term "hit." The *hit* is an obscenely bloated and a totally misleading measure for the popularity of a web location.

You see, a person does not really "visit" a web site. They instead ask for small *packet* bits and pieces. In random order.

For instance, a visit to a home page may return the page itself in a single packet, an image or two in additional packets, and possibly a few artistic rules, buttons, or selected gimcracks. Dozens to hundreds of site "hits" may be involved in one access.

On top of that, some visitors arrive by mistake, take one look and leave. Yet others are those spiders and the tireless net crawlers from the index services. Some visitors may promptly return in a few minutes for one reason or another. Is this one hit or two? What if they return in an hour? In a day? In a week?

Instead of the "hits," you should be worried about how many important and key files of yours are getting fully downloaded. Say your catalog or a hot and unique new reprint.

There is one standard way to sort all of this out: Your ISP has two files related to your site called the *log file* and the *error file*. You should make arrangements with your ISP to gain routine access to these files.

Your log file line entry describes every access by who made it when. Repeated entries tell you how long the visitor stayed, which pages they accessed, and how they left. The error file is particularly useful to spot any internal links you have that are not working. Or to spotlight ISP traffic problems. Sadly, the error file can *not* spot a bad *external* link.

Once transferred to your host, these are plain old text files in a standard format. You can snoop around with any old word processor or editor. Or enter them into any spreadsheet or data base program.

What if you really want to know how many left-handed Brazilian cat fanciers visited your site at 2 am on Tuesdays? My own preference here is to stash the log file on my PostScript printer's hard disk. And then use PostScript as a super power general-purpose computer language to extract and present useful results. But you'll find lots of *web tracking* software out there. The free *Webtrac* site analysis software from [www.lids.com](http://www.lids.com) is an older, but more or less typical code.

A pair of quick-and-dirty rules of thumb: To approximate your actual number of useful visitors, divide your hits by 60. Or log characters by 4500.

There are also "odometer" visitor number services. But I feel that this is *odometer* as in *odious*. I'm not all that convinced that these web

counters are useful or desirable.

Especially when they stick and give you obnoxious error messages. Or if they spill Java all over your screen.

Besides, an odometer reading less than 50,000 or

so will loudly proclaim that "this site sucks." Which strongly suggests adding 52,761 to your web count before you display it.

### Promoting Your Site

So, once you get your web site up and running, how do you get anyone worthwhile to visit it?

First off, it is probably *not* a good idea to promote your site too early. What you think you are going to have and what you really are offering are usually wildly different.

It is a good idea to have your site up for *at least* six weeks before you aggressively promote it. Before any promotion, it is also a good idea to already have so much content on your site that it *can't be covered in one visit*.

Second, you might not want just anyone visiting your site. Instead, you will probably want to focus all your promotion efforts upon those who are likely to share your views. Or those who may buy something from you.

Traffic for traffic's sake makes no sense whatsoever.

At any rate, your first promotion effort should be to link to the *index services*. Start with [www.yahoo.com](http://www.yahoo.com) and use their *add url* service. Then use Yahoo's links to reach the other indexes.

Better yet, you might check out [www.2com.com/~upfront/launch/](http://www.2com.com/~upfront/launch/). This free service can link you up to the top 20 or so index services.

Next, go to a really great site that wins lots of awards and boasts of it. The *Science Hobbyist* site you'll find at [www.eskimo.com/~billb/](http://www.eskimo.com/~billb/) should work out just fine. Then mine their hot list of award issuing sites.

It is also a good idea to register your name and E-Mail address with such services as [www.whowhere.com](http://www.whowhere.com) — Along with your site domain. And, of course, be sure to have a hot site link *inside* your E-Mail signature file.

But your most important and most useful traffic builder is the *exchange link*. You first provide a hot link to somewhere and then ask them to give you one back.

Threads in the web.

You'll have the best luck by cross linking sites that are the same size as yours or somewhat smaller. *Always provide their link on your site first.*

The chances are that if you have a personal interest in a site, others will too. It is better to focus on stuff you can genuinely use.

And don't just provide a link. Tell your users *what* this link is and *why* you like it. Avoid using any text-only links. Instead, provide a button or some larger graphic to make for easier mousing around.

By the way, if someone provides you with a free link, netiquette leaves you with two and only two options: Quickly give them a hassle free link in return or else send them an annual check for \$30,000.00.

Don't forget *non-web* resources in promoting your site. All the printed web magazines are always looking for new sites to review. So suggest yours. Several times. Any time you see a list of web sites anywhere, figure out how to contact the listee.

Of course, you should prominently mention your site in any printed ads you may be running. And don't forget the power of the *adveto-rial*. Especially when it's combined with some subtle mention to visit my own web site found at <http://www.tinaja.com>

### Unpromoting Your Site

What if you receive *too much* site traffic? So much sheer volume that it is overloading your ISP? Or causing dropouts, delays, and other problems to those you really want visiting?

First, make sure your home page keywords are tightly focused. If you put *sex*, *drugs*, or *rock* and roll in your keywords, you'll be generating a lot of worthless traffic. As will getting yourself on a porno filter blacklist.

For every porno "bandstop" filter, you can also find a porno "band-pass" filter elsewhere on the net. These essential services clearly complement each other.

For every dry spot, there's a wet spot. Yin and yang.

Your ISP can install software *filters* for you that restrict unneeded traffic. These are sometimes called *JavaScript applets*. Or else use a CGI, short for *Common Gateway Interface*.

If, as I do, you are unable to offer any foreign sales or service, there's no point at all in welcoming any non-US country codes. If you are not busily ripping off the government, then a block of .gov domains might end up a good idea. To avoid non-buying students, block .edu.

Those indexing web crawlers can have a stick run through their



## RESOURCE BIN

treads by proper use of a *robots.txt* file.

Certain traffic problems can be ISP caused. This can be the case if a lot of *send timed out* or *read timed out* errors appear in your log file. The solutions here are to complain loudly. Or to pick a better ISP.

Your E-Mail traffic can be very much reduced by ignoring most of it. And, above all, not unleashing a pen pal by repeated responses. I use this criteria as an E-Mail filter: *Is there a 10 percent probability of a 10 cent net positive cash flow as a result of my answering?*

The surest methods to *dramatically* reduce your visitors is to require use of passwords or charge an access fee. Which brings us around to ...

### Showing A Profit

Very few web sites generate a net positive cash flow. But it is possible. If you are in it for the long term. If you give lots away to sell a little. If you use *pull* advertorials rather than *push* advertising. If you are seeking more indirect results (referral, awareness, contact) than any immediate hard cash sales. If you have totally unique products offered at a fair price.

And, above all, if and only if you have great heaping bunches of useful and unique site content.

There are four main ways to fund a site: by use of sponsors, advertisers, cash-and-carry, or subscription.

A sponsor pays you for a portion of your site to offer their catalogs or to save webmastering hassles. Or else because they believe in what you are doing. Or have some vested interest in your content.

For instance, on a community site, you would provide all the upcoming events and the local school lunch menus (including the knockwurst ala king and the butter-scotch pudding au jus) for free, but charge the businesses \$12.00 per month and churches \$5.00 per month for their listings and content.

An advertiser simply pays you for a billboard on your site. The fees range from \$5.00 to \$40,000.00, depending on your site popularity. Or sometimes paid on a per-visit basis. There are also net co-op advertising exchanges.

With cash-and-carry, a user pays so much per download or per hour so he can access your premium material. A patent file, technical reprints, or a map repository are examples.

With a subscription, the user pays a flat fee for unlimited site access over a given time period. I personally feel a single time long term charge makes more sense than by the month.

Your users will not view this as an ongoing obligation. And the payment hassles are few and far between. \$25.00 for six month's access sounds about right to me. You must, of course, have both a "free" and a "fee" area.

Reliable and secure electronic petty cash isn't quite here yet. But you can certainly expect it within a year. For now, visa-over-voice-phone or use of fax still seems the best route.

Subscription or cash-and-carry, you will have to provide lots of no-charge stuff, including free trials. Make it completely obvious *exactly* what *all* of the charged stuff is all about. Through annotated descriptions or abstracts.

All of the above combos can be used. As might cooperative zero cash exchange promotions between sites. While zero net cash, these can very much boost your relevant traffic.

### This Month's Contest

I've once again summarized some web resources for you in this month's sidebar. Many of these services and links mentioned can also be reached at my [www.tinaja.com](http://www.tinaja.com) Last month's column appears as file RESBN55.PDF on the *Resource Bin* library shelf.

As our contest this month, just tell me a webmastering trick or technique I am not yet aware of. Or else tell me about your web experiences.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

Send all your *written* entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial.

Let's hear from you. **NV**

**Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and consulting services. Don also has two free catalogs full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.**

**Don is in the process of setting up his Guru's Lair at <http://www.tinaja.com>**

**Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his US Internet address of [don@tinaja.com](mailto:don@tinaja.com)**

## ELECTRONIC TEST EQUIPMENT BOUGHT & SOLD

Altech 360D11, Frequency Syn. 01-2GHz	\$1,000	HP 8569B, Spectrum Anz. High Performance	\$9000
Anritsu ME6454, Microwave Radio Test Set	\$1,000	HP 8620C, Sweeper Mainframe	\$400
Antelco 1040A, Meter Calibrator, AC/DC Voltage/Current	\$1,200	HP 8621B, RF Draw, with 86350A, 8-12.4GHz, 8620C	\$400
Argosystems AS210, Frequency Calibration System	\$3,500	HP 86220A, RF Plug-in, 10-1300MHz	\$600
Astrosystems A1202S/R-01, Decade Syncro		HP 86222B, RF Plug-in, 0.1-2.4GHz, Opt. 02, 04	\$1,200
Resolver Standard	\$400	HP 86241A, RF Plug-in, 3.2-6.5GHz	\$400
Austron 2100, Loran C Timing Receiver	\$600	HP 86250C, RF Plug-in, 8-12.4GHz	\$400
Balco 911A, Frequency Response Analyzer (unused)	\$400	HP 86260A, RF Plug-in, 12.4-18GHz	\$400
Ballantine 1627A, Scope Calib., with vac. heads	\$1,000	HP 86290B, RF Plug-in, 2-18GHz w/Scale	\$1,400
Bird 43, Wattmeter, 7 Slugs	\$400	HP 8640B, Signal Gen., 5-512MHz, Opt. 3	\$1,200
Bonton 102 C/E, Signal Gen., 1KHz-512MHz	\$800	HP 8640B, Signal Gen., 5-1024MHz, Opt. 1, 2	\$2,000
Bonton 250A, RX Meter, Same as HP	\$350	HP 8654A, Signal Gen. 10-520MHz AM/FM	\$500
Bonton 82AD, Modulation Meter, 10MHz-1.2GHz, HP1B	\$650	HP 8656A, Signal Gen., 1-990MHz AM, FM, HP1B	\$2,000
Bruel & Kjaer 1612, Bandpass Filter	\$250	HP 8660A, Synthesized Signal Gen., Opt. 5, 100	\$650
Bruel & Kjaer 2107, Frequency Analyzer	\$200	HP 86601A, RF Plug-in, 110MHz	\$250
Bruel & Kjaer 2305, Level Recorder	\$250	HP 86602B, RF Plug-in, 1300MHz	\$500
Cushman CE-6030, Com. Monitor, with Opt. 05, HP1B	\$5,000	HP 8683A, Signal Gen. 2.3-6.5GHz, Opt. 1, 2	\$1,500
DDC SR-400, Synchro Resonance Simulator	\$400	HP 8750A, Storage Normalizer	\$250
DR Thedig MILL-102, Ohmmeter, 1 Million-2 Terraohm	\$400	HP 8821A, Medium Gain Bank Amp	\$150
Eaton 38K11, Synthesizer, 1-2000MHz Opt. 01, 03, 183	\$2,500	FR FM/AM-1000A, Service Monitor	\$2,500
EIP 371, Source Locking Microwave Counter, 18GHz	\$1,500	Itasca 393, Lock-in Amplifier	\$300
EIP 451/P1/P2/P3, Microwave Pulse Counter, 18GHz	\$700	Keithley 169, Digital Multimeter	\$80
ESI 296, Auto LCR Meter	\$650	Leeds & North 1091, Capacitor Decade, .001uF-1uF	\$150
Fluke 332B, DC Voltage Standard 0-1100VDC	\$300	Marconi 2955, Radio Comm. Test Set, OCXO	\$5,000
Fluke 3330B, DC Voltage, Current Calibrator	\$400	Micro-Tel SG800, Swept Signal Generator, 1-18GHz	\$2,000
Fluke 335A, DC Voltage Standard, 0-1100VDC	\$600	Narda 7000/T202/T206, Microwave Multimeter, .01-18GHz	\$1,000
Fluke 5200A, Programmable AC Voltage Standard HP1B	\$1,600	Narda 7927F, Attenuator, 2-12.4GHz 0-20dB	\$100
Fluke 540B, Thermal Transfer Standard	\$900	North All 540/10, Resolver Synchro Bridge	\$600
Fluke 750A, Reference Divider	\$600	NWS Model 85, ASCOPE	\$100
Fluke 8010M, Digital Multimeter	\$70	Panametrix Epoch 2002, Ultrasonic Flaw Det.	\$1,000
Fluke 8500A, Digital Multimeter 6.5 Digits, DC Only	\$250	Phillips 3211, Scope, 15MHz 2Ch.	\$200
Fluke 8502A, Digital Multimeter, AC, DC, Ohms	\$300	Phillips PM3260, Scope Dual Trace Delayed Sweep	\$250
Fluke 8505A, Digital Multimeter, AC, DC, Ohms	\$400	Phillips PM3267, Scope, 100MHz, Dual Trace	\$400
Fluke 8506A, Thermal RMS Multimeter HP1B	\$1,200	Polarad 1105 E-L, Sig. Gen., 1020A Mod., 8-2.4GHz	\$300
Fluke 8921A03, True RMS Voltmeter	\$600	Polarad 1207, Signal Source 3.8-8.2GHz	\$200
Fluke 9010A, Micro-System Troubleshooter Opt. 001	\$450	Polarad SPNH, Generator 20Hz-20KHz	\$450
Fluke A55, Thermal Converter Set, 7 Pieces, Cables	\$1,800	PPM RS, Resistor Standard, 1-111.1K, 1 Ohm Res	\$150
General Radio 1422-CB, Standard Cap.	\$300	Racal Dana 1515, Delay Pulse Generator	\$500
General Radio 14820, Standard Inductor, 2 Henry	\$100	Racal Dana 1992, Universal Counter, High Stab. HP1B	\$800
General Radio 1538A, Stroboscopic, Strobe Scope	\$300	Racal Dana 9035/11A, Computer Counter, Opt. 01/06/55, Unused	\$300
General Radio 1538-P4, High Intensity Flash Capacitor	\$100	Racal Dana 9082P, Signal Gen. 1.5-520MHz AM, FM	\$1,000
General Radio 1650A, Impedance Bridge	\$200	Racal Dana 9303, True RMS RF Level Meter	\$650
Gigatronics 60016-12, Synthesized Source	\$1,500	Racal Dana 9515, Universal Counter, HP1B, Opt. 41	\$200
Gould 4500, Digital Storage Scope, 35MHz	\$450	Sencore TF30, Super Cricket Transistor Tester	\$200
Guideline 9152/P4, Standard Cell, Double Oven	\$300	T.B.E. 208, C, L Meter, 1HF-10uF, 1H-10H	\$300
Hameg HM 208, Digital Storage Scope, Unused	\$600	Tek 1105, Scope, 500MHz w/2) 11A71 Plug-ins	\$2,000
HP 105A, Quartz Frequency Standard	\$600	Tek 1401/324, Spectrum Analyzer, 1-500MHz	\$800
HP 1124A, 100MHz Active Divider Probe, Unused	\$100	Tek 1502/04, TDR Cable Tester, with Chart Recorder	\$1,495
HP 11710B, Down Converter, Frequency Standard	\$200	Tek 1503, TDR Cable Tester 0-50,000 Ft.	\$1,295
HP 11971K, Waveguide Mixer, 18-25MHz	\$800	Tek 178, Linear IC Test Fixture, For 577	\$300
HP 1200A, Scope, Dual Trace, 1mV-20V	\$100	Tek 2213A, Scope, 60MHz Dual Trace	\$450
HP 1415A, Time Domain Reflectometer Plug-in, 141T	\$200	Tek 2215, Scope, 60 MHz Dual Trace	\$450
HP 1417, Spectrum Analyzer Mainframe	\$500	Tek 284, Pulse Generator	\$350
HP 1707B, Scope, 75MHz Dual Trace	\$250	Tek 464, Scope/100MHz Dual Trace, Storage	\$500
HP 1725A, Scope, 275MHz Time Interval	\$600	Tek 465M, Scope, 100MHz Dual Trace, Delayed Sw.	\$400
HP 1741A, Scope, Storage, 100MHz	\$450	Tek 466, Scope, 100MHz Dual Trace, Storage	\$600
HP 1815A/1816A, TDR/Sampler, DC-4GHz	\$400	Tek 466D/4M4, Scope, 100MHz Dual Trace, DMM	\$650
HP 3300A, Function Gen. with 3302A Phase Lock	\$150	Tek 475, Scope, 200MHz, Dual Trace	\$800
HP 3320A, Frequency Synthesizer	\$250	Tek 485, Scope, 350MHz Dual Trace	\$800
HP 3320B, Frequency Synthesizer	\$350	Tek 624, XY Monitor	\$200
HP 3325A, Synthesized Function Generator	\$1,800	Tek 7403N, Scope w/2) 7A29, 7B10, 7B15	\$4,000
HP 3400A, RMS Voltmeter 1mV-300V, 10Hz-10MHz	\$150	Tek 7403N, Scope Mainframe, Rack Mount	\$200
HP 3455A, High Accuracy Voltmeter 6.5 Digit	\$300	Tek 7895, 400MHz Delaying Time Base	\$150
HP 3570A, Network Analyzer	\$350	Tek 7CT1N, Curve Tracer Plug-In	\$350
HP 3575A, Phase Gain Meter, Opt. 01, Dual Displays	\$600	Tek 7L18/7603, Spectrum Anz. 1.5-18GHz	\$3,000
HP 3580A, Spectrum Anz., 5Hz-50KHz, 1Hz Res	\$800	Dig. Storage	\$3,000
HP 3580A, Spectrum Anz., LED Readout	\$1,500	Tek 7512, TDR/Sampler	\$400
HP 3581C, Selective Level Meter	\$600	Tek AM501, Operational Amp Plug-In	\$150
HP 3586C, Selective Level Meter, 50 Ohm	\$1,000	Tek AM503, Current Probe Amp	\$400
HP 394A, Attenuator, 1-2GHz, 200 Watts	\$125	Tek DC503, Universal Counter Timer TM500	\$150
HP 4270A, Automatic Capacitance Bridge	\$600	Tek DC504, Counter/Timer TM500	\$100
HP 432A/478A, Power Mtr., Cable, Mount, 10MHz-10GHz	\$300	Tek DC508A, Counter, 1.3GHz Opt. 01	\$500
HP 432B, Power Meter, Digital Display	\$250	Tek DC502, Multimeter TM500 Modular System	\$100
HP 4800A, Vector Impedance Meter	\$100	Tek FG504, Function Generator, 0.01Hz-40MHz	\$400
HP 5004A, Signature Analyzer	\$1,200	Tek MR501, XY Monitor Scope	\$200
HP 5328A, Universal Counter, 500MHz, HP1B	\$350	Tek P6020, Current Probe, Amp Kit	\$250
HP 5334A, 100MHz Universal Counter, HP1B	\$1,200	Tek P6045, FET Active Probe	\$100
HP 5340A, Frequency Counter, 18GHz	\$1,000	Tek P6046, Differential Probe Kit	\$250
HP 5341A, Counter, 10Hz-4.5GHz LEDs & HP1B	\$700	Tek P6020A, FET Probe Kit, 500MHz, Unused	\$400
HP 5342A, Microwave Freq. Counter, 18GHz		Tek P6430, Temperature Probe	\$100
Opt. 01, 011	\$2,000	Tek P6452, Data Acquisition Probe	\$50
HP 5345A, Universal Counter	\$450	Tek P6464, Pattern Generator Probe, New In Box	\$50
HP 54200A, Digital Storage Scope, Dual Trace, 200MG/S	\$1,000	Tek P6465, Pattern Generator Probe, New In Box	\$50
HP 54201D, Digitizing Scope, 300MHz	\$1,600	Tek P5501-1, Power Supply 0-20V, TM500	\$150
HP 6177C, DC Current Source 0-50V, 0-500mA	\$300	Tek P5503A, Dual Tracking Power Supply, TM500	\$200
HP 7015B, XY Recorder	\$200	Tek S3, Sampling Head	\$100
HP 745A, AC Calibrator, 1mV-110V 10Hz-110KHz	\$350	Tek S5, Sampling Head	\$100
HP 7790, Directional Coupler, 1.7-12.4 GHz	\$200	Tek S51, Trigger Countdown Head	\$400
HP 8018A, Serial Data Generator	\$300	Tek S5201, Scope, 5MHz	\$200
HP 8165A, Programmable Signal Source, .0001-50MHz	\$1,800	Tek SG502, Sig. Gen. 5Hz-50MHz TM500 Sys.	\$200
HP 8410B, Network Analyzer	\$200	Tek SG503, Sig. Gen. 250KHz-250MHz	\$600
HP 8412A, Phase Magnitude Display	\$400	Tek T202, Scope, LCD Handheld	\$500
HP 8443A, Tracking Gen., 100K-110MHz LED Display	\$1,200	Tek T0501, Time Mark Generator	\$400
HP 8444A/059, Tracking Generator	\$1,200	Tek TM503, Mainframe 3 Slot, TM500	\$100
HP 8445B, Spectrum Anz., Automatic Pre-Selector	\$400	Tek TR501, Tracking Generator, 1.2GHz for 7L12	\$800
HP 8552B, Spectrum Anz., IF Section	\$2,000	Tek TR503, Tracking Gen. 1-1800MHz for 492, 4, 6	\$1,000
HP 8553B, Spectrum Anz. Display Section	\$2,000	Vu-Dia 5110, Semiconductor Tester, In/out Circuit	\$250
HP 8553B/8552B, Spect. Anz. 141T System, 1KHz-110MHz	\$1,000	Wavetek 1002, Sweep/Sig. Gen. 0-500MHz	\$350
HP 8554A/8552B, Spect. Anz. 141T System, 100KHz-1.2GHz	\$1,400	Wavetek 114, Sweep/Trigger VCG	\$100
HP 8555A/8552B, Spect. Anz., 141T System, .01-18GHz	\$1,600	Wavetek 144, HF Sweep Gen. .0005Hz/10Hz	\$200
HP 8556A, Plug-In, Spectrum Analyzer, 20Hz-300KHz	\$400	Wavetek 145, 20MHz Pulse/Function Generator	\$300
HP 8557A/180TR, Spectrum Analyzer, .01-350MHz	\$1,000	Wavetek 154, Programmable Waveform Gen., .001Hz-10MHz	\$350
HP 8558B/180TR, Spectrum Analyzer, 1-1500MHz	\$2,000	Wavetek 2002A, Signal Gen. Sweeper, 1-2500MHz	\$1,600
		Wavetek 452, Filter, Dual Hi/Low, 1Hz-10KHz	\$450
		Wavetek 7530A, FFT Spectrum Analyzer 0-100KHz	\$1,000
		Wavetek 8501, Peak Power Meter, 30MHz-18.5GHz	\$2,000
		Wavetek 859, Programmable Waveform Gen.	\$1,000
		Wavetek 907, 7-11GHz Signal Generator	\$650

## PHELPS INSTRUMENTS

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## OSCILLOSCOPES & ACCESSORIES

### TO 100 MHz

TEK 2336YA 100 MHz Dual Channel Oscilloscope	\$1,000.00
TEK 7A18 75 MHz Dual Trace Amplifier	\$100.00
TEK 7A22 1 MHz High CMRR Differential Amplifier	\$300.00
TEK 7B53A 100 MHz Dual Time Base	\$175.00
TEK SC502 15 MHz Dual Trace Oscilloscope, TM500 series	\$375.00

### ABOVE 100 MHz

TEK 475 200 MHz Dual Trace Oscilloscope	\$850.00
TEK 485 350 MHz Dual Channel Oscilloscope	\$1,100.00
TEK 7104 1 GHz Oscilloscope, with 7A29, 7A29-04, 7B10, 7B15	\$5,000.00
TEK 7854 400 MHz Waveform Processing Oscilloscope frame	\$1,250.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B92A	\$500.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B80, 7B85	\$1,000.00
TEK 7904A 500 MHz Oscilloscope Frame	\$750.00
TEK 7A13 105 MHz Differential Comparator	\$300.00
TEK 7A16A 225 MHz Single Trace Amplifier	\$125.00
TEK 7A19 600 MHz Single Trace Amplifier	\$175.00
TEK 7A19-opt. 4 600 MHz Single Trace Amplifier, variable delay line	\$200.00

TEK 7A24 400 MHz Dual Trace Amplifier	\$350.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$175.00
TEK 7A29 1 GHz Single Trace Amplifier	\$550.00
TEK 7A29-opt. 04 1 GHz Single Trace Amplifier, variable delay line	\$650.00
TEK 7B15 1 GHz Delaying Time Base	\$450.00
TEK 7B80 400 MHz Delayed Time Base	\$175.00
TEK 7B85 400 MHz Delta Delaying Time Base	\$200.00

### STORAGE

TEK 7834 400 MHz Storage Oscilloscope, w/7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series	\$700.00

### SAMPLING

TEK 7S11 Sampling Unit	\$300.00
TEK 7T11 Sampling Sweep Unit	\$750.00
TEK 7R903/7S11/7T11-S 4 12 GHz Sampling Oscilloscope System	\$1,750.00
TEK S-4 14 GHz Sampling Head	\$300.00

### PROBES

TEK 1101 Accessory Power Supply, for FET probes	\$250.00
TEK P6046 100 MHz Differential Probe	\$750.00
TEK P6101A 34 MHz 1X Modular Probe, 2m length 'NEW'	\$25.00
TEK P6108A 100 MHz 10X Modular Probe, 2m length 'NEW'	\$50.00
TEK P6201 900 MHz 1X/10X/100X FET Probe	\$500.00
TEK P6202A 500 MHz 10X FET Probe	\$300.00
TEK P6203 10X 1 GHz Active Probe, for 11000 series	\$450.00
TEK P6701-opt.01 O/E Converter, 450-1050 nm/0-1 mW: DC-700 MHz, FC conn.	\$675.00

### CALIBRATION

TEK 067-0587-01 Signal Standardizer Calibration Plug-in, 7000 series	\$300.00
TEK CG5001-opt.01/TM5006 Programmable Oscilloscope Calibrator, with power module	\$7,000.00
TEK CG551AP/TM506A Oscilloscope Calibrator, with pulse head & power module	\$3,500.00

## WAVEFORM GENERATORS

### FUNCTION

HP 3310A 5 MHz Function Generator	\$325.00
HP 3310B 5 MHz Function Generator, monocyte & var. phase trigger	\$425.00
HP 3312A 13 MHz Function Generator, sweep, AM, FM	\$850.00
HP 8015A 50 MHz Dual Output Pulse Generator	\$650.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$375.00
TEK FG502 11 MHz Function Generator, TM500 series	\$325.00
TEK FG503 3 MHz Function Generator, TM500 series	\$275.00
TEK FG504 40 MHz Function Generator, TM500 series	\$875.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 188 4 MHz Sweep/Function Generator, 20Vp-p	\$275.00
WAVETEK 23 12 MHz Synthesized Function Generator	\$1,100.00

### PULSE

HP 214B 10 MHz Pulse Generator, 50V/50 Ohms, auto duty cycle	\$1,650.00
HP 8005B 20 MHz Dual Output Pulse Generator	\$450.00
HP 8012B 50 MHz Pulse Generator, variable Tr	\$600.00
HP 8013B 50 MHz Dual Output Pulse Generator, 3.5 nS fixed Tr	\$600.00
HP 8015A-002 50 MHz Dual Output Pulse Generator, burst mode option	\$750.00
HP 8080A/81A/82A/83A 300 MHz Word Generator	\$600.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
HP 8080A/91A/93A 1 GHz Clock Generator	\$600.00
HP 8082A 250 MHz Dual Output Pulse Generator	\$1,400.00
PHILIPS PM5785B 125 MHz Dual Output Pulse Gen., burst mode, 1 nS Tr	\$875.00
TEK PG501 50 MHz Pulse Generator, TM500 series	\$250.00

TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$700.00
WAVETEK 801 50 MHz Pulse Generator	\$450.00

### PROGRAMMABLE

HP 3314A Multi-Waveform Generator, 0.001 Hz-19.99 MHz, HP1B	\$3,500.00
HP 3325A-002 Synth/Function Gen., 1 uHz-21 MHz, 40V out 1 uHz-1 MHz	\$2,400.00
HP 8160A 50 MHz Programmable Pulse Generator, HP1B	\$2,500.00
HP 8165A-002,003 Prog. Signal Source, 1 mHz-50 MHz, log sweep, rear out	\$2,000.00
TEK AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$1,400.00
TEK AWG5105 Arbitrary Waveform Generator, 50 MS/s, 12 bits	\$1,700.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$2,200.00
TEK FG5010 Programmable 20 MHz Function Generator, TM5000 series	\$1,200.00
TEK PFG505 Programmable 12 MHz Pulse/Function Generator	\$900.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB	\$1,500.00

## VOLTAGE & CURRENT

### VOLTMETERS

HP 3456A 6-1/2 Digit Voltmeter	\$850.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$1,500.00
SOLARTRON 7081 8-1/2 digit Voltmeter	\$3,900.00
SOLARTRON 7150 5-1/2 digit Multimeter, GPIB	\$450.00

### CALIBRATION

DATA PRECISION 8200-488 DC Voltage/Current Calibrator, 0-100V/0-100 mA, GPIB	\$1,375.00
FLUKE 332B/AF DC Voltage Calibrator, 0-1111V, 0-50 mA, 7 decades	\$675.00
FLUKE 343A DC Voltage Calibrator, 0-1100V, 7 decades, 20 ppm acc.	\$1,375.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$1,500.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A	\$3,750.00
FLUKE 720A Kelvin-Variety Voltage Divider, 7 decade	\$2,250.00
FLUKE 731B DC Reference Standard	\$400.00
HP 11049AA AC Thermal Converter, 3V, 20 Hz-100 MHz	\$175.00
VALHALLA 2703 AC Volt. Std., 0-120V/10 Hz-100 kHz, 120-1200V/10 Hz-1 kHz	\$2,500.00

### VOLTAGE SOURCES

HP 6114A Precision Dual Range Power Supply, 20V 2 A / 40V 1 A	\$875.00
HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

### CURRENT METERS & SOURCES

DRANETZ 656A / (3) TR2019A Current Demand Analyzer, w/(3) current probes 300A max.	\$5,000.00
FLUKE Y5020 Current Shunt, to 20 A, 0.01 ohm, DC-5 kHz	\$400.00
HP 6177C DC Current Source, to 50V, 500mA	\$600.00
HP 6181C DC Current Source, to 100V, 250 mA	\$675.00
HP 6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA	\$325.00
KEITHLEY 614A Electrometer	\$1,000.00
KEITHLEY 617 Programmable Electrometer	\$2,750.00
KEITHLEY 642 Electrometer	\$2,900.00
LEEDS & NORTHRUP 4360 Precision Current Shunts, 15-500 Amp	\$650.00
TEK CT-5-opt.05 High Current Transformer for P6021/A6302, to 1000A	\$500.00
VALHALLA 2301 Programmable Single Phase Power Analyzer	\$1,250.00
VALHALLA 2575A AC/DC Active Current Shunt, 20 mA-100 A, DC-10 kHz	\$1,000.00

## IMPEDANCE & COMPONENT TEST

### L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
E.S.I. 296V 4-1/2 Digit LCR Bridge, 120 Hz & 1 kHz	\$700.00
HP 4261A 3-1/2 digit LCR Meter, 120 Hz/1 kHz	\$1,000.00
HP 4262A-101 4-1/2 digit LCR Meter, 120 Hz/1 kHz/10 kHz, HP1B	\$2,200.00
HP 4274A-001 5-1/2 digit LCR Meter, 100 Hz-100 kHz, inl. DC bias	\$4,250.00

### STANDARDS

E.S.I. RS-925 9-Decade Resistor, 0.01 ohm-1.2 Megohm	\$1,600.00
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$700.00
E.S.I. SR1050-10M Resistance Transfer Standard, 10 Megohms/step	\$3,000.00
FLUKE 5450A Programmable Resistance Standard, 2 & 4 wire	\$1,750.00
GR 1403-SERIES Standard Air Capacitors, 0.1% accuracy	\$150.00
GR 1409-SERIES Standard Mica Capacitors, 0.05% accuracy	\$150.00
GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res.	\$175.00
GR 1432-U 4-Decade Resistor, 0-111.10 ohms, 0.01 ohm resolution	\$125.00
GR 1433-U 4-Decade Resistor, 0-111.10 ohms, 0.01 ohm resolution	\$475.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$550.00
GR 1434-G 7-Decade Resistor, 0.1, 111,111.0 ohms, 0.1 ohm res.	\$400.00
HP 16380A Standard Air Capacitor Set; 1, 10, 100, 1000 pF	\$1,675.00

VALHALLA 2724A Programmable Resistance Standard, 0-11 Gigohms, GPIB	\$1,675.00
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### HI & LO RESISTANCE

GR 1666 DC Resistance Bridge, 1 micro-ohm - 100 kilohms	\$750.00
HP 4329A High Resistance Meter, SE5-2E16 Ohms, 10-1000V test	\$1,350.00
VALHALLA 4150-ATC 4-1/2 digit Ohmmeter, 20 milliohms-2 kilohms, 4-wire	\$1,000.00

### CURVE TRACERS

TEK 576 Curve Tracer, with standard test fixture	\$2,350.00
TEK 577D1/177 Storage Curve Tracer, with standard test fixture	\$2,250.00
TEK 7CT1N Curve Tracer, to 0.5W, 7000 series	\$400.00

### T.D.R.

TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$2,000.00
TEK 7S12/S-6/S-52/7854 T.D.R., 0-375 feet, 45 pS Tr, w/digital storage display	\$2,750.00

## POWER SUPPLIES

### SINGLE OUTPUT

HP 6031A Autoranging Supply, to 20V / 120 A / 1000W max., HP1B	\$2,000.00
HP 6201B 20V at 1.5A CV/CC Power Supply	\$200.00
HP 6206B Dual Range 0-60V 0.5 A / 0-30V 1 A CV/CL Supply	\$250.00
HP 6207B 160V at 200 mA CV/CC Power Supply	\$300.00
HP 6260B-027 10V at 100A CV/CC Power Supply	\$675.00
HP 6261B-027 20V at 50 A CV/CC Power Supply	\$675.00
HP 6263B 20V at 10 A CV/CC Power Supply	\$400.00
HP 6266B 40V at 5 A CV/CC Power Supply	\$400.00
HP 6267B 40V at 10 A CV/CC Power Supply	\$550.00
HP 6268B-027 40V at 30 A CV/CC Power Supply	\$850.00
HP 6299A 100V at 750 mA CV/CC Power Supply	\$250.00
HP 6384A 4.0-5.5V at 8 A CV/CL Power Supply	\$175.00
HP 6434B 40V at 2.5 A CV/CC Power Supply	\$800.00
HP 6448B 600V at 15 A CV/CC Power Supply	\$850.00
KEITHLEY 2404 HV Power Supply, 0-1200V, 0-10 mA, CV/CL	\$250.00
SORENSEN DCR 110-45T 110V at 45 A CV/CC Power Supply	\$2,200.00
SORENSEN DCR 150-6B 150V at 6 A CV/CC Power Supply	\$650.00
SORENSEN DCR 300-6B 300V at 6 A CV/CC Power Supply, 120VAC 30 A line	\$950.00
SORENSEN DCR 300-8A 300V at 8 A CV/CC Power Supply, 208/230VAC line	\$950.00
SORENSEN SRL 20-12 20V at 12 A CV/CC Power Supply, low noise	\$550.00
SORENSEN SRL 60-8 60V at 8 A CV/CC Power Supply, low noise	\$950.00
TEK PS501-1 Power Supply, 0-20V, 2 mV res., 400 mA, TM500 series	\$175.00

### MULTIPLE OUTPUT

HP 6227B Dual 25V at 2 A CV/CC Power Supply, tracking	\$550.00
HP 6253A Dual Output 20V 3 A CV/CC Power Supply	\$500.00
HP 6255A Dual Output 40V 1.5 A CV/CC Power Supply	\$500.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$800.00

### MISCELLANEOUS

HP 95501A HP1B Isolated DAC/Power Supply Programmer	\$175.00
HP 6824A Bipolar Power Supply/Amplifier, to 50V, 1 A	\$400.00
HP 6827A Bipolar Power Supply/Amplifier, to 100V, 500 mA	\$800.00
KEPCO BOP 100-4M Bipolar Supply / Amplifier, 0-100V, 0-4 A	\$1,000.00

## TIME & FREQUENCY

### UNIVERSAL COUNTERS

HP 5314A 100 MHz/100 nS Universal Counter	\$225.00
HP 5315A-001 100 MHz/100 nS Universal Counter, TCXO, 1 GHz C-channel	\$650.00
HP 5315A-001, 003 100 MHz/100 nS Universal Counter, HP1B, 1 GHz C-channel	\$800.00
HP 5316A-003 100 MHz/100 nS Universal Counter, HP1B, 1 GHz C-channel	\$1,000.00
HP 5316A-003, 006 100 MHz/100 nS Counter, 1 GHz C-ch., offset/normalize	\$1,100.00
HP 5334A 100 MHz Universal Counter, HP1B	\$875.00
HP 5335A 200 MHz Universal / Statistical Counter	\$1,500.00
HP E1420A-010, 030VXI card 200 MHz/2 nS Univ. Counter, TCXO& 2.5 GHz C-ch	\$900.00
PHILIPS PM6654/056 120 MHz/2 nS Programmable High Res. Counter, OCXO, GPIB	\$850.00
RACAL-DANA 1992-04, 55 100 MHz/1 nS Univ. Counter, 1.3 GHz C-channel, OCXO, GPIB	\$850.00
TEK DC5004 Programmable 100 MHz/100 nS Counter/Timer, TM5000 series	\$350.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$600.00
TEK DC5010 350 MHz/3.125 nS Univ. Counter, TM5000 series	\$1,000.00
TEK DC503A 125 MHz Universal Counter/Timer, TM500 series	\$450.00
TEK DC509 135 MHz High Resolution Universal Counter/Timer, TM500	\$550.00

### FREQUENCY COUNTERS

EIP 371 18 GHz Source Locking Counter, GPIB	\$1,500.00
EIP 575 18 GHz Source Locking Counter, GPIB	\$3,250.00
EIP 578-opt.02, 06 26.5 GHz Source Locking Counter, power meter & MMW opt's	\$7,500.00





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FLUKE 7220A-opt. 111 1.3 GHz Communications Counter, TCXO option	\$650.00
HP 5305B/5300B-001 1.3 GHz Counter Package w/TCXO ref., high res. audio	\$450.00
HP 5340A-001, 011 18 GHz Frequency Counter, OCXO reference, HPIB	\$1,900.00
HP 5340A-005, 011 23 GHz Frequency Counter, HPIB	\$2,000.00
HP 5342A 18 GHz Frequency Counter	\$2,400.00
HP 5342A-003, 011 18 GHz Freq. Counter, +22 dBm, -20 dBm dynamic range, HPIB	\$2,750.00
HP 5342A-01, 04, 05, 11 24 GHz Frequency Counter, OCXO, DAC, and HPIB	\$3,900.00
HP 5382A 225 MHz Frequency Counter	\$200.00
<b>STANDARDS</b>	
HP 105A Quartz Oscillator, 0.1/1.0/5.0 MHz	\$750.00
HP 5087A-031 Distribution Amp., 0.1/1.0/5.0 MHz x 4 channels each	\$1,250.00

## AUDIO & BASEBAND

<b>SPECTRUM ANALYZERS</b>	
HP 8556A LF Section, 20 Hz-300 kHz	\$500.00
<b>DISTORTION ANALYZERS</b>	
HP 334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$550.00
HP 339A Distortion Analyzer, built-in low distortion osc.	\$2,400.00
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame	\$1,500.00
<b>RMS VOLT METERS</b>	
FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz	\$700.00
FLUKE 8921A True RMS Voltmeter, 180 uV-700 V, 2 Hz-2 MHz	\$700.00
HP 3400A RMS Voltmeter, 10 Hz-10 MHz	\$250.00
<b>OSCILLATORS</b>	
FLUKE 6011A Synthesized Generator, 10 Hz-11 MHz, 10 Hz res.	\$1,200.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator	\$200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max.	\$225.00
HP 239A Low Distortion Oscillator, 10 Hz-100 kHz	\$450.00
HP 652A Test Oscillator, 10 Hz-10 MHz	\$300.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz	\$350.00
TEK SG502 Sine/Square Osc. 5 Hz-500 kHz, 70 dB step atten., TM500	\$350.00
TEK SG505-opt. 01 Low Distortion Oscillator, 10 Hz-100 kHz, intermod. opt.	\$1,000.00
<b>MISCELLANEOUS</b>	
HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display	\$900.00
HP 4437A Step Attenuator, 0.1-19.9 dB, DC-1 MHz, 600 ohms unbal.	\$200.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave	\$500.00
KROHN-HITE 3202 / 3202R Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct	\$600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct.	\$700.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz	\$1,000.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00

## RF & MICROWAVE

<b>SPECTRUM ANALYZERS</b>	
HP 11517A/18A/19A/20A Mixer, 12.4-40 GHz, w/adapters, for 8555A, 8565A, etc.	\$675.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 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 11971A WR28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B	\$1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B	\$1,100.00
HP 5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$4,000.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz	\$450.00
HP 8444A Tracking Generator, 0.1-1300 MHz, for 8554B	\$800.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554, 8568, etc.	\$1,500.00
HP 8445B Prescaler, 1.8-18.0 GHz, for HP 8555A	\$800.00
HP 8552B IF Section, 1 kHz-110 MHz	\$750.00
HP 8553B RF Section, 1 kHz-110 MHz	\$500.00
HP 8554B RF Section, 0.1-1250 MHz	\$800.00
HP 8554B/8552B/141T Spectrum Analyzer, 100 kHz-1250 MHz, 100 Hz resolution	\$2,000.00
HP 8555A RF Section, 0.01-18 GHz	\$950.00
HP 8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res.	\$2,250.00
HP 8555A/8552B/8445/141 As above, w/1.8-18 GHz Prescaler, opt. 003 freq. display	\$3,000.00
HP 8559A/853A Spectrum Analyzer, 10 MHz-21 GHz, 1 kHz res., w/display	\$5,500.00
TEK 492-opt. 1.2.3 Spectrum Analyzer, 50 kHz-21 GHz, 100 Hz min. res. bw.	\$8,000.00
TEK 496P Spectrum Analyzer, 10 kHz-1.8 GHz, 30 Hz res., GPIB	\$5,500.00
TEK 7L13/7613 Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz min. res., w/frame	\$2,250.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L12/13/14	\$1,250.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/415/6	\$1,375.00
<b>NETWORK ANALYZERS</b>	
HP 11590A Bias Network, 1.0-12.4 GHz, N(f)	\$375.00

HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11664D WR28 Detector, 26.5-40 GHz, for 8755/6/7	\$750.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$375.00
HP 11666A Reflectometer Bridge, 0.04-18 GHz, for 8755/8756	\$1,200.00
HP 8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator	\$1,250.00
HP 85050D APC7 Calibration Kit, for 8510 series	\$1,100.00
HP 8505A-005/8503A Network An., 0.5-1300 MHz, w/S-Parameter & phase lock	\$5,000.00
HP 8755C(3) 11664A/182T Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame	\$1,750.00
HP 8756A(3) 11664A Scalar Network Analyzer, w/(3) detectors, 0.01-18 GHz	\$3,750.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz	\$1,950.00
WILTRON 640/G50/E(2)/7B50(2) Network An., w/1-1500 MHz source, (2) log amp, (2) det.	\$1,675.00
<b>SIGNAL GENERATORS</b>	
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res, GPIB	\$2,000.00
GIGATRONICS 600/10-18, opt. 06 Synthesized Source, 10-18 GHz, 1 MHz res., OCXO, GPIB	\$3,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$3,500.00
GIGATRONICS 875/88 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$7,000.00
GIGATRONICS 910/12-18, opt. 6, 14, 16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO	\$3,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP 8616A Signal Generator, 1.8-4.5 GHz	\$450.00
HP 86408-001, 002, 003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc.	\$2,750.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM	\$625.00
HP 8656A Signal Generator, 0.1-990 MHz, AM, FM, HPIB	\$2,900.00
HP 8660D/86603A/86632B Synthesized Signal Generator, 1-2600 MHz	\$7,000.00
WAVETEK 907 Signal Generator, 7.0-11.0 GHz, 0 dBm levelled	\$1,000.00
<b>SWEEP GENERATORS</b>	
HP 8350A/86290B-H08 Programmable Sweep System, 2.0-22.0 GHz, +4 dBm lvl'd	\$5,500.00
HP 8600A Digital Marker, for HP 8601A	\$400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$500.00
HP 8620C Sweep Oscillator Frame	\$550.00
HP 8620C-01 Sweep Oscillator Frame, HPIB programmable	\$675.00
HP 86220A RF Plug-in, 10-1300 MHz, +10 dBm levelled	\$800.00
HP 86222A RF Plug-in, 10-2400 MHz, +13 dBm levelled	\$1,375.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm levelled	\$675.00
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HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$500.00
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HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$675.00
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HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm levelled	\$800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$2,250.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$2,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlv'd.	\$2,000.00
<b>POWER METERS</b>	
ANRITSU MP-81B WR10 Power Sensor, 75-110 GHz, for ML83A or ML4803A	\$1,875.00
ANRITSU MP-82B WR8 (Pin Flange) 90-140 GHz Power Sensor	\$2,500.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$500.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz Ni/Fi sensor	\$375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$375.00
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HP 432C Autologging Digital Power Meter, 10 uW-10 mW f.s.	\$425.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$1,000.00
HP 435A/8481H Power Meter, 10 MHz-18 GHz, -15 to +35 dBm	\$1,150.00
HP 435A/8482A Power Meter, 100 kHz-4.2 GHz, -30 to +20 dBm	\$1,000.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm	\$1,150.00
HP 435A/8483A Power Meter, 0.1-2000 MHz, -30 to +20 dBm, 75 ohms	\$1,000.00
HP 435A/8484A Power Meter, 10 MHz-18 GHz, -70 to -20 dBm	\$1,000.00
HP 436A-022 Digital Power Meter, HPIB option	\$1,400.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$400.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series	\$400.00
<b>RF MILLIVOLTMETERS</b>	
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$1,375.00
<b>AMPLIFIERS, MISCELLANEOUS</b>	
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BOONTON 82AD FM/AM Modulation Meter, 10-1200 MHz	\$800.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz	\$500.00
HP 8901A-002, 010 Modulation Analyzer, 150 kHz-1300 MHz, OCXO, int. cal.	\$5,500.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts	\$800.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts	\$800.00
MARCONITF2304 AM/FM Modulation Meter, 18-1000 MHz, FM dev. 1.5-150 kHz	\$500.00
MICROWAVE SEMI CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28VDC	\$325.00

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GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$450.00
GR 900-Q GR900 14mm Interseries Adapters	\$125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz	\$450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP 775D Dual Directional Coupler, 20 dB, 450-940 MHz	\$275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz	\$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	\$275.00
HP 778D Dual Dir. Coupler, 20 dB, 100-2000 MHz, N(m/f/f/f)	\$550.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7/N(f/f/f)	\$400.00
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HP 8498A-030 30 dB Attenuator, 25 Watts, DC-18 GHz, N(m/f)	\$600.00
HP K422A/WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HP K532A/WR42 Frequency Meter, 18.0-26.5 GHz	\$500.00
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HP R422A/WR28 Flat Broadband Detector, 26.5-40 GHz	\$400.00
HP R532A/WR28 Frequency Meter, 26.5-40 GHz	\$500.00
HP R914B/WR28 Moving Load, 26.5-40 GHz	\$300.00
M/A-COM 3-19-300/10WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f)	\$200.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
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TRGV551WR15 Frequency Meter, 50-75 GHz	\$600.00
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TRGV551WR10 Frequency Meter, 75-110 GHz	\$900.00
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WILTRON 87A50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port	\$750.00

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P.A.R. 5205-94, 95, 96 Lock-In Amp. 20 Hz-20 kHz, int. osc., lin/log, GPIB	\$2,750.00
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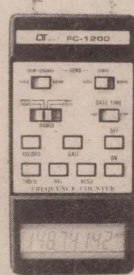
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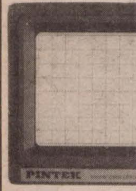
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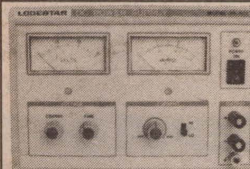
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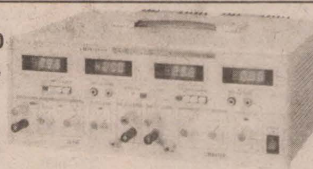
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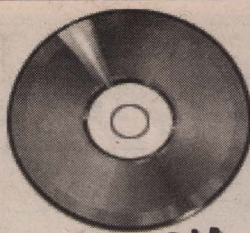
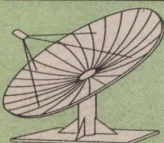
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# Sometimes Two are Better Than One

# Open Channel

by Joseph J. Carr  
K4IPV

Over the years, my experience in electronics — at both technician and engineer levels — has led me into a lot of work with sensors and transducers. That's why I was interested in the Speake Ltd. FGM-3 magnetic sensor, which we covered here last month. The US distributor of the sensor, Fat Quarters Software, provided me with a sample to evaluate. Discussions with the vendor showed me that the device could be used as a magnetic metal detector, especially for ferrous objects.

During my experiments, I wondered whether or not the resolution of such a detector could be improved. During a portion of my professional life, I worked on radar systems. Modern radars use a technique called monopulse resolution improvement (MRI), and I wondered whether or not the same method would work with other forms of sensor. I didn't have two magnetic sensors to experiment with, but I had some optical sensors, and if the method works for optical sensors, it will probably work with other sensors, as well. Before discussing the method, let's look at the idea of sensor resolution.

## Sensor Resolution

Sensors designed to detect some other objects do not have a point-source detection zone, but rather they have a field of regard over which any object within it will be detected. Consider Figure 1A. Here we see a light sensor (e.g., photoresistor, photodiode, etc.) arranged to detect a light source (e.g., a light emitting diode) that travels along in front of the sensor over a straight line path.

If the sensor had an extremely thin field of regard, then we could know with high precision when the LED was opposite the sensor. At the instant of detection, its location would be well known. In real life, there is no such luck. A real sensor will have a detection profile more-or-less like Figure 1B. As the LED comes within the field of regard, the output voltage of the sensor begins to build, and will reach a peak when the LED is directly opposite the most sensitive spot on the sensor. After the LED passes this most sensitive point, the output voltage will begin to fall off until it is near zero again when the LED's path takes it out of the field of regard at the other end of the path. The output waveform is considerably fatter than the equivalent size of the "target" (i.e., our LED).

Hrumpfffff! So what? The nature of the problem this causes is seen in Figure 2. Resolution, in this context, refers to the ability of the sensor to detect two identical targets spaced at some distance apart. The resolution is the smallest separation where the user of the instrument can detect the fact that two different targets are present, not just one. In the radar world, we use feet or meters between identical targets to define the resolution. Other sensors will use smaller or larger units, but the idea is the same.

In Figure 2, the problem is that the sensor field of regard is too broad to detect both

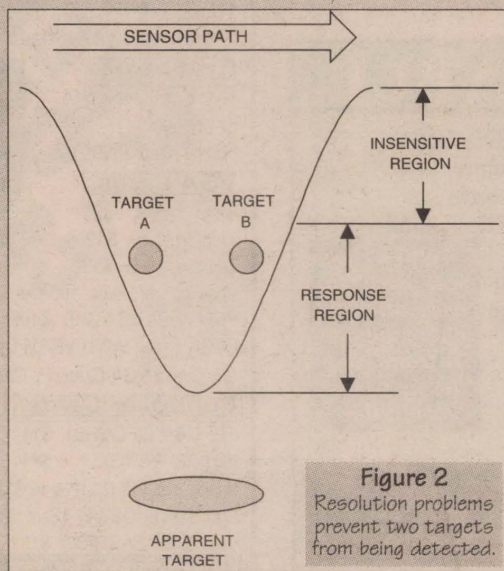
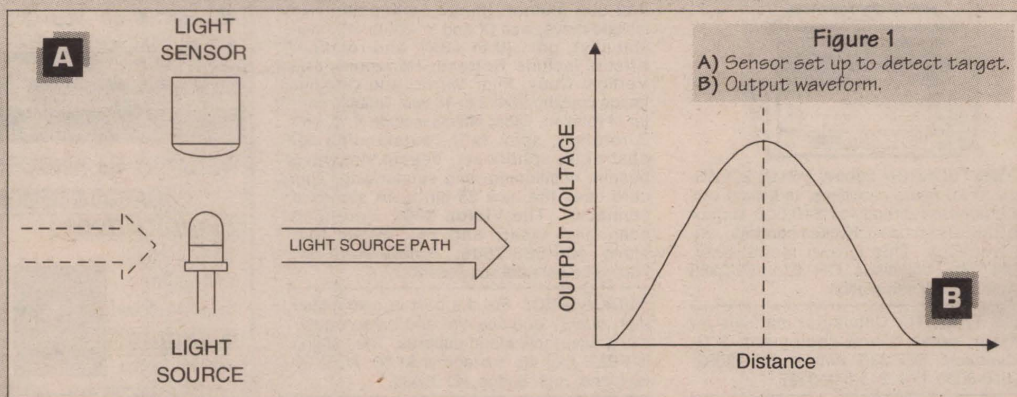
targets. The circuitry will be designed to accept signals that are above some threshold, and reject signals below that level. In Figure 2, the "response region" defines the area where signal detections are accepted, while the "insensitive region" is the portion of the curve where the circuitry will not see a detection. Note that both target "A" and target "B" are within the field of regard (which we called "beamwidth" in radar), so are seen as one target by the user ("apparent target" in Figure 2).

Now note what happens when the field of regard is narrower, as in Figure 3. In this case, no geometry of sensor and target will cause both targets to be within the field of regard at the same time, so the user of the instrument will see two distinct detections. Because the response of the sensor is not uniform as the sensor passes in front of the targets, the apparent targets will be a little oblong, rather than round.

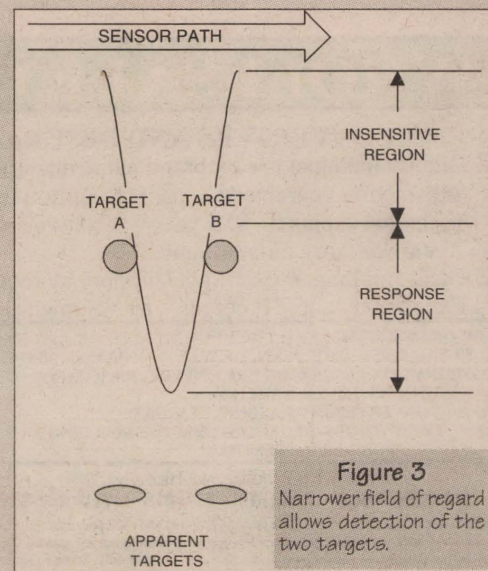
Whether your application is industrial process control, scientific instruments, or a

detector to find buried artifacts in a treasure field, the result of improving the resolution of your sensor system is that it becomes possible to: a) judge the approximate size of the detected object; and b) tell if more than one object is present.

Figure 4 shows how resolution is defined for most types of sensor. The curve shown is the "normal" curve, a.k.a. the "bell shaped curve." This curve is reasonably representative of many different forms of sensor, although be aware that it is not found on all sensors (some similar curve will be, however). Assume that we define the peak response as the zero decibel (0 dB) point. The resolution, which we will label "beamwidth" (BW) for lack of a better term, is the width of the curve at a point where the response drops off -6 dB for voltage (dBv) or current (dBi), or -3 dB for power. In the example of Figure 4, the peak response occurs at position  $X_0$ .



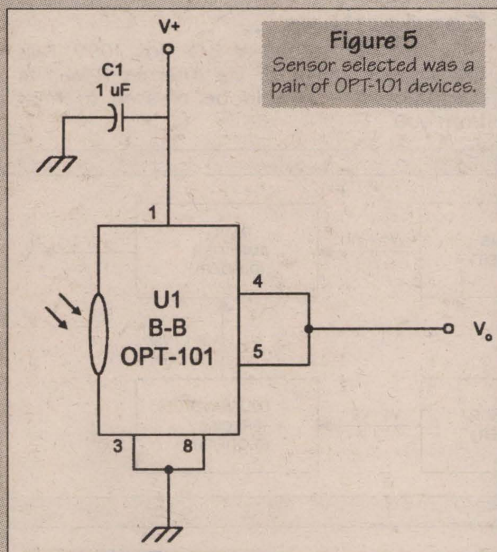
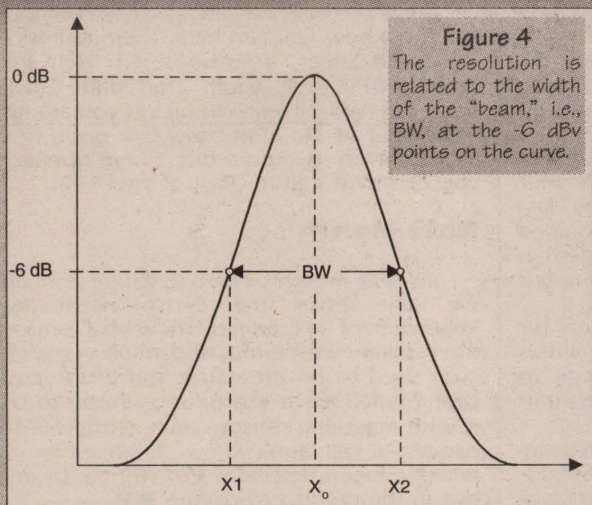
**Figure 2**  
Resolution problems prevent two targets from being detected.



**Figure 3**  
Narrower field of regard allows detection of the two targets.



# Open Channel



while the beamwidth is the distance  $X2-X1$ . The detection circuitry is usually designed to respond only to signals that are larger than the -6 dBV level, i.e., signals that are produced when the target is positioned between  $X1$  and  $X2$  in Figure 4.

## My Test Set-Up

Although my first inkling about using MRI to improve sensors other than radars involved speculating about using the Speake FGM-3 magnetic sensor in a high-resolution metal

detector, I didn't want to use that sensor because it was a bit costly. Although the FGM-3 prices are quite reasonable for magnetic sensors, it was simply too much to mess with on a hunch. So I decided to use an optoelectronic sensor. The sensor that I selected was the Burr-Brown OPT-101 device (two were needed). Figure 5 shows a block representation of the OPT-101. It comes in both SIP and eight-pin miniDIP forms. The pinouts shown in Figure 5 are for the eight-pin miniDIP version. When you see one of these devices it is like any other miniDIP chip, but is made of clear plastic, and has an optically sensitive region. The field of regard for this device is  $\pm 80$  degrees.

The simplest connection for the OPT-101 is shown in Figure 5. Two pins (3 and 8) are grounded, and one pin (1) is connected to a  $V+$  source between +2.7 VDC and +36 VDC (I selected +12 VDC because that's what I have on the workbench). A  $1 \mu F$  capacitor is used to decouple the  $V+$  power supply connection. For the LED circuit I produced, the output voltage of the OPT-101 was from a few millivolts (mV) to +260 mV. Higher outputs would be realized with a stronger light source (mine was deliberately reduced in output). Also, by inserting a resistor between pins 4 and 5, one can increase the feedback resistance of the internal op-amp, and thereby produce more gain. With pins 4 and 5 shorted, as shown, however, the resistor is the internal 1 megohm value.

The next problem was to make a test jig. Two OPT-101 devices were mounted in an eight-pin IC socket on a piece of perforated board. When the OPT-101s are butted end-to-end like that, the center-to-center distance between peaks was one centimeter (1 cm). That arrangement took care of the sensors, but what about the light source? The LED had to be pulled along in front of the sensors at the same distance from the plane of the sensor faces all along the path of travel. I solved that one from my ages-old junk box. I had an old AM car radio mechanical tuner. It had a worm gear drive and a dial. A small ruler (calibrated 0 to 100 mm, with large marks every 1 cm) was glued to the old dial scale. An LED and resistor were mounted on a small sliver of perforated board, and that assembly was soldered to the dial pointer of the car radio tuner. Neat, huh? I now had

"micrometer-like" control over the position of the light source relative to the sensor assembly, and could measure the position by the markings on the ruler.

Figure 6A shows the geometry of my test set-up. The two OPT-101 sensors are designated OPTO-1 and OPTO-2, and they are spaced  $\Delta X$  apart (in this case  $\Delta X = 10 \text{ mm} = 1 \text{ cm}$ ). The LED was not as bright as it could be because it was connected to the +12 VDC source through a 1,200 ohm resistor, which means that 8 or milliampere were flowing in the LED (15 mA is the normal brightness current for this LED).

The fields of regards of the two sensors are identical because the sensors were identical (plus or minus manufacturing tolerances). This produces the double-humped outputs shown in Figure 6B. The two curves represent the theoretical outputs of the two sensors as the LED was translated across their sensitive plane at a constant height. The curves should be identical in shape and amplitude. Note that the peaks occur at points equivalent to  $\Delta X$  apart.

Several different detection schemes can be used to detect the position of the target. First, either curve can be used alone, and the peak noted. But this is not the best approach for the same reason that we don't radio direction find using the broad aspect of a loop antenna. The peak is simply too broad to be certain when the peak is present. We tend to have to go back and forth across it to settle on a good guess where the true peak is located.

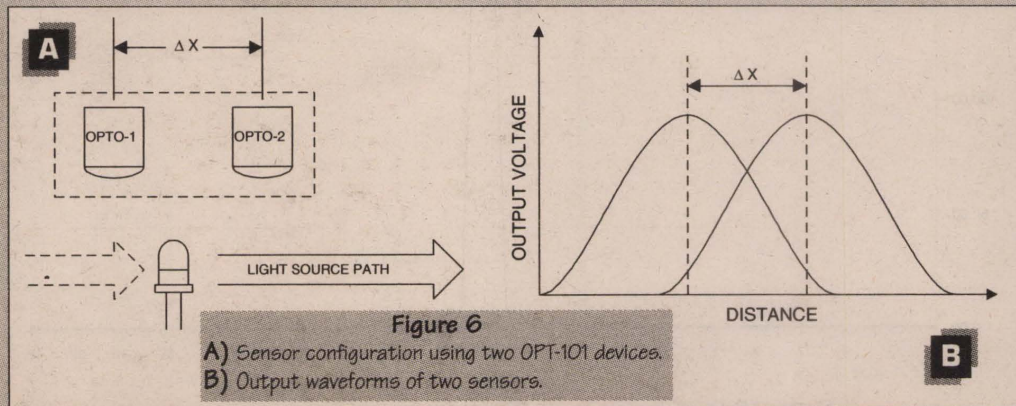
Another approach to detection is to sum the voltages and note where the dip between them occurs. Obviously, if we pass a peak and then come to a notch in the summed curves, then we have found the correct spot, right? Well, okay, I'll give that to you, but note in Figure 7 what often happens when the outputs of two sensors are algebraically added: the null tends to fill in and produce an actual null that is only marginally narrower than the peaks, if that.

So how do we solve the problem? Enter the Sensor Resolution Improvement (SRI) circuit.

## Sensor Resolution Improvement

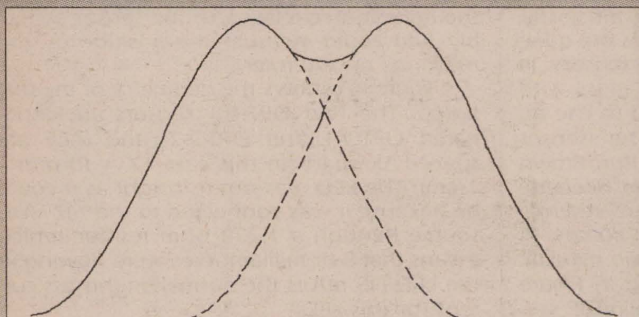
The SRI circuit is devised from the radar world's MRI concept. In monopulse radar, the antenna is divided into two identical halves, each of which is fed the same transmit pulse. On receive, however, they work independently, to produce two signals ( $S1$  and  $S2$ ). These signals are processed to form new signals consisting of the sum ( $S1 + S2$ ) and the difference ( $S1 - S2$ ). The absolute value (i.e., without regard to polarity) of the difference signal —  $ABS(S1-S2)$  — is then created (a fancy radar guy's way of saying it was full-wave rectified). The system then takes the ratio  $(S1+S2)/(ABS(S1-S2))$ , and presents it. This resultant is a very much narrower version of the original. Two signals were, indeed, better than one in the resolution department.

Figure 8 shows the signal processing flow needed to make SRI work for other forms of sensors (in this case, my optical sensors OPTO-1 and OPTO-2 are used). The outputs of OPTO-1 and OPTO-2 are labelled  $V1$  and





# Open Channel



**Figure 7**

Some filling in of the dip occurs when waveforms are summed.

V2, respectively. These signals are fed to inputs of a summing amplifier and a difference amplifier. The outputs of those amplifiers are V1+V2 sum signal and V1-V2 difference signal. The difference signal is fed through a fullwave precise rectifier (an op-amp circuit), to create the ABS(V1-V2) signal. These signals are both fed to the inputs of an analog divider that produces an output of:

$$V_o = \frac{K(V1+V2)}{ABS(V1-V2)}$$

(K is a scaling factor that all analog multipliers and dividers have.) If you plot the output voltage  $V_o$  against the position of the target, then you will note a startling increase in resolution. How much? Figure 9 shows the result of the trials with the LED. The data was collected, and then fed through an Excel spreadsheet to find the resultant seen in Figure 9.

You'll have to tune in next month to find out how it was done ... (I know, I'm a dirty rotten, #S@#S@, but there is only so much space and I have something else to cover.) In next month's column, we will take a look at some of the circuits that can be used to make this system work.

## Save 144 MHz and 440 MHz!

The spectacular growth of the telecommunications and data communications industries has created a tremendous need for additional frequencies in the radio spectrum. Unfortunately, the spectrum is terribly limited. It seemed crowded when we had less complex telecommunications systems in the USA. A number of industry groups have proposed a reallocation of much of the spectrum to these new services. In the past, they overlooked the ham bands. But the success of one service in carving a little out of our 220 MHz band has led to an official position forcing reallocation of the 144-MHz (two-meter) and 440-MHz ham bands to other services.

Hams lost 11-meters to the Citizen's Band service in 1957 because they weren't using that band. They lost part of 220 MHz for the same reason, but two-meters, and to some extent 0.75-meters are well populated. We might lose those bands not for lack of use, but for the lack of political clout. The Federal Communications Commission was once populated with a large number of engineers,

many of whom were ham operators themselves. But today the "new FCC" is populated with lawyers ... and that's a bad sign for anyone at any time.

To make matters worse, there is a World Radio Conference coming up in 1997. The last WRC was 1979, and we gained some bands in the HF region in that one. But this time it might be different.

The official US position for WRC97 is being crafted at this time, and the FCC needs to know your opinion. Express it in three ways:

First, write your congressional representatives and let them know of your interest. Ask them to take a position in favor of ham radio and communicate it to the FCC.

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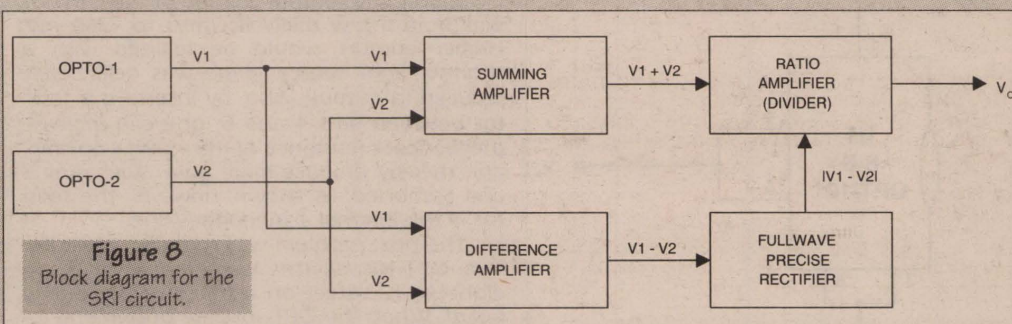
ask them how you can help. Their address is 225 Main Street, Newington, CT 06111 (tell them K4IPV sent you!). The ARRL E-Mail address is [hq@arrrl.org](mailto:hq@arrrl.org) — In fact, if you are not a member of the ARRL, now is a good time to join, even if you are not a ham operator, you can lend a little clout of your own.

## Next Month ...

In next month's Open Channel column, we will revisit the Sensor Resolution Improvement (SRI) project, show you some of the resultant waveforms, and some of the circuits used to do an actual trial of the concept. Sometime in the future, I hope to try it with magnetic sensors such as the FGM-3 devices. I still don't know if SRI works to improve metal detectors, but will try to find out in the months to come. **NV**

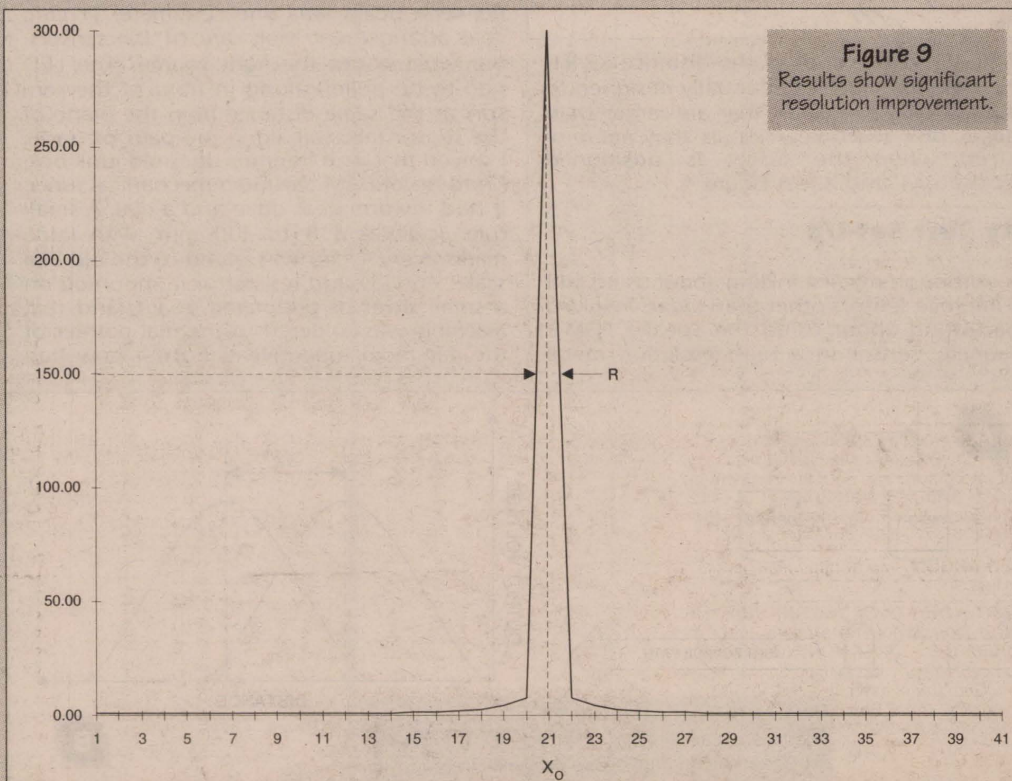
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**Figure 8**

Block diagram for the SRI circuit.



**Figure 9**

Results show significant resolution improvement.



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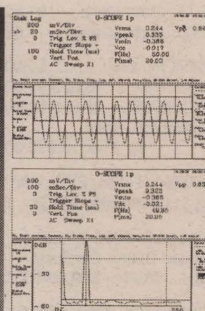
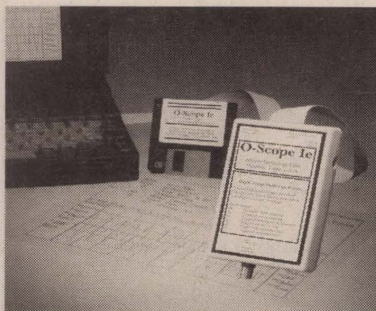
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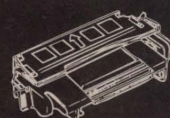
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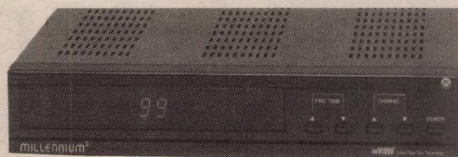
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The inductor, or coil, is the third of three passive components, the other two being the resistor and capacitor. Like the capacitor, it stores energy. Yet while the capacitor does so in an electrostatic field, the inductor stores energy in an electromagnetic field. More importantly, an inductor acts to oppose any change in current. The ability to store energy and oppose a change in current (inductance) makes the inductor a useful component, one worth exploring.

Though not as widely used as capacitors, inductors, nonetheless, find extensive application in DC and AC circuits. In the former, we see them in solenoids, relays, speakers, the basic meter movement, and in electronic sensors. In AC circuits, they combine with other passive components to form simple low-pass, high-pass, band-pass, and band-stop filters.

Figure 1b. Note, each type of inductor has a unique symbol.

Inductors, of course, exhibit inductance. The unit of inductance is the henry, symbolized by an H. In many applications, millihenries (mH) and microhenries (uH) are more common units.

Two characteristics determine the inductance of an inductor: (1) its permeability and (2) its physical parameters.

Coils are wound on either non-magnetic or magnetic materials. Non-magnetic cores consist of air, wood, copper, plastic, and glass. The permeability (ease with which a magnetic field can be established) of these materials is the same as for a vacuum. Magnetic materials are those such as iron, nickel, steel, or cobalt. These materials have permeabilities far greater than that of a vacuum. They are classified as ferromagnetic. Such cores provide a better path for the magnetic lines of force, thus permitting a stronger magnetic field.

Physical parameters, such as number of turns,

section, and travels out into the surrounding space, diminishing in strength. The magnetic field represents stored energy.

When current ceases to flow, the magnetic field that was established by it collapses back into the wire. This collapsing magnetic field induces a voltage into the wire. Thus, stored energy is returned to the circuit in the form of voltage, which, if the circuit is complete, will produce current.

If we wind a current-carrying wire into a coil, we have an inductor. The strength of the magnetic field surrounding that inductor is determined by the amount of current in the coil, the number of turns, how tightly the turns are wound, and the permeability of the core. All work to effect electromagnet field strength and the amount of inductance (L) in the coil.

## Opposing a Change in Current Flow

An inductor has the ability to oppose a change

# Inductors

by  
Ronald A. Reis

# Store that Energy



In this article, we'll examine the physical characteristics of inductors, how energy is stored in a magnetic field, ways an inductor acts to oppose a change in current, and inductive reactance. We'll conclude by exploring resistive-inductive, RL, filters.

## The Inductor: Coil that Wire

Inductors come in a wide range of shapes and sizes, as seen in Figure 1a. Some are tiny, no bigger than a 1/2-watt resistor. Others are larger than a baseball. Coils can be fixed or variable. They can be wound on an air core (actually a hollow cardboard tubing) or a core of powdered or laminated iron.

Schematic symbols for inductors are shown in

length, and cross-sectional area of the core, as shown in Figure 2a, also determine the inductance of a coil. Inductance is inversely proportional to core length and directly proportional to cross-sectional area. Furthermore, inductance is directly related to the number of turns squared. The mathematical relationship of these factors is shown in Figure 2b, where L is inductance in henries, N is the number of turns,  $\mu$  is the permeability, A is the cross-sectional area in meters squared, and l is core length in meters.

## Storing Energy in a Magnetic Field

The ability of a coil to store energy in a magnetic field is based on the principle of electromagnetism.

Every current-carrying wire produces a magnetic field that emanates from the wire's center, cuts through its cross-

section. If current is increasing, the inductor will act to oppose the increase. If current is decreasing, the inductor acts to oppose the decrease. In the former, current eventually increases to a constant value, but, because inductance is present, it will take longer to do so. In the latter, current inevitably decreases to a set value (or to zero), but again, will take longer to do so because of circuit inductance.

The role of inductance to oppose a change in current can also be summarized by Lenz's Law:

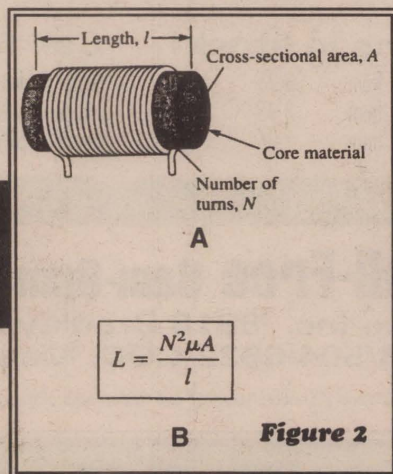
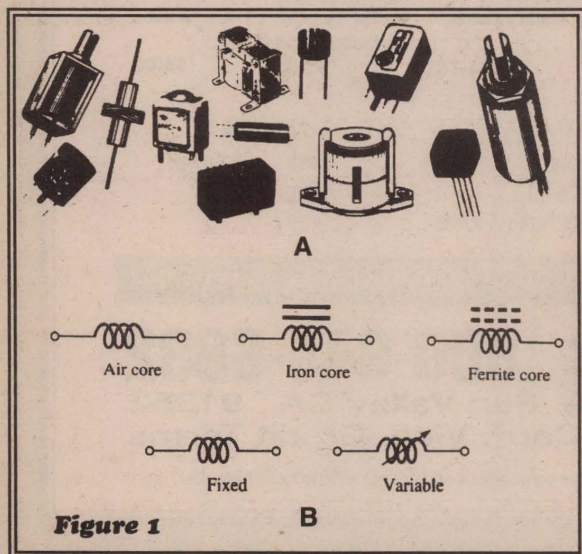
"When the current through a coil changes, an induced voltage is created as a result of the changing magnetic field and the direction of the induced voltage is such that it always opposes the change in current."

In other words, a changing current, producing a changing magnetic field (expanding or contracting), induces a voltage into the very coil in which current is flowing. This is called self-inductance. The induced voltage will create its own current in the coil. Polarity of the induced voltage, and thus direction of the resulting, "induced" current, will act to provide an opposing or aiding current to the original. When the original current increases, an opposing "induced" current is created. When the original current decreases, an aiding "induced" current is produced.

Lenz' Law is illustrated in Figure 3. Let's examine the figure closely.

In Figure 3a, the current is constant, being determined by battery voltage and resistor R1. (For purposes of explanation, we assume the coil has zero resistance.) Remember, a voltage is induced only if current, and the resulting magnetic field, is changing. If current is constant, the magnetic field, while present, is not changing. Thus in Figure 3a there's no induced voltage.

In Figure 3b, the switch is quickly closed. Total circuit resistance decreases (for resistors in parallel, total resistance is less than the lowest





resistor) and current attempts to increase. But as current increases, the magnetic field begins to expand. This expanding (changing) magnetic field induces a voltage, and thus current, that opposes the increase for an instant.

After switch closure, the rate of magnetic field expansion decreases (Figure 3c). Eventually current in the coil reaches a steady, constant value determined by battery voltage and total circuit resistance (Figure 3d). While the current is now greater than before the switch was closed, it took time to reach the new value.

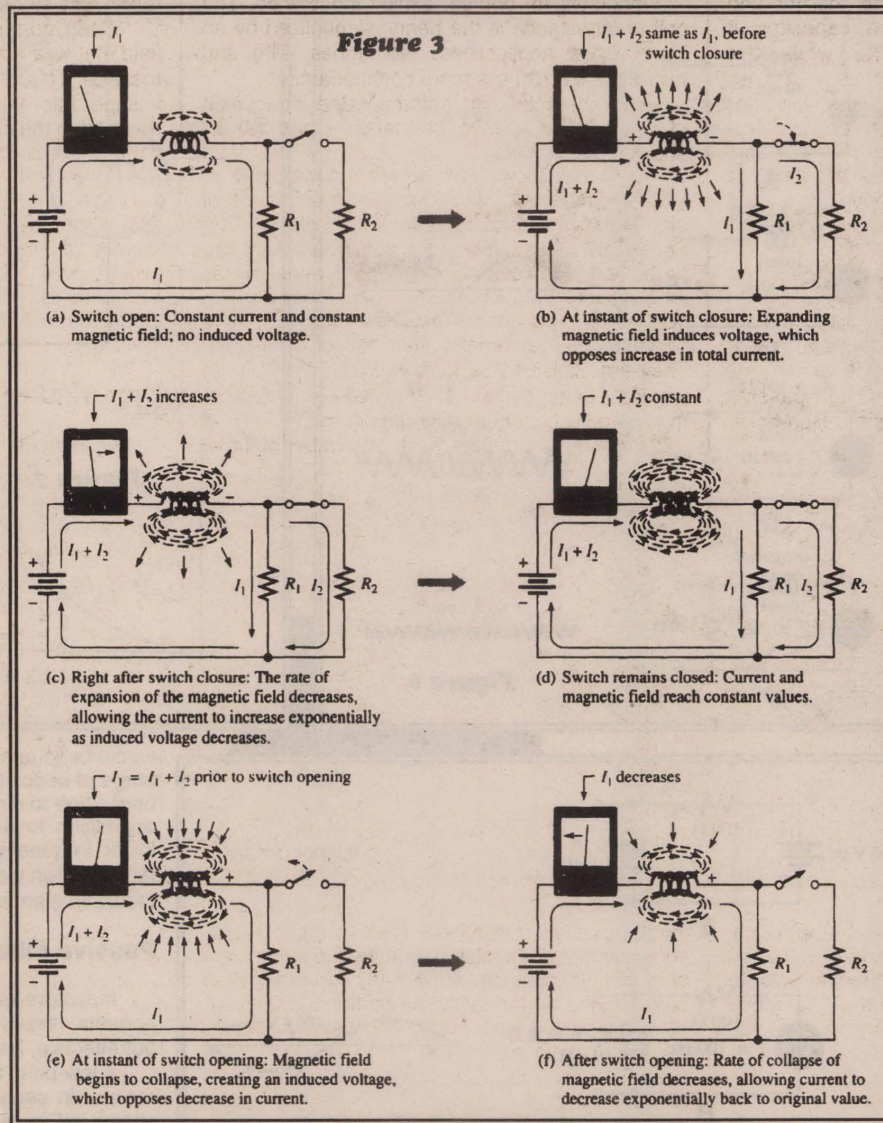
In Figure 3e, the switch is suddenly opened. With more resistance in the circuit, less current "wants" to flow. As current decreases, the magnetic field begins to collapse, inducing a voltage into the coil. The resulting "induced" current opposes this decrease. We say the "induced" current is aiding the original current, flowing in the same direction as it tries to help maintain the original current value.

Eventually, though, current decreases to the original value determined by battery voltage and  $R_1$  (Figure 3f).

To summarize: "The polarity of induced voltage is opposite battery voltage for an increase in current and aids battery voltage for a decrease in current."

### Inductive Reactance

Opposition to current flow in a DC circuit is known as



resistance. It's measured in ohms. Opposition to current flow in an AC circuit is called reactance. It, too, is measured in ohms.

When an AC circuit has inductance, opposition to current flow exhibited by the inductor is known as inductive reactance. The letter X identifies reactance. When used in conjunction with the subscript L, the term  $X_L$  denotes a value of inductive reactance.

If alternating current flows in an inductor, that current is much less than the resistance of the coil windings alone would allow. Why? Because, as we saw above, current variations in the inductor, producing a varying magnetic field, causes voltage across the inductor (self-inductance) that at times opposes the applied voltage. The result is inductive reactance, the additional opposition to a sine wave alternating current.

The amount of  $X_L$  can be expressed by a simple formula:

$$X_L = 2\pi fL$$

where:

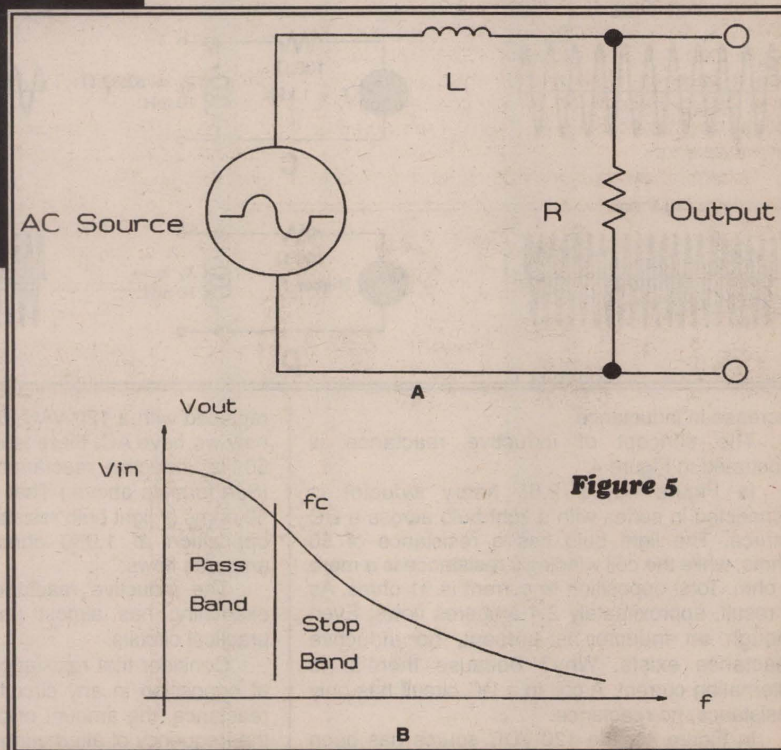
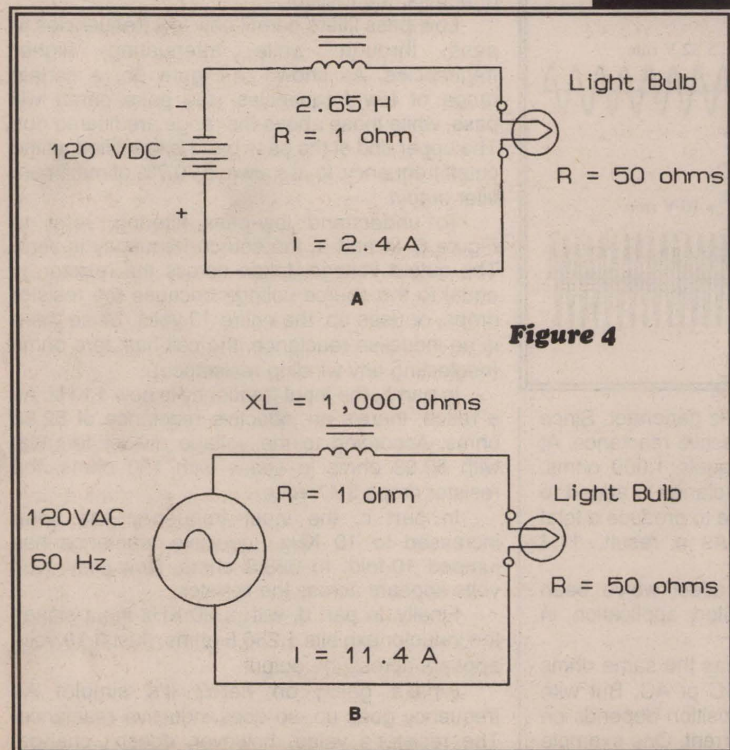
$X_L$  equals inductive reactance in ohms.

$2\pi$  is a constant of 6.28 for a sine wave.

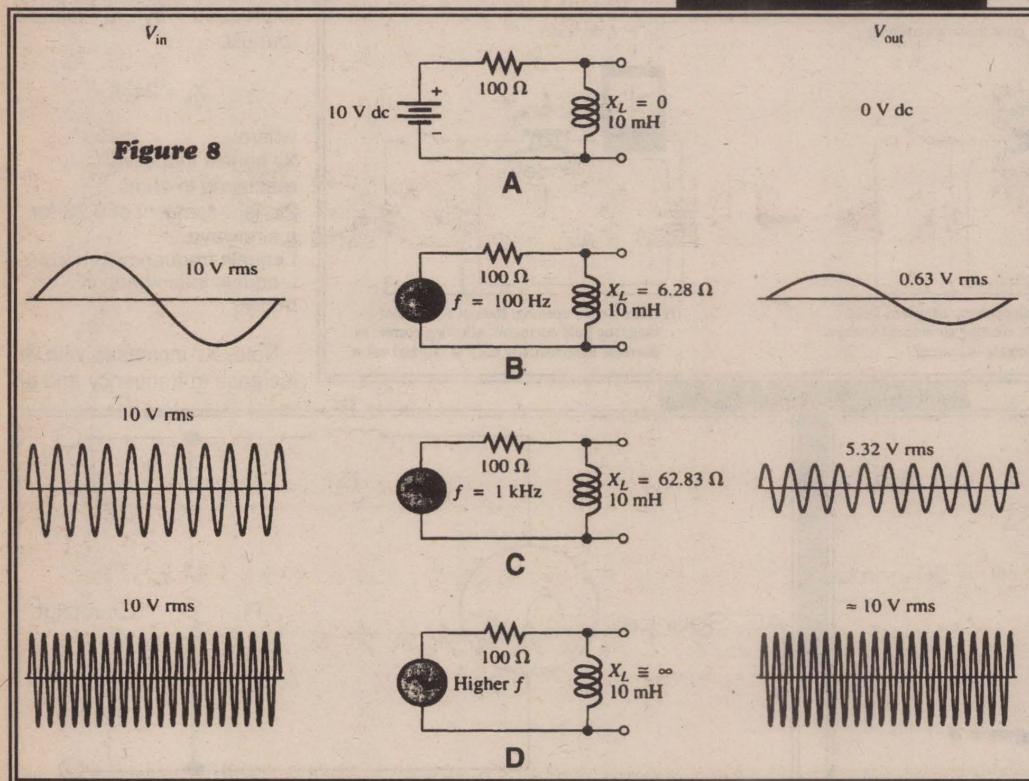
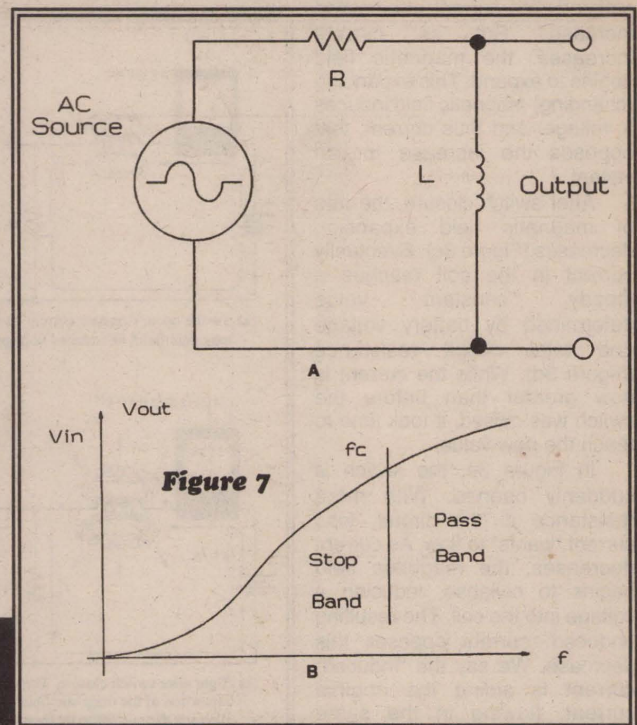
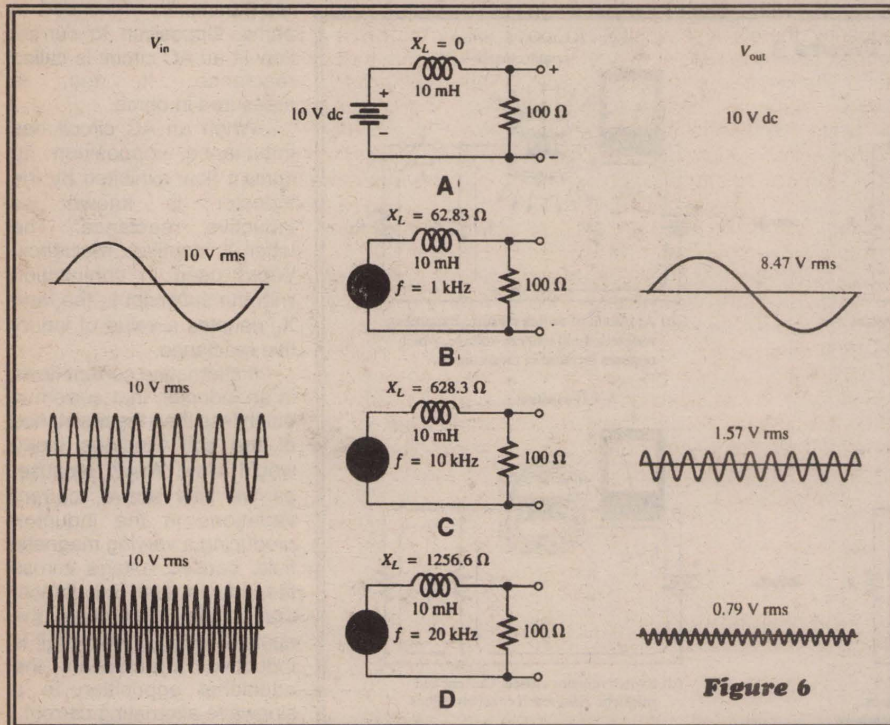
$f$  equals frequency in hertz.

$L$  equals inductance in henrys.

Note,  $X_L$  increases with an increase in frequency and an







would be to use  $X_L$  where it's desired to have high ohms of opposition to alternating current, but little opposition to direct current. Or, to use  $X_L$  for more opposition to a high-frequency AC compared to lower frequencies. We take advantage of these factors when we design simple passive filters with inductive elements. Let's take a look.

## Passive Filters

Inductors are used with other passive components, resistors, and capacitors, to form simple, but effective, frequency filters.

A low-pass filter, consisting of an inductor and resistor in series across an AC signal source, is shown in Figure 5a. The output signal is taken off, or across, the resistor.

Low-pass filters permit only low frequencies to pass through while attenuating higher frequencies. As shown in Figure 5b, a certain range of low frequencies (the pass band) will pass, while those above the range are filtered out. The upper end of the pass band is identified as the cutoff frequency,  $f_c$ . It's always 70.7% of maximum filter output.

To understand low-pass filtering, refer to Figure 6. In part a, the source frequency is zero. The output voltage, taken across the resistor, is equal to the source voltage because the resistor drops, or uses up, the entire 10 volts. Since there is no inductive reactance, the coil has zero ohms (neglecting any winding resistance).

In part b, the input frequency is now 1 KHz. As a result, there's an inductive reactance of 62.83 ohms. According to the voltage divider formula, with 62.83 ohms in series with 100 ohms, the resistor drops 8.47 volts.

In part c, the input frequency has been increased to 10 KHz. Inductive reactance has jumped 10-fold, to 628.3 ohms. Now only 1.57 volts appears across the resistor.

Finally, in part d, with a 20 KHz input signal, the inductor exhibits 1,256.6 ohms. Just 0.79 volts appears across the output.

What's going on here? It's simple! As frequency goes up, so does inductive reactance. The resistor's value, however, doesn't change.

increase in inductance.

The concept of inductive reactance is illustrated in Figure 4.

In Figure 4a, a 2.65 henry inductor is connected in series with a light bulb across a DC source. The light bulb has a resistance of 50 ohms, while the coil winding's resistance is a mere 1 ohm. Total opposition to current is 51 ohms. As a result, approximately 2.4 amperes flows. Even though an inductor is present, no inductive reactance exists. Why? Because there's no alternating current. A coil in a DC circuit has only resistance, no reactance.

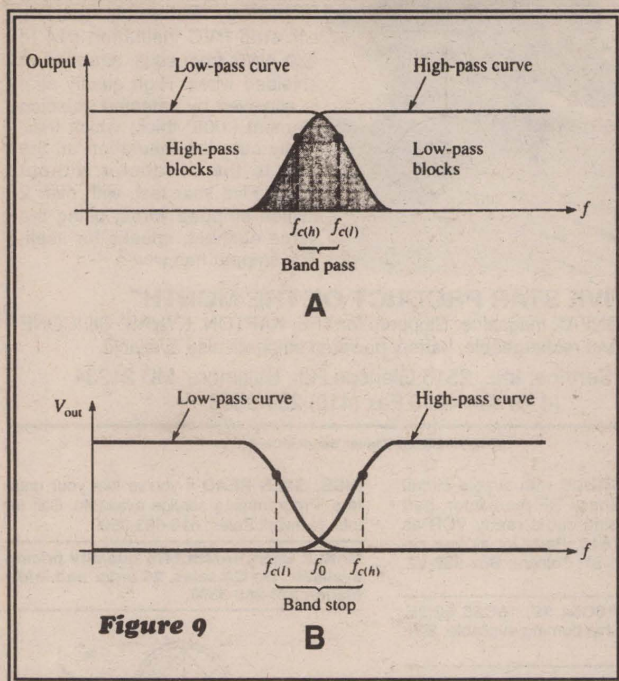
In Figure 4b, the 120-VDC source has been

replaced with a 120-VAC, 60-Hz generator. Since now we have AC, there is inductive reactance. At 60-Hz, inductive reactance equals 1,000 ohms. (See formula above.) That reactance is added to 50 ohms of light bulb resistance to produce a total opposition of 1,050 ohms. As a result, 11.4 amperes flows.

The inductive reactance effect we've been examining has almost unlimited application in practical circuits.

Consider that resistance has the same ohms of opposition in any circuit, DC or AC. But with reactance, the amount of opposition depends on the frequency of alternating current. One example





Since the source voltage (10 volts) remains | produces an inductive reactance of 6.28 ohms.

constant, with each increase in frequency there's less voltage to be dropped across the resistor, the circuit output. Remember, in a series circuit, voltage drop is proportional to resistance. As the voltage across one resistive element increases (inductor, in this case), it decreases across the other resistive element (resistor).

A high-pass filter, also consisting of an inductor and resistor in series across an AC signal source, is shown in Figure 7a. Note, in this case, the signal is taken off the inductor.

High-pass filters, as you would expect, permit only high frequencies to pass through while attenuating lower frequencies. As we see in Figure 7b, a range of high frequencies (the pass band) will pass, while those below the range are filtered out. As with a low-pass filter, the cut-off frequency,  $f_c$ , is 70.7% of maximum filter output.

Referring to Figure 8a, with a source frequency of zero, no inductive reactance is present and there's zero voltage across the inductor, and, thus, the output.

In part b, a 100 Hz source signal

The output voltage is 0.63 volts.

In part c, a 1 KHz source signal results in a 62.83-ohm inductive reactance. Output voltage is now 5.32 volts.

And in part d, with a high enough frequency from the source, inductive reactance reaches infinity. In that case, all the input voltage would appear across the output.

What we're seeing, of course, is the reverse of a low-pass filter. Essentially, the only difference between the circuits of Figures 6 and 8 is the point at which we take the output signal. For a low-pass filter, the signal is taken off the resistor. For a high-pass filter, it's taken across the inductor.

By combining low-pass and high-pass filters, we create a band-pass filter, one that allows a certain band of frequencies to pass and attenuates, or rejects, all frequencies below and above the pass band (Figure 9a). Furthermore, a band-stop filter can also be created from low- and high-pass filters. In terms of response, this type of filter is essentially the opposite of a band-pass filter. It allows all frequencies to pass except those lying within a certain stop band (Figure 9b).

Too bad we don't have space to delve deeply into band-pass and band-stop filters, as well as numerous other inductor applications. But I think we've covered enough to give you the message. An inductor may be just a coil of wire wound on a core. Yet it has some remarkable uses. **NV**

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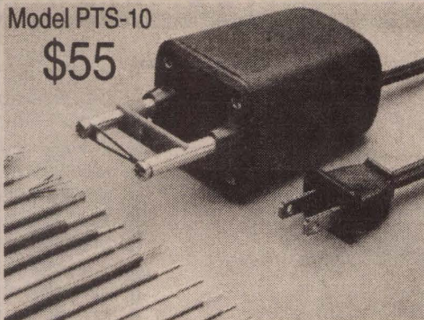
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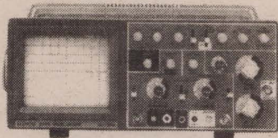
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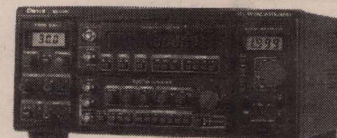
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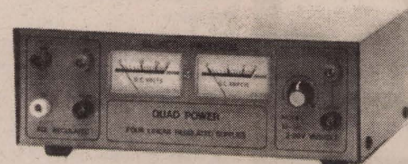
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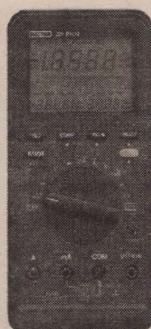
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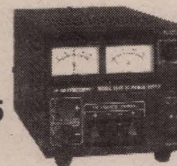
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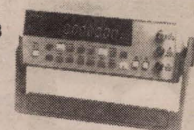
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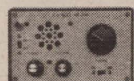


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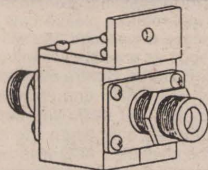


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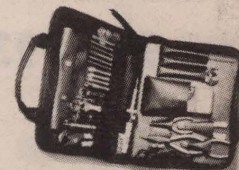
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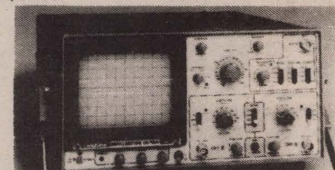


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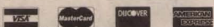
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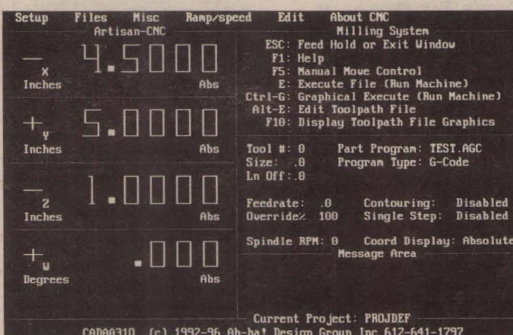
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# Stamp Applications:

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

by Scott Edwards

**This month, we're going to blast our way through two frequently requested applications: a circuit for connecting the BS2 to the phone line to take advantage of the DTMFout instruction, and an all-in-one LED display for the BS1.**

**In BASIC for Beginners, we'll discuss binary-coded decimal (BCD) numbers, which just happen to be useful for both DTMF and LED-display applications.**

**But first, a word from our sponsor regarding Internet access to this column and many of the goodies discussed here:**

### Apps on the Net

You can now retrieve past columns of Stamp Applications from the *Nuts & Volts* web site, [www.nutsvolts.com](http://www.nutsvolts.com) — Click on the button for the library, and your browser will take you to [ftp.nutsvolts.com](http://ftp.nutsvolts.com/pub/nutsvolts/library) and the directory `/pub/nutsvolts/library`. Go into the subdirectory `/stampapps` and you'll see a listing of Adobe Acrobat files for numbers 1 through whatever of this column (this is number 19).

If you're interested in some of the Stamp-related products sold by my business, Scott Edwards Electronics, the information is just a couple of levels up on the same ftp site. The path is `/pub/nutsvolts/scott` (of [ftp.nutsvolts.com](http://ftp.nutsvolts.com)). Again, the files are in Acrobat format (now supported directly by many browsers) and include the current catalog, user's manuals to our most popular products, and samples of our AppKit documentation.

Now back to our regularly scheduled program ...

### Connect BS2 to Phone Lines, Give the BS1 an LED Display

#### Project double-header for the BASIC Stamps I and II

#### Phone-Line Interface

The BS2 can generate telephone "touch" tones with its DTMFout instruction. However, you can't just hook the BS2 to the phone line and start dialing. There are several reasons:

- Audio from most sources, including the BS2, is single-ended (also known as ground-referenced). The signal voltage is the difference between a single wire and ground. Since phone lines travel far and wide — connecting locations with vastly different ground potentials and picking up noise along

the way — they use differential signaling. A signal voltage is the voltage difference between the two wires that make up a phone-line pair.

- Phone systems use the presence of a load on the line to determine when to go off hook and present a dial tone to local phone or other equipment and a busy signal to others trying to dial in.

- The phone line carries more than just audio signals; a direct-current (DC) supply voltage, a high alternating-current (AC) ringing voltage, and dangerous voltage spikes all show up on the phone lines.

- Despite its rugged signals, the Federal Communications Commission (FCC) considers the phone system to be tender as a newborn babe. They insist that their baby be protected from voltages that might confuse or hurt it.

For all those reasons, you need an interface to connect anything, including the BS2, to the phone line. If you're manufacturing a product, the FCC requires that you use an approved Data Access Arrangement (DAA). Because of the expense involved in getting regulatory approval for DAAs, they tend to be priced out of proportion to the cost of the components involved — \$25.00+ in small quantities. DAAs are also generally not available from the usual electronics parts outlets.

If you just want to experiment with the BS2's DTMF capabilities, a full-blown DAA is probably overkill, anyway. Using a simple circuit I found in the *Encyclopedia of Electronic Circuits, Volume 5*, by Graf and Sheets (TAB/McGraw Hill, 1995; ISBN 0-07-011077-8), I had a BS2 up and dialing in just a few minutes. My adaptation of the circuit appears in Figure 1, complete with part numbers and sources.

The circuit meets all the basic requirements for a phone-line interface. The transformer converts single-ended audio from the BS2 into differential signals. The Sidactor and back-to-back zeners on either side of the transformer clamp voltage transients to 280V on the phone side, and approx-

imately 4.5V on the Stamp side.

Once you're hooked up, dialing the phone is simple. The DTMFout instruction just needs to know the BS2 pin number to use and a list of digits to dial. For example, to dial 555-1234 through pin 0:

```
DTMFOUT 0,[5,5,5,1,2,3,4]
```

DTMFout sends each tone for 200 milliseconds (ms) followed by 50 ms of silence. This gives the phone-company equipment plenty of time to detect and respond to the tones. However, you can also customize the durations of the tones and silences as follows:

```
DTMFOUT 0,<tone>,<quiet>,<list>
```

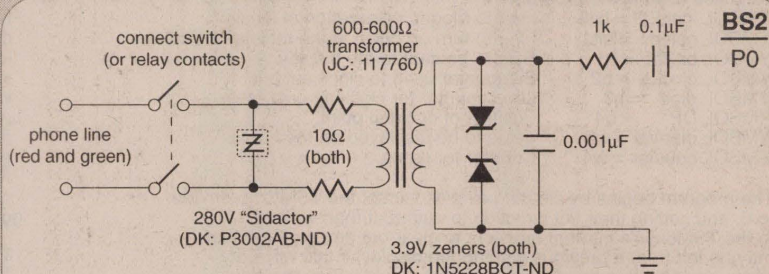
The tone and quiet times are in ms. So, to dial 555-1234 with 1-second tones and 0.5-second silences, you'd program:

```
DTMFOUT 0,1000,500,[5,5,5,1,2,3,4]
```

The obvious application for DTMFout is to build a super-deluxe telephone dialer. But don't forget all of the other services you can now control from the telephone keypad — like pagers, voice mail, menu routers, automated information systems, etc. For example, you could have the BS2 dial your pager if it detected an intruder in your home, or a burst pipe in your basement, or a crashed computer at your office. If you frequently access your bank's account-information system, you could automate the menu-walkthrough with the BS2.

#### Integrated LED Display/Driver

An earlier column on the MAX7219 LED display



#### Parts Sources

Digi-Key (DK), 1-800-344-4539  
or 218-681-6674

Jameco (JC), 1-800-831-4242  
or 415-592-8097

Figure 1 - Phone-line interface for the BS2.



# Stamp Applications:

play driver (no. 10, Dec. '95; available from the *Nuts & Volts* web site as ST\_AP10.PDF) drew a lot of interest.

The MAX chip makes it easy to talk to seven-segment LED displays up to eight digits long. Unfortunately, using the chip requires quite a bit of wiring to get all those LEDs connected.

Some readers asked for an integrated version of the MAX, incorporating LEDs and driver into a single module. I searched, and found the Three-Five System's TSM6755. Its display drivers aren't

as fancy as the MAX7219 — you have to tell them specifically which LED segments to turn on — but the additional programming effort is more than balanced by the simplicity of the hardware. Figure 2 shows the complete hook-up.

The TSM6755 module is available from my order desk as an AppKit with code on disk for the BS1, BS2, and PIC microcontrollers (Sources) and full manufacturer's docs. The module is available by itself from Farnell Components (1-800-718-1997).

Although the TSM6755 is easy to use, it shares one drawback with other LED displays: it draws a lot of current. With all 34 LEDs on at 10 milliamperes (mA) each, the display can draw 340 mA. That's more than the 50-mA rating of the BS1's voltage regulator, or the 100-mA rating of the Counterfeit (BS1 kit; Sources).

There are at least three solutions to this problem: (1) Use a separate five-volt power supply with a rating of at least

## Sources

The TSM6755 AppKit is available for \$25.00 from:

### Scott Edwards Electronics

P.O. Box 160, Sierra Vista, AZ 85636-0160

phone 520-459-4802; fax 520-459-0623

E-Mail 72037.2612@compuserve.com

Internet archive (catalog, user manuals, samples) located at: [ftp.nutsvolts.com](http://ftp.nutsvolts.com) in directory /pub/nutsvolts/scott

Visa, Mastercard, American Express, and Discover accepted. Personal checks and money orders also welcome.

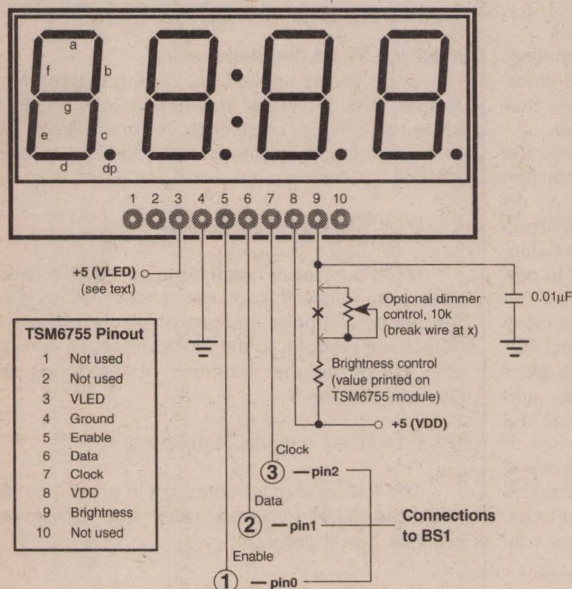
For more information on the BASIC Stamp, contact:

### Parallax, Inc.

3805 Atherton Road, #102, Rocklin, CA 95765

phone (916) 624-8333

Internet <http://www.parallaxinc.com>



Note: The two digits on the lefthand side of the display have additional vertical segments to form a + sign in the center of the digits. However, in the TSM6x55 modules, these segments are not fitted with LEDs, and will not light.

**Figure 2**  
Connecting the TSM6755 LED display module.

### Listing 1: Using the TSM6755 with BS1

' Program: IIIV\_LED.BAS

' This program controls TSM6x55 LED displays. It demonstrates the basics of communicating with the TSM6x55s by displaying the value of a counter on the LEDs.

' Hardware interface with the TSM6x55:

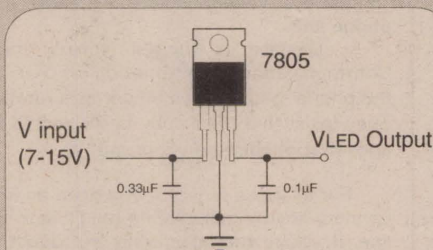
SYMBOL DATA\_n = 1 ' Bits are shifted out this pin # to display.  
SYMBOL DATA\_p = pin1 ' Data valid on rising edge of this clock pin.  
SYMBOL CLK = 2 ' Activates TSM6x55 to accept data.  
SYMBOL Enable = 0

' Variables used in the program.

SYMBOL initLED = bit0 ' Flag to trigger initialization of display.  
SYMBOL colon = bit1 ' Flag to turn on colon in the middle of display.  
SYMBOL bitPat = b1 ' Byte to be sent to the display.  
SYMBOL clocks = b2 ' Bit counter used to clock out bits.  
SYMBOL digit = b3 ' Loop counter for clocking out bytes.  
SYMBOL DP = b4 ' Position of decimal point.  
SYMBOL dispVal = w3 ' Value to be displayed on the LEDs.  
SYMBOL counter = w4 ' Counter for demo.

' The program begins by clearing all pins except the TSM6x55 enable to 0, and setting their I/O direction to output. It then writes 0s to the TSM6x55's internal registers to clear out any garbage that may be left from a previous write to the display. If this were not done, any 1s left in the display registers would cause the display to load newly arrived data before it should, garbling the display.  
let port = \$FF01 ' Dirs = \$FF (all outputs) and Pins = 1 (low).  
let initLED = 1 ' Set up to initialize the display.  
gosub IIIV\_write ' Clear display registers.  
let initLED = 0 ' Switch to normal operation.  
let colon = 0 ' Turn off the colon.

' The decimal-point variable serves three functions: (1) If it's



**Figure 3**  
Voltage regulator for VLED.

500 mA. These show up in the electronics catalogs from time to time at bargain prices. (2) Use the circuit in Figure 3 to convert any 7- to 12-volt DC supply to regulated five volts for VLED. (3) If you're using a Counterfeit with its 100-mA regulator, you can test the module at reduced brightness. Just use a brightness-control resistor of at least triple the value printed on the TSM6755 module.

On the software side of things, the program listing that accompanies this column tells the tale. The subroutine IIIV\_write converts a 16-bit value between 0 and 9999 into decimal digits; converts the digits into patterns of LEDs corresponding to the individual numerals; and sends these patterns to the TSM6755 by a clocked (synchronous) serial method. The subroutine allows the program to specify the location of a decimal point, and to determine whether or not to blank leading zeros. Leading zeros are the implied zeros to the left of the first non-zero digit of a fixed-length display. Huh? Okay, suppose you want to display "123" on a four-digit display. Do you want to

' in the range of 0 to 3, it turns on the decimal point of the corresponding digit (numbered right to left). (2) If it's in the range of 1 to 3, it also turns off leading-zero blanking of the display, allowing numbers like "0.123" to be displayed. (3) If DP is 0 or greater than 3, leading-zero blanking is on, so that numbers like "26" don't display as "0026." When DP is 0, the rightmost decimal point is on, leading-zero blanking, so that single-digit numbers display like so: "4." For our demo, we'll turn off the decimal points and turn on leading-zero blanking.

let DP = 255

' No decimal point; no leading zeros.

### ' MAIN PROGRAM LOOP

' Now that the display is properly initialized, we're ready to send it data. The loop below increments a 16-bit counter and displays the lower 4 digits on the TSM6x55. A subroutine takes care of converting the value into digits, suppressing leading zeros, and sending data to the display.

Loop:

let dispVal = counter  
gosub IIIV\_write  
let counter = counter+1  
pause 200  
goto loop

' Copy counter into dispVal.  
' Write it to the display.  
' Increment the counter.  
' Slow things down a bit.  
' Do it again.

### ' TSM 6x55 SUBROUTINE

' This routine converts the value in dispVal into a series of bit patterns that light up the appropriate LEDs on the display to show individual digits. It sends these bytes to the display via a clocked (synchronous) output in which a bit is placed on the data line, then the clock line is pulsed to shift that bit into the display.

IIIV\_write:  
low enable  
high DATA\_n  
pulsout CLK,1

' Activate the display.  
' Send a start bit (1) to the display.  
' Clock out the start bit.



# Stamp Applications:

see "123" (leading zeros blanked) or "0123" (leading zeros allowed)?

Apart from the leading zeros, extracting the digits of a number is straightforward. Just take the remainder of the division by 10 (value // 10 in PBASIC) to get the ones-place digit. Then divide the value by 10 and do it again. I point this out because digit-extraction is a common requirement for driving displays. It's important enough that Parallax has added a digit-extraction function called DIG to the BS2.

## BASIC for Beginners

In past columns, we discussed several common numbering systems: decimal, binary, and hexadecimal. If you recall, hexadecimal (or hex, for short) is the preferred shorthand for binary, since each digit neatly expresses a nibble (four bits). Hex digits range from 0 through F, representing decimal values of 0 through 15.

There's another important application for hex numbers: providing a reasonable way for a computer to store and manipulate decimal digits. Hex numbers used this way are referred to as binary-coded decimal (BCD).

The idea is this: instead of using hex numbers' full range of values (0-15), restrict them to the values that overlap with the decimal system (0-9). Each hex, excuse me BCD, digit fits neatly into four bits. When it's time to display those digits, no conversion is required. Just put the value of each BCD nibble on the corresponding digit of the display.

Contrast that to the approach required for converting pure binary values into decimal digits. The one's digits is extracted by taking the remainder of division by 10. The binary value is then divided by

10 and the one's digit extracted again until all digits are done.

We take built-in division capabilities for granted with the Stamps, but division is difficult for limited micros. If division can be avoided, the resulting program will be smaller and faster than one that uses division.

How do you decide when BCD might be the better way to go? This depends on your application, and which Stamp you're using. The BS1 does not have nibble variables, so its ability to deal with BCD is limited.

The BS2 does have nibble (nib) variables, and the ability to define arrays — variables with multiple cells that can be addressed by providing an index value. It has hex format modifiers for debug and serout instructions that also work for displaying BCD digits.

Listing 2 is a BS2 program that demonstrates some basics of BCD by implementing a BCD counter that counts from 0 to

999,999 on the debug screen. That points out yet another handy use of BCD: to construct counters that exceed the limits of built-in word (16-bit) variables. **NV**

### Listing 2: Demonstrating BCD Counting with the BS2

' Program: BCD\_DEMO.BS2

' This program implements a counter to demonstrate the basics of working with binary-coded decimal (BCD) numbers with the BS2.

' Variables used in the program.

BCDcnt var nib(6) ' Six-digit BCD counter.  
i var nib ' Index into array of BCD digits.  
nonZ var bit ' Flag used in blanking leading zeros.

' You can enter a starting value for the counter by changing the digits stored in BCDcnt below.

BCDcnt(5) = 0: BCDcnt(4) = 0: BCDcnt(3) = 0  
BCDcnt(2) = 0: BCDcnt(1) = 0: BCDcnt(0) = 0

#### Main Loop of Demonstration Program

' All of the real action takes place in the subroutines—all this main program loop does is to display the BCD number, increment it, and repeat. Forever.

Main:

gosub BCD\_display ' Show the BCD number.  
gosub BCD\_inc ' Add 1 to the BCD number.  
goto Main ' Do it again.

#### BCD Subroutines

' =====BCD\_display

' This routine displays the six BCD digits stored in BCDcnt() on the screen using the debug instruction. It incorporates logic to eliminate leading zeros (i.e., to display values like "001234" as "1234"). A zero is defined as a leading zero if it is to the left of the first non-zero digit. We also have to consider the case in which all digits are zero; here we don't want to blank the zero in the ones place. In the routine, a flag (nonZ) is set to 1 by the first non-zero digit. The if/then instruction right below the label "skip1" takes care of the rest. It says, "if this digit is 0, AND the first non-zero digit hasn't come yet, AND this isn't the ones place, then don't print this digit."

BCD\_display:

nonZ = 0 ' Turn on leading-zero blanking.  
for i = 5 to 0 ' For each digit..  
if BCDcnt(i) = 0 then skip1 ' In effect: "if digit is not 0..  
nonZ = 1 ' ..then nonZ = 1"  
skip1: ' See comments above for next line.  
if BCDcnt(i) = 0 and nonZ = 0 and i <> 0 then skip2  
debug hex1 BCDcnt(i) ' Place the digit on the screen.  
skip2:  
next ' Process all 6 digits.  
debug cr ' Send a carriage return.  
return ' Return to program.

' =====BCD\_inc

' This subroutine increments (adds 1 to) the 6-digit BCD number stored in BCDcnt. It works like grade school arithmetic: add 1 to the ones digit. If the result is 10, put zero into the ones digit and carry the 1 to the 10s digit. The routine uses a loop to carry the 1 all way up to the 6th digit when the number to be incremented is 999999.

BCD\_inc

i = 0 ' Start at lowest digit.  
incLoop:  
if i > 5 then done ' Stay within the 6 digits, 0-5.  
BCDcnt(i) = BCDcnt(i) + 1 ' Increment digit.  
if BCDcnt(i) < 10 then done ' If no carry-the-one, we're done.  
BCDcnt(i) = 0 ' Otherwise, zero this digit..  
i = i + 1 ' ..and increment the next digit.  
goto incLoop ' Keep going until out of digits..  
done: ' ..or no more carries.  
return ' Return to program.

for digit = 0 to 3 ' Convert and send digits 0 - 3 (1s to 1000s).  
bitPat = dispVal//10 ' Get the ones digit of dispVal.  
if DP < 4 AND DP > 0 then noZblank ' No 0 blanking if 0 < DP < 4.

' The line below blanks 0s in the leftmost positions of the display.

' A digit is defined as a leading zero by these three rules:

- ' (1) The digit must be a 0 (bitPat = 0), and
- ' (2) It must be the leftmost digit of the number (dispVal = 0), and
- ' (3) It must not be the only digit of the number (digit <> 0).

' If a digit meets these three rules, then it is changed from 0 to blank.

if bitPat = 0 AND dispVal = 0 AND digit <> 0 then blank  
noZblank: ' Look up LED pattern matching digit value.  
lookup bitPat,(111,40,93,124,58,118,119,44,127,62),bitPat

' To turn on the decimal point for a particular digit, its bit pattern must be ORed with 128 (%10000000). So the two lines below are meant to work as: "If DP = digit then bitPat = bitPat OR 128." The backwards logic is required because PBASIC can only go to a label as the outcome of if/then. Below are several more examples of negative logic to work around this limitation.

if DP <> digit then skip0  
bitPat = bitPat I 128 ' Turn on bit 7 of LED (decimal point).

skip0:  
if initLED = 0 then skip1 ' "If initLED = 1 then bitPat = 0"

blank:  
bitPat = 0 ' Send all zeros to display.

skip1:  
for clocks = 1 to 8 ' Send eight bits.  
let DATA\_p = 0 ' If msb of bitPat = 1, then let  
IF bitPat < \$80 then skip2 ' ..DATA\_p = 1, else DATA\_p = 0.  
let DATA\_p = 1

skip2:  
pulsout CLK,1 ' Pulse the clock line.  
let bitPat = bitPat \* 2 ' Shift bitPat one bit to the left.  
next clocks ' Continue for eight bits.  
dispVal = dispVal/10 ' Divide dispVal by 10 to get next digit.

next digit  
DATA\_p = colon ' Now put the colon bit on the data line.  
pulsout CLK,1 ' And clock it out to the display.  
pulsout CLK,1 ' This takes 3 clocks; 2 for the LEDs of  
pulsout CLK,1 ' the colon, plus 1 to load the display.  
high enable ' Disable the TSM6x55.  
return ' Return to program.



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# Questions & Answers

# TECH FORUM

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

## QUESTIONS

I would like information on the unique electrical and mechanical characteristics of the electrical switch gear (switches, relays, contactors, etc.) used in diesel-electric locomotives. I found an oblique reference to this unique equipment in an old locomotive maintenance manual, but I haven't been able to locate any details. Any pointers to existing literature or references on these subjects would be greatly appreciated.

**9961** Joseph F. Richmond  
Joppa, MD

I'm looking for some information on an electronic timing advance to replace a mechanical centrifugal advance. This electronic device should replace the distributor completely. Newer GM vehicles have such features. I'm trying to replace the distributor for '79 Honda Civic CVCC and '88 Toyota Tercel. Is this possible? Where can I get more information?

**9962** James Lee  
via Internet

Is it feasible to modify digital clocks so that the hour or minutes can be set back individually? There are some clocks that have reverse setting, but they affect hours and minutes simultaneously.

**9963** Ramon Eller  
Pittsburgh, PA

I need information on higher power laser beams. I do not understand the difference from 1 MW to a 100 MW. Could you please educate me? Where can I purchase such products?

**9964** Brent Wessock  
Las Vegas, NV

I have a Professional Computer-Basic made by Texas Instruments. I have two problems.

First I need to find the bootup disks and documentation. It uses two diskettes to start up, and I have lost them along with the owner's manual. I have tried Radio Shack repair, but they don't have an idea where to get them. My second problem is getting beyond the error codes. How do I find out what the error codes mean?

**9965** Ray Kuharec  
Bridgeport, CT

I have searched quite a while for a simple solution to a problem. I have a PC controlled stepper motor driver system (Arrick Robotics) that controls two size 23 five-volt, one-amp, six-wire stepper motors. I would like to replace

one or two of these motors with similar motors with more torque. These type of motors usually have higher current needs, such as three to five amps and sometimes lower voltage. Can this be done using a separate power supply and perhaps opto isolators and Darlington transistors? Can anyone supply a schematic? I don't have an EE!

**9966** Nicholas I. Oshana Jr.  
Bristol, CT

I have a small 8-cylinder gas engine. Is there some way for me to activate an auxiliary electric cooling pump when the engine drops below 1000 RPM?

**9967** Bob DeVoe  
Grosse Ile, MI

Do you know of a low-cost, tunable, line powered, 88-108 MHz telephone transmitter with a range of about 100 feet maximum? Can you show me a circuit of how to build one?

**9968** J. Carroll  
Denver, CO

## ANSWERS

### ANSWER TO #9962 - AUGUST 1996

There were two questions actually asked here. To solve the power problem for the walkman, you can purchase what you need at Radio Shack. You can purchase the following units depending on the current requirements of the walkman:

Part#	Current rating
270-1560	up to 300 mA
270-1562	up to 400 mA
273-1801	up to 1 amp

Depending on the brand of walkman, you may also need to purchase 270-1563 for the correct size adapter. To solve your reception, you can use a longer piece of audio cable coming out of the headphone jack on the walkman. The audio cable is actually the antenna on a walkman. You will get better reception if you have the wire horizontal and not vertical. Also, the higher the cable is from the ground, the better reception you'll get.

Mike Dunmire  
Lemoyne, PA

### ANSWER TO #99611 - AUGUST 1996

There are a few places where you can still find parts and software for the Tandy Coco3. The place that I'd recommend first would be Radio Shack, since Tandy is the manufacturer. They have a list of software available from Ft. Worth. I can guarantee that you'll have to special order the items, but they may be able to ship directly to your address and save you a return trip. You can also try 1-800-THE-SHACK and if

you have internet access, they can be found at Tandy.com

The other place I would recommend is *PCM Magazine*. They usually have a good selection of retailer advertisements for older Tandy computers.

I am pretty sure that you will not be hooking a CD-ROM up to it, however check your local Radio Shack for those data cassettes for the CCR-81, they may have some at discontinued prices, or may be able to special order them also.

Mike Dunmire  
Lemoyne, PA

### ANSWER TO #9968 - AUGUST 1996

The HTX-100, as stated, is a transceiver, meaning that it can transmit and receive. Because it takes considerably more power to transmit than receive, the display blanks out after a few seconds to conserve vital battery power. This feature can also be found on the TRC-225 walkie-talkie. The original question doesn't state if this occurred from the beginning or is a developed "problem," so I assume that this is the correct answer to the question.

Mike Dunmire  
Lemoyne, PA

### ANSWER TO #9963 - AUGUST 1996

Dongles are hardware security keys which plug into the parallel port of a computer and allow a particular piece of software to operate. Typically, when you start the software application, the security key is interrogated and information is read back into the program. The information may be a single byte or several hundred bytes and must match exactly the same data generated by an algorithm within the software. For example, a specific pseudo random code that is millions or billions of bits long can easily be generated with a few flip-flops and gates in the key and a few lines of code by the software. When the program is invoked for the first time, the key is initialized to the first bit in the enormously long, but known sequence. At various times, the software application will interrogate the key again and the next byte(s) in the sequence are sent and compared with that generated by the software. If at any time there is a discrepancy, you will be unceremoniously exited from the application. Often, after the application is initially started, the key can actually be removed since it is common to only interrogate the key at startup and then anytime thereafter that you try and save your work. Obviously, the key would have to be re-inserted prior to saving.

Since each key may work differently from any other, it is difficult to build a "universal dongle" for all appli-

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
- If you do not want your name, address, or phone number available to the reader please so indicate or it will be assumed that you have no objection.
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- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.

## QUESTION INFO TO BE CONSIDERED FOR PUBLICATION

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

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- 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.

cations. There are, however, some things which you can do depending on whether the key is available (perhaps you can borrow one temporarily) or not. The following methods may provide varying degrees of success:

(1) First disassemble the software (using, say, DEBUG) and attempt to rewrite the code to jump over that part which accesses the protection routine. This will require a fair amount of knowledge of assembly coding, port addresses, etc.

(2) Attach a logic analyzer to the key and monitor what it is doing. You



## TECH FORUM

may not be able to determine the sequence that it is using. But you will be able to record the information from, say, the first dozen interrogations. A simple ROM based circuit could then defeat the key. This approach will only prove useful when a single byte or a few bytes are sent per activation of the key (which must also be available).

(3) Purchase a piece of software specifically designed to eliminate the need for the key. Some companies such as Safesoft Systems Inc. (204)669-4639, write software which will work for individual applications for people who have "lost" their own legal key.

The software works in one of two ways. The first type is run only one time during which it will permanently rewrite your original application to eliminate the need for the key. The second type must be activated prior to invoking your program which it does not modify. It simply remains resident in your computers memory and emulates the operation of the hardware key. If they have a "softkey" for your particular application, you can buy it for about \$200.00, but it is not universal.

(4) You can purchase the "Hard Lock Analyzer" from A-GO Technologies Inc. (604)736-0588 or E-Mail: mchung@iceonline.com for about \$200.00. It is a hardware board (7" by 4.3") which plugs into a PC slot in your computer and can acquire up to 64K bytes of sequence information.

With the original key attached, you place the board in "learn" mode. Afterwards, it will operate in emulate mode. Depending on the number of bytes that the key is required to supply each time that it is invoked will determine how many saves you will be able to do before having to restart the application and initialize the sequence.

The legality of any of these methods is an open question, but not, I'm sure, to the software manufacturers! In any event, these software keys are definitely a nuisance especially when you have half a dozen or more to contend with. Some can be "stacked" end-to-end while others simply refuse to operate unless they are the sole proprietor of the port. It is for this reason that many software manufacturers seem to be moving away from these keys to protect their software.

**Jay Rabkin**  
Pasadena, CA

### ANSWER TO #89610 - AUGUST 1996

How simple converting a two meter rig to 100 MHz less for both transmit and receive depends on the rig. Generally speaking, it's not practical because of the great frequency change. Going from 144 to 44 would require changing all the non-IF tuned circuits, and assuming it's not a synthesized system, swapping crystals. Synthesized rigs would be even rougher since there's computer code to go along with it. It's not something I'd recommend trying.

Question 2, on changing the scan mode from 1-400 to 400-1, this would require a change to the operating code for the synthesizer of the Pro 2004. If you could obtain the necessary chips (blank) hack the code, rewrite it, burn a new chip, and re-install it successfully, you could probably do it. But whether it

scans up or down, it's still going to find the active channels in the same amount of time.

**Richard M. Nelson**  
Newport News, VA

### ANSWER TO #8961 - AUGUST 1996

Although your problem may be a cable as you suggest, I would first make sure that the printer select switch on the computer is set correctly. Unlike "real" Apple II computers, the Laser 128 has both parallel and serial ports built-in. Either one can be used as the standard printer port (i.e., accessed via the PR#1 command), therefore there is a switch on the unit to select which port you use to connect to your printer. Since you stated that the computer hadn't been used for a while, I'm betting someone changed the setting of this switch.

**Jeff Mazur**

### ANSWER TO #8964 - AUGUST 1996

Cordless Telephone Frequencies

Chan	Base	Handset
1	43.72	48.76
2	43.74	48.84
3	43.82	48.86
4	43.84	48.92
5	43.92	49.02
6	43.96	49.08
7	44.12	49.10
8	44.16	49.16
9	44.18	49.20
10	44.20	49.24
11	44.32	49.28
12	44.36	49.36
13	44.40	49.40
14	44.46	49.46
15	44.48	49.50
16	46.61	49.67
17	B	46.63 49.845
18	C	46.67 49.86
19		46.71 49.77
20	D	46.73 49.875
21	A	46.77 49.83
22	E	46.83 49.89
23		46.87 49.93
24		46.93 49.99
25		46.97 49.97

Channels A-E handset frequencies are also used for baby room monitors and low-power handie-talkies.

Effective June 5, 1995, channels 1-15 are authorized and the original 10 channels are renumbered 16-25.

**Jerome Kowalewski**  
Milwaukee, WI

### ANSWER TO #89613 - AUGUST 1996

Modems, internal or external are turned on by communications software. I like Quick Link II which I use for both FAX and data. There are lots of others, but Quick Link II has automatic search for the port, IRQ and address that the modem is set to. Also, it is menu driven and almost trouble free. You may have to experiment with modem speed until you get garbage and back down to the last that worked well, if you don't know the speed.

**Travis Brackeen**  
St. Louis, MO

### ANSWER TO #8965 - AUGUST 1996

You want to build a thyristor controller with output that responds to a DC input voltage from a sensor. This could be done digitally with a counter and comparator, or using some kind of reasonably fast microcontroller design.

*Continued on page 117*

# The Filter Company

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David P. - CA *We called around for help on filters and nobody had any answers except one, call the "THE FILTER COMPANY" we did and had an answer in a matter of minutes.....*

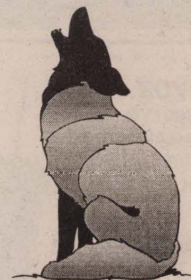
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RESISTANCE (ohm)

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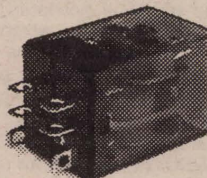
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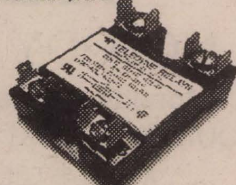
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Connection: screw or quick connects.

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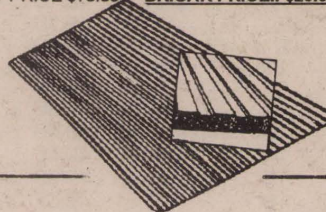
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•CONTROL LSI T6963C TOSHIBA

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•DIT PIXELS 143(W) x 153(H) mm •VIEW AREA 74.8(W) x 98.4(H) mm

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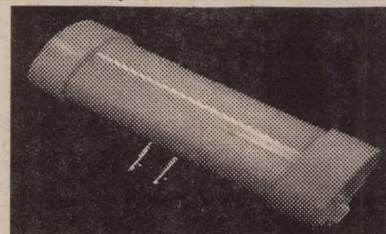
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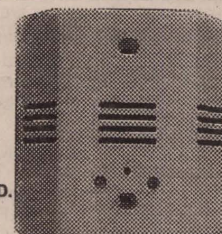
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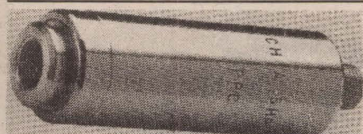
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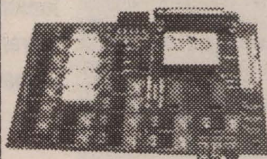
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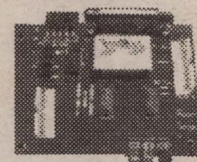
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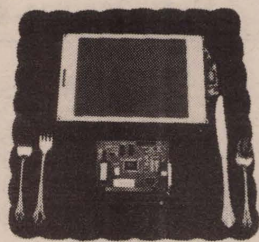
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Nuts & Volts Magazine/September 1996 67



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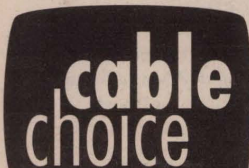
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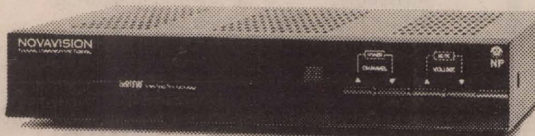
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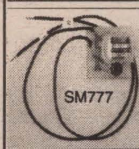


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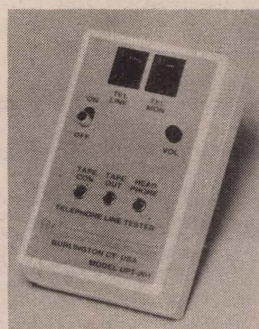
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# Home Security with PCM and The Parallel Port

by Jeff Stefan

Don't throw out that old XT! Turn it into a security system!

This article shows you how to create a simple home security system with a personal computer using PCM as the application framework. PCM, which stands for Pseudo Cooperative Multitasking, is an application framework, written in C, that helps you build structured control programs. The original PCM article appeared in the June '96 issue of *Nuts & Volts*, and also contains a short tutorial on different types of multitaskers and their design. Reading the original article will enhance your understanding

and BIOS. The parallel port interface is simple, useful, and easy to program. All of the input scanning and output processing is written using Turbo C, and is by no means exclusive to the PCM application framework. It can be used in any Turbo C program to control the parallel port.

## Controlling the Parallel Port

The PC parallel port is designed to connect to a printer via a DB-25P female connector mounted on the PC side, and a Centronics 36-pin male connector at the printer.

Figure 1 shows the parallel port pinout.

There are 12 outputs and five inputs. The 17 I/O lines are controlled and monitored by three registers labeled: Data, Status, and Control. In most of the PC parallel port literature, the lines assigned to the Data register have a D prefix. For example, data line zero is referred as D0, data line one is D1, and so on. The Status register lines have a S prefix (S0 through S7), and the Control lines have a C prefix (C0 through C7).

The installed parallel ports (LPT1, LPT2, and LPT3) and their base addresses are located in the PC's BIOS interrupt vector table. These addresses are standard from machine to machine, and are easy to find. This is called the I/O Base Address. The address for LPT1 resides at vector table address 0000:0408 hex or 0x408 (this is how C likes to see hexadecimal numbers). The contents of this address depend on the type of display adapter connected to the PC. If a PC has a monochrome adapter, the parallel port addresses change. Figure 2 is a table showing the addresses for both the non-monochrome and monochrome printer port addresses.

One way to determine the parallel port addresses on your machine (chances are it's 0x378 for LPT1), is by using the DOS program debug. At the C:\> prompt, type debug to start the program, then enter the dump command d 0:0408. This displays the printer addresses, with the output appearing as in Figure 3.

The address is displayed as it appears in raw memory. It looks backwards, because it is. The low byte, 78 hex, is displayed first, then the high byte, 03 hex, is displayed next. This is called Little Endian byte ordering (Motorola chips use Big Endian byte ordering). It works out with the Intel architecture that this is the most convenient way to load the microprocessor's registers from memory.

For all practical purposes, just look at the second byte and put it in front of the first when determining the physical address. Believe it or not, the names Big and Little Endian come from the book *Gulliver's Travels*, by Jonathan Swift. In *Gulliver's Travels*, the Big Endian and Little Endian political parties argued whether it's better to open soft boiled eggs from the big end or the little end!

Another way to find the parallel port addresses is to write a short C program using the MK\_FP

macro. MK\_FP means make far pointer. This creates a full address from the memory segment and offset values passed in as the macro arguments. The following short program, getport.c, gets the address of LPT1, the first parallel port, using MK\_FP.

```

*****
* getport.c
* gets first parallel port I/O Base Address
*****
#include <stdio.h>
#include <dos.h>
void main(void)
{
    unsigned int PortAddress;
    PortAddress = *(unsigned far *)MK_FP(0x40,0x008);
    printf("LPT1 is at: [0x%2X]\n",PortAddress);
}
    
```

In this article, the I/O Base Address used is 0x378.

Now that you know how to find the I/O Base Address, you need to know how to read from and write to the registers. Turbo C, like most C

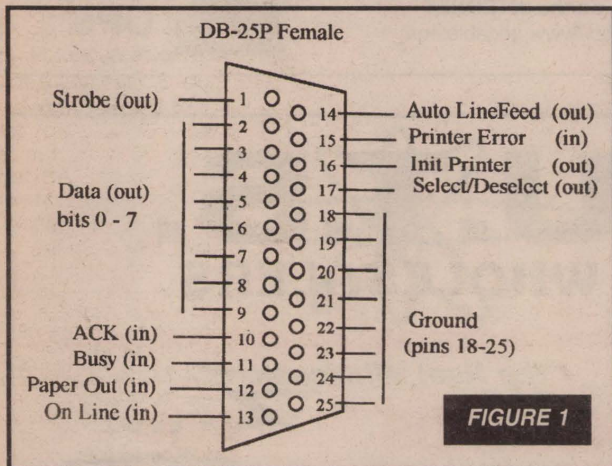


FIGURE 1

Port Address	Without mono	With mono
LPT1	0x378	0x3b
LPT2	0x278	0x378
LPT3	n/a	0x278

FIGURE 3

FIGURE 2

```

-d 0:0408
0000:0408 78 03 00 00 00 00 00 00
    
```

of PCM.

The PC parallel port is used for the application program's inputs and outputs, utilizing a home-built parallel port interface. The code presented writes directly to the hardware, bypassing DOS

Data Register							
D7	D6	D5	D4	D3	D2	D1	D0
pin 9	pin 8	pin 7	pin 6	pin 5	pin 4	pin 3	pin 2

I/O Base Address: 0x378  
1 = Hi 0 = Lo

FIGURE 4

compilers, offer four functions to read and write to the PC's input/output registers. These functions are:

```

int inportb(int PortAddress); /* Read a byte (8 bits)
from I/O port PortAddress */
int inportw(int PortAddress); /* Read a word (16 bits)
from I/O port PortAddress */
void outportb(int PortAddress, unsigned char
Data); /* Write a byte (8 bits) to I/O PortAddress */
void outportw(int PortAddress, int Data); /* Write a
word (16 bits) to I/O PortAddress */
    
```

## The Data Register

The data register is an eight bit read/write register. The data register lies right at the I/O Base Address (0x378), as shown in Figure 4.

To write to the Data Register, you need to use outportb(0x378,Data);. The Data parameter value writes to the individual bits you need to turn on or turn off. The easiest way to write to a register is to create a set of #define statements to set the individual bits and pass them as the Data arguments:

```

#define CLEAR_DATA_BITS 0x00
#define SET_DATA_D0 0x01 /* binary 0000 0001 */
#define SET_DATA_D1 0x02 /* binary 0000 0010 */
#define SET_DATA_D2 0x04 /* binary 0000 0100 */
#define SET_DATA_D3 0x08 /* binary 0000 1000 */
#define SET_DATA_D4 0x10 /* binary 0001 0000 */
#define SET_DATA_D5 0x20 /* binary 0010 0000 */
#define SET_DATA_D6 0x40 /* binary 0100 0000 */
#define SET_DATA_D7 0x80 /* binary 1000 0000 */
    
```

To set bit D0, use outportb(0x378,SET\_DATA\_D0);.

That's all there is to it. To set more than one bit at a time, create a unique #define. For example, if



## Status Register

S7	S6	S5	S4	S3	S2	S1	S0
pin 11	pin 10	pin 12	pin 13	pin 15	?	?	?

I/O Base Address: 0x378+1

S0 Undefined	S3 Error	1 = True
S1 Undefined	S4 On Line	1 = True
S2 Undefined	S5 Paper Out	1 = True
	S6 Ack	1 = True
	S7 Busy	0 = True

FIGURE 5

```

/*
 * Filename: secure.c
 *
 * Description: model security system based on PCM
 *
 * Copyright (c) 1996 Jeffrey M. Stefan
 */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>
#include <conio.h>
#include <time.h>
#include <dos.h>

/* Use this define to define the maximum tasks in your application.
 * Make sure that the number of tasks you run are at least equal to
 * the number defined here, otherwise unpredictable (bad) things
 * will happen. There are three tasks in this system.
 */
#define MAX_TASKS 3

/* The following defines are used for task return identifiers. The
 * individual tasks may return something to the main loop. Using
 * these defines identify the task.
 */
#define TASK1_RET 1
#define TASK2_RET 2
#define TASK3_RET 3

/* Function (task) prototypes. These functions should return ints
 * in order to inform main that it has finished processing. For
 * example, nTimeMenuTask should return TASK1_RET, which is defined
 * as 1.
 */
int nTimeMenuTask(void);
int nPortTask(void);
int nMonitorTask(void);

void CursorOff(void);
void CursorOn(void);

/* Parallel Port Addresses. This is important! If you have a monochrome
 * monitor, the DATA_PORT address should be 0x3ab instead of 0x378.
 */
#define DATA_PORT 0x378 /* LPT1 Port Address for Data */
#define STATUS_PORT DATA_PORT + 1 /* LPT1 Port Address for Status */
#define CONTROL_PORT STATUS_PORT + 1 /* LPT1 Port Address for Control */

/* AND Mask Defines to read and write individual bits
 */
#define CLEAR_DATA_BITS 0x00
#define SET_DATA_D0 0x01
#define SET_DATA_D1 0x02
#define SET_DATA_D2 0x04
#define SET_DATA_D3 0x08
#define SET_DATA_D4 0x10
#define SET_DATA_D5 0x20
#define SET_DATA_D6 0x40
#define SET_DATA_D7 0x80

#define READ_STATUS_S7 0x80
#define READ_STATUS_S6 0x40
#define READ_STATUS_S5 0x20
#define READ_STATUS_S4 0x10
#define READ_STATUS_S3 0x08
#define READ_STATUS_S2 0x04
#define READ_STATUS_S1 0x02
#define READ_STATUS_S0 0x01

/* Global Variables
 */
int Duration = 0;
int AlarmActive = 0;
int AlarmTripped = 0;

```

FIGURE 6

## Status Register AND Masks

	S7	S6	S5	S4	S3	S2	S1	S0
	1	1	1	0	0	?	?	?
AND Mask Value:	0	1	0	0	0	0	0	0
Result:	0	1	0	0	0	0	0	0

you want to set bits zero and two, this comes out to be a hexadecimal five.

Use #define SET\_DATA\_HEX5 0x05 /\* binary 0000 0101 \*/ to set the two bits

The Status Register is shown in Figure 5.

The contents of the Status Register is read using the inportb( PortAddress) function. A typical function call is StatusRegState = inportb(0x378+1);.

simultaneously.

## The Status Register

The Status Register is used to read inputs, and is addressed at I/O Base Address +1. Software can only read this register. Any attempt to write to the Status Register is ignored.

The Status Register is shown in Figure 5.

The contents of the Status Register is read using the inportb( ) function. In order to examine individual bits, a mask value must be used. This is similar to the way the SET\_BIT defines are used to set individual output bits. The masks used are called AND masks, as shown in Figure 6.

If only one bit is set, as in the AND Mask Value in Figure 6, then that is the only bit that is effectively compared. Note that S5 is set and read, but is ignored when ANDed with the AND Mask Value. The AND Masks defines are as follows:

```

#define READ_STATUS_S7 0x80 /* binary 1000 0000 */
#define READ_STATUS_S6 0x40 /* binary 0100 0000 */
#define READ_STATUS_S5 0x20 /* binary 0010 0000 */
#define READ_STATUS_S4 0x10 /* binary 0001 0000 */
#define READ_STATUS_S3 0x08 /* binary 0000 1000 */

```

An AND mask with S7 effectively inverts the output. If the switch assigned to S7 is open, this produces a one at the S7 input pin 11, and a zero appears at the S7 register bit. This special case is handled by considering a zero output from the AND mask as true (the switch being open), and a one output as false (the switch being closed). This is a constraint of the parallel port hardware, and cannot be changed. Bits S1, S2, and S3 contain garbage and cannot be used.

AND Mask Values are called using the following form:

```

int Result = 0;
int AllClosed = 0;
int FrontDoor = 0; /* S7 bit */
int BackDoor = 0; /* S6 bit */
int Window1 = 0; /* S5 bit */
int Window2 = 0; /* S4 bit */
int Window3 = 0; /* S3 bit */

unsigned char StatusRegState = 0;

/* These variables are required to get the system time.
 */
time_t timer, first, second;
struct tm *tblock;

/* main : main() acts like a task dispatcher or task scheduler.
 */
main()
{
    int nRetVal = 0; /* Return value from called function (task) */
    int nCtr = 0; /* Function a(task) array index counter */

    int (*fp)(); /* Function (task) pointer */

    int *afp[] = { /* array of function (task) pointers */
        nTimeMenuTask,
        nPortTask,
        nMonitorTask,
        NULL
    };

    clrscr();
    CursorOff();

    /* Dispatch Tasks using infinite loop.
    */
    for(;;)
    {
        fp = afp[nCtr]; /* Get the task address */
        nRetVal = (*fp)(); /* execute task and get return value */
        nCtr++; /* increment task counter */

        if(nCtr==MAX_TASKS) /* If last task was run, start over */
        {
            nCtr=0;
        }

        /* The following switch statement processes the return values
        * from the task that just returned. The task may fill a data
        * structure, signal event, or act on some other data. This
        * area will be application specific.
        */
        switch(nRetVal)
        {
            case TASK1_RET:
                /* Process the data that nTimeMenuTask worked on.
                * (none in this application)
                */
                break;

            case TASK2_RET:
                /* Process the data that nPortTask worked on.
                * (none in this application)
                */
                break;

            case TASK3_RET:
                /* Process the data that nMonitorTask worked on.
                * (none in this application)
                */
                break;

            default:
                break;
        }
    }
}

```



## Control Register

C7	C6	C5	C4	C3	C2	C1	C0
?	?	?	no pin	pin 17	pin 16	pin 14	pin 1

I/O Base Address: 0x378+2

C0 Strobe C4 Interrupt Control  
C1 Auto Line Feed C5 Bidirectional Control  
C2 Init Printer C6 Unused  
C3 Select/Deselect C7 Unused

FIGURE 7

```
StatusRegState = inportb(0x378+1); /* get the status
port register info */
S6Bit = (StatusRegState & READ_STATUS_S6); /*
check if S6 is set */
if(S6Bit)
    printf("Back Door is Open!!");
else
    printf("Back Door is Closed");
To handle S7, use this:
StatusRegState = inportb(0x378+1); /* get the
status port register info */
S7Bit = (StatusRegState & READ_STATUS_S7); /*
check if S7 is not set */
if(!S7Bit)
    printf("Front Door is Open!!");
else
    printf("Front Door is Closed");
```

In the PCM home security system application, the S6Bit monitors the back door, and the S7Bit monitors the front door.

## The Control Register

The Control Register is designed to send control commands to a printer, and is addressed at I/O Base Address + 2. The Control Register is shown in Figure 7.

Two of the interesting bits in the Control Register are C5, the Bi-directional Control Bit, and C4, the Interrupt Enable Bit. On newer PCs, the

parallel port data bits are read/write, instead of write only. Whether data is read or written depends on the state of C5. If C5 is set to a one, then data is output. If C5 is zero, then the outputs are effectively disconnected, and the data lines may be used for inputs. The Interrupt Enable Bit, C4, allows an external device to generate an interrupt request (IRQ). If this bit is set, then an interrupt is generated on the low transition of the Status Register ACK input signal, C6. Usually this interrupt is set by jumpers to IRQ5. To use the interrupt, an interrupt service routine must be written, the address must be entered into the interrupt vector table, and the interrupt mask register must be enabled for IRQ5. Most of the older PC parallel ports do not have Bidirectional data lines, and almost none of the PC operating systems utilize the Interrupt Enable Bit. Our PCM application does not use the Control Register.

## Building the Parallel Port Interface

Building the Parallel Port Interface is straightforward, and is built using three SN74LS367 hex buffers and five 4.7K resistors. This is a bare bones interface that you will probably want to expand. Why not just use the parallel port alone to directly control inputs and outputs? Without some type of buffer, you run the risk of frying your parallel port. Using just the PC's internal +5 VDC power, the data outputs can only source 2.6 mA. Remember, the standard parallel port printer cable is only six feet long. I've seen them run about 20 feet, but that's really pushing it. Do not run unprotected! Buffering the inputs and outputs is simple and sensible, and using SN74LS367 TTL hex buffer chips is a cheap, easy, and reliable solution. The only shortcoming is that an external +5 VDC power supply is required, but the

```
/*
 * nTimeMenuTask : This task gets the system time, displays, then
 * dispatches menu selections.
 */
```

```
int nTimeMenuTask()
{
    static int nState = 0;
    int InCmd = 0;
```

```
/*
 * The static nState variable remembers where the task left off.
 * When the task is called again by the dispatcher in main loop,
 * the switch statement will place the program counter at the last
 * known state. This is effectively a cooperative context switch.
 */
```

```
switch(nState)
```

```
{
    case 0 :
```

```
/*
 * Get and Display System Time
 */
```

```
nState = 1;
```

```
/*
 * System Time Calls
 */
```

```
timer = time(NULL);
tblock = localtime(&timer);
```

```
if(AlarmActive)
```

```
{
    if(Result <= Duration)
    {
        second = time(NULL);
        Result = difftime(second,first);
    }
}
```

```
return(TASK1_RET);
break;
```

```
case 1 :
```

```
/*
 * Change nState to whatever new state is required.
 */
```

```
gotoxy(30,3);
printf("=====\n");
gotoxy(30,4);
printf("= Main Menu =\n");
gotoxy(30,5);
printf("=====\n");
gotoxy(30,6);
printf("= 1. Set Alarm =\n");
gotoxy(30,7);
printf("= 2. Clear Alarm =\n");
gotoxy(30,8);
printf("= 3. Exit =\n");
gotoxy(30,9);
printf("=====\n");
```

```
gotoxy(1,1);
```

```
/*
 * get menu selection and
 * check for shutdown request
 */
nState = 0;
```

```
if(kbhit())
```

```
{
    InCmd = getch();
```

```
switch(InCmd)
```

```
{
    /*
     * Set Alarm
     */
```

```
case 0x31:
```

```
nState = 2;
break;
```

```
/*
 * Clear Alarm
 */
```

```
case 0x32:
```

```
Duration = 0;
AlarmActive = 0;
AlarmTripped = 0;
Result = 0;
nState = 0;
break;
```

```
/*
 * exit System
 */
```

```
case 0x33:
```

```
nState = 4;
break;
```

```
default:
```

```
nState = 0;
break;
```

```
} /* switch */
```

```
return(TASK1_RET);
break;
```

```
case 2 :
```

```
/*
 * Set Alarm. The tasks are temporarily suspended here
 * in order to get new duration and time mark.
 */
```

```
nState = 3;
```

```
clrscr();
gotoxy(30,3);
printf("=====\n");
gotoxy(30,4);
printf("= Set Alarm =\n");
gotoxy(30,5);
printf("=====\n");
gotoxy(30,6);
printf("= 1. Enter Escape Time =\n");
gotoxy(30,7);
printf("= 2. Go =\n");
gotoxy(30,8);
printf("= 3. Cancel =\n");
gotoxy(30,9);
printf("=====\n");
gotoxy(1,1);
```

```
if(lkbit())
{
    InCmd = getch();
    switch(InCmd)
```

```
{
    /*
     * Enter Duration
     */
```

```
case 0x31:
```

```
gotoxy(30,11);
printf("Enter Duration:(min): ");
scanf("%d",&Duration);
Duration = Duration * 60;
gotoxy(30,11);
printf(" ");
gotoxy(1,1);
nState = 2;
break;
```

```
/*
```

```
* GO!
```

```
case 0x32:
```

```
nState = 0;
first = time(NULL);
AlarmActive = 1;
clrscr();
break;
```

```
/*
```

```
* Cancel
```

```
case 0x33:
```

```
Duration = 0;
AlarmActive = 0;
Result = 0;
nState = 0;
clrscr();
```



added expense of a surplus power supply is well worth it. If you rely on the internal five volts from the parallel port for power, you could damage or destroy your port if something goes wrong.

Figure 8 shows the switch inputs for the simple security system, running through a SN74LS367 hex buffer. The switches are held low when closed, and pulled high when open.

Figure 9 shows how to connect the Data Lines (D0-D7) to the hex buffer chips. The Control Register outputs can be wired the same way. This PCM application doesn't use any outputs, and simply emits the PC's bell when the system is armed and violated.

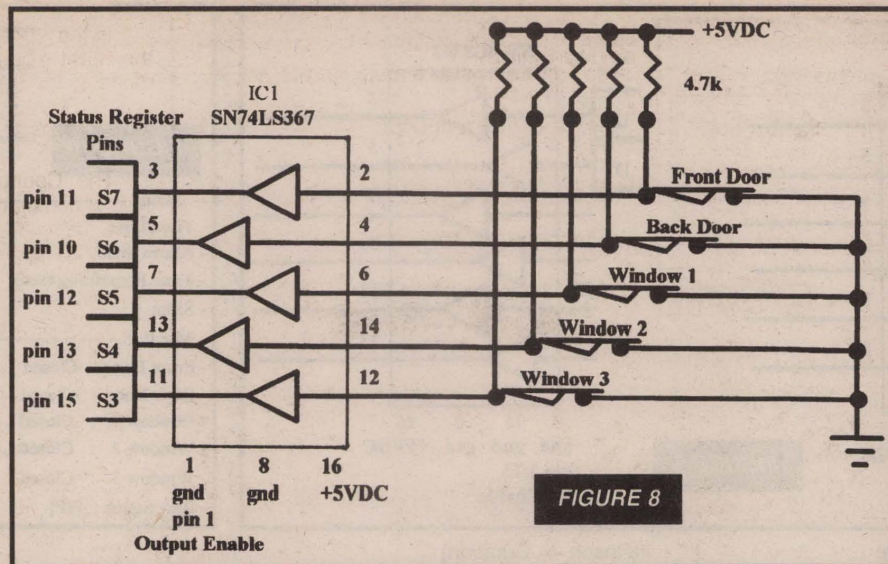


FIGURE 8

## The Home Security System

The PCM Home Security program is named secure.c. The display interface, shown in Figure 10, is intentionally very simple, and you are encouraged to customize and enhance it. The main display page is also shown in Figure 10.

The Main Menu selections allow the user to set and clear the alarm system (which is simply the bell output on the PC). Figure 11 shows the Set Alarm menu. The user first sets the escape time which delays the alarm system until everyone is out of the house. The alarm is triggered when Go is

selected, and aborted when Cancel is selected. The display returns to the Main Menu screen, and the Time Remaining (sec) value starts counting down. If the doors and windows are not closed by the time the value counts down to zero, the alarm sounds. If the alarm is active and any of the doors or windows are opened, the alarm will sound. To deactivate the alarm system, press menu selection 2, Clear Alarm.

Again, the program features are intentionally kept to a bare minimum. Keeping it lean allows you to put in the features you want, without being burdened with taking out things you don't like, or have little use for. This program is designed for easy expansion.

## The secure.c Program

The Secure PCM application contains three tasks:

```
int
nTimeMenuTask(void);
int nPortTask(void);
int nMonitorTask(void);
```

The nTimeMenuTask gets the system time, displays and dispatches menu selections. The PC's system time is monitored by using the calls:

```
timer = time(NULL);
tblock =
localtime(&timer);
```

The Time Remaining value in the Status display area is

```
break;
default:
    nState = 0;
    break;
} /* switch */
return(TASK1_RET);
break;

case 3:
    /* Change nState to whatever new state is required.
    ***** */
    nState = 0;

    return(TASK1_RET);
    break;

case 4:
    /* Exit Task Here
    ***** */
    clrscr();
    gotoxy(1,1);
    printf("*** System Shutdown ***");
    cursorOn();
    exit(0);
    nState = 0;
    return(TASK1_RET);
    break;

default:
    break;
} /* switch */
return(TASK1_RET);
}

/* nPortTask : parallel port control task.
***** */
int nPortTask()
{
    static int nState = 0;

    switch(nState)
    {
        case 0:
            /* Read inputs from Status Register
            ***** */
            StatusRegState = inportb(STATUS_PORT);

            /* Get the status bit state
            ***** */
            FrontDoor = (StatusRegState & READ_STATUS_S7);
            BackDoor = (StatusRegState & READ_STATUS_S6);
            Window1 = (StatusRegState & READ_STATUS_S5);
            Window2 = (StatusRegState & READ_STATUS_S4);
            Window3 = (StatusRegState & READ_STATUS_S3);

            /* Display Front Door status
            ***** */
            if(!FrontDoor)
            {
                gotoxy(20,17);
                printf("OPEN ");
            }
            else
            {
                gotoxy(20,17);
                printf("CLOSED");
            }

            /* Display Back Door status
            ***** */
            if(BackDoor)
            {
                gotoxy(20,18);
                printf("OPEN ");
            }
            else
            {
                gotoxy(20,18);
                printf("CLOSED");
            }

            /* Display Window1 status
            ***** */
            if(Window1)
            {
                gotoxy(20,19);
                printf("OPEN ");
            }
            else
            {
                gotoxy(20,19);
                printf("CLOSED");
            }

            /* Display Window2 status
            ***** */
            if(Window2)
            {
                gotoxy(20,20);
                printf("OPEN ");
            }
            else
            {
                gotoxy(20,20);
                printf("CLOSED");
            }

            /* Display Window3 status
            ***** */
            if(Window3)
            {
                gotoxy(20,21);
                printf("OPEN ");
            }
            else
            {
                gotoxy(20,21);
                printf("CLOSED");
            }

            /* Set state of AllClosed
            ***** */
            if(FrontDoor && !BackDoor && !Window1 && !Window2 && !Window3)
            {
                AllClosed = 1;
            }
            else
            {
                AllClosed = 0;
            }
        }
    }
}
```



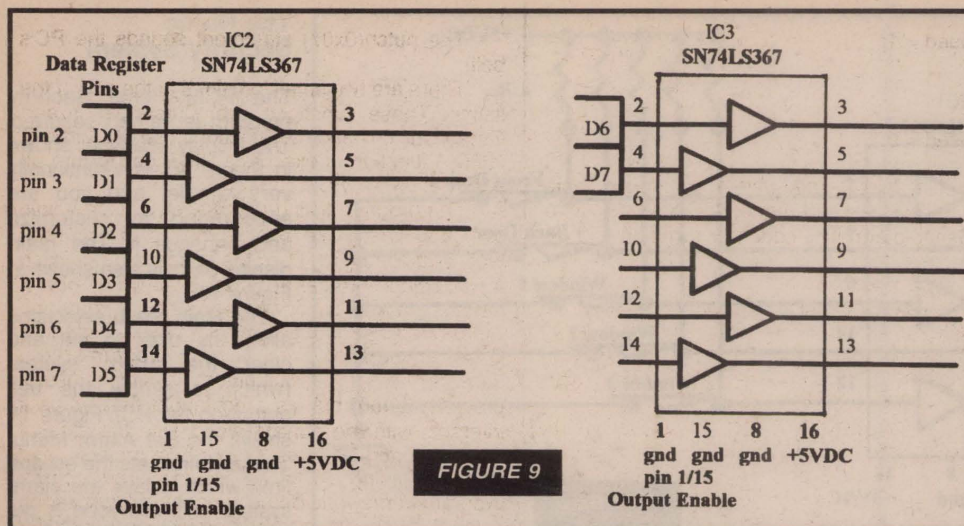


FIGURE 9

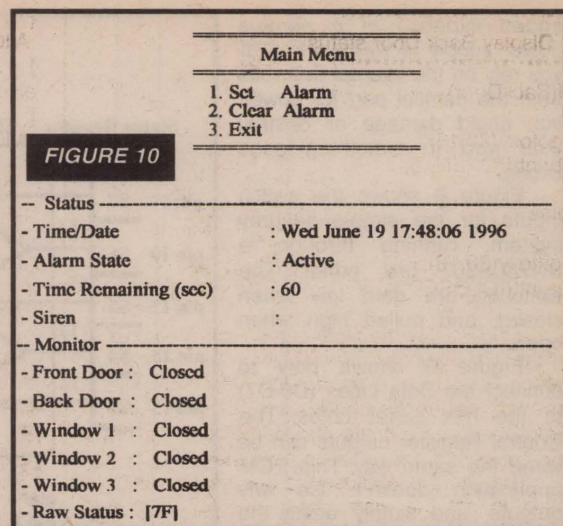


FIGURE 10

determined by the following code:

```
if(AlarmActive)
{
```

```
if(Result <= Duration)
{
    second = time(NULL);
    Result = difftime(second,first);
}
```

The variable first, which holds a previously stored time value, is set by the first = time(NULL) line of code in the GO command switch statement. Calling the difftime() function this way is a standard way of comparing time values, and is often used to benchmark algorithm execution time.

The nPortTask reads and processes the parallel port inputs. The Status Register is read by StatusRegState = inportb(STATUS\_PORT);. The state of the individual bits is checked by:

```
FrontDoor = (StatusRegState &
READ_STATUS_S7);
BackDoor = (StatusRegState &
READ_STATUS_S6);
Window1 = (StatusRegState &
READ_STATUS_S5);
Window2 = (StatusRegState &
READ_STATUS_S4);
Window3 = (StatusRegState &
READ_STATUS_S3);
```

Each of the status bits are examined and displayed by a series of if-else statements, starting with the Front Door switch.

```
/* Display Front Door status
***** */
if(!FrontDoor)
{
    gotoxy(20,17);
    printf("OPEN ");
}
else
{
    gotoxy(20,17);
    printf("CLOSED");
}
```

#### Set Alarm

1. Enter Escape Time
2. Go
3. Cancel

Enter Duration: (min) :

FIGURE 11

```

    }
    AllClosed = 0;

    nState = 0;
    return(TASK2_RET);
    break;

    default :
    break;
} /* switch */

return TASK2_RET;
}

/* nMonitorTask : Status Display Task
***** */
int nMonitorTask()
{
    static int nState = 0;
    int TimeDif = 0;

    switch(nState)
    {
        case 0 :
            /* Change nState to whatever new state is required.
            ***** */
            nState = 1;
            gotoxy(5,11);
            printf("Status\n");
            gotoxy(5,12);
            printf("Time/Date : %s\n", asctime(tblock));

            gotoxy(5,13);
            if(AlarmActive)
                printf("Alarm State : Active\n");
            else
                printf("Alarm State : Inactive\n");

            gotoxy(5,14);
            if(AlarmActive)
            {
                TimeDif = Duration - Result;
                printf("Time Remaining (sec): %2d\n", TimeDif);
            }
            else
                printf(" ");

            gotoxy(5,15);
            if(AlarmActive && TimeDif <= 0 && !AllClosed)
            {
                AlarmTripped = 1;
            }
            else
            {
                printf("Siren : \n");
            }

            if(AlarmTripped)
            {
                gotoxy(5,15);
                printf("Siren : ALERT!\n");
                putchar(0x07);
            }
        }
    }
    return(TASK3_RET);
    break;

    case 1 :
        /* Display switch status then return to
        * state 0 to monitor alarm.
        ***** */
        nState = 0;

        gotoxy(5,16);
        printf("Monitor\n");
        gotoxy(5,17);
        printf("Front Door : \n");
        gotoxy(5,18);
        printf("Back Door : \n");
        gotoxy(5,19);
        printf("Window 1 : \n");
        gotoxy(5,20);
        printf("Window 2 : \n");
        gotoxy(5,21);
        printf("Window 3 : \n");
        gotoxy(5,22);
        printf("Raw Status : [%2X]", StatusRegState);
        gotoxy(5,23);
        printf("\n");

        return(TASK3_RET);
        break;

    default :
    break;
} /* switch */

return TASK3_RET;
}

/* CursorOff: turns off cursor using BIOS screen interrupt 0x10.
***** */
void CursorOff()
{
    union REGS regs;

    regs.x.ax = 0x0100;
    regs.x.bx = 0;
    regs.x.cx = 0x3200;
    int86(0x10, &regs, &regs);
}

/* CursorOn: turns on cursor using BIOS screen interrupt 0x10.
***** */
void CursorOn()
{
    union REGS regs;

    regs.x.ax = 0x0100;
    regs.x.bx = 0;
    regs.x.cx = 0x0607;
    int86(0x10, &regs, &regs);
}

```



```
*****
* Display Back Door status
*****
```

```
if(BackDoor)
{
  gotoxy(20,18);
  printf("OPEN ");
}
else
{
  gotoxy(20,18);
  printf("CLOSED");
}
```

Notice that the state of the Front Door switch in the if statement is different than the Back Door switch. Remember that S7 in the Status Register is inverted, so !FrontDoor checks to see if the variable FrontDoor is zero. If it is, the door is opened. This is the opposite of the remaining switches.

The variable AllClosed is one of the variables used to set the alarm. If all of the doors and windows are closed, then AllClosed is set to one. If any door or window opens, AllClosed is set to zero.

```
if(FrontDoor && !BackDoor && !Window1 &&
!Window2 && !Window3)
```

```
{
  AllClosed = 1;
}
else
{
  AllClosed = 0;
}
```

The last task in the system is nMonitorTask. This task receives and monitors the switch state and sets the alarm. The code that turns on and off the alarm is:

```
if(AlarmActive && TimeDif <=0 && !AllClosed)
{
  AlarmTripped = 1;
}
else
{
  printf("- Siren : \n");
}
```

```
if(AlarmTripped)
{
  gotoxy(5,15);
  printf("- Siren : ALERT\n");
  putch(0x07);
}
```

```
}
```

The putch(0x07) statement sounds the PC's bell.

There are two small functions at the end of the listing. These functions are CursorOff( ) and CursorOn( ). These two functions use the Turbo C int86( ) function to execute a BIOS call to turn off and turn on the PC's cursor.

The program listing is pretty short, just a little over 600 lines. Like the original PCM program, type it in, compile it, build the interface, and watch it run. Run it through a debugger to watch how it switches in and out of tasks and how it reads the Status Register inputs. Like a lot of you, I spend a large amount of time writing programs and tinkering with small computers. Writing a useful program is fun, but it's a downright thrill when it interacts with the outside world. Use the parallel port code and interface in your own projects, and consider using PCM as a structured control program framework. Some suggested applications using PCM and the parallel port include a sprinkler control system, a garage door control and security system, and a home weather station. So dust off and fire up that old computer. There's still some life left in that old XT! **NV**

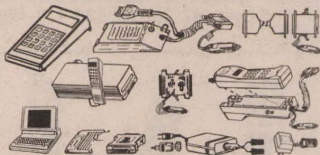
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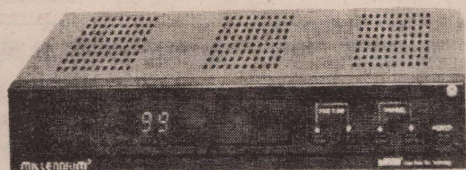
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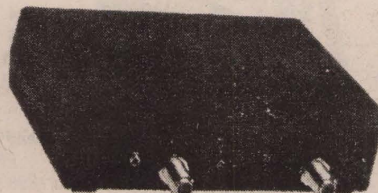
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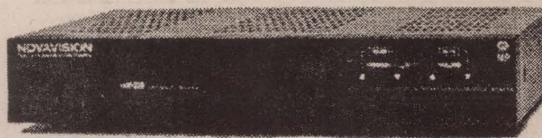
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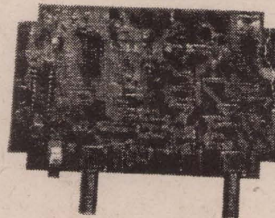
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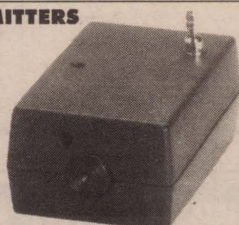
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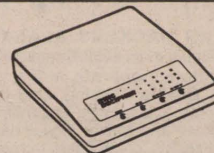


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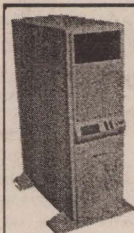
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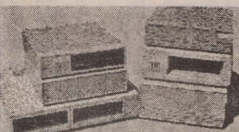
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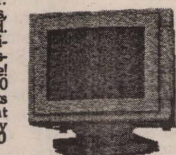
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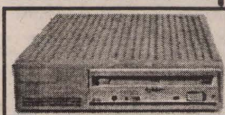
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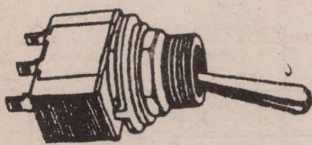


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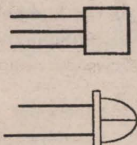
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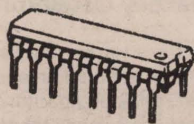
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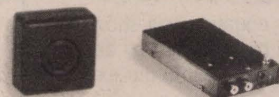
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# THE SOLDERLESS BREADBOX

by Don Wilcher

## Using Oscillators

My first encounters with oscillators occurred while taking an electronics circuits analysis course. In that class, I learned about sinusoidal waveform theory, positive feedback, amplifiers, and tuned circuits. All this information was digested by performing experiments in the lab, building, and analyzing oscillator circuits.

The circuits that were breadboarded in the lab consisting of Colpitts, Hartley, and Armstrong networks. The frequencies of these circuits were recorded and compared to the calculated values. In addition to learning about these transistor circuits, we'd even experiment with a 555 Timer astable circuit.

Well this month, you will be able to experience the excitement that I've experienced by experimenting with a couple of oscillators. In the following paragraphs, we will investigate the basic components of an oscillator and see how to use this waveform generator in some useful applications. So without further delay, let's examine the make-up of a basic oscillator.

## Oscillator Basics

An oscillator is a device or circuit that produces sinusoidal or other repetitive waveforms. Generally speaking, oscillators can be divided into three groups: (1) common sinusoidal (sinewave) oscillators, which produce and output waveforms that are sinusoidal; (2) common relaxation oscillators or multivibrators which produce nonsinusoidal (sawtooth, square, and pulse) waveforms; and (3) miscellaneous signal sources whose operation is based on principles and techniques less commonly encountered in projects like those discussed here in this column, such as "gas ionization oscillators," "electron-coupled oscillators," and "negative resistance oscillators."

The make-up of most oscillators is amplifiers with positive feedback. Positive feedback is where the output signal is fed back to the input of the electronic circuit.

In using this design scheme, the oscillator's amplification must be greater than unity (1), feedback must

be positive, and magnitude of the feedback signal must be high enough to sustain continuous oscillation. Another key component of the oscillator is its resonant frequency/sinusoidal characteristics.

If an inductor is wired in parallel to a capacitor and both these components are in series with a voltage source with a switch positioned between them to select one of the passive components, a damping wave can be produced. If the voltage is across the capacitor, it will begin to charge and, with the switch in the inductor position, the voltage across the capacitor is released (discharged). If the switch is toggled between the capacitor and inductor at some pre-determined rate, this charging and discharging effect will continue at a repetitive energy pattern. This pattern is a sinewave. The frequency of this simple passive circuit can be determined by using the equation:

$$\text{Equation 1: } [f = 1/2 \times \pi \times \text{Square root } (L \times C)]$$

where:

$f$  is the resonant frequency of the tuned circuit in hertz  
pi equals 3.1412

$L$  is the inductor in henries

$C$  is the capacitor in farads

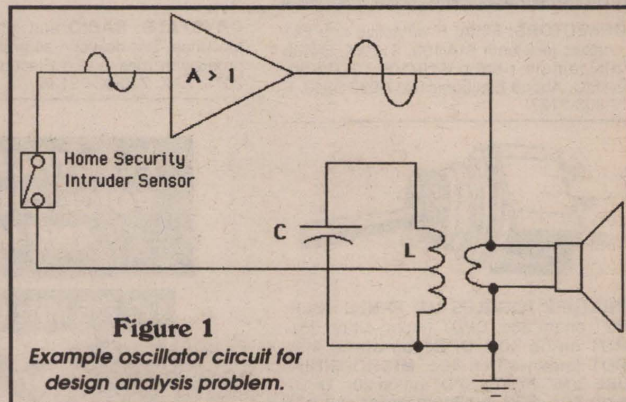
## Example Circuit Analysis

The oscillator circuit shown in Figure 1 will be used in a home security system for an audible alarm. What frequency would this circuit produce given a  $L$  of 10 henries and a  $C = 0.02$  microfarads? Making the appropriate substitutions into the equation, the resonant frequency equals

$$fr = 1/2 \times 3.1412 \times \text{square root } (10H \times 0.02 \mu F)$$

$$fr = 356 \text{ Hz}$$

An observation of this equation will show that the resonant frequency can be increased by decreasing the value of  $L$  or  $C$ . If we go back to our example



**Figure 1**  
Example oscillator circuit for design analysis problem.

oscillator circuit in Figure 1, by changing the value of 0.02  $\mu F$  to 0.002  $\mu F$  the resonant frequency equals

$$fr = 1/2 \times 3.1412 \times \text{square root } (10H \times 0.002 \mu F)$$

$$fr = 1125 \text{ Hz}$$

This equation is a very useful tool for doing quick analysis on oscillator circuits such as the Hartley or the Colpitts. These two circuits use the LC-tuned network tied together with a transistor amplifier. Figure 2 shows the schematic circuits for the Hartley and Colpitts' oscillators. In observing these two circuits, some common differences are the number of passive components used and their placement. The major difference between the Hartley and Colpitts is the method of feedback.

In a Colpitts oscillator, the feedback is obtained across a portion of the total capacitance instead of a portion of the coil as in the Hartley. The resonant frequency of the Colpitts can be varied by changing either  $C_1$ ,  $C_2$ , or both. In the Hartley, changing  $C$  or  $L$  will allow the resonant frequency to vary.

Now that the basics of oscillators have been discussed, let's take a closer look at the Hartley Oscillator via a "hands-on" project.

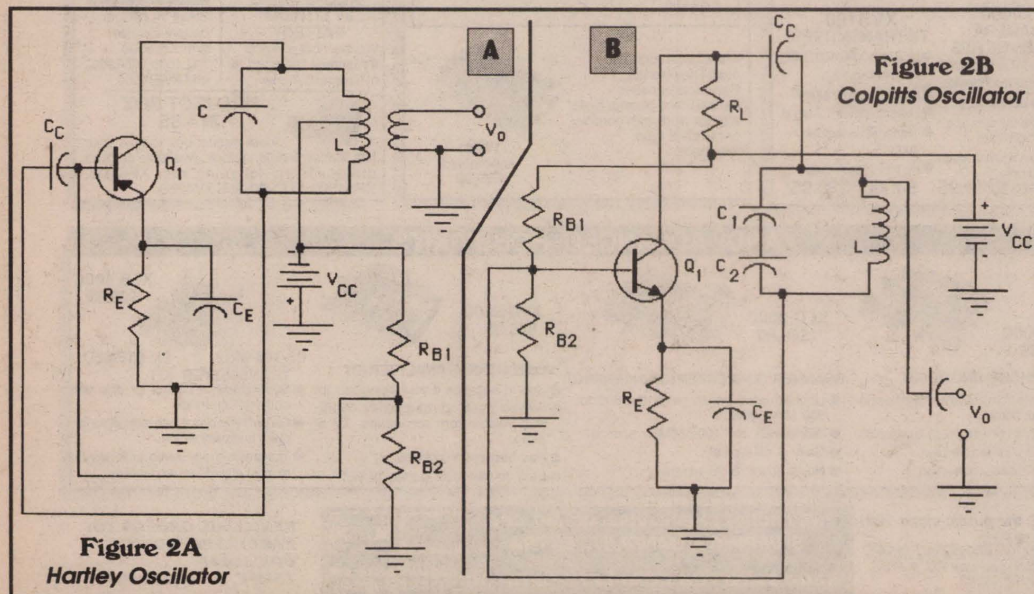
## An Experimental Hartley Oscillator

The circuit in Figure 3 is a Hartley Oscillator. The tuned circuit establishes the resonant frequency for the oscillator. The 0.02 microfarad capacitor and the primary coil of a PCB transformer create the tuned circuit. The resonant frequency measured with a Fluke 87 Digital Multimeter (DMM) was 268 Hz. This particular multimeter has frequency measurement capabilities so that's why I chose to use this instead of a frequency counter. (Well, the real reason is that I was too lazy to get the frequency counter from off the shelf in the lab.)

The waveform of this oscillator is shown in Figure 3B. The reason behind this weird-looking signal is the piezo's internal resonant frequency intermixing with the Hartley's output. Another interesting item to point out is the "L" value from the circuit is missing. The reason for this missing component value is to illustrate the usefulness of the "fr" calculator shown in Equation 1. By doing some algebraic manipulation, we get the final equation to calculate "L"

$$\text{Equation 2: } [L = 1 / C \times 4 \times \pi^2 \times fr^2]$$

making the appropriate substitutions into this equation:



**Figure 2B**  
Colpitts Oscillator

**Figure 2A**  
Hartley Oscillator



# THE SOLDERLESS BREADBOX

$$L = 1 / 0.02\mu F \times 4 \times 3.1412^2 \times 268\text{Hz}^2$$

$$L = 17.6 \text{ or } 18 \text{ H}$$

For those of you who are not familiar with computer equation notation, the "x" means square. With this "L" calculator, any value of inductance can be computed, knowing a constant capacitance value and a desired resonant frequency. To calculate a "C" value given a constant inductance and "fr" values, the equation would be:

$$\text{Equation 3: } [C = 1 / L \times 4 \times 3.1412^2 \times \text{fr}^2]$$

The piezo-buzzer provides an audio output and the 470K resistor establishes the proper bias for the 2N2222 NPN transistor amplifier. The feedback path starts from the transformer coil and is sent to the base via the collector-base junction of the transistor. By depressing the key, the output of the oscillator can be heard through the piezo-buzzer and is vibrated by the resonant frequency of the tuned circuit. One application that immediately comes to mind is a Morse Code Sender. By depressing the key appropriately, dots and dashes (messages) can be transmitted across the air. For those of you who are into ham radio, this circuit will make a great practice tool for the communication's portion of the radio license exam.

Another application that this circuit can be used in is science demonstrations in automotive engineering. By adding a variable resistor to the Hartley Oscillator, a fuel sending unit simulator can be created. But what is a fuel sending unit?

## Fuel Sending Unit Simulator

Quite often, we engineers come across an engineering problem where we need to reproduce a problem or solution on the bench. Instead of devoting personnel, manhours, and equipment to solve a vehicle problem, a simulator will be created first to create the problem in a control environment. Simulators allow engineers to reproduce the physical environment of interest on the bench.

In terms of the fuel sending unit, the Hartley Oscillator can simulate the action of the device quite easily by adding a variable resistor. Basically, a fuel tank sending unit looks like a toilet bowl float with a variable resistor and is used to measure the amount of gasoline in a fuel tank of an automobile. Figure 4 shows a pictorial diagram of the fuel tank sending unit.

Depending on the amount of gasoline in the fuel tank, the variable resistor will send an electrical signal to the fuel gauge. The fuel gauge will show how much fuel is in the fuel tank. The electrical signal is proportional to the amount of resistance in the circuit. Less resistance would indicate a full fuel tank, whereas an empty tank would have more resistance on the variable resistor/sending unit.

The simulator circuit in Figure 5 was derived from a science teachers class I conducted in July of this year. The organization that sponsored this training session is called the Detroit Area Pre-College Engineering Program (DAPCEP). DAPCEP helps to motivate minority students to pursue careers in science and engineering by allowing them to take Saturday enrichment courses at local universities and corporations.

In designing this circuit for the teachers, I did not have 50 analog meters to give to the teachers. What was available for this project were the piezo-buzzers on the 60-In-1 Electronic Lab kits from Radio Shack that I used for the weekend program. So, instead of having a fuel gauge for visual indication of fuel used, the piezo provided an audible indicator for fuel.

With the circuit in Figure 5 breadboarded, closing the switch and turning the shaft of the 1K variable resistor will increase the volume of sound heard

through the piezo-buzzer. Less amplitude correlates to low fuel in the tank where more amplitude corresponds to a full fuel tank. The frequency of this simulator can be changed by changing the value of "C" in the tuned circuit if a more desirable tone is required for those of you with sensitive ears.

## Breadboarding Techniques

The circuits described in this column were designed and built using the Radio Shack 60-In-1 Electronic Lab kit. The cost of the lab kit is about \$14.99. This kit is wonderful for trying out circuit concepts, testing design hypothesis, and science and engineering demos. All of the components are mounted on the board and wiring is accomplished using spring terminals and pre-cut wire. This particular kit does not have integrated circuits, but they can be added by using a solderless breadboard and wiring them to the pre-mounted components of the kit.

This method of construction allows the novice to build some innovative gadgets and devices without spending a lot of money for parts. Plenty of Solderless Breadbox projects and experiments were derived from this kit, as well as using the 200 and 300-In-1 kits I have in the lab. The applications of these kits are only limited by the user's imagination and ingenuity.

## Further Thoughts And Experimentation

Well folks, there you have it! This topic only scratched the surface of what oscillators can do, as well as circuit types. The 555 timer is an excellent IC for creating one-shot and free running oscillators.

The 741 op-amp can be used to create sawtooth, sine, and squarewave signals for testing all types of analog circuits, digital circuits, and systems. One project that comes to mind is to create a function generator capable of producing triangle and squarewave signals. This circuit is a standard device and can be found in any electronics hobbyist book in the public library.

In addition, the Hartley Oscillator circuit described can be used to test those inductors lying around the bench. By attaching test leads to the circuit for connecting an inductor, this circuit will sound off if the inductor is good. This oscillator circuit lends itself to making a great and cheap audible continuity checker, as well. The circuit that is being worked on will provide a tone if the circuit is not broken. If the circuit being troubleshooted is not working, the oscillator will sit in silence.

Last, upcoming school year, those of you who have children, now is the time to prepare for science fairs. This circuit has all of the makings for a good science topic on sound waves and measurements. By measuring the sound using a dB (decibel) meter, and knowing the setting of volume control, a graph of dB vs control setting can be plotted. Well enuf said, see ya next month in the breadbox!!! NV

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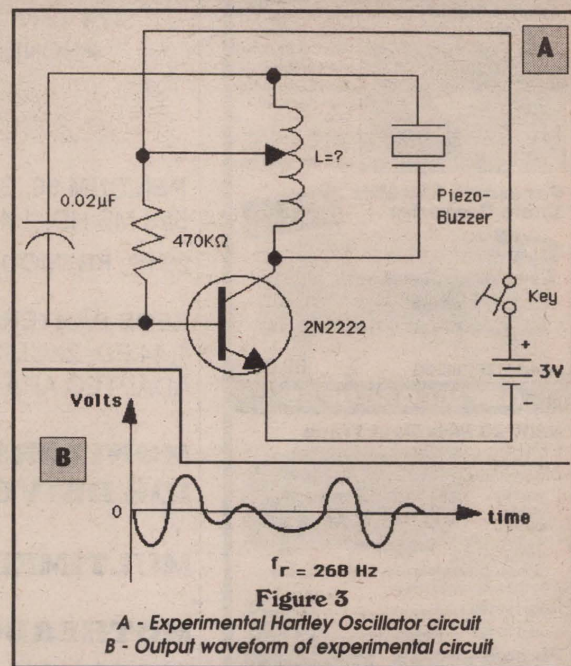


Figure 4

Pictorial diagram of a fuel tank sending unit  
Courtesy of Chrysler Corporation

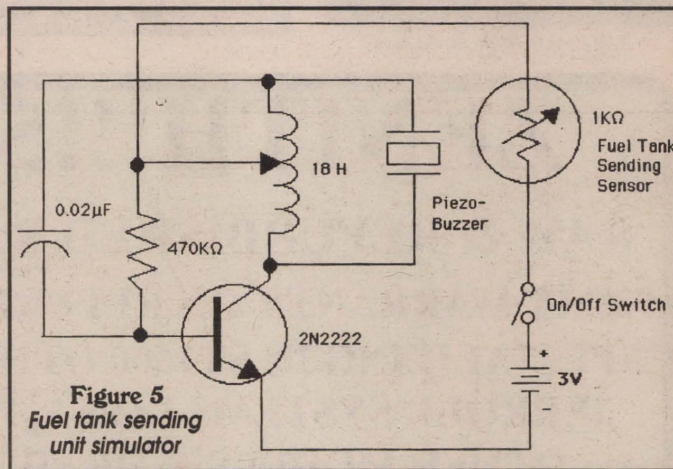
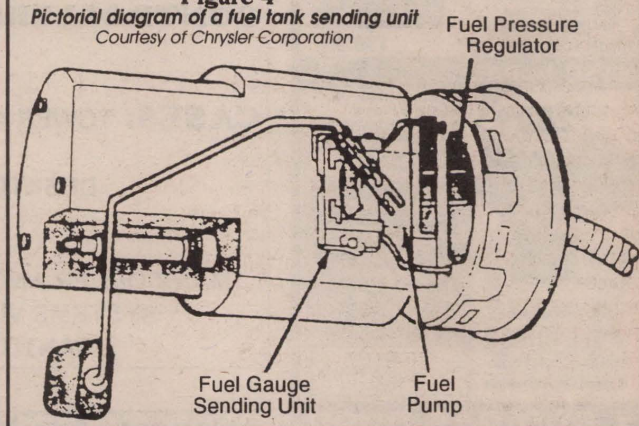


Figure 5  
Fuel tank sending unit simulator

## Resources

The Art Of Electronics, 2nd Ed.: Paul Horowitz and Paul Winfield Hill, Cambridge Press, 1989.

Electronic Principles And Circuits: an Introduction to Electronics for the Technician: William E. Long and Paul L. Evans, John Wiley & Sons Inc., 1974.

Radio Shacks Science Fair 60-In-1 Electronic Project Lab: Cat. No. 28-261.



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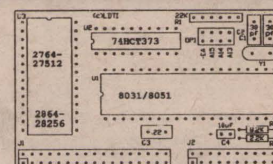
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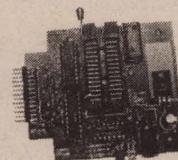
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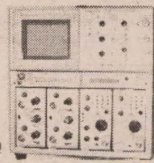


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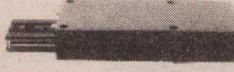


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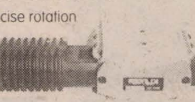


**LINEAR SLIDE, NEAT Model SC300**, Anodized aluminum, industrial quality. Ball bearing, 50lb. cap. Like new, some have a scratch on the edge where a dummy used a utility knife to open the boxes. Size: 1.75"Wx4"Lx.75"H with 3.4" travel. Use two for x-y. Ltd Qty. **Reg.\$86ea. Special \$34 or 3/\$85**



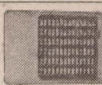
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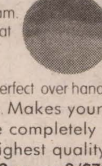
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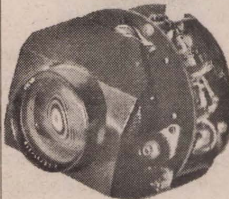
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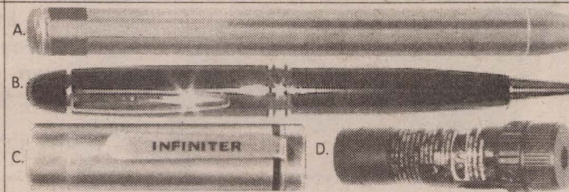
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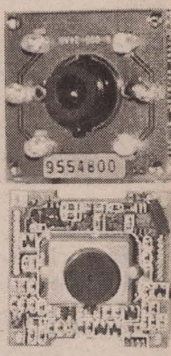
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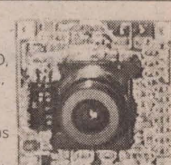
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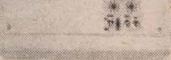
head, 0.5 lux, 330 lines, 1/3" CCD, 3mm, 110° FOV lens, 12VDC @150mA, auto shutter and AGC. Size: Head, 1.37" x 1.57", Proc. 1.96" x 3.93", weight, 2.3 Oz. **NEW.....\$279ea.**



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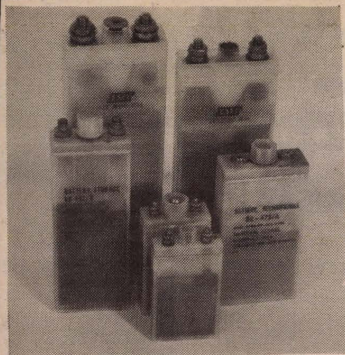


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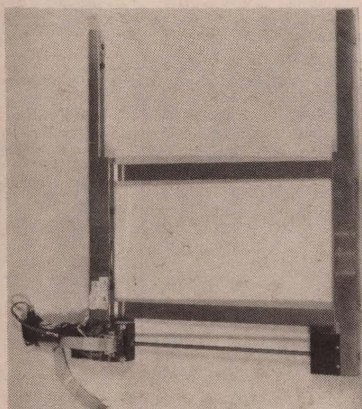
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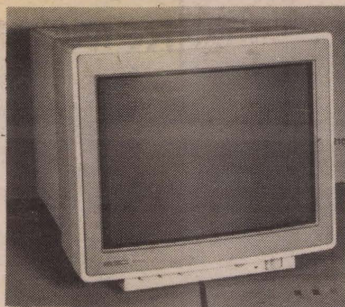
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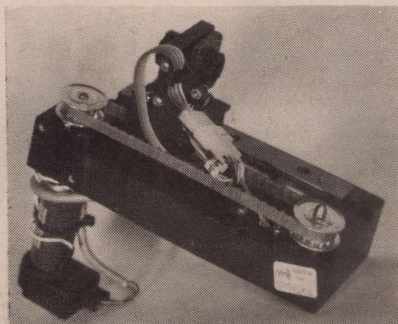
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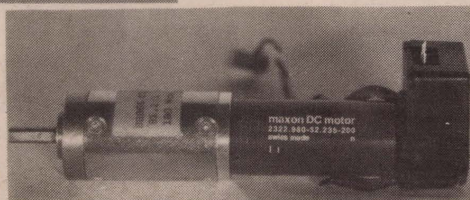
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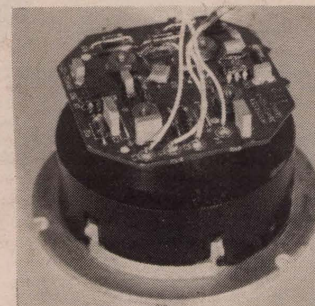
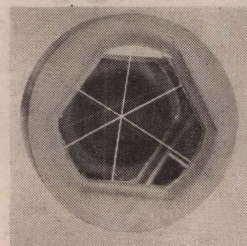
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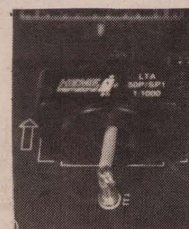
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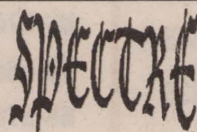
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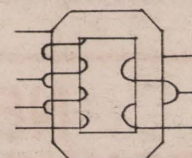
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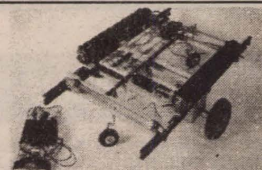
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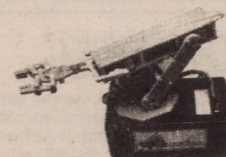
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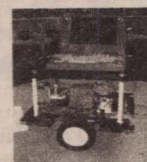
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by Karl Lunt

# AMATEUR ROBOTICS

## Three guys take on the 68hc12

In mid-June, Motorola announced its latest family of microcontrollers (MCUs), built around the newly-designed CPU12 core. The company targeted the first chip in this group, dubbed the 68hc812a4, for sampling by early July. Billed as a migration path from the 68hc11 to the 68hc16, the 68hc12 is packed with features ideal for robotics. Since most of the Seattle Robotics Society (SRS) members use 68hc11's in their robots, there was immediate interest in the new chip.

This month, I'll describe the journey that Kevin Ross, Marvin Green, and I took in developing a low-cost hacker tool set for the 68hc12. I'll also introduce you to several valuable sources of info on this chip, and give you a brief outline of the power this new device can provide in your robot designs.

### A look at the 68hc12

I don't want to spend a lot of space on describing the 68hc12; for full details, contact your local Motorola distributor and ask for a copy of the *MC68HC812A4 Technical Summary* (MC68HC812A4TS/D). While you're at it, get a copy of the *CPU12 Reference Manual* (CPU12RM/AD), which serves as a programmer's reference manual for using the instruction set.

If you can't wait, or don't have access to a Motorola distributor, you can download .pdf files of both documents from links reachable from <http://129.38.232.2/index.html> (yes, I know it's not a very user-friendly address). Just browse through the 68hc12 links and you'll get there. Please note that these are very large files; the file for the *Technical Summary* holds 180 pages of text and drawings, and is an exact duplicate of the printed document distributed by Motorola.

If you have an Acrobat reader (also available from the Motorola web site), you can actually view this document on your screen before printing it. This makes a very handy reference source, though I had some problems with my version. It acted as if it was using an imported font, rather than a font already on my machine, and the characters within the font got mixed up. This resulted in plausible, but wrong numbers for items such as pin numbers or timing info. The printed document, however, came out perfect.

I applaud Motorola for making these documents available in this format, especially as they followed the formal announcement of the chip by only a day or so. The documents contain enough information to start designing a 68hc12 system, even though at the time, the real chips weren't available and the printed docs weren't shipping.

The first difference you notice between the 68hc812a4 and its older cousin, the 68hc11, is speed. Not only does this chip run on a crystal of up to 16 MHz, its internal CPU clock runs at half the crystal frequency, rather than using a quadrature system like the 68hc11. So right off, you're

looking at a 4x speed boost by going to the newer device.

The 'a4 carries much more on-chip memory than the 68hc11 variants, as well. This first chip contains 1K of static RAM and 4K of EEPROM; plenty of room for fairly strong projects. It also contains an expanded set of 68hc11 peripherals, so you veteran 'hc11 users will feel right at home moving up.

For example, the 'a4 carries two asynchronous serial ports (SCI) and a synchronous serial port (SPI). Both have been enhanced over the same peripherals found in the older 'hc11. The 68hc12 SPI contains additional logic supporting a bidirectional serial interface. This means that a 68hc12 can send and receive data using only a clock line and a single data line, rather than the two data lines previously required. Note, however, that it appears all SPI transfers are still forced to use eight-bit exchanges.

Motorola also enhanced the two SCI channels over that found on the 68hc11. These SCI peripherals can perform parity calculations in hardware, and use separate modulus counters for baud rate generation. The latter gives you much more flexibility in defining baud rates. Oddly enough, given a crystal of 16 MHz, the fastest baud rate this chip can support is 38.4K baud.

The 68hc11's timer/counter system has always been one of its strongest points. Long-time readers of this column know well how to use it for generating pulse-width modulation (PWM) signals with zero software overhead. But the basic 68hc11 only supports this feature on its four output-com-

vos with no software overhead.

In the timer/counter area, Motorola has really beefed up the versatility of the pulse accumulator. It now uses a 16-bit counter and you can insert a /256 or a /65536 prescaler, if desired. On the downside, the 'a4 still only carries one pulse accumulator.

The 'a4 has an improved real-time interrupt (RTI) system, as well. Many of my projects use the 68hc11's RTI system to control down-counting timers, for timing motor motions or actuator delays. But using the typical 8 MHz crystal on a 68hc11, the fastest RTI signal I can get is 4.1 msecs. This is fine for most uses, but sometimes I need to divide a second into finer slices. The 'a4 provides seven different RTI rates, and using a 16 MHz crystal can get the RTI time slice down to 1.024 msecs.

The 'a4 also has an eight-channel A/D system much like that of the 68hc11. In the 'a4, these A/D channels provide eight-bit resolution, but the I/O registers for providing the A/D data all occupy two bytes. I asked a Motorola representative if this meant that future versions of the CPU12 family would offer 10-bit or higher resolution on the A/D ports, but he replied "No comment." I noted, however, the faintest of smiles on his face, so I'm looking for more resolution down the road.

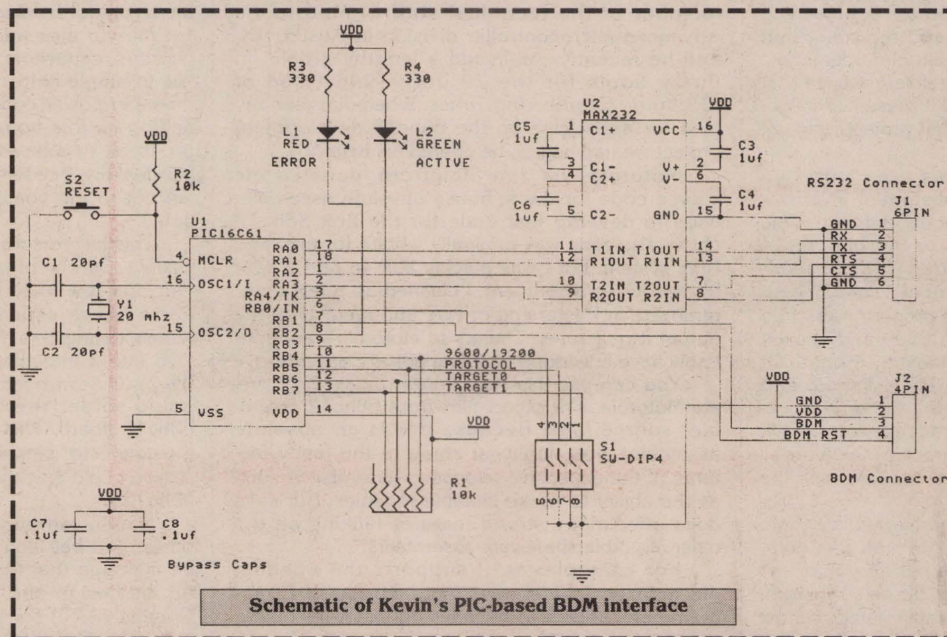
Motorola did address one complaint I've long had with the 68hc11 A/D system. The 'a4 lets you read all eight A/D channels with one command, and to pull the results from eight separate registers. This eliminates the convoluted folding of eight A/D channels into four result registers, as used in the 68hc11.

The CPU12 family also offers features not seen on the generic 68hc11. For example, the 'a4 MCU has up to 24 I/O lines with key wake-up interrupt ability. Key wake-up means that the MCU can generate an interrupt if the state changes on one of these special input lines. You can use this wake-up interrupt feature to make a keypad that doesn't need to scan the matrix continuously; it just wakes up whenever the user presses a key.

The 'a4 also supports a non-multiplexed address and data bus, for memory expansion. The CPU12 architecture permits addressing of up to 5 Mbytes of external memory, using a windowing system. This is not as clean a layout as that used by the

68hc16, since some of the larger address space gets folded into windows in the chip's 64K linear address space. Still, it eliminates all of the hardware gyrations used by most 68hc11 large-memory designs.

Along with the increased address space, the 'a4 has seven programmable chip select lines. These I/O lines provide chip select signals for

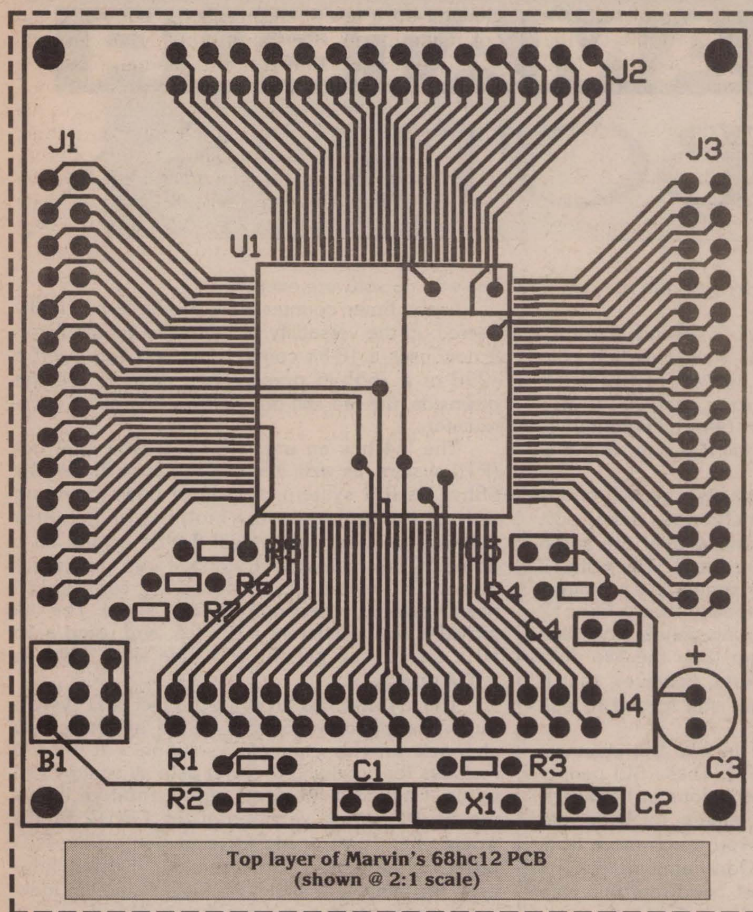


Schematic of Kevin's PIC-based BDM interface

pare (OC) channels, while the remaining three channels can only handle input compare (IC) functions.

The 68hc812a4 has eight timer/counter channels, any of which can be configured for IC or OC operation. You can still slave any of these OC channels to timer 7, which acts as a master timer channel. This would let you run seven hobby ser-





whatever address space you declare, simplifying the addition of external memory or I/O devices.

Motorola has abandoned the 68hc11's bootstrap loader in favor of a background debug module (BDM) similar to that used on the 68hc16 and 68332 chips. The BDM provides the main entry way to the 'a4, providing support for downloading programs, dumping memory and registers, and doing single-step, trace, and breakpoint operations. The CPU12 BDM system is very different from that used in the other two chips, and it presented a substantial obstacle in getting our first project running; more on this later.

Hidden inside the CPU12 are even more surprises. Motorola has made substantial improvements to the programmer's model, adding some very powerful indexing modes to not only the X and Y registers, but to the S (stack) and PC registers, as well. These enhancements should help quiet the grumblings from those programmers who moved to the 68hc11 from the 6809 and felt the pain of the 68hc11's feeble indexing modes. Of course, software types are rarely satisfied, and many will ask why Motorola didn't throw in a second stack register or another accumulator. Still, the CPU12 represents a big upgrade to the 68hc11 family, and I'm looking forward to working with the new model.

And Motorola added support for fuzzy logic and digital signal processing (DSP) on this chip. Several special CPU12 opcodes permit you to set up a fuzzy logic engine in only 50 or so instructions. The docs go into considerable detail on how to set up and use these instructions, and Jim's article, cited above, includes much more information. The DSP instructions, while lacking the strength of a full-power DSP controller, will get you started on DSP programming and will solve some problems previously beyond the reach of the 68hc11.

In all, this first member of the CPU12 family is a large win for those who have outgrown the 68hc11. Readers of this column should prepare for

once Marvin and Kevin finished their tasks.

We quickly realized that we just didn't have enough information to complete our individual tasks. Using the Internet, I was able to locate a Motorola engineer, Jim Sibigroth, who proved to be a valuable 68hc12 resource. Jim is a senior member of the technical staff at Motorola's Advanced Microcontroller division in Austin, TX, and he recently published a lengthy article on Fuzzy Logic for the 29 July 1996 issue of *Electronic Engineering Times*. When Jim read my plea for assistance on the 68hc12 development project we had begun, he offered his help.

Motorola, via Jim Sibigroth, donated the source code for the in-house absolute assembler used to develop test code for the first 68hc12 chips. The code was originally written for use on a Unix system, but I was quickly able to port it over to the DOS environment. I cleaned up a few bugs, removed an Easter egg or two, and prettied up the output it generates. Thanks to Motorola's support, I now have a working absolute 68hc12 assembler.

You can use this tool, known as as12, to create Motorola .s19 object files from 68hc12 assembler source files. Because this is an absolute assembler, you don't get some of the fancy features of the expensive relocating assemblers, such as the ability to make linkable modules. But as12 does offer many strong features lacking on the older Motorola shareware assemblers.

For example, as12 supports the #define, #include, and #ifdef constructs familiar to C programmers. as12 also provides an extensive macro capability, useful for defining a set of commonly-used functions.

I didn't lack for sample assembler language source code to use in testing as12. The CPU12 chips are source-compatible with 68hc11 assembly. Note the term "source-compatible," not "object-compatible." You can assemble a 68hc11 source file and get code that will run on a CPU12 device, but you cannot take a 68hc11 executable

a shift toward 68hc12 projects, though I intend to keep supporting my 68hc11 tools such as SBasic.

### The first 68hc12 project

Motorola's announcement fired up a lot of people in the SRS and on the Internet. Marvin, Kevin, and I immediately grabbed the available docs and started checking out what was obviously the future in small robots. Each of us focused on a different aspect of this new chip.

Marvin Green, developer of the 68hc11 BOTBoard and BOTBoard-2, used his documentation to start the design of a single-chip PCB; sort of a BOTBoard for the 68hc12. Kevin Ross, with his expertise in PC-based software and his considerable Windows experience, took up the challenge of a PC-based front end for the BDM. And I zeroed in on PC-based tools, such as an assembler, for writing new 68hc12 programs

file and expect it to run on a 68hc12 chip.

This happens because Motorola kept the assembler mnemonics the same for both chips, but revamped much of the underlying opcodes. For example, the 68hc11 instructions dealing with the Y-register all begin with a \$18 pre-byte. Thus, a LDY #5a5 assembles into the bytes \$18 SCE \$00 5a5, where the instruction LDX #5a5 becomes SCE \$00 5a5. This means your 68hc11 programs pay a one-byte penalty for each use of the Y-register.

On the 68hc12, however, Motorola re-arranged the opcodes so the penalty disappears. Instructions using the X- and Y-registers assemble to the same number of bytes. One obvious fallout of this re-arrangement means that 68hc11 object files won't run on the 68hc12.

You can check out the new as12 assembler by accessing my web site at <http://www.seanet.com/~karillunt> — Note that this is a .zip file for running on a PC. Those of you with Macs, take heart. Porting of this assembler to the Macintosh environment is underway, and a Mac version of as12 should be ready by the time you read this.

My next task was to get my hands on some actual 68hc12 chips. After a few calls to Motorola, I reached their samples desk at 1-800-635-8293. I signed up for two samples of the 'a4, which arrived by mail a few days later. Interestingly, these chips carried the part number PC68HC812A4. The PC prefix marks these as prototype devices, with designs even more unstable than the XC, or experimental chips. This means these chips are using silicon dies with a design that may well be unreliable or poorly documented. As it turns out, the PC chips I received had some serious design flaws in them, which hampered our efforts. But we only discovered that later.

Now, however, I was the proud owner of two 68hc12 chips, each housed in a 112-pin thin quad flatpack (TQFP) package. This package design uses leads only 0.5 mm wide on 0.65 mm centers. Marvin's efforts to design his board were slowed because we just couldn't get definitive information on lead arrangement and spacing. Eventually, however, he received enough information to complete the layout for holding the chip.

Marvin also added traces for the necessary resistors, capacitors, and other passives to use the 'a4 in single-chip mode. He included the same three-pin power connector and four-pin serial connector on this board as used on his BOTBoard products. And he even added four layouts for 28-pin dual-row headers, used to bring each pin of the 'a4 out to the board edge for probing or connection.

This last feature really makes his board design flexible. On one of his prototype boards, I installed four dual-row male IDC headers. I then built up a Radio Shack experimenter board with matching female connectors. Now I can just plug my 68hc12 PCB into a matching experimenter board, moving the MCU from board to board as needed. Or, you could solder the female connectors into the 68hc12 board. This would let you plug wires into the connector pins and out to a prototyping board, so you could quickly build up test circuits around a 68hc12.

Marvin ran his ideas past Kevin and I many times, and between the three of us we eventually hit a design that Marvin liked. He then packaged up his design and shipped it to Alberta Printed Circuits (APC) for etching. APC, as usual, did a first-rate job and had the boards back to Marvin in a couple of days.

While Marvin was getting his PCB design finalized, Kevin was up to his armpits in the BDM interface. His task would have been far simpler if Motorola had stuck with the BDM design used in the 68hc16 and 68332 devices. Those chips use a three-wire interface that contains a clock line, a data-in line, and a data-out line. The clock line,



## ROBOTICS . . . ROBOTICS . . . ROBOTICS . . . ROBOTICS . . . ROBOTICS

controlled by the host, means that the PC talking to the MCU dictates the rate at which the data transfer occurs. Thus, you have no problems with synchronizing the timing between the host and target systems.

For some reason, Motorola dumped this design on the 68hc812a4, opting instead for a one-wire interface. Here, the target and host exchange data over a single wire. The timing for the exchange is dictated by the target MCU, in that the host must use a data transfer rate that is based on the MCU's crystal. Unfortunately, the host does not have visibility as to the transfer rate, since there is no clocking signal in the BDM interface.

After much discussion among us, Kevin chose to build a BDM interface around a PIC 16c84. He needed to use a 20 MHz PIC device, to keep up with a 'a4 using a 16 MHz crystal. We had built our first boards using 8 MHz crystals, however, so Kevin could get by with a 10 MHz PIC, available from Digi-Key for less than \$10.00. Refer to the accompanying schematic of Kevin's PIC-based BDM interface. Note that the schematic calls out a PIC 16c61, which is basically a one-time programmable version of the 16c84.

The PIC 16c84 is highly cool, since it comes with 1K of EEPROM to hold your code. It doesn't have a lot of on-chip peripherals such as serial ports, but the bloody thing runs so fast that you can bit-bank serial data with little trouble. Plus, Microchip's web site at <http://www.microchip.com> is crammed with technical info, application notes, and source code for plenty of finished projects and subsystems. You can also find the latest versions of Microchip tools, such as the MPASM PIC assembler.

Kevin designed his BDM interface to run from the PC's serial port. The first cut at his PIC electronics used 5 VDC and a four-wire cable to the target 68hc12 board. This cable supplies connections for ground, +5 VDC, BDM data, and a reset line. The latter wire is needed because Kevin's PIC uses it to reset the target board and control what mode the target enters after reset.

As you can see from the accompanying schematic, there just isn't very much to this BDM interface board. Kevin added some LEDs for status display, a MAX232 to provide the needed RS-232 level shifting, and a DIP switch to select one of several operating modes on power-up. For example, one switch tells the PIC that the target system runs with either an 8 or 16 MHz crystal.

Most of the hard work in Kevin's design took place in the PC and PIC software. Kevin created a very nice Windows-based program that acts somewhat like a modem program, exchanging data and commands with the PIC BDM interface. As the PIC receives each command, it translates it into the proper BDM sequence and sends it to the target. If the PIC needs to handle a response from the target, it collects the data and translates for passing back to the PC host.

### Putting it all together

Our mutual efforts converged one Friday afternoon at my home in Bothell, WA. Marvin had driven up from Portland with several copies of his first PCB, and Kevin had brought much of his software design tools over from nearby Woodinville. With our gear spread out on a table in my living room, we began the task of integrating all our efforts.

While Kevin worked on completing the PIC software, Marvin started building up one of his 68hc12 boards and I began breadboarding a PIC BDM interface. It took a couple of hours, but I finally had the electronics ready to fire up. Marvin, in the meantime, had all of his 68hc12 board soldered except for the one device none of us wanted to touch, the MCU itself. The fine pitch on its leads just looked like too much for us to handle, given our relatively crude tool set.

We solved this problem with typical software ingenuity; we went out for Chinese food. By the time we returned, we had a plan of action. And since these were my chips, I was elected to start the soldering operation.

I began by spreading a very thin film of Kester paste flux on the traces destined to hold the 68hc12 chip. I intentionally used the thinnest possible film, since I only wanted enough paste to stick the chip into place. I then positioned the chip onto the board, taking care to align the dot on the chip's case with pin 1 on Marvin's board.

If you build such a board of your own, pay close attention to this alignment procedure. The text on the chip's surface, giving the Motorola logo and part number, gets printed in a random orientation, and you cannot use the printing for chip alignment. Always use the alignment dot when placing the chip on the board.

Next, I worked very carefully to gently shift the chip on the trace layout, aligning the chip's leads with the matching traces. This took a little time, as the flux only keeps the chip from sliding, but lets you push it around fairly easily. Once I had the board resting on my work surface and I was satisfied with the alignment, I was ready to solder the leads.

I cleaned the tip of my grounded soldering iron, then added a thin film of solder to the tip. Be sure to use a grounded-tip iron to minimize risk of static damage while soldering the chip in place. Then, using only the soldering iron and no other solder, I gently touched the trace at one of the chip's corners. The solder plating on the trace melted and fused with the film of solder on the iron's tip, then wicked underneath the pin. When it cooled, the lead was soldered. I then moved to the diagonally opposite pin and repeated the operation. This left the chip tacked in place at two corners, essentially immobilizing it.

Take care during these steps not to touch the chip or its leads. If you do, you risk misaligning the chip and soldering it in the wrong place at the same time. Once soldered by two or more adjacent pins, you will have a tough time removing the chip and repositioning it.

With the chip locked in place, I started at a third corner and began soldering the remaining pins. I still soldered only to the traces, letting the melted solder wick underneath the pins to complete the connection. We took turns on this phase and when done, I went over all connections with a magnifying glass to check for opens or shorts. Satisfied that we had actually soldered this baby in place accurately, we were ready for some power.

We connected Kevin's BDM electronics to the PC and to the 68hc12, then applied power in the form of four Renewal C-cells. Using a logic probe, we were able to verify that the MCU's clock was operating properly. This sparked a lot of grinning and congratulations, since it meant that Marvin had designed the correct trace layout for the many power and ground pins, as well as the passives needed to get the chip running.

When Kevin entered a command on his PC screen and actually got a response from the BDM interface, there was more stomping around and high-fiving. We were having a great time celebrating these small steps, because it had taken so much hard work just to get this far.

However, we eventually sobered up when we realized that the PIC BDM interface was not returning the proper responses to our commands. Evidently, the MCU was either not running or the PIC interface had some kind of timing problems. We spent an hour or more trying different fixes, but we finally called it quits around 2:00 AM that Saturday morning.

During the next week, Kevin worked with Keith Payea, another SRS stalwart, to verify the timing on his PIC interface. He

cleaned up a few small problems, but still could not make the MCU respond properly. In desperation, I once again turned to the Internet, posting a request for help to the 68hc11 listserver. And once again, Jim Sibigroth came through. Thanks to his intimate knowledge of this chip's inner workings, he was able to solve our problem. It turns out that "first silicon," that is the experimental devices we were using, had a flaw in the BDM logic. This flaw inserted an additional /2 in the BDM timing chain, making the chip's interface run at half the advertised speed.

Kevin added code to his PIC firmware to compensate for this timing flaw and the MCU "woke up" and began talking to the PIC via the BDM interface! Immediately, Kevin was able to write data to RAM, to download simple programs, and to single-step through those programs. We had done it! Using nothing but cheap hacker tools and the club's expertise, we had put together a 68hc12 development system.

### What's next?

This kind of project just grows without bounds. Marvin is already making plans for selling his 68hc12 PCB; contact him directly for pricing and availability. Kevin has also talked about selling PIC chips already programmed with the firmware for his BDM interface; I've supplied his E-Mail address elsewhere. As I've already mentioned, you can get a copy of the current version of the as12 assembler from my web site.

In the meantime, I've already started work on converting tiny4th to run on the 68hc12 MCU; the code should be finished by the time you see this. Check on my web site for a copy of the new compiler. Porting SBasic to the 68hc12 will take considerably more time, but I will work on it whenever I can.

And then there are all the robots to build using this new chip. The small physical size and huge I/O capabilities mean that you can pack a lot of robot smarts into a very small package. Previous designs that called for one or two added chips can now be done using just this one device. And Marvin's 68hc12 BOTBoard is only slightly larger than its 68hc11 cousin, so you won't pay a large price in real estate for using the newer device.

If you think that 4K of EEPROM might limit you in your designs, then stick around until the fourth quarter, when Motorola is scheduled to ship first silicon on the 'b32 version of the 68hc12. This device will contain 32K of flash EPROM. As I understand, it is targeted to come out in an 80-pin QFP package, which will make it even smaller than most 68hc11s. The smaller lead count means that Motorola will sacrifice some of the I/O; check the Motorola web sites for details on this new chip. **NV**

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8741	\$3.95	MC68881RC20	\$9.95
8742	\$4.95	MC68882RC25	\$14.95
8748	\$4.95		

All parts, all socket pulls must be Cleaned & Eased. \*Note: Speed selection available at additional charge and all parts subject to availability.

### EPROMS

2516	\$0.65	27C256	\$2.25
2716	\$0.65	27512	\$2.45
2732	\$0.75	27C512	\$2.65
2764	\$0.95	27C010	\$4.95
2764A	\$0.95	27C100	\$4.95
27C64	\$1.25	27C1001	\$6.50
27128	\$1.45	27C1024	\$3.95
27128A	\$1.45	27C020	\$5.95
27256	\$1.90		

All DRAMS are clean socket pulls and have full leads.  
4164-15.....\$0.18 Ea. 41256-15.....\$1.00 Ea.  
4164-12.....\$0.25 Ea. 41256-12.....\$1.25 Ea.  
41256-10.....\$1.35 Ea.

## NEW ALPS 2.88 MEG 3.5" FLOPPY DISK DRIVE FOR 755 SERIES THINKPAD LAPTOP

New 2.88 Meg 3.5" floppy disk drive, by Alps for IBM Thinkpads 755 Series computers. This drive replaces the 1.44 Meg drive by transferring it into the original mounting bracket (5 min.) and it will be auto-detected when the computer is started. Supports 720K/1.44Meg/2.88Meg standards. TP755/2.88 (IBM P/N 1619718).....\$79.95 Ea.

## NEW MATSUSHITA 4X CD-ROM DRIVE (CR-504-B SCSI INTERFACE)

New four speed CD-ROM drive with motorized tray. (Caddy less design) Interface: SCSI 5-1/4" half height. Face plate color: Cream. Supported directly by OS/2, Windows 95, Windows NT. Note: No software included. CR-504-B 4X CD-ROM MAT.....\$129.95 Ea.

## NEW SEAGATE MEDALIST XE 540 MEG 3.5" ST-360A (IDE) HARD DISK DRIVE

Seagate's Medalist XE series 540 Meg ST-360A hard disk drive. Voice coil actuator, thin film head, spindle speed 3.811 RPM, 8msSec. Access time, 120K buffer. Full Cap. 1057 Cyl/16 heads/63 sectors. ST-360A Seagate.....\$149.95 Ea.

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Pulled from working equipment 1.44 Meg, 3.5" in 5-1/4" mounting bracket. 30 day guarantee. 5-1/4" half height off-white color face plate. Interface: 34 pin & 4 pin power. Sony MP-F17W-70D.....\$19.95 Ea.

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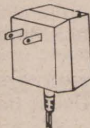
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9.5Vdc 750Ma	\$3.50 Ea.
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12Vdc 200Ma	\$1.50 Ea.
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12Vdc 800Ma	\$6.95 Ea.
12Vdc 830Ma	\$4.95 Ea.
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1 MEGX8-10 30P SIMM (8 chip).....\$6.95 Ea.

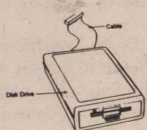
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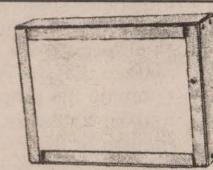
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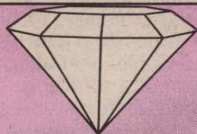
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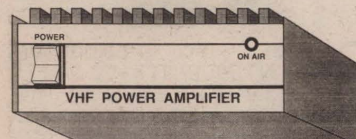
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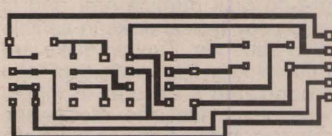


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Describes in detail how Fax machines are hacked and countermeasures (hacking Faxes is much more complex than just connecting a third Fax to the phone line). Includes Fax protocols, commo parameters, and 2:1 and 4:1 compression. And insights into designing Fax interception devices and modifying existing Faxes into Stealth Faxes do the job. \$49.

**PBX HACKING**

1000s of PBXs are hacked to the tune of about \$8 Billion/yr! While our "VOICE MAIL HACKING" (below) details how VMSS are hacked for "phun" and profit - including VMS methods for hacking PBXs themselves - "PBX HACKING" addresses all other issues relating to PBX hacking, including countermeasures. As your business or agency afford a \$90,000 phone fraud loss (average loss due to hacked PBXs)? As described in Forbes Magazine article. \$29.

**VOICE MAIL HACKING**

How Voice Mail Box (VMB) systems are used and the specific ways they are hacked. Includes ASPEN, MESSAGE CENTER, BIX, GENESIS, RSVP, CENTAGRAM, EZ, AUDIX, SYDNEY, PHONE MAIL, CINDY, SPERRY LINK, etc. An absolute must for all users, sysops and security personnel! \$29.

**HACKING ANSWERING MACHINES**

How answering machines are hacked to listen to - even erase - messages, and to convert them into mini-VMBs. And countermeasures - protect yourself from snoops, stalkers, burglars and pranksters! \$29.

**PHREAKING CALLER ID & ANI**

Details on how they work and dozens of effective ways of defeating Caller ID, ANI, \*69, \*57, Call Blocking and \*67. Also describes Caller ID, Orange, Beige, Cheese and CF Boxes, ESS, S57, E-911, various CLASS services, CNA, NON PUB DA, CAMA, DNR, 800-ECR, Diverters, LD Extenders, Centrex - more. \$29.

**Beyond PHONE COLOR BOXES**

Detailed phone color boxes described - many circuits. Plus Call Forwarding, Conferencing, Phreak History, Glossary, Diverters, Extenders, Loops, REMOBS, Bridging Heads & Cans, Optocom, 3rd Party and many other non-box methods - more. \$39.

**COMPUTER PHREAKING**

Describes in detail how computers penetrate each other, and how VIRUSES, TROJAN HORSES, WORMS, etc are implemented. Dozens of computer crime and abuse methods and countermeasures. Includes disk filled with hacker text files and utilities, and the legendary FLUSHOT+ protection system (Ed. Choice, PC Magazine). BBS advice, password defeats, glossary - much more! Manual + Disks\* \$39.

**Beyond VAN ECK PHREAKING**

Eavesdropping on TV and computer video signals using an ordinary TV described in detail. Includes security industry reports. Range up to 1 KM. Plans include both the Consumertronics and the original Top Secret Van Eck designs! \$29.

**The Ultimate SURREAL MANUAL**

Underpaid, overworked, harassed or abused? Victim of office politics? Stuck in a dead-end job? Can't find a good job? Expect to be laid off, fired or transferred soon? The ultimate no-holds-barred, looking-after-#1 Machiavellian techniques to find, obtain, optimize and keep top pay, and benefits. THE RULES OF THE GAME FOR A GAME WITHOUT RULES! From resume to CEO. \$29.

## STOPPING POWER METERS

As reported on "60 MINUTES": How certain devices can slow down (even stop) watt-hour meters - while loads draw full power! Device plugs into one outlet and normal loads into other outlets. Also describes meter creep, overload droop, etc. Plans \$29. **The I.Q. MANUAL:** External magnetic ways (applied to meter itself) to slow down and stop watt-hour meters while drawing full loads. Plans. \$25.

**KW-HR METERS:** How watt-hour meters work, calibration, error modes (many), ANSI Standards, etc. Demand and Polyphase Meters. Other experimental results to slow and stop meters by others. \$25. Any 2. \$47. All 3. \$69.

**UNDER ATTACK!**

Electromagnetic interference and Electronic Weapon Attacks cause: Cancer, birth defects, and profound psychological, neurological, cardiovascular and immune system disorders! Destructive to people, animals, plants, equipment! Includes **ACTUAL CASES OF EM ATTACKS** (we investigated!) Includes how to verify and pinpoint EMI and electronic attack sources, and specific countermeasures. \$29. **EM BRAIN ATTACKS:** Tutorial and plans to defeat **ELECTROMAGNETIC WEAPONS** and **LAB DEVICES**. Optimum circuits, freqs, waveforms, duty cycles, intensities. Thorough. \$29. Both \$49.

**MIND CONTROL**

Concern and fear increases over EM and ultrasonic mind (and body) control technologies - especially implants! Unfortunately, there is much more misinformation and disinformation published than facts. Some victims are controlled and exploited by arm-chair "experts" and so-called "victims'" assistance groups - one even demands the **policing of the Internet** to prevent and remove postings it doesn't approve off! \$39. Visit our web site at: <http://users.aol.com/wizguru/mindcontrol.html>

**RADIONICS MANUAL**

Exciting electrical, electronic and electromagnetic therapeutic, diagnostic and preventive devices (mostly experimental). History, descriptions, plans (dozens), availability of Radionics Devices from early to modern. While drugs cost \$ Hundreds, electricity costs pennies! \$29. **HEAL THYSELF:** Plans for 3 major electronic therapeutic devices of types approved by FDA. \$24. **EMF & LIGHT THERAPIES:** Systematic study of the germicidal properties of EMFs and lights *in vitro* and *in vivo*. Bands include μwaves, 4IR, 6 visible and 3 UV, using continuous, single-pulse, strobe, random pulse rate and width exposures. \$29. Any 2. \$49. All 3. \$69.

**HIGH VOLTAGE DEVICES**

HV device plans: Stun Gun, Taser, Prod, Can, Flasher, Blaster, Zapper, Audio/RF/Radar Jammer, Jacob's Ladder, Plasma & Van de Graaff Guns, Fence Charger, Belger Counter, Ozon Generator, Flash Stunner, Plasma Blim, Kirlian, Gen! All plans for only \$29.

**STEALTH TECHNOLOGY**

Police radar is fascinating! It also has error rates of 10-20%! Every known error mode - stealth method and material used to minimize radar reflections - tactic and strategy to fight unjust radar tickets (that cost you \$100s in insurance and risk cancellation) - methods to detect and jam signals - fully described! \$29.

**SECRET & SURVIVAL RADIO**

Optimum survival and security radio equipment, methods, freq allocations and voice/data scrambling/encoding. Includes small receivers/transmitters, telemetry, antenna optimization, remote monitoring and control, security, surveillance, and ultrasonic, fiber-optic and infrared commo. 70+ circuit plans, tables. \$29.

**CRYPTANALYSIS TECHNIQUES**

5 powerful menu-driven crypto programs (in .COM and .BAS source codes) to analyze, decrypt "secure" ciphertexts. Worked-out examples. Installation by prestigious "Computers & Security. Manual + Disk\* \$29.

**By an ORDER of the MAGNITUDE**

The most comprehensive, hard-hitting, hi-tech survival book ever written! Topics include electronic, computer, commo, chemistry, energy, weaponry, cryptography, concealment, revenge, alarm, disguise & ID change, etc designs, tactics and strategies to survive an increasingly dangerous and brutal world. Field-expedient use of technology in various threat and conflict environments and scenarios. Comprehensive. \$49.

**ROCKET'S RED GLARE**

Design and construction of solid-propellant amateur and survival rockets. Emphasis on formulation, manufacture, installation of propellants, motors, igniters, etc. Includes list of commonly available materials, and the design of launch pads and test beds (with schematics). \$29. **FIREWORKS:** How firecrackers (M-80s, blockbusters, cherry bombs), small rockets, volcanos, fountains, sparklers and safety fuses are made and colored. Simple, cheap, common ingredients. \$9. Both \$36.



# New Product

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

**NUTS & VOLTS MAGAZINE**  
NEW PRODUCT EDITOR,  
430 PRINCELAND CT., CORONA, CA 91719

# News

## NOTEPOWER 75 INVERTER



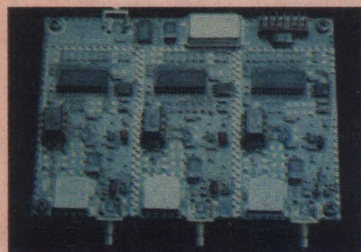
The NOTePower 75 from Statpower Technologies Corporation is a compact new inverter designed to offer 75 watts of AC power from the convenience of your own car's cigarette lighter or any 12-volt battery source. It gives you the convenience of operating or recharging most portable computers, cellular phones, fax machines, camcorders, and video games from your vehicle.

The suggested retail price for NOTePower 75 is \$79.95 US/\$109.95 Canada.

For additional information, contact:

**STATPOWER TECHNOLOGIES CORP.**  
7725 LOUGHEED HWY.  
DEPT. NV  
BURNABY, BRITISH COLUMBIA  
CANADA V5A 4V8  
604-420-1585 FAX: 604-420-1591

## MINIATURE MULTIPLE SYNTHESIZER



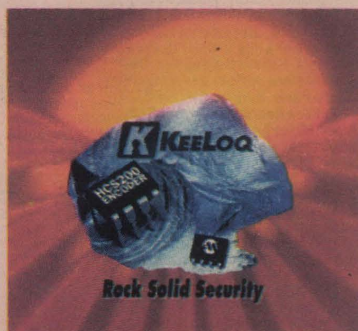
This small, low-cost multi-synthesizer allows you to easily implement double or triple conversion radios and up/down converters. Each PLL can be set to a frequency between 100 MHz and 2800 MHz via jumpers on the board. Each of the three RF outputs capable of delivering +5 dBm. Isolation between each PLL is >60 dB. There is an on-board reference oscillator and will accept an external reference oscillator as well. Requires

only one +5 VDC power supply. This unit is available as a board or module.

For more information, contact:

**RF PROTOTYPE SYSTEMS**  
9400 ACTIVITY RD.  
STE. J, DEPT. NV  
SAN DIEGO, CA 92126  
619-689-9715 FAX: 619-689-9733  
1-800-874-8037

## KEELOQ® CODE-HOPPING ENCODER



Microchip Technology Inc., introduces the entry-level HCS200 encoder which incorporates the KEELoQ® code-hopping technology to provide a substantially higher security solution at about the same price of existing fixed-code systems. A proprietary encryption algorithm helps prevent interference or unwanted communications in remote-control, consumer-oriented applications.

Microchip's KEELoQ family of code-hopping devices provides "rock-solid" security in remote-keyless-entry (RKE) systems using infrared, radio frequency, or microwave transmissions, as well as highly secure smart card solutions.

For more information, contact:

**MICROCHIP TECHNOLOGY, INC.**  
2355 W. CHANDLER BLVD.  
DEPT. NV  
CHANDLER, AZ 85224-6199  
602-786-7200 FAX: 602-899-9210

## ACCELERATED FLOPPY DRIVES

Corporate Systems Center (CSC) announces the release of the X10 floppy disk drive. The X10 drive and its proprietary controller function reliably at speeds 10 times faster than conventional 3.5" drives.

X10 data transfer rates are similar to those of the popular IOMEGA

Zip drive, but the X10 does not require special media. Ordinary 720 K and 1.44 MB diskettes are used in the X10. Much of the X10's performance boost is due to faster motors and simultaneous double-sided technology. This technology allows both sides of a disk to be written to or read from at the same time.

The X10 is designed to replace high-end disk duplicators, and is able to copy typical disks in as little as five seconds. Typical disks are not completely filled with data and the controller's on-board microprocessor provides the intelligence to skip over blank areas on the disk.

The X10 accelerated floppy drive retails for \$149.00.

For more information, contact:

**CORPORATE SYSTEMS CENTER**  
1294 HAMMERWOOD AVE.  
DEPT. NV  
SUNNYVALE, CA 94089  
408-743-8782 FAX: 408-745-1816  
www.corpsys.com

## XPLORER



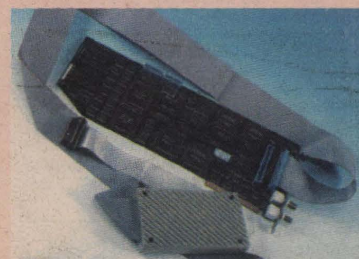
Optoelectronics announces a new communications product, the Xplorer Test Receiver. The Xplorer test receiver is a multi-purpose nearfield communications test and surveillance sweeper that sweeps the entire FM communications band from 30 MHz-2GHz in less than one second, while tuning in nearby

transmitters. It automatically stops on any active frequency, demodulates the audio, and displays the frequency of the transmitted signal. At the same time, the Xplorer will decode and display sub-audible signaling tones including DCS, CTCSS, and DTMF, as well as display FM deviation and relative signal strength. The Xplorer can also be operated in VFO mode for manual tuning to a specific frequency. The price of the Xplorer is \$899.00.

For additional information, contact:

**OPTOELECTRONICS, INC.**  
5821 N.E. 14TH AVE., DEPT. NV  
FT. LAUDERDALE, FL 33334  
954-771-2050 FAX: 954-771-2052

## NT5000 ROM-EMULATOR



Geotest, Inc. introduces the NT5000/NT5100 CPU Commander-ROM Emulator. The NT5000 is a powerful and versatile PC-based tester used to test µP-based boards by completely emulating an on-board microprocessor.

These features included: The NT5000 runs unmodified at full speed and requires no special fixturing; users need only to know one high-level language set of commands and no assembly language is required to use the basic functions of the NT5000; new microprocessors can be added with just a software upgrade; basic functions include: Read, Write, RAM Test, ROM CRC, Fill, Copy, and Move.

For additional information, contact:

**GEOTEST, INC.**  
18242 W. MCDURMOTT ST.  
STE. A, DEPT. NV  
IRVINE, CA 92714  
1-800-886-1201  
714-263-2222 FAX: 714-263-1203

## 2950AR RUBIDIUM FREQUENCY STANDARD



Novatech Instruments, Inc. introduces the Model 2950AR Atomic Resonance Rubidium frequency standard. The 2950AR has simultaneous sinewave outputs of



## New Products

10 MHz, 1 MHz, and 100 KHz.

The 2950AR is ideal for use as a master oscillator in laboratories and ground stations, as well as for test and calibration. The 2950AR sells for \$3,950.00 and delivery is eight weeks ARO.

For more information, contact:

**NOVATECH INSTRUMENTS, INC.**  
1530 EASTLAKE AVE. E.  
STE. 303, DEPT. NV  
SEATTLE, WA 98102  
206-322-1562 FAX: 206-328-6904  
E-MAIL: novatech@eskimo.com  
http://www.eskimo.com/~ntsales

### LV40PORTABLE

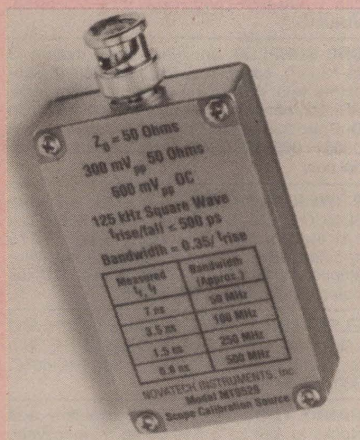


Engineers on the move can now have a universal programmer in their briefcase without needing a PC or a main electricity supply. The LV40Portable handheld programmer from ICE Technology can be battery or main driven and has a built-in keypad and LCD display.

For more information, contact:

**ICE TECHNOLOGY, INC.**  
P.O. BOX 1438, DEPT. NV  
HENDERSON, NC 27536  
919-693-0678 FAX: 919-693-0681  
E-MAIL: icetechusa@icetech.com  
http://www.icetech.com

### SCOPE CALIBRATOR



Novatech Instruments, Inc. introduces the Model MTS529 scope calibration source. This battery-operated device is small enough to fit in the palm of your hand. It has a BNC plug on one end and is designed to be connected directly to

the BNC input of an oscilloscope. The MTS529 generates a crystal-controlled, 125 KHz squarewave that has a fast rise time and calibrated amplitude.

The MTS529 is available from stock for \$169.00 each in single unit quantities; dropping to \$85.00 each at 1000-piece quantities.

For additional information, contact:

**NOVATECH INSTRUMENTS, INC.**  
1530 EASTLAKE AVE. E.  
STE. 303, DEPT. NV  
SEATTLE, WA 98102  
206-322-1562 FAX: 206-328-6904  
http://www.eskimo.com/~ntsales

### MOUSEMITT KEYBOARDERS™



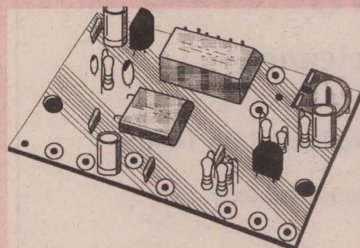
MouseMitt International's new MouseMitt Keyboarders™, glove-like wrist supports worn on each hand, have come to the aid of computer users, Internet surfers, and World Wide Web voyagers.

Carpal Tunnel Syndrome (CTS), and Repetitive Stress Injury (RSI), are endemic in the personal computer and Internet age. MouseMitt Keyboarders were developed to specifically guard against the stress and injury associated with repetitive hand movements, as well as provide gentle therapy for CTS and RSI sufferers. Suggested retail price is \$19.95 per pair.

For more information, contact:

**MOUSEMITT INTERNATIONAL**  
P.O. BOX 67370, DEPT. NV  
SCOTTS VALLEY, CA 95067-7370  
1-800-489-6488  
E-MAIL:  
mousemitt@mousemitt.com  
http://www.mousemitt.com

### CTCSS ENCODER/DECODER MODULE



Hamtronics announces a new version of their subaudible Tone Encoder/Decoder module. The new

Continued on page 110

## Q.B. VIDEO

(800) 249-3025

Enjoy the hassle free operation of a one piece replacement converter for you second television or replacement for your current rental box. Each unit comes with a descrambler installed. Units ideal for Non B.B. systems. Descramblers can be installed in:

Millennium 3*	TV86	Timeless Products
Single	5 Lot	10Lot
\$149	\$135	\$125

\* Now available with A/B (Dual) inputs- \$20.00 OR available with A/B (Dual) Inputs and R.F. bypass, for inview capabilities - \$ 25.00.

### THE BOSS SERIES

An excellent replacement converter for B.B. systems with video inversion. Also made to replace 03/07/08 systems and Zenith ST series. Units available in Millennium 3\* (100 Channel) or Panasonic (85 Channel).

	Single	5 LOT	10LOT
<b>BOSS 1</b>	<b>\$239</b>	<b>\$210</b>	<b>\$195</b>
Replaces Pio, and B.B. systems			
<b>BOSS 2</b>	<b>\$239</b>	<b>\$210</b>	<b>\$195</b>
Replace all 03/07/08			
<b>BOSS 3</b>	<b>\$239</b>	<b>\$210</b>	<b>\$195</b>
Replace all Zenith ST series.			
<b>NOVAVISION</b>	<b>\$219</b>	<b>\$195</b>	<b>\$185</b>
Models 5600, 5700, 5800			

### CONVERTERS

	SINGLE	10LOT
Millennium 3	\$68	\$62
Centurion	\$65	\$59
Timeless	\$65	\$59
TV86	\$65	\$59
Viewstar	\$65	\$59
Panasonic	\$75	\$69

### REFURBISHED

XRD-3	\$35	\$29
Regal CR83	\$45	\$39

### DESCRAMBLERS

	SINGLE	10LOT
TNT	\$52	\$48
TVT	\$48	\$44
M80	\$62	\$58
PIO+	\$64	\$60
S 1000P	\$42	\$37
S 80P	\$46	\$39
Am. Flag	\$40	\$34
Gamma 7	\$40	\$34
<b>FILTERS</b>	<b>\$14</b>	<b>\$10</b>

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Nuts & Volts Magazine/September 1996 93



### VCR REPAIR D-BASE

The VCR Repair D-Base is a disk for service centers or serious hobbyists who need to cut troubleshooting time when repairing VCRs. Nearly 10,000 problems and cures related to particular makes and models. This may be the most comprehensive VCR repair program around. Also details on obtaining free upgrades for life to those that purchase the program \$39.00

### FCC ID GUIDE

Over 5000 manufacturers listed by FCC number with full addresses. If your repairing anything you can't afford to be without this guide. \$25.00

### MAC HACK

Finally a CD for Mac users full of hacking tools and information all for the Mac. Everything in the hacking world is usually for PCs but this CD contains source code, viruses, war dialers, schematics, networking, internet, BBS tools, cracking tools and information all for Macs. Works with all Power PC and 680XX machines. CD \$39.95

### MONITOR TECH REPAIR

Repair and refurbish all types of computer monitors with this program. This monstrous database of information details the most common cures to monitor problems for all brands. If your in the computer repair biz you can't afford to be without it. Will save you tons of money by cutting troubleshooting time. Also a good primer to help you learn monitor repair. \$25.00 Send me your tip and you can receive free updates for life. Monitors only no TVs

### PC SPEC BOOK

Contains all the important information for upgrading and repairing PCs. Complete error code listings, memory mapping charts, IRQ and DMA maps, BIOS and CMOS tables for adding peripherals, disk drive controller specs, vendor list and directory, serial, mouse and keyboard info and much, much, more. Over 300 pages of info pocket size to fit in your case \$8

### COMPLETE CABLE

The most thorough book on cable ever published. Details the most popular makes and models with schematics, and turn on guides. Also PCB layouts, and details for building your own cable testers for various systems. Plus full details on building universal video sync generators and other info available nowhere else. \$39.00 Includes 2 disks worth of cable chip files for programming your own chips, and details for building a universal PIC descrambler.

### PC EXPANSION CARD GUIDE

Thousands of jumper settings and documentation for all the most popular cards on the market today and the past. Controller cards, video cards, network cards, I/O cards of all types. This is a good book to have along with the Hard Disk D-Base to complete your computer reference guide. A must needed book for system builders \$15.00

### MEGATRONICS

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### MANUALS - SCHEMATICS WANTED cont.

**MANUALS WANTED** for amateur, audio, test equipment, TV, VCR. A.G. Tannenbaum, Box 386, Ambler, PA 19002. 215-540-8055, FAX 215-540-8327.

**HEATHKIT R/C** receiver model GDA-19-2. Will buy manual or copy. Call 909-679-3942.

**WANTED: DANCAD 3D** version 2.6 user outfit set. Discs and manuals for DANCAD, DANCAM, DANPLOT. Call Dan at 301-990-8336 or FAX 301-990-8336.

**WANTED: TEST EQUIPMENT SERVICE MANUALS!** And catalogs, for HP, Tektronix, Fluke, etc. Pepper Systems, 214-353-0257; 214-902-9511 FAX.

### MISC. ELECTRONICS FOR SALE

**PHAZER RADAR/LASER JAMMER COMBO.** Jams all police radar. No more tickets or manufacturer pays them! 3-yr warranty. 30-day money back guarantee, \$180 complete. MO/Visa/MC/COD. Kortesis Marketing, Box 460543, Aurora, CO 80046. 303-548-3995, FAX 303-699-6660.

**HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE.** European and American screwdrivers, nutdrivers, pliers, hex keys, balldrivers, and much more! Wiha, Bondhus, and Knipex! Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 908-758-8388.

**SILENT SAM,** patented turn signal reminder for all vehicles. Doesn't bug you. Beeps only if you forget to cancel. \$22. Free flyer. Toll free 1-800-398-5605.

**STRANGE GOODIES!** Coil winder, Leeson (toroidal type, programmable) for AWG#16-AWG#50, call. Formex magnet wire: 73lbs AWG#12 \$250, 4 each 80 lb. spools AWG#21 \$275 each. Tek 465 oscilloscope \$275. Sencore SC61 oscilloscope (has VOM, freq. counter), \$375. 4 each Dovetron RTTY terminals MPC1000CR/TII \$100 each. Rate of turn table, Boxcar averages, misc. instrument test and aviation items, misc. test gear. List mailed. AMSL, Vermont. Ph. 802-254-9459. FAX 802-257-4862.

**RG-384 COAXIAL** cable, 500' \$100 delivered. 2000' \$100 FOB Jasonville. Sample \$3. Send check to: William Miller, Box 201, Jasonville, IN 47438.

**CLOSEOUT ITEMS** from BNF. Wind speed indicator kit \$5, \$13/3, Tesla coil kit \$19, \$55/3. Fan/motor speed control \$3, \$10/4, 2-1/2" ID 1-1/2" D. Solder pot 3, 13/4 voice/sound activated switch modu. \$1. Components by the foot assorted, \$1/10' 500 pts. 2 speed sw. motor/lamp control \$1/2, 12/\$5. Mallory Sonalert SC628 \$3.50, \$16/5. Security keylock switch, w/2 keys \$3/2. Cable box's Oak L30 or Oak G26 \$3, \$10/4, mix or match, all working units. 6x9 TV speakers \$1, \$5/6. 14550 UART \$1.50. Send SASE for flyer. BNFE, Rte. 1S, Peabody, MA 01960. WWW.BNFE.COM V508-536-2000, F508-536-7400. Established 1964.



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**CNC SURPLUS,** brushless servo motors (3 to 13 HP), controllers. Motorola 68000 computers with VGA mono, membrane keypads, RS-232, new used. Stepper motors. List. Jim DuBois, 330 State Road 101, Amherst, NH 03031. 603-673-3645. E-Mail: TmpstFugit@aol.com

**POWER SUPPLIES** 0-50 VDC, 0-2 amp \$245. 0-8 VDC, 0-80 amp Lambda \$185. Tek 1A1 plug-in \$75. University Sound ID75 speaker driver \$10. ea. Ideal thermal wire stripper N045=133B \$47.50. Brooks Surplus Sales, Rt. 3, Macon, GA 31206.

**ELECTRON TUBES:** All types bought and sold. Daily Electronics, B-6 10914 NE 39th St., Vancouver, WA 98682. 1-800-346-6667, 360-896-5476 FAX.

**GABAY TOOL** offers UTC & local-time wall clocks at \$26.50 & \$14.65 ea. respectively. Ppd. George Gabay N9QQR initially made these clocks just for use in his own station. His address is West 5541 Buckhorn Dr., New Lisbon, WI 53950.

**MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES** 818-842-3539, FAX 818-845-3613.

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SA-8550

SA-8590

DPBB-7

DPV-5

DPV-7

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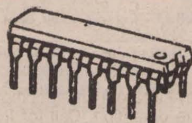
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# Events

## SEPTEMBER 1996

### SEPTEMBER 1

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Anklam 510-447-3857  
**CA - SANTA ROSA** - Computer Show. Sonoma Co. Fairgrounds. MarketPro. 415-456-6730

### SEPTEMBER 4-5-6-7

**NY - ROCHESTER** - Antique WA Conf. Marriott. Joyce 607-739-5443

### SEPTEMBER 7

**CA - OAKLAND** - Computer Show. Convention Center. Robert Austin. 1-800-346-0100  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**CA - STOCKTON** - Computer Show. Civic Auditorium. MarketPro. 415-456-6730  
**FL - PLANTATION** - Computer Show. Holiday Inn. Directions: 954-472-5600. Dealers: 954-792-6639  
**FL - POMPANO BEACH** - Computer Show & Sale. Palm-Aire Hotel. Narisaam 1-800-436-6707  
**IL - ROLLING MEADOWS** - W9DXCC DX Convention & Banquet. Holiday Inn. 708-343-1696  
**IN - SPENCER** - Owen Co. ARA Hamfest. Kathryn Smith 812-829-2140  
**IN - SUMMIT CITY** - Hamfest. Allen Co. Fairgrounds. Fort Wayne RC. Bill or Becky 219-471-5657  
**KS - TOPEKA** - NE KS ARC Hamfest. Expocentre Ag Hall. Robert Nall 913-267-9399  
**MA - WILMINGTON** - Computer Show. Shriner's. KGP Productions 908-297-2526  
**MA - FALMOUTH** - FARA Auction. Methodist Church. Jo 508-548-1121  
**ME - WINDSOR** - Ham/Electronic Flea Market. Fairgrounds. Frank 207-623-9217  
**MI - SOUTHFIELD** - Computer Show. Southfield Pavilion. 313-283-1754  
**MN - WALKER** - Hamfest. Cass-Hubbard ARC. Bill Beebe 218-547-3147  
**PA - ALLENTOWN** - Computer Show & Sale. Merchant's Square. Peter Trapp Shows. 607-369-2796  
**PA - UNIONTOWN** - Hamfest. Uniontown ARC club house grounds. Carl 304-594-3779  
**PA - ERIE** - Hamfest '96. Radio Assn. of Erie. Chris Robson 814-474-1211

### SEPTEMBER 7-8

**AL - HUNTSVILLE** - Computer Show. Von Braun Civic Center. ComputerShow 770-907-6225  
**CANADA - MANITOBA - AUSTIN** - Hamfest. Manitoba Amateur Radio Museum. 204-728-2463  
**CA - OAKLAND** - Robert Austin Computer Show. Convention Center. 1-800-346-0100  
**CA - VENTURA** - Computer Show. Ventura Fairgrounds. MarketPro. 415-456-6730  
**KY - LOUISVILLE** - Hamfest, Computer Show, & State Convention. Kentucky Fair & Exposition Center. 812-294-4905

### SEPTEMBER 8

**CA - SACRAMENTO** - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730  
**CA - SAN DIEGO** - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730  
**IA - DUBUQUE** - Hamfest/Radiofest/Computer Expo. Dubuque Co. Fairgrounds. Loren Heber 319-556-5755  
**IL - JOLIET** - Hamfest '96. Inwood Recreation Center. Bolingsbrook ARS. 708-759-7005  
**FL - FORT LAUDERDALE** - Computer Show. Sheraton Inn. Directions: 954-772-7770. Dealers: 954-792-6639  
**FL - WEST PALM BEACH** - Computer Show & Sale. Palm Beach Airport Hilton. Narisaam 1-800-436-6707  
**MA - DARTMOUTH** - Radio & Electronic Fleamarket. Clouthouse. Bill 508-996-2969  
**MA - SEEKONK** - Computer Show. Johnson & Wales Inn. Northern Computer Shows 508-744-8440  
**MD - GAITHERSBURG** - FAREFEST '96. Montgomery Co. Agricultural Center. 301-490-3188  
**MI - LANSING** - Computer Show. Holiday Inn South Convention Center. 313-283-1754  
**NY - BINGHAMTON** - Computer Show & Sale. Kalurah Temple, Endicott. Peter Trapp Shows. 607-369-2796  
**NY - WOODBURY** - Ham/Electronic Flea Market. LIMARC. Mark 516-796-2366  
**OH - FINDLAY** - Hamfest & Computerfest. Hancock County Fairgrounds. 419-423-3402  
**PA - BUTLER** - Hamfest & Computer Show. Butler Farm Showgrounds, Roe Airport. 412-282-1183  
**PA - PHILADELPHIA** - Computer Show. Holiday Inn Sports Complex. Micro-Mart 609-924-2344

### SEPTEMBER 13-14-15

**IL - PEORIA** - Superfest 1996, ARRL National Convention. Downtown Peoria Civic Center. Peoria

# CALENDAR

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. 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:

**Nuts & Volts Magazine  
Events Calendar**

430 Princland Court

Corona, CA 91719

Phone 909-371-8497

Fax 909-371-3052

E-mail events@nutsvolts.com

### SEPTEMBER 27-28

**KS - WICHITA** - Hamfest. Wichita ARC State Convention. Sonjia Cowart-Clover 316-284-0262

### SEPTEMBER 27-28-29

**FL - MELBOURNE** - Computer/Electronics Show. Civic Auditorium. Bill Arflin 407-777-9692  
**WA - WALLA WALLA** - Hamfest. SE. WA Section Convention. Walla Walla Valley ARC. 509-525-2529

### SEPTEMBER 28

**AL - ANNISTON** - Hamfest. City Meeting Center. AAERC. Harold 205-435-4833  
**CA - CONCORD** - Computer Show. Centre Concord. MarketPro. 415-456-6730  
**CA - SAN DIEGO** - Computer Show. Scottish Rite Center. MarketPro. 415-456-6730  
**CA - YUBA CITY** - Computer Show. Yuba-Sutter Fair. MarketPro. 415-456-6730  
**GA - GAINESVILLE** - Hamfest. Lanierland ARC. Jerry Adams 770-967-2445  
**IN - TERRE HAUTE** - Computer Fair. Vigo Co. Fairgrounds. 812-442-0110  
**LA - ALEXANDRIA** - Hamfest. Central LA ARC. Jon Kissick 318-487-0971  
**MI - HUDSONVILLE** - Hamfest. Grand Rapids ARA. Dave Devos 616-698-7022  
**MI - GRAND RAPIDS** - Super Swap '96. Unity Christian High School. Dave DeVos 616-698-7022  
**MI - TAYLOR** - Computer Show. Democratic Club Hall. 313-283-1754  
**MN - CHISHOLM** - Hamfest. Midrange ARC. Dan Weinberger 218-492-4501  
**NY - HORSEHEADS** - Elmira International Hamfest/Computerfest. Chemung County Fairgrounds. Elmira ARA. Dave 607-589-7495  
**TN - COOKEVILLE** - Hamfest. Cookeville Rptr. Assn. & TN Tech ARS. Rick King 615-526-7171

### SEPTEMBER 28-29

**AL - MOBILE** - Hamfest. Mobile ARC. Bill Cleveland 334-661-3892  
**KY - LOUISVILLE** - Computer Fair. Kentucky Fair & Expo Center. 513-263-3378  
**NC - CHARLOTTE** - Computer Show. Metrolina Expo Center. ComputerShow 770-907-6225  
**NJ - MORRISTOWN** - Computer Show. National Guard Armory. KGP Productions 908-297-2526

### SEPTEMBER 29

**CA - ANTIOCH** - Computer Show. Contra Costa Fairgrounds. MarketPro. 415-456-6730  
**CA - CONCORD** - Computer Show. Centre Concord. MarketPro. 415-456-6730  
**CA - OXNARD** - Computer Show. Community Center. MarketPro. 415-456-6730  
**CA - SANTA ANA** - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813  
**IL - GLEN ELLYN** - Computer Show & Sale. College of DuPage. 708-940-7547  
**MA - FRAMINGHAM** - Fleamarket & Exams. Framingham High School. FARA. 508-435-0564  
**MI - MADISON HEIGHTS** - Computer Show. UF & CW Hall. 313-283-1754  
**MI - MIDLAND** - Computer Show. Holiday Inn. Five Star Productions. 810-230-0988  
**NH - NASHUA** - Computer Show. Sheraton Tara Hotel. Northern Computer Shows 508-744-8440  
**NY - YONKERS** - Electronic Flea Market. Lincoln High School. Metro 700C Network. 914-969-1053  
**OH - ASHLAND** - ARRL Hamfest. Ashland Area ARC. David Fike 419-289-1082

908-574-2873

### SEPTEMBER 20-21-22

**WA - SEATTLE** - Digital Communications Conference. Quality Inn Seattle Airport. ARRL & TAPR. 817-383-0000  
**WI - WAUSAU** - Computer Sale/Show. Wausau/Marathon Co. Park. Blue Star Productions. 612-788-1901

### SEPTEMBER 21

**AR - MOUNTAIN HOME** - Twin Lakes ARC Hamfest. Phil Waters 501-425-7406  
**CA - BAKERSFIELD** - Computer Show. Red Lion Inn. MarketPro. 415-456-6730  
**CA - SEBASTOPOL** - Swapmeet/Auction. Holy Ghost Hall. Sonoma County Radio Amateurs. Rick 707-575-4455  
**FL - ST. PETERSBURG** - Computer Show. Days Inn. Directions: 813-522-3191. Dealers: 954-792-6639  
**MA - FALL RIVER** - Computer Show. White's of Westport. Northern Computer Shows 508-744-8440  
**ME - LINCOLN** - Hamfest. Ella Burr School. BARC. Sylvia Cockburn 207-732-5185  
**MI - LIVONIA** - Computer Show. Livonia Elks Hall. 313-283-1754  
**NE - LEXINGTON** - Consignment Auction. Knights of Columbus Hall. Randy 308-987-2312  
**NJ - PENNSAUKEN** - Computer Show. South Jersey Expo Center. KGP Productions 908-297-2526  
**NY - HAMBURG** - Western NY Section Convention. Harold Smith 716-424-7184  
**OK - ALTUS** - Hamfest. Altus Area ARA. Mart Dennis, POB 73, Altus, OK 73521  
**OR - PORTLAND** - Ham Fair. Pay N Pak Building. Delta Park. 503-257-4822  
**RI - FORESTDALE** - Ham/Electronic Flea Market & Auction. VFWD Hall. Rick 401-725-7595  
**VT - RANDOLPH CENTER** - Central VT ARC Hamfest. Tom Girardi 802-244-7836

### SEPTEMBER 21-22

**AK - ANCHORAGE** - Hamfest. Kincaid Park Outdoor Center. ARRL. Robert Wilson 907-271-5304  
**CA - VALLEJO** - Computer Show. Solano Co. Fairgrounds. MarketPro. 415-456-6730  
**IL - GRAYSLAKE** - Radio Expo '96. Lake County Fairgrounds. Chicago FM Club. 708-457-0966  
**VA - VIRGINIA BEACH** - Hamfest. Virginia Beach Pavilion. 804-HAM-FEST

### SEPTEMBER 22

**FL - NEW PORT RICHEY** - Hamfest/Computer Show. Recreation Center. Ron 813-376-6575  
**FL - ST. PETERSBURG** - Computer Show. Best Western Mirage. Directions: 813-525-1181. Dealers: 954-792-6639  
**MI - ADRIAN** - Adrian ARC Hamfest. Brian Sarkisian 517-265-1537  
**MI - DEARBORN** - Computer Show. Civic Center. 313-283-1754  
**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre. Five Star Productions. 810-230-0988  
**MO - COTTLEVILLE** - Swapfest. St. Charles Co. Community College. St. Peters ARC. 314-723-4200  
**NH - PORTSMOUTH** - Computer Show. Frank Jones Center. Northern Computer Shows 508-744-8440  
**NJ - MT. HOLLY** - Hamfest/Computer Show. Mt. Holly Armory. South Jersey Radio Association. 609-596-7749  
**OH - CLEVELAND** - Hamfest Assn. of Cleveland Hamfest. 1-800-CLE-FEST  
**WI - MADISON** - Hamfest. Dane Co. ARES. Bob Aspinwall 608-222-3444

Area Amateur Radio Club. 309-692-3378

**WI - MADISON** - Computer Sale/Show. Dane Co. Expo Center. Blue Star Productions. 612-788-1901

### SEPTEMBER 14

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**CA - LOS ALTOS HILLS** - Electronics Flea Market. Foothill College. Parking Lot A. 408-734-4453  
**CA - MONTEREY** - Computer Show. Conference Center. MarketPro. 415-456-6730  
**CA - SAN FRANCISCO** - Computer Show. Cow Palace. Robert Austin. 1-800-346-0100  
**CA - SAN JOSE** - Computer Show. Santa Clara Co. Fairgrounds. MarketPro. 415-456-6730  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**CT - PAWCATUCK** - Electronic Auction. Neighborhood Center. Bill 401-596-5849  
**IN - INDIANAPOLIS** - AGI Computer Fair. Indianapolis Events Center. 317-299-8827  
**LA - PRAIRIEVILLE** - Ascension ARC Hamfest. Shane Dugas 504-673-8396  
**MA - TOPSFIELD** - Computer Show. Fairgrounds. Northern Computer Shows 508-744-8440  
**MI - KALAMAZOO** - Computer Show. County Fairground. 313-283-1754  
**NY - BALLSTON SPA** - Hamfest '96. Saratoga County Fairgrounds. Saratoga County RACES Association. Lenny 518-885-4933  
**NY - SYRACUSE** - Computer Show & Sale. NY State Fairgrounds, Horticultural Bldg. Peter Trapp Shows. 607-369-2796  
**OH - CLEVELAND** - Computer Show & Sale. Cloverleaf Trading Center. Peter Trapp Shows. 607-369-2796

### SEPTEMBER 14-15

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 1-800-346-0100  
**FL - MELBOURNE** - Hamfest. Platinum Coast ARS. Allen Hudson 407-773-9658

### SEPTEMBER 15

**CA - LANCASTER** - Computer Show. Antelope Valley Fairgrounds. MarketPro. 415-456-6730  
**CA - MODESTO** - Computer Show. Centre Plaza at Red Lion. MarketPro. 415-456-6730  
**CT - NEWTOWN** - Western CT Hamfest. Edmond Town Hall. Candlewood ARA. John 203-438-6782  
**IL - ORLAND PARK** - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123  
**KY - LOUISVILLE** - Computer Fair South. Executive West Hotel. MEKA Enterprises 812-333-9300  
**MA - CAMBRIDGE** - MIT RS & Harvard Wireless Club Hamfest. Nick Altenburnd 617-253-3776  
**ME - AUGUSTA** - Computer Show. Civic Center. Northern Computer Shows 508-744-8440  
**MI - FARMINGTON HILLS** - Computer Show. Activity Center. 313-283-1754  
**MI - MT. CLEMENS** - L'Anse Creuse ARC Hamfest. Ralph Irish 810-731-6760  
**NE - OMAHA** - AK-SAR-BEN ARC Hamfest. Dave 402-592-4930  
**NJ - HAMILTON TWP.** - Fallfest '96. Tall Cedars of Lebanon picnic grove. DVRA. 609-882-2240  
**OH - AKRON** - Computer Show & Sale. Tadmor Shrine Temple. Peter Trapp Shows. 607-369-2796  
**WV - WHEELING** - Triple Stars RAC Hamfest. Ralph McDonough 614-546-3930

### SEPTEMBER 17

**OH - TOLEDO** - Computer Show. Masonic Great Hall. 1-800-893-SHOW

### SEPTEMBER 20

**NJ - PISCATAWAY** - Ham & Electronics Auction. North Stelton Firehouse. Piscataway ARC. Marty

Continued on page 103



# MISC. ELECTRONICS FOR SALE cont.

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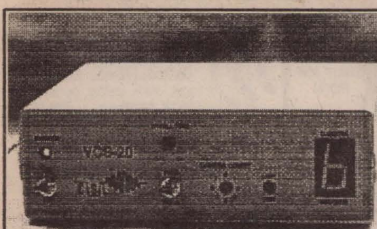
Item id	Pc 1 - 10	Item id	Pc 1 - 10
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Z - Tac 3	16.96 - 13.95	TC - 07	17.95 - 12.95

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# ELECTRONICS

## Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYSERS, on the Internet at TJBERS@aol.com or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

### Relay Contact Resistance

**Q.** Concerning electromechanical relay contacts, I would like information about the so-called "dry contact" effect. I hear it occurs when a set of contacts switches less than a minimum current that causes contact surface deterioration that leads to increased contact resistance. Do all relay contacts exhibit this phenomenon?

**Joseph F. Richmond**  
Joppa, MD

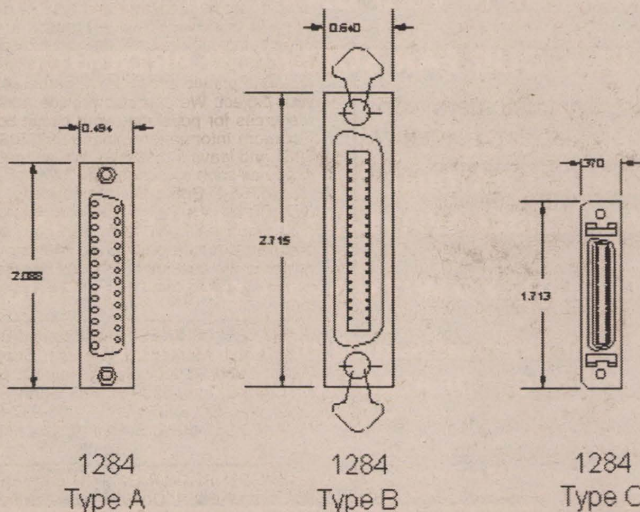
**A.** I think what you're asking about is the lack of arcing that often cleans relay contacts. When a switch or relay breaks contact, there's a residue arc "connection" that most engineers try to squelch using snubber circuits. DC voltages are the hardest to squelch, and can actually do damage to the contacts by burning them out. AC voltages, by their very nature, automatically extinguish the arc because the voltage has to pass through zero on its way from positive to negative. When the switching current is very low, you don't get arcing, which can cause the relay contacts to oxidize ("rust") that, over time, increases the contact resistance. For these applications, they make a wetted relay. A wetted relay uses mercury on its contacts. Because mercury is a liquid, a new surface is formed each time the contacts break, which prevents oxidation and provides lower contact resistance.

### IEEE Printer Cables

**Q.** A lot of the new printers sold today tell you, for best results, to use a IEEE printer cable. While shopping at a national computer store chain, I found a wide variety of printer cables, ranging in price from \$6.00 for a standard parallel cable to \$18.00 for a bidirectional cable to over \$30.00 for an IEEE cable. All these cables have a DB25 male connector on one end and a 36-pin Centronics connector on the other. Can you tell me what the difference is besides the price?

**Charles E. Heisler K3VDB**  
Red Lion, PA

**A.** It used to be so simple, didn't it? The \$6.00 cable is the type you'd use with an old dot-matrix printer. In the last few months, printer vendors have started shipping printers that talk back to the PC, telling it things like it's out of paper or ink. For these, you need a bidirectional cable. The IEEE 1284 cable is double-shielded to prevent EMI (electromagnetic interference), and allows you to send data to your printer at 2 MBs.



If that's not confusing enough, the IEEE 1284 standard also specifies a mini, 36-pin "Centronics" connector (above) that forces you to look at the back of the printer before you buy a printer cable. Will an IEEE cable make your computer run faster? Not likely unless you've bought a Pentium system with a

color laser printer in the last month.

### Dot-Laser Printer Problem

**Q.** I bought a Panasonic KXP-1624 dot-matrix printer in need of repair. At first it was totally dead, but I was able to coax it back to life. Unfortunately, it's totally confused. The self-test works okay, but documents print in gibberish. I have new printer drivers that Panasonic sent to me, and have installed them several times over with the same results. Any suggestions?

**George R. Adam**  
Rio Vista, CA

**A.** The last time I repaired a printer (a year ago), it cost me \$80.00, and that was for a dot-matrix printer that needed a new "motherboard" which I had to install myself. If I had to do it again, I wouldn't. Why? Because you can buy an ink jet printer for about \$200.00 — and they're a lot faster! Perhaps, with my editor's blessing, we can have a future article that takes a hard look at who's who in the ink jet printer market.

### Fluorescent Ballast

**Q.** I'm interested in converting all of my fluorescent light fixtures from the bulky, noisy, short-lived, and generally poor quality ballast transformer type, to the quiet, cheap, and long-lived capacitor ballast type. I need to know several things before I embark on this journey. Is the principal of capacitance reactance for fluorescent tubes the same as inductance reactance, or are there other factors that come into play when using capacitors? Is there anything out of the ordinary when choosing a capacitor for this type of work other than the AC rating and duty cycle?

**Chris Bieber, CA**

**A.** Let's start at the beginning. Capacitors are a lot different than inductors in that one has leading current and the other has lagging current, and the two have to be in sync to equalize the power factor. Since a fluorescent tube is basically a capacitive device, you need an inductor to balance the equation. Fluorescent lamps also require a high-voltage kick to get them started — a kick that the ballast provides. The ballast provides power for the filaments, too. In other words, a capacitor ballast won't work. What you're probably thinking of as a "capacitor" ballast are actually electronic ballast, which are found in newer fixtures. They're essentially a switching power supply in a metal case. BTW, the reason ballast transformers are "short-lived" is not the fault of the transformer, but the fault of a bad lamp. When you see a fluorescent tube flickering, replace it now. What happens is that as the tube dies it draws a lot of current, which overheats the ballast.

### Laser Printer Woes

**Q.** I have a Panasonic KXP-4420 laser printer that was working fine. Now all of the sudden, it doesn't work. When I turn it on, it goes through the warm-up process then gives the error message "Call service - E31." I'm curious if I REALLY need to call for service. Is this something I can correct?

**Jeff Aust**  
via Internet

**A.** Unfortunately, no. This warning means the fuser assembly heater isn't working. That's the part that makes the laser printer a laser printer. It could be the heater itself (\$200.00) or a problem with a sensor on the controller board (\$150.00) — plus labor. What I would do is replace your defunct laser printer with a color ink jet printer, like Cannon's BJC4000 (\$249.00).

### Door Ajar Indicator

**Q.** I used to have a Sears brand garage door opener that had a provision for sending a low voltage to an open door indicator. Instead of using the large, ugly, Sears indicators, I ran low-voltage wiring to a retro-junction box and, with a resistor to drop the 24 volts, used a flashing LED. I recently replaced the Sears opener with a new Genie brand garage door opener, but it lacks this feature. I would like to use the garage door indicators I have installed in the house without rewiring them. Is there a way, other than using X-10 devices, of utilizing a low-voltage open door indicator with the Genie door opener that would allow me to use my existing low-voltage indicators?

**Dean Olson**  
Omaha, NE

**A.** What I'd do is use a magnetic switch like the kind used in home security

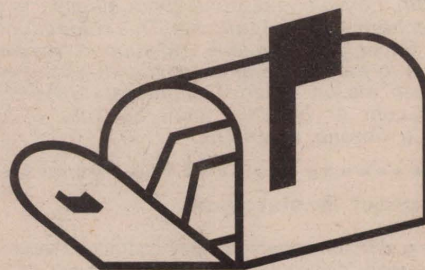
Continued on page 118



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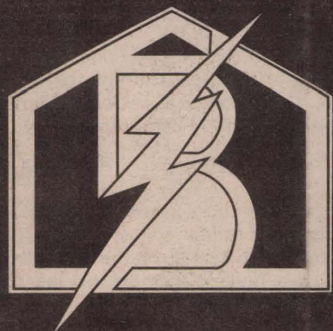
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## Events CALENDAR

Continued from page 98

### OCTOBER 1996

#### OCTOBER 1

**OH - FINDLAY** - Computer Show. Hancock Recreation Center. 1-800-893-SHOW

#### OCTOBER 4-5

**CANADA - ONTARIO - OTTAWA - QCWA** International Convention. Keith Bedal 613-828-1870  
**NH - ROCHESTER** - Hamfest. Hosstraders. Joe Demaso 207-469-3492

#### OCTOBER 4-5-6

**IL - QUAD CITY** - Computer Sale/Show. QCCA Expo Center. Blue Star Productions. 612-788-1901

#### OCTOBER 5

**CA - SAN FRANCISCO** - Computer Show. Cow Palace. Robert Austin. 1-800-346-0100  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**FL - MIAMI** - Tailgate Swap Meet. University of Miami Parking Lot #2. The Flamingo Net. Bill, 73 Palm Ave., Miami Beach, FL 33139  
**IN - PERU** - Hamfest. Miami Co. & Cass Co. ARCs. Gary Donaldson 219-382-2203  
**MO - WARRENSBURG** - Hamfest. Warrensburg Area ARC. Denise Haye 816-429-5909  
**NH - MANCHESTER** - Computer Show. NH State Armory. Northern Computer Shows 508-744-8440  
**SC - ROCK HILL** - Hamfest. York County ARS. George Trunk 803-327-4344  
**TX - BELTON** - Ham Expo. Bell Co. Expo Center. Temple ARC. Mike LeFan 817-773-3590

#### OCTOBER 5-6

**CA - SACRAMENTO** - Computer Show. Cal Expo. MarketPro. 415-456-6730  
**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 1-800-346-0100  
**GA - NORCROSS** - Computer Show. North Atlanta Trade Center. ComputerShow 770-907-6225  
**MA - BOXBORO** - ARRL Convention. Boxborough Woods Hotel & Conference Center. 617-334-5770  
**MS - BILOXI** - ARRL Hamfest. B.J. Byrd 601-832-3249

#### OCTOBER 6

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Anklam 510-447-3857  
**IN - BEDFORD** - Hamfest. Lawrence Co. 4-H Fairgrounds. Dewey Sowders 812-279-5546  
**IN - HUNTINGTON** - Hamfest. Huntington County ARS. Ray Tackett 219-786-0057  
**MA - TAUNTON** - Computer Show. Holiday Inn. Northern Computer Shows 508-744-8440  
**NY - WOODBURY** - Hamfest. Long Island Mobile ARC. Mark Nadel 516-796-2366  
**OH - SPRINGFIELD** - Hamfest. Clark Co. Fairgrounds. Independent Radio Assn. 513-568-4070  
**PA - WARRINGTON** - ARRL Hamfest. Mt. Airy VHF Radio Club. Paul Drexler 609-538-1687

#### OCTOBER 11-12-13

**AZ - MESA** - ARRL Convention. Sheraton Mesa Hotel & Conference Center. Scottsdale ARC. 602-837-6492  
**CA - BAKERSFIELD** - Hamfest. Bakersfield AREA. Ed Harlander 805-589-4163  
**MN - ST. PAUL** - Computer Sale/Show. State Fairgrounds. Blue Star Productions. 612-788-1901  
**TX - HOUSTON** - South Texas Section Convention. Darrell Glueck 713-544-4829

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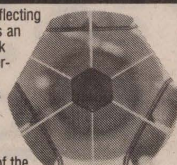
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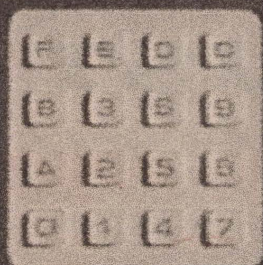
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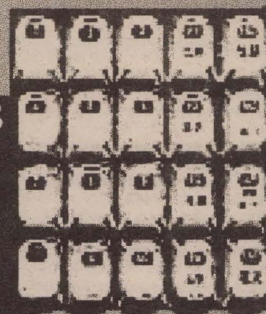
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# Events CALENDAR

**TN - MEMPHIS** - MemFest, Shelby Farms Show Place Arena, Mary Moore 901-758-0661

## OCTOBER 13

**CT - DURHAM** - Hamfest, Computer Show & State Convention, Fairgrounds, Kit 860-873-2978, Bill Wawrzniak 203-269-8252

**IL - OAK BROOK TERRACE** - Hamfest, Oak Brook Terrace, Chicago ARC, George 312-545-3622

**MD - COLUMBIA** - Hamfest, Howard County Fairgrounds, Columbia ARA, 410-964-4378

**MI - FLINT** - Computer Show, Holiday Inn, Gateway Centre, Five Star Productions, 810-230-0988

**MI - MASON** - Ham Fair, Ingham Co. Fairgrounds, LCDRA & CMARC, Jeff Oberg 517-393-4713

**NJ - LINCOLN** - Shore Area Hamfest & State Convention, Al Allen 908-495-3246

**NY - QUEENS** - Hall of Science ARC Hamfest, NY Hall of Science parking lot, Arnie 718-343-0172

**OH - LIMA** - Hamfest, Northwest Ohio ARC, 419-647-6321

## OCTOBER 15

**OH - TOLEDO** - Computer Show, Masonic Great Hall, 1-800-893-SHOW

## OCTOBER 18-19

**FL - STARKE** - Hamfest, Bradford Area ARC, Lev Francis 352-473-3511

## OCTOBER 18-19-20

**CA - CONCORD** - PACIFICON '96, Mt. Diablo ARC, Richard Schulze 510-932-6125

**GA - ATLANTA** - Grove Communications Expo, Larry Van Horn 704-837-9200

## OCTOBER 19

**CA - BAKERSFIELD** - Computer Show, Red Lion Inn, MarketPro, 415-456-6730

**CA - OAKLAND** - Robert Austin Computer Show, Convention Center, 1-800-346-0100

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet, Santee Drive-In, 619-561-0052

**PA - SENECA** - Hamfest, Ft. Venango Mike & Key Club, Mary Housholder 814-437-2036

**TN - GRAY** - ARRL Hamfest, Bristol, Kingsport, & Johnson City ARCs, Wendell Messimer 423-928-4407

## OCTOBER 19-20

**AL - HUNTSVILLE** - ComputerShow, Von Braun Civic Center, 707-907-6225

**FL - WEST PALM BEACH** - Hamfest, South Florida Fair Expo Center, Vi Kienapp 407-585-9074

**MA - MARLBOROUGH** - Computer Show, Royal Plaza Trade Center, KGP Productions, 908-297-2526

**TX - EL PASO** - International Hamfiesta, Ron Love 915-595-3371

**TX - HOUSTON** - Gulf Coast Ham Convention, 1-800-231-3057

## OCTOBER 20

**CA - LANCASTER** - Computer Show, Antelope Valley Fairgrounds, MarketPro, 415-456-6730

**CA - STOCKTON** - Computer Show, Civic Auditorium, MarketPro, 415-456-6730

**CO - GOLDEN** - Hamfest, Jefferson Co. Fairgrounds, Joe Dickinson 303-771-9577

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**MA - CAMBRIDGE** - Hamfest, MIT RS & Harvard Wireless Club, Nick Altemund 617-253-3776

**MI - KALAMAZOO** - Hamfest, Kalamazoo Co. Fairgrounds, 616-657-4482

**MI - WARREN** - Swap-N-Shop, OLR Conference Center, Kevin 810-636-3414

**NY - MELVILLE** - Hudson Division Conv./Hamfest, Huntington Hilton Hotel, JoAnn Colletti 516-399-1877

**NY - MELVILLE** - LI NY RCARC Ham/Electronics Flea Market, Steve 516-584-5909

**PA - GREENSBURG** - Hamfest, Greensburg Hose Company #1, Foothills ARC, Al 412-523-3727

**PA - SELLERSVILLE** - Hamfest, Sellersville Fire House, Linda Erdman 215-679-5764

## OCTOBER 22

**OH - LIMA** - Computer Show, Holiday Inn Lima, 1-800-893-SHOW

## OCTOBER 25-26-27

**OK - KINGSTON** - Hamfest, Texoma Hamarama Assn, Charles Bilbay 405-924-0687

## OCTOBER 26

**CANADA - QUEBEC** - LONGUEUIL - Hamfest, Francois Drien 514-672-9994

**CA - SANTA ROSA** - Computer Show, Sonoma Co. Fairgrounds, MarketPro, 415-456-6730

**FL - PORT ST. LUCIE** - Hamfest '96, Port St. Lucie

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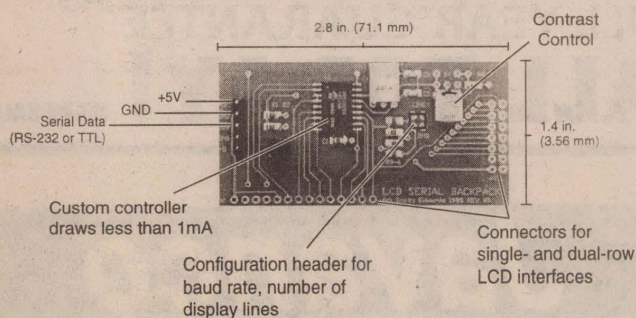


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## Events CALENDAR

Mark J. Campbell 515-281-5430

**IL - GLEN ELLYN** - Computer Show & Sale, College of DuPage, 708-940-7547

**IN - LEBANON** - Hamfest, Boone Co. & Clinton Co. ARCs, Michael Ottinger 317-482-1866

**MA - SOUTHWICK** - Ham/Electronic Flea Market, HCRA Rec. Ctr. Barry 413-747-7010

**MD - WESTMINSTER** - Computer & Hamfest, Carroll Co. Ag Center, CCARC, George 717-632-1621

**OH - MARION** - HamFiesta & Computer Show, Marion Co. Fairgrounds, MARC, Karen 614-499-3565

**PA - NEWTOWN** - Hamfest, Bucks Co. Community College, Penn Wireless Assn. Steve 215-752-1202

### OCTOBER 29

**OH - COLUMBUS** - Computer Show, Aladdin Temple, 1-800-893-SHOW

## NOVEMBER 1996

### NOVEMBER 2

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet, Santee Drive-in, 619-561-0052

**FL - SORRENTO** - Hamfest & Electronic Expo, East Lake Chamber of Commerce, Tony 352-360-1380

**IL - GODFREY** - ARRL Hamfest, Lewis & Clark RC, Brent Urfer 618-498-4865

**NY - HEMPSTEAD** - Computer Show, Hofstra University, Field House, 908-297-2526

**OK - ENID** - Hamfest, Hoover Bldg., Garfield Co. Fairgrounds, Fred N5QXL, Jeff EnidARC@AOL.COM

### NOVEMBER 2-3

**CA - OAKLAND** - Robert Austin Computer Show, Convention Center, 1-800-346-0100

**CA - SACRAMENTO** - Computer Show, Cal Expo, MarketPro, 415-456-6730

**GA - LAWRENCEVILLE** - ARRL Hamfest, Alford Memorial RC, Randy Bassett 770-410-3989

**OH - CINCINNATI** - Computer Fair, Cincinnati Gardens, Mark Hanslip 513-263-3378

**TN - NASHVILLE** - Computer Show, State Fairgrounds, ComputerShow 770-907-6225

**TX - ODESSA** - Hamfest, Ector Co. Coliseum Exhibit Bldg., C. West Texas ARC, Robert 915-335-7980

### NOVEMBER 3

**CA - LIVERMORE** - Swapmeet, Las Positas College, Noel Anklam 510-447-3857

**MI - MIDLAND** - Computer Show, Holiday Inn, Five Star Productions, 810-230-0988

**OH - CANTON** - ARRL Hamfest, Massillon ARC, Jack Cale 216-477-8261

**PA - TREVOSE** - Photographic Show, Radisson Hotel, OMM Productions 610-527-5903

### NOVEMBER 9

**AL - MONTGOMERY** - Hamfest & Computer Show, Garrett Coliseum, South Alabama State Fairgrounds, Montgomery ARC, Phil 334-272-7980

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

**FL - TITUSVILLE** - ARRL Hamfest, Titusville ARC, Clyde Lee 407-267-9375

**IN - INDIANAPOLIS** - AGI Computer Fair, Indianapolis Events Center, 317-299-8827

**LA - WEST MONROE** - Hamfest, Conv. Center, Becky Ketchell 318-343-3530

**PA - HERSHEY** - Hamfest, Hershey Armory, Harold Baer 717-566-8895

**SC - MYRTLE BEACH** - Radio/Computer Show, High School, Dave Berry 803-248-9401

### NOVEMBER 9-10

**GA - DALTON** - Computer Show, NW GA Trade & Conv. Center, ComputerShow 770-907-6225

**NJ - EDISON** - Computer Show, NJ Convention & Expo Center, Raritan Center Expo Hall, 908-297-2526

### NOVEMBER 10

**CT - BRANFORD** - SCARA Flea Market, Branford Intermediate School, 203-483-0856

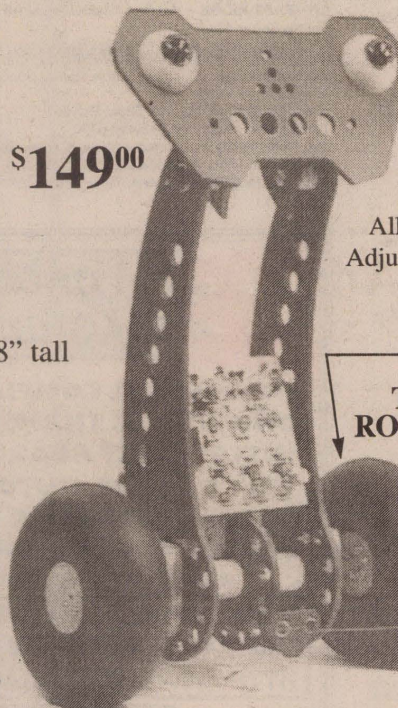
### NOVEMBER 15-16-17

**IA - DES MOINES** - Computer Sale/Show, State Fairgrounds, Blue Star Productions, 612-788-1901

### NOVEMBER 16

**GA - WATKINSVILLE** - ARRL Hamfest, Athens Radio Club, David Alper 706-354-1952

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# Events CALENDAR

## NOVEMBER 16-17

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 1-800-346-0100  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052  
**IN - FORT WAYNE** - Hamfest. Allen Co. War Memorial Coliseum Expo Center. Don 219-484-1314  
**MA - METHUEN** - Computer Show. Valley Expo Center. KGP Productions. 908-297-2526

## NOVEMBER 17

**IL - ORLAND PARK** - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123  
**KY - LOUISVILLE** - Computer Fair South. Executive West Hotel. MEKA Enterprises 812-333-9300  
**NC - BENSON** - JARSFest '96. American Legion Complex. 919-894-3352, 919-894-3100  
**NY - POUGHKEEPSIE** - Hamfest. Mt. Beacon ARC. Ken Akasofu 914-485-9617

## NOVEMBER 20

**FL - ST. PETERSBURG** - ARRL Hamfest. Pelican Chapter #128 (QCWA). Don Bice 813-347-2702

## NOVEMBER 23

**CA - OAKLAND** - Robert Austin Computer Show. Convention Center. 1-800-346-0100

## NOVEMBER 23-24

**FL - TAMPA** - Radio/Computer Conv. FL Expo Park, Expo Hall. Jean 813-525-5178  
**NC - CHARLOTTE** - Computer Show. Metrolina Expo Center. ComputerShow 770-907-6225  
**PA - FT. WASHINGTON** - Ft. Washington Expo Center. KGP Productions 908-297-2526

## NOVEMBER 24

**CA - SANTA ANA** - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813  
**IL - GLEN ELLYN** - Computer Show & Sale. College of DuPage. 708-940-7547

## NOVEMBER 29-30

**OH - SHARONVILLE** - Computer Show. Sharonville Convention Center. 1-800-672-3472

## NOVEMBER 29-30-DECEMBER 1

**GA - MARIETTA** - ComputerShow. Cobb County Civic Center. 770-907-6225

## NOVEMBER 30

**IL - LITCHFIELD** - Amateur TV Club Banquet. Ariston Restaurant. Scott Millick 217-532-3837  
**IN - EVANSVILLE** - Winter Hamfest. Vanderburgh Co. Fairgrounds. Neil 812-479-5741

## NOVEMBER 30-DECEMBER 1

**NJ - PENNSAUKEN** - Computer Show. South Jersey Expo Center. KGP Productions 908-297-2526  
**OH - COLUMBUS** - Computer Fair. Veterans Memorial. Mark Hanslip 513-263-3378

## DECEMBER 1996

### DECEMBER 1

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Anklam 510-447-3857  
**KY - ERLANGER** - Computer Show. Holiday Inn. Cincinnati Airport. 1-800-672-3472  
**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre. Five Star Productions. 810-230-0988

## DECEMBER 6-7

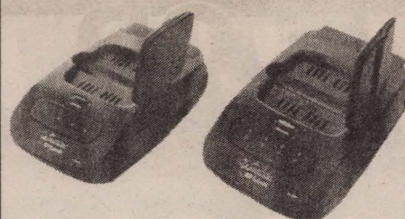
**AR - HOT SPRINGS** - Arkansas DX Convention. Dave Jacques 501-760-1181

## DECEMBER 7

**CA - SAN FRANCISCO** - Computer Show. Cow Palace. Robert Austin. 1-800-346-0100  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052  
**IN - INDIANAPOLIS** - AGI Computer Fair. Indianapolis Events Center. 317-299-8827  
**LA - MINDEN** - ARRL Hamfest. Minden ARA. Jimmy White 318-377-2501

## DECEMBER 7-8

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 1-800-346-0100



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Nuts & Volts Magazine/September 1996 **107**



# THE LASER

## EXPERIMENTER

Conducted by  
Anthony Charlton

**W**elcome! This month, we'll take a look at the recent developments and price reductions of diode lasers.

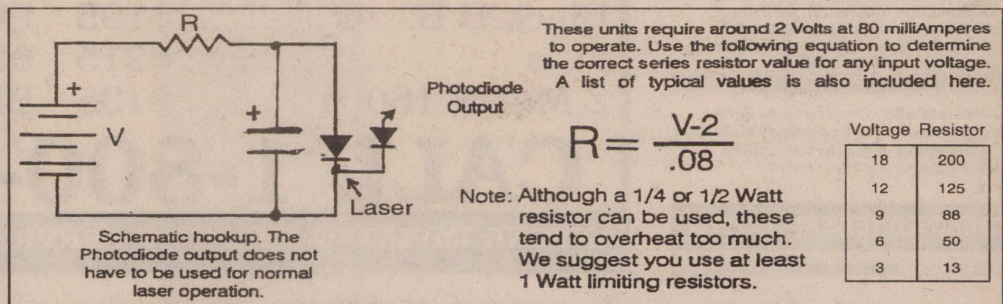
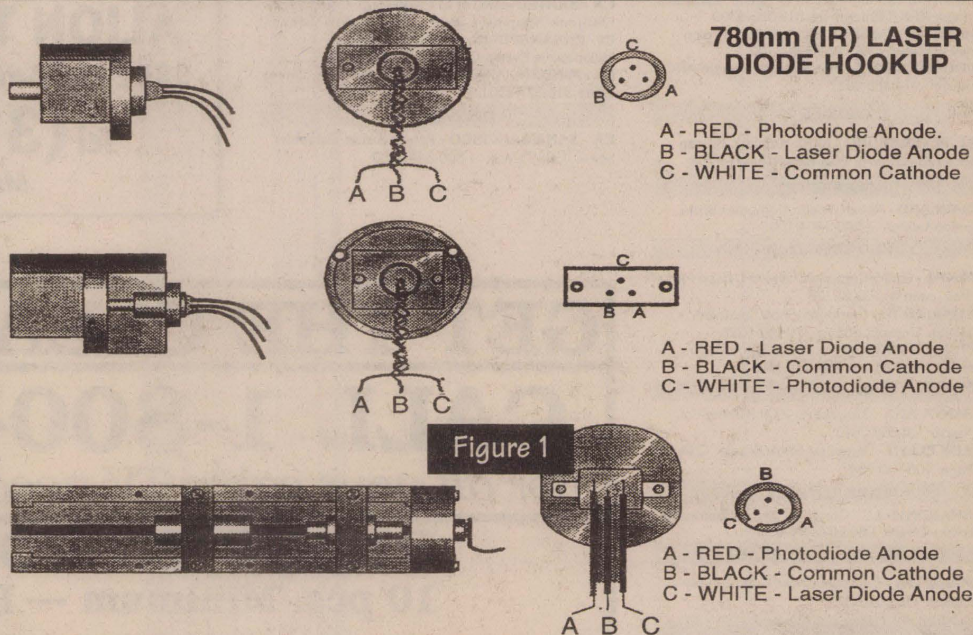
This is an *Intermediate Level* project. Years ago, one milliwatt helium-neon lasers were the only type within the experimenter's budget, being about \$100-\$200 for a system, depending upon what type you chose to buy. And before that era, they were only available for use in a laboratory. Nowadays, we have five milliwatt diode lasers that operate in the visible spectrum which can be purchased for \$33.00 right out of the Digi-Key catalog {1}, and for less from other suppliers. Digi-Key offers lasers at 670 nm, which is very visible, and a ruby-red color rather than the orange-red of a He-Ne. They also sell infrared laser diodes that operate at 780 nm, which is barely visible. In addition, they are carrying visible laser diode modules which have their own drive circuitry inside. A couple of these are quite pricey, ranging from \$75.00 to \$200.00 in single quantities.

Diode lasers are different from He-Nes and other lasers because of their power requirements and beam profile characteristics. Sans a lens, a diode laser beam spreads out rapidly, losing power at a short distance. This is called **ASTIGMATISM**. The neat thing about a diode laser is its ability to be powered by just a couple of 1.5 volt batteries. However, I prefer to use a nine-volt battery or regulated power supply to allow more of a "cushion" in the circuit. Nevertheless, there are plenty of laser pointers and modules on the market which use two small 1.5 volt, common batteries. They have integrated circuit regulated power supplies inside that make the adjustment automatically for the lower voltages without potential for destruction of the laser diode.

Speaking of destruction, a laser diode is **VERY** sensitive to stray static electricity charges. If you work with these, you must take proper measures to eliminate static. One is a wrist strap grounded through a one megohm resistor to a utility (earth) ground. This can be homemade, such as from aluminum foil you place around your wrist. Be sure and use the resistor and keep away from directly grounded objects like if you have such an arrangement with your metal worktable. Since, otherwise, if your soldering iron or power supply developed an internal short, you could be electrocuted if you were connected between the faulty equipment and an earth ground. But this applies to all electronic equipment.

Next comes the soldering iron. It, too, must be grounded. In this case, you can either purchase an already grounded iron, or add a ground wire that runs from the iron to a utility ground. If you intend to work on a metal worktable, that should be grounded too. Your diode(s) want to be kept in their protective static-proof containers until you're ready to assemble and have taken the above precautions. If you think I'm being fussy, consider this true tale: A fellow told me about walking across a rug, touching a then \$100.00 diode, and blowing it out! Once the diode is installed in your circuit, it will be far less

{1} I am not affiliated with Digi-Key, nor any other company mentioned here, but often mention D-K in articles because of their excellent selection of products and quick service. Request their free catalog, and you'll never regret it.



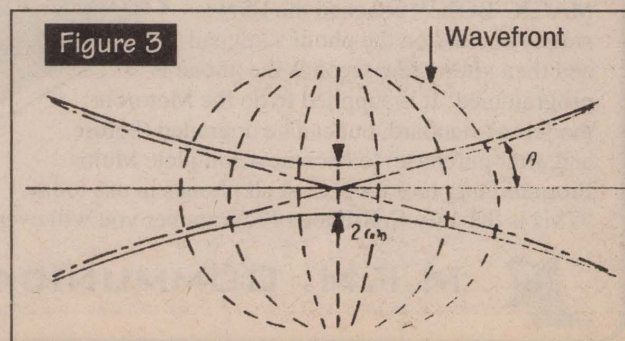
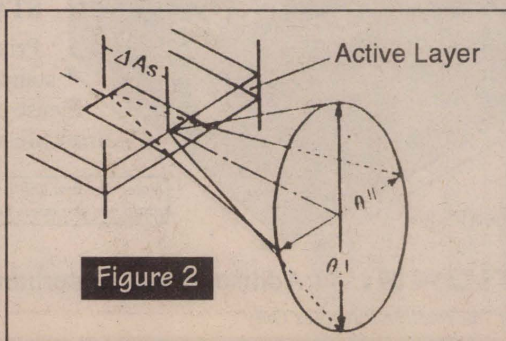
likely to be bothered by static. Keep it away from high voltage, though. Use 0.1 uF bypass capacitors on the circuit board across the power supply rails and you should have no problems.

### Soft Start Circuit

Diode lasers are also subject to voltage SPIKES which can ruin them. Use a 47 to 100 uF capacitor across the power supply rails so that the laser can start running without the possibility of voltage spikes. Figure 1 shows one simple circuit to satisfactorily drive a laser diode without incorporating the feedback internal diode

in the circuit. This is courtesy of MWK Industries. They sell several laser diode types and are listed in the Sources box. I have modified the circuit minorly by adding a capacitor (value is not specified; use your own judgement and available parts) across the power supply rails as shown, thus increasing the survival percentage of the laser diodes. Several common 780 nm diode configurations are shown; these are typical of what one finds in CD players, but the circuit also applies to visible laser diodes.

Should you want a more sophisticated set-up, which will cost you more, contact Meredith Instruments who appear in Sources. It is interesting to see what





**Table 1**  
**Some Visible Laser Diode Wavelengths**

Wavelength in nanometers	Color
633	Orange-red
635	Orange-red
640	More reddish
650	Red
655	Red
670	Quite red
680	Darker red
685	Darker red
690	Ruby red
750	Dark ruby red
780	Barely visible
785	Barely visible
790	Practically invisible
800	Invisible

**Note:** There are many, many types of laser diodes available. From a few milliwatts to 150,000 watts (on a pulsed basis). Most of these emit in the infrared spectrum, which doesn't concern us at the moment. To list them all would take two or three columns!

diode manufacturers and vendors offer. Much is now pre-assembled using surface mount technology. This has the advantage of short lead lengths and using an advanced technology which combine to lessen the potential damage to diodes, increase efficiency, and lessen power consumption.

If you want a first-class experimenter kit, you may

want to contact LNS Technologies, who is also in Sources. While their kit isn't the cheapest, the superb manual and Heathkit style of their engineering makes the assembly and usage a pleasure. Plus, they offer an inexpensive repair service if you have a problem.

## Optical Astigmatism

Figure 2 shows the astigmatism of a laser diode and its beam geometry. Lensing is essential for a tight beam. Diode lasers use what is called an ASPHERIC lens to achieve tight (or any) collimation. That is a lens which combines several lens geometry configurations in one unit. Aspheric lenses may be either plastic or glass. The plastic ones are cheaper, of course. Lenses are available from several dealers in the Sources list. Investigate who has what, and their current availability.

Note the geometry of the beam pattern as depicted in Figure 3. The BEAM WAIST is also different from He-Ne and other gas lasers. Clearly, we have a peculiar profile as

compared to a He-Ne, hence the need for aspheric lensing.

## Laser Diode Structure

Figure 4 shows the basic structure of a laser diode. Note the interspersed layers of different

semiconductors. It is fascinating that the precise arrangement of these materials provide internal mirrors, where the laser beam is amplified and bounced from mirror-to-mirror. After many bounces, which amplifies the weak laser light, output eventually becomes a usable laser beam. Note the tiny size of the diode laser chip; uM is an abbreviation for one-millionth of a meter, so these are pretty small.

Figures 5 and 6 show different structures of the layered semiconductor material that make up two different diode lasers. Figure 6 is particularly interesting because it shows convergence of three beams into one. This is not unusual, for the more powerful lasers have several beams that converge into one single beam.

## Integrated Circuit Driver ICs

There are several IC drivers available on the market. Most I've seen are made by Sharp. Surplus dealers often carry these along with a little resistor and capacitor kit so you can assemble your own power supply. Perhaps you'd like to explore the possibility, and it would make a great class project. We'd like to get into these in a future column. If you like the idea, drop us a note at the Laser Experimenter's P.O. box listed elsewhere in this column. Well, that's it for now. We shall see you all next time! **NV**

## Closing Quote:

"I am here to support the assertion that light of every kind is itself an electrical phenomenon — the light of the sun, the light of a candle, the light of a glowworm."

— Heinrich Rudolf Hertz  
German physicist (1857-1894)

## SOURCES

**MWK Industries**, 1269 West Pomona, Unit 112, Corona, CA 91720; ph: (909) 278-0563, FAX: (909) 278-4887. Hours: 8-5 PST weekdays, 10-3 Saturdays. Free catalog. Source for new and used laser equipment, supplies, and optics. Carries a wide variety of He-Ne, some laser diodes, and other lasers suitable for the experimenter hobbyist and professional.

**Meredith Instruments**, P.O. Box 1724, 5035 North 55th Avenue #5, Glendale, AZ 85301. Order line: (800) 722-0392, FAX: (602) 934-9482, Internet: <http://www.mi-laser.com> — Carries new and surplus laser diodes and driver modules.

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**Society for Amateur Scientists**, 4951 D. Clairemont Square, Suite 179, San Diego, CA 91777; ph/FAX: (619) 239-8807. Internet: [scarlson@sas.org](mailto:scarlson@sas.org) Organization specifically started for gathering amateur scientists of all kinds together. Not a hobbyist organization unless you're serious.

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**Images Company**, P.O. Box 140742, Dept. N, Staten Island, NY 10314; ph: (718) 698-8305. Carries

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**Amateur TV Quarterly**, 1545 Lee Street, Des Plaines, IL 60018. Voice: (708) 298-2269, FAX: (708) 803-8994. Publisher of a magazine and several books geared to amateur TV. Mentioned here because of the general interest to experimenters and the parallel to our laser video endeavor. Contact them for the current pricing of a sample issue and brochure.

**Small Parts, Inc.**, 13980 N.W. 58th Court, P.O. Box 4650, Miami, FL 33014-0650. A valuable resource for construction materials, tools, and hard-to-find items such as telescoping tubing, sheet metal, metric hardware etc. Free catalog. Catalog requests: (305) 558-1255.

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**Geo-Monitor**, 65 Washington Street, #400, Santa Clara, CA 95050; ph: (408) 749-6770, FAX: (408) 249-3780. Publishes a technical newsletter about earth science, and may be useful to those interested in using lasers to record seismic activity.

**Edmund Scientific Company**, 101 East Gloucester Pike, Barrington, NJ 08007-1380; ph: (609) 573-6250, FAX: (609) 573-6295. Free catalog. Supplier of a wide variety of educational and scientific equipment including lasers and an extremely comprehensive line of optics.

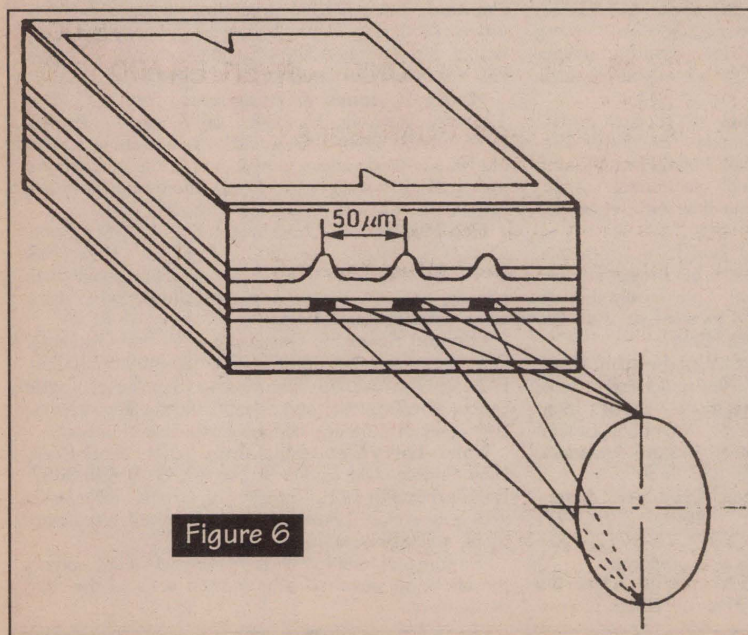
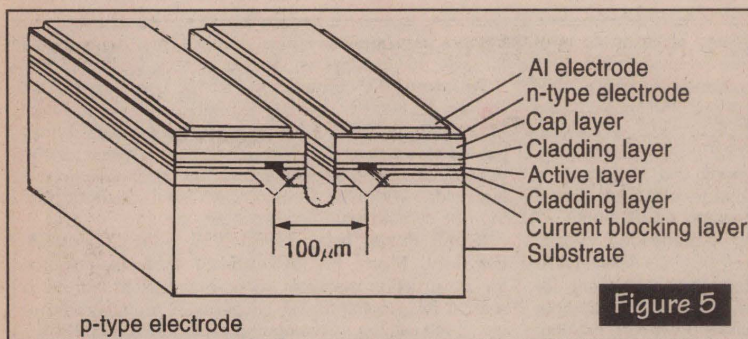
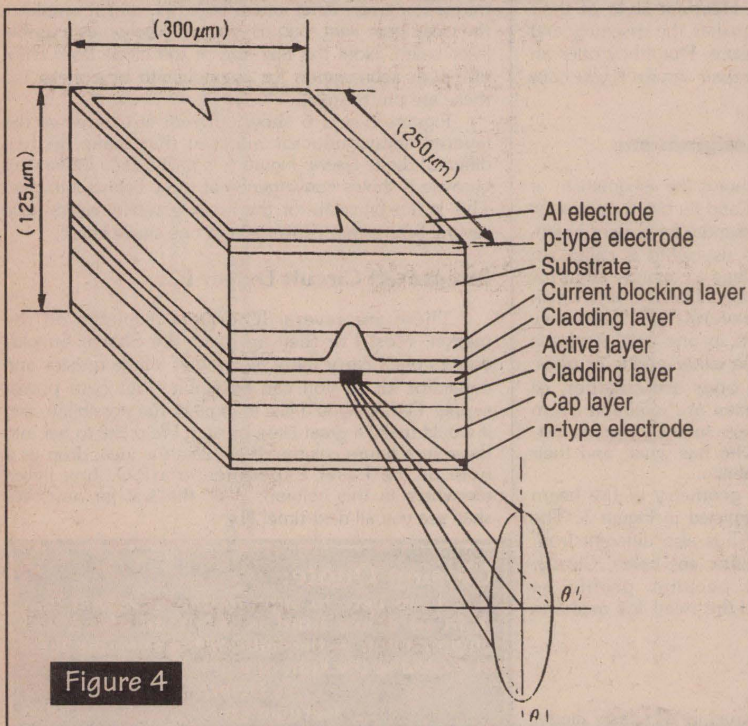
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# THE LASER

## EXPERIMENTER



Continued from page 93

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TD-5 module has several new features, including crystal control for precise tone accuracy and a convenient DIP switch for tone selection without test equipment. General information in the manual helps you install the module in any transceiver. It is available either as a kit for only \$39.00 or factory wired and tested for only \$59.00.

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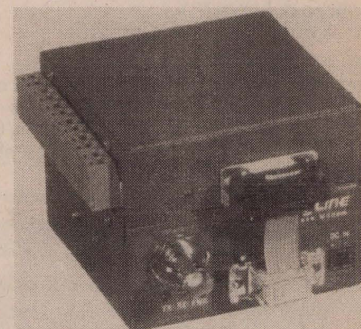
antennas, ground, lightning protection, tuned circuits, and detection are covered for the beginner. The unending compromise between selectivity and sensitivity is discussed for the crystal set designer. Advanced topics such as the use of multi-tuned circuits and wave traps follow for the more experienced experimenter.

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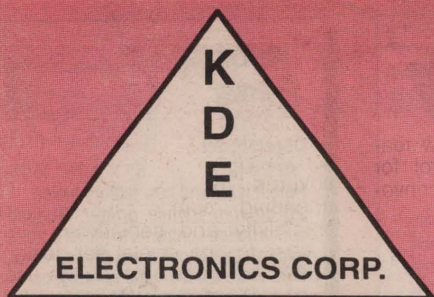
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Continued on page 114





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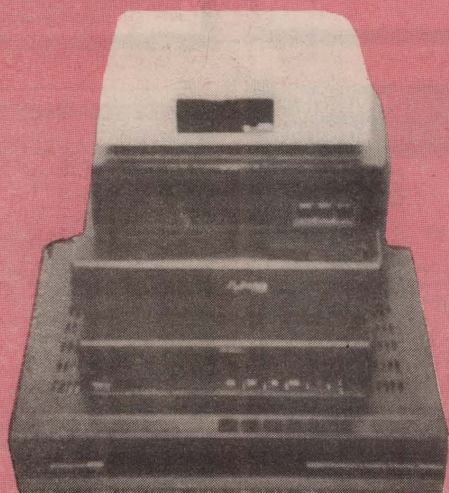
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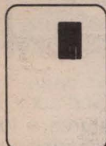
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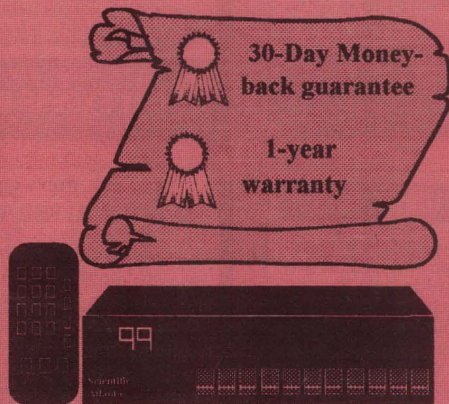
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Continued from page 110

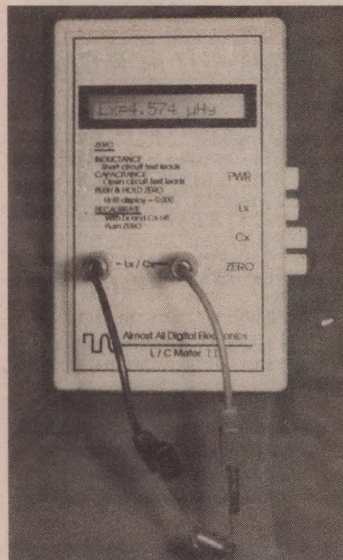
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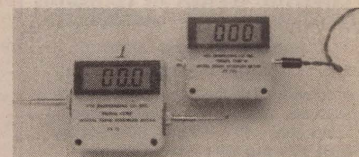
types of inductors and capacitors commonly used in RF and audio circuits. L/C Meter II features a four-digit display plus engineering units (pF, uF, uHy, mHy).

L/C Meter II is available as either a complete kit priced at \$79.95 + \$4.00 S/H or completely assembled for \$99.95 + \$4.00 S/H. Due to its unique self-calibration, the kit version of L/C Meter II is a "put it together and it works" project.

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# MICROWAVE EXCITEMENT AT 10,000 MHz

by Gordon West

**T**he amateur radio 10,000 MHz microwave band is called "X-BAND." It's also known as "10 gigahertz" (GHz), actually pronounced 10 "jig-a-hertz." Look it up in the dictionary. The first letter "G" is soft like the letter "J!"

The amateur X-band extends from 10,000 to 10,500 MHz. This is an incredible 500 MHz of spectrum that we need to use, or quite possibly LOSE. You see, every now and then, Federal and private radio spectrum prospectors will tune up certain areas of VHF, UHF, and microwave frequencies and take a spectrum analyzer "snapshot" to prove band occupancy or radio band dis-use. If the X-band is grossly under-used by amateur radio operators, it's relatively easy for the private sector to call this to the attention of the Federal Communications Commission and come up with a plan to take over the ham-unused band and sell it off making gazillions of dollars for both the Feds, as well as privateers looking for more frequencies. And between you and me, I hope they don't take a snapshot today because the ham activity on 10 GHz isn't all

ate on the amateur radio X-band, with no licensing and operating restrictions other than a valid ham ticket, with or without code, Technician level or higher. For you non-technical hams, you could pick up the Tech ticket in about three days by studying my no-code-plus book available at all Radio Shack stores.

Ten thousand megahertz (10,000 MHz) is not unreasonably high for quality, medium-range and sometimes long-range microwave communications.

**Wide-band FM voice**  
**Narrow-band SSB voice**  
**Spread-spectrum voice**  
**Amateur wide-band television**  
**Amateur television repeaters**  
**FM and SSB repeaters**  
**CW propagation beacons**  
**Weak signal SSB and CW tropospheric ducting**

At 10,000 MHz, well above the marine radar bands and well above most home microwave oven frequencies, two-way SSB contacts well beyond 1,000 miles have been established. In August of

1994, armchair copy communications on 10,000 MHz were conducted between XE2/N6XQ in Baja, CA up to WB6CWN way up near the San

tain-top stations, and up to 400 miles and more during X-band contests when participating hams bring out their big microwave dish antennas and go for the best range possible from the very best location.

Up on 10 GHz, location is everything. Since we are transmitting on microwave frequencies which are identical to X-band radars, things in the way will block great range capabilities. Two X-band stations transmitting a fraction of a watt into modest horn antennas might only work a couple of miles with homes and trees in between their microwave path. If both stations went to their roof tops, range could expand out to 10 or 20 miles. If one station went to the top of a hill, and another station went to the roof of an office building, range could expand out to 50 miles. If both stations went to big mountains, X-band communications could conceivably span to the line-of-sight distance between both mountains in relatively calm, warm air.

A good way to approximate microwave range in miles is to take the square root of the building or mountain height in feet, and the square root of the other station's height in feet, and add these two numbers together for your estimated communications range at 10,000 MHz. For instance, a microwave operator running equipment atop a 100-foot building would give you a line-of-sight-to-the-horizon range of 10 miles. This is calculated by the square root of 100 feet of height equaling 10. If the other microwave station has driven up to the top of a 5,000 mountain peak, their line-of-sight-

range would be about 70 miles. Now add 70 miles plus 10 miles, and 80 miles is your minimum microwave communications range. Since atmospheric refraction adds about 20 percent additional range, you could probably stay in touch out to about 100 miles separated. During periods of tropospheric ducting where microwave signals get caught up in an upper inversion layer, the range could be as much as 200 or more miles. Maybe even 300 miles over water. Maybe more.

You are probably beginning to wonder why I'm not talking much about microwave power levels. The reason I don't talk about them much is because the power levels aren't much! One hundred milli-

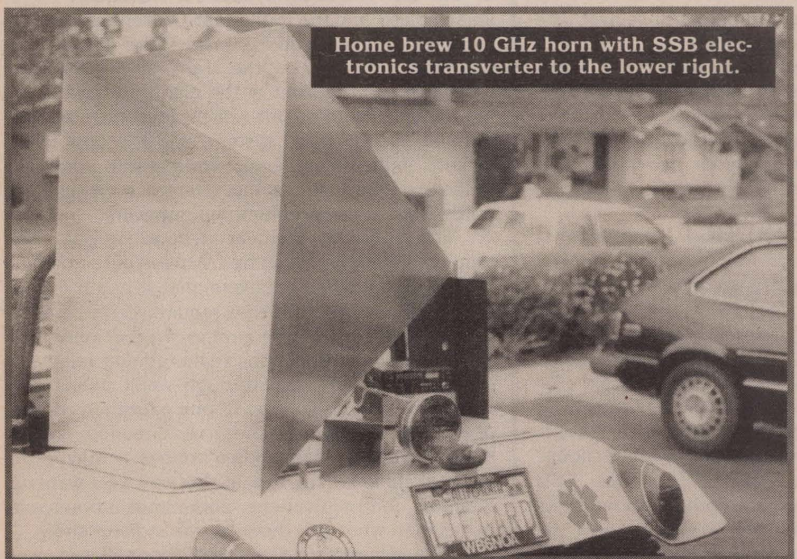
watts (0.1 watt) is quite common at these frequencies. One-tenth of a watt, on a line-of-sight basis, could carry well over several hundred miles with the right type of antenna and a good amount of antenna gain. More about antennas later.

One hundred milliwatts is the operating level of most start-up microwave systems that are pur-

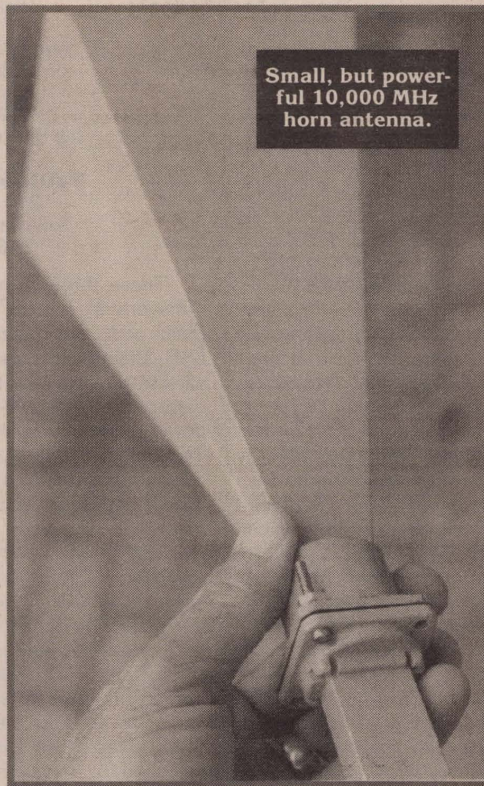
Waveguide joints at 10 GHz must be perfectly aligned to minimize SWR.



Home brew 10 GHz horn with SSB electronics transverter to the lower right.



Small, but powerful 10,000 MHz horn antenna.



Francisco Bay area, spanning over 1,124 miles — earning these two microwave ham

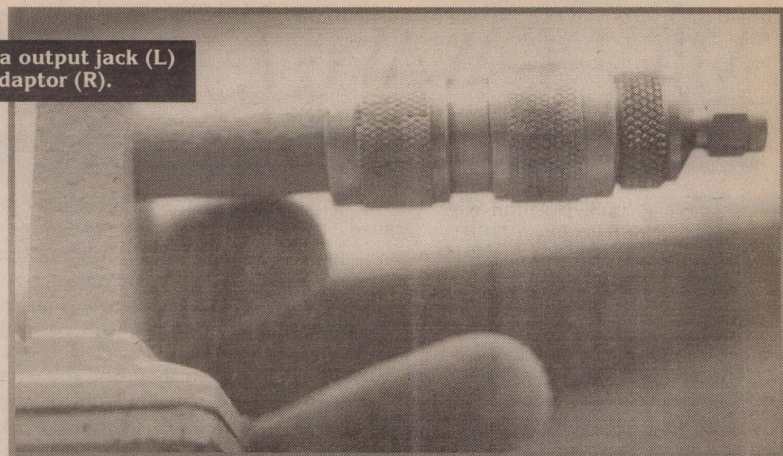
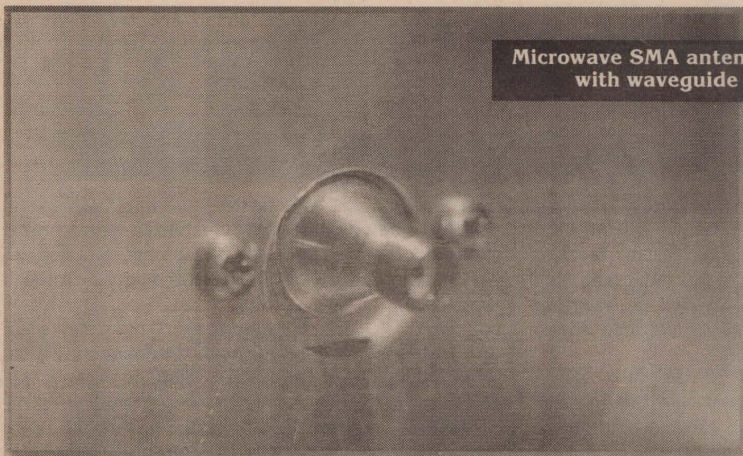
operators a place in the X-band record book. Typical communications range on X-band is about 50 miles for low-level stations, 100 miles for moun-

that much.

Hopefully this article will help. It takes only a no-code Technician class license or higher to oper-



Microwave SMA antenna output jack (L)  
with waveguide adaptor (R).



chased over-the-shelf, ready-to-go, or put together in modules. Some microwave home brewers are working down at the 10 milliwatt levels, using automatic door opener gunnplexers within the heart of their X-band system. Ten milliwatts will go just about as far as 100 milliwatts on a line-of-sight basis.

Where higher power counts is when trying to jam a signal through trees, clouds, rain, and taking a bounce off of a nearby mountain or building. Power levels approaching one watt work nicely in these applications. But to obtain one watt output at 10,000 MHz, relatively expensive power amplifiers called "traveling wave tubes" may need to be employed.

Power levels at 100 milliwatts are readily available in 10 GHz pre-assembled or kit systems. For over 15 years, a fully assembled, tuned, and tested 10 GHz FM transceiver is offered by Advanced Receiver Research (P.O. Box 1242, Burlington, CT 06013; 203-582-9409). You can order the equipment with either 10 milliwatts or higher output levels, and this is plenty to get you on the air.

The ARR transceiver comes with its own plastic horn antenna; VXO for sliding up and down the band; and full-duplex, crystal-clear, wide-band FM communications to link up with other stations using ARR transceivers or homebrew gear.

All you need to do is add 12 volts and a simple crystal microphone, and you are set for action. The unit is ready to play, out of the box, and I have personally communicated well over 250 miles on FM at X-band using one of these low-power ARR transceivers.

Working another station for your first time on 10 GHz will require pre-planning. It's not that you can turn your set on, call a CQ, and instantly make a contact. Just won't happen. Even if you live on a hill. You need to set up a schedule, an approximate frequency, and precise antenna pointing in order to link up. Since we are up at microwave X-band frequencies, the antenna must be of the same polarization and aimed at the other station with which you are attempting to link up. Within 10 miles, bounces do occur. But beyond 10 miles, you need to take steady aim to lock onto the other station. The voltage-controlled oscillator (VXO) is similar to a "VFO," and your automatic frequency control is normally in the off position as you are tuning up and down the band ready to make contact with another station in the direction of your horn antenna. After a little bit of playing, you'll get the hang of tuning with one hand, swishing the horn back and forth with your other hand, and keeping an ear out for the FM carrier of the other station. Once you hear their carrier, they will hear your carrier, and both of you will be able to talk full duplex because your transmit and receive are separated by your 30 MHz intermediate frequency.

Once you begin to understand each other over the air, maneuver your antenna slightly left and

right, and zero in for the best signal. If you are more than 10 miles away, the signal will build and fade as clouds and warm/cool air masses refract and reflect your signals.

The Advanced Receiver Research 10 GHz amateur transceiver is a fun way to get started on microwaves. But this unit is not going to lead you to any DX record because wide-band FM is simply too wide and too noisy for microwave weak-signal work. When you have worked at least 20 other FM X-band stations, time to graduate up to single side-band and CW.

Ten gigahertz (10 GHz) SSB transceivers are not available "over the counter." But they do come pre-assembled into modules that you can pull together in just a few days.

#### **SSB Electronics**

124 Cherrywood Drive  
Mountaintop, PA 18707  
**717-868-5643**  
(Ask for Jerry.)

#### **Down East Microwave**

P.O. Box 2310, RR 1  
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(Tell them Gordo sent you.)

#### **Pauldon Associates**

210 Utica Street  
Tonawanda, NY 14150  
**716-692-5451**

These three companies offer 10 GHz X-band transverters. The transverter must be driven by a multi-mode, two-meter or 10-meter transceiver. The SSB Electronics transverter works nicely with almost any type of two-meter, multi-mode transceiver when the two-meter set is run in the low-power position. Transverters cannot run with more than one watt input, and SSB Electronics has a special circuit which keeps your two-meter SSB mobile or base station from overpowering the input.

The transverter will take 10,000 MHz microwave signals and downconvert them to 144 MHz or 28 MHz. When you go into transmit, the transverter up-converts your 28 or 144 MHz signal to the desired operating frequency on X-band. The SSB Electronics system includes pre-assembled modules that are "plumbed" with tiny RF rigid copper coax sections, fitted with SMA connectors to keep losses down. The antenna switch-over relay is designed for microwave frequencies with negligible loss on X-band. You can write or call SSB Electronics for a detailed look at the required modules for X-band and pictorial layouts on how the system can go together as a weekend project once you have "plumbed" all of the pre-assembled pieces together. The modules are from Europe, but each one is tuned and tested by Jerry at SSB Electronics.

The output of the X-band transverter terminates to a gold-plated SMA receptacle, and here is where your antenna system begins. On microwaves, coaxial cable only a few feet in length can quickly attenuate weak signals. Ten gigahertz (10 GHz) waveguide is the answer, and SMA-to-waveguide adapters are easily seen for a few bucks each at ham swap meets. They are also seen, brand new, for over \$100.00 in catalogs! I suggest you try the swap meets first!

What you are looking for is a "WR-70" transition which may accept the SMA or end-connector and transition to 7,000 MHz-12,000 MHz waveguide. I prefer a short section of flexible waveguide between the output of my X-band transverter to the horn or dish antenna I plan to use. A four-foot section of flexible military surplus waveguide can be seen selling at hamfests for under \$40.00, but if you price it out new expect to pay over \$100.00. Again, shop the swap meets.

Your antenna system at X-band may be a simple horn to get you started. Small plastic horns with a radio-reflective metallic coating are an inexpensive way to beam your signal out and receive other signals up to about 50 miles away. The horn is rather broad in its transmission and reception, and 10 or 15 degrees either side of "dead on" will still lead to reasonable communications. But for the more serious DX operator, a two-foot or four-foot dish is preferred.

The two-foot and four-foot parabolic dish antennas have a variety of opportunities to feed them. At my 10 GHz station, I feed from the back of the dish through cylindrical waveguide to a splash plate, and the round plate in front of the dish captures full illumination of the entire dish. Other operators may mount the transmit portion and receive section in front of the dish and have nothing behind. There are also offset feed systems, the popular "penny feed" system, and the opportunities are endless if you enjoy working with parabolic reflectors. Many times the circular waveguide is made from common plumbing hardware.

The two-foot dish at X-band frequencies requires you to be within five degrees of the distant X-band signal when relative signal strength is low. Four-foot and six-foot dishes require you to be within one degree of precise aiming. When signals are strong, multiple reflections make aiming relatively simple. Swing the dish through weak peaks and valleys; and when you get to one extremely strong peak, that's probably the true direction of the incoming signal. Maybe it's a bounce — maybe it's the real thing — but this is the way you want to maintain communications. Sometimes a bounce is better than what you thought was a direct shot.

X-band contacts are usually coordinated over the two-meter band. In Long Island, NY, there are regular VHF nets to encourage X-band equipment construction and X-band operation. It has been found that handheld signals on two meters approx-



imate the results you are going to obtain at 10,000 MHz. If you can communicate on two meters with low-power handhelds, you can certainly make the grade on 10 GHz X-band. However, if you and the other station can't hear each other on two meters handheld, chances are you won't be able to make the X-band path work. I have never, never, NEVER found that I could establish communications on 10 GHz where I could NOT on a pair of two-meter handhelds. Nor have I ever found crystal-clear two-meter handheld communications that I couldn't easily do on 10 GHz.

Many microwave experts have put up X-band beacon stations specifically to attract newcomers to 10 GHz, and to assist newcomers in perfecting their antenna and receiver systems by having a reference signal on the air, 24 hours a day. The frequency 10,368.185 normally downconverts to 144.028 to begin your search! If your local X-band beacon is slightly higher in frequency, tune higher on your two-meter, multi-mode transceiver. If it's lower, tune lower. Most beacons run horizontal polarization. Most usually operate CW, and continuous beacon reception is easily possible up to 100 miles distance. Continuously transmitting beacons will allow you to fine-tune your system on receive; and when you have increased reception capabilities through antenna improvements, transmit range will also increase, too.

### How Much Will It Cost?

The Advanced Receiver Research 10 GHz completely assembled set-up, Model TR10GA, running 10 milliwatts output, runs about \$500.00. Add 12 volts, plus an external speaker or headphones, provide a simple Radio Shack high-impedance mike, and you are on the air, full duplex. There are plenty of other operators out there on 10 GHz wide-

band FM, so you'll have plenty of folks to talk to.

If you're putting together the transverter system, expect to pay about \$1,000.00 for the necessary pre-assembled modules:

XLO-1 local oscillator module  
XRM-1 10.368 GHz receive downconverter  
XTM-1 10.368 GHz transmit upconverter  
HP8761 single-pole, double-throw RF switch  
SMA to 10 GHz waveguide adaptor  
Control relay  
Output TR relay

You will also need to score a multi-mode two-meter or transmeter radio to act as the transmitter/receiver system that is necessary for the transverter. You can sometimes find used multi-mode equipment for as little as \$300-\$500. Even inexpensive 10-meter SSB sets converted from the CB radio service could work as your transmitter/receiver. Be sure to specify what frequency your system is running on, in order to obtain the right transverter modules.

Suitable waveguide will be "WG16," 29.8 mm by 39.4 mm, flexible, about five feet long, under \$100.00.

You can build your own dish antenna and save big bucks, or spend big bucks like \$500.00 for a perfect spun-aluminum 10 GHz dish. I would rather build my own, and the \$30.00 VHF/UHF manual from the Radio Society of Great Britain, available at all ham radio stores, offers multiple pages of microwave homebrew projects. The RSGB VHF/UHF manual, now in its Fourth Edition, is considered the \$30.00 "bible" for homebrew enthusiasts at microwave frequencies.

The American Radio Relay League sponsors 10 GHz contests on August 17 and 18, as well as on September 21 and 22. These weekends bring out more 10 GHz activity than any other time of

year. You should plan ahead and try to uncover which two-meter frequency will be used for coordination. Almost all coordination takes place on two meters. Ask on your local repeater where the 10 GHz X-band groups hang out. Each area has their own two-meter favorite frequency, almost always simplex. Remember, if you can easily communicate between you and the other station on two-meter simplex with a handheld, this is easy X-band communications range.

So give X-band a try. It is by no means the very highest microwave ham band — there are five others even higher — and ARR even builds a 24 GHz system once the bug strikes! And every time you see a small dish on a building top, chances are it's a commercial microwave system operating well up to 100 GHz. And if you still want to operate higher, read over the laser communications column in this same magazine and see what happens when microwaves turn into lightwaves.

Enjoy X-band with your amateur radio license.  
NV

Some sources for 10 GHz and microwave building are:

**Holzman Electronics**  
108 Sawtell Ave.  
P.O. Box 2421  
Brockton, MA 02405-2421

**Danielson Sales**  
508 South N St.  
Indianola, IA 50125

**K-Mec**  
4862 Montgomery Rd.  
Ellicott City, MD 21043

## TECH FORUM

Continued from page 65

In practice, you may actually find it easier to do what I did: use a simple analog ramp generator and comparator. Let me refer you to my favorite IC, the LM3900 quad current-difference amplifier. Get the data sheet, or consult a good cookbook.

It's easy, with just a few components, to build a ramp generator that ramps from nearly 0 VDC to nearly VCC with very good output linearity. The key is to have ramp reset every time the AC power line voltage crosses zero; again, you can use one section of the LM3900 for the zero-crossing detector. Now each time the power line sine wave goes from 0 to 180 degrees, your ramp will go from minimum to maximum. Use another section of the LM3900 to amplify (and, if necessary, invert) the DC signal from your sensor.

Finally, a section of the IC serves as a comparator. When the [amplified] sensor voltage equals the ramp voltage, the comparator output will turn on an opto-isolator. The output of the opto triggers your thyristor circuit and turns on the load. As the sensor calls for more power, the comparator will switch earlier in the power cycle, and more power will be delivered to the load. Purists will point out that a graph of power delivered, relative to turn-on time (in degrees past zero-crossing) is not linear; while the ramp is linear. Therefore, the control curve of sensor voltage, relative to power delivered, is NOT a straight line. That's true. BUT many sensors don't have linear output

in the first place. And, in any case, the system will eventually reach equilibrium, settling down to the amount of output power you need to maintain the sensor at the desired setpoint.

At first glance, this circuit may not be seem glamorous, but it has advantages. The chip count is lower than with a pure digital circuit. There's no code to develop, as with a micro-controller approach. Adjustments are as near as your nearest trimpot. And finally, it will work with a minimum of debugging.

**Greg Miller**  
State College, PA

### ANSWER TO #8966 - AUGUST 1996

Seems like someone is always asking how to change apples into oranges or make do with something through extensive modifications. I won't say it's not possible to modify a two meter rig for aviation band, but there is a big difference besides frequency, namely that aviation bands are AM, while two meter is FM. The answer to this question, besides changing crystals, would be to re-tune the front end and output stages, possibly requiring component changes. It's a big jump. But even if that were accomplished, converting from FM to AM is not practical, especially on a nice, compact solid-state rig. Then there's the issue of licensing ... how small is this foreign country, and would such a non-approved transceiver even be legal?

**Richard M. Nelson**  
Newport News, VA

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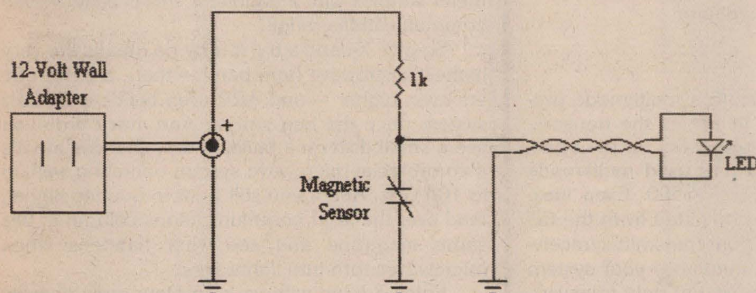
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systems. Basically, it's a magnet/reed relay that's closes when the door is closed (you can get switches that open when the door shuts, but at higher cost). You can buy them at most hardware stores and any Radio Shack for about \$5.00. You'll also need a power source. I suggest a 12-volt AC-to-DC wall adapter, like those used for wireless phones and Ninetendo (Radio Shack has a good selection of them). The fact that you have a voltage dropping resistor makes this an easy fix. Here's how it looks:



Of course, you'll have to position the magnetic switch so that when the garage door is fully closed, the reed relay closes, too, and shunts the current from the LED to ground. You may need to adjust the value of your dropping resistor for the new voltage (halve it), but probably not.

### Screen Goes Black At Boot

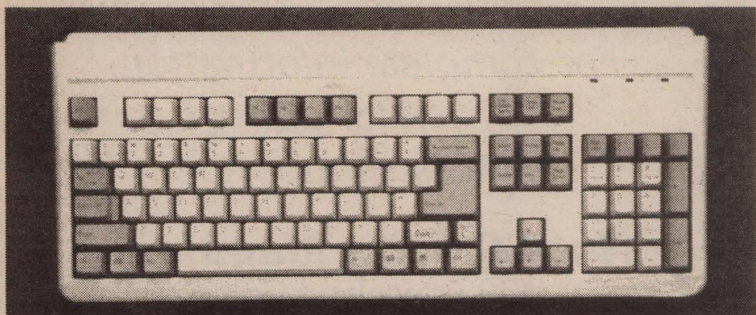
**Q.** I have a 486-50 PC that quit booting up right. I replaced the back-up battery, but still nothing. Sometimes I get a screen for a brief period, but then it goes black. I've tried delete, etc. Nothing works. Are there any programs/methods I can use that does not require the use of a monitor to get my PC running?

**G. Hall**  
Mineral, VA

**A.** I have two thoughts on the subject. My first take is that you've changed the video somehow, and it's Windows that's going blank, not your PC. What I'd do is insert a floppy DOS boot disk, any version beyond 5.0 will work, change to the WINDOWS directory, and type SETUP. Now choose VGA from the video offerings, remove the diskette and reboot. If you can't get a DOS prompt using this method, try another video card and/or monitor. Second, have you installed a new adapter lately? 486-50 motherboards are very finicky because of the 50-MHz bus speed. All too often they crash at the least change. My suggestion is to backtrack, removing one card at a time — power off, of course — until the problem is cured. Been there, had to do that.

### Keyboard Error

**Q.** I just upgraded my computer's motherboard and CPU and have run into an annoying problem. When I turn on the computer, I get a "keyboard error or keyboard not present" error message along with an alarm signal. The problem goes away if I unplug and then plug in the keyboard and hit reset. If I turn on the computer with the keyboard unplugged, I still get the error message, but not the alarm. I think it's a keyboard problem. My current configuration is a Rhino 9 motherboard with Award BIOS and a Cyrix 6x86 P120+ CPU. The keyboard is made by IBM in 1986 and says model M on the underside label.



**D. Deutscher**  
via Internet

**A.** It's been a long time since I've seen one of those keyboards. Chances are you've spilled more than one cup of coffee on it, and it's survived as well as can be expected. I believe it's now time to retire it. I say that because the fact that you've upgraded to a 6x86 CPU tells me you've also upgraded to Windows 95, in which case you'll want a Windows 95 keyboard, like the Nova 9500 from Maxi Switch (602-746-9378). But there is one more thing to check first. Check in your BIOS setup (press Ctrl-Del on power up) and see how the BIOS recognizes the keyboard and responds to errors.

### Needs Obsolete Timer

**Q.** The LM322N timer IC is no longer available. Is there a direct substitute?

**Ramon Eller**  
Pittsburgh, PA

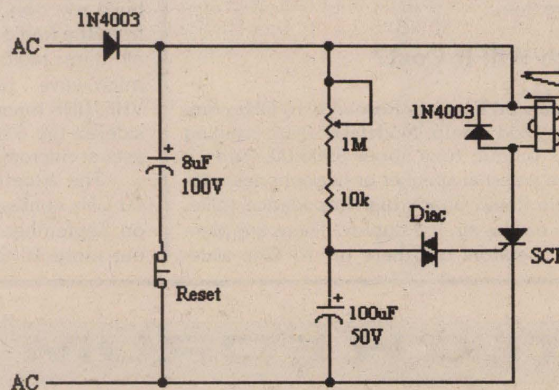
**A.** Nope. However, there are still some LM322N chips in the pipeline. I located three with my first phone call (415-457-0466); Digi-Key (800-344-4539) is out of stock, though. The LM122 is electrically identical. It comes in a metal can and will fit in your 14-pin DIP socket with some lead twisting. National Semiconductor recommends using the LM555 for new designs.

### Diac Timer

**Q.** I've been using a UJT 4891 unijunction transistor to control an SCR in a timer circuit. Unfortunately, I can no longer find a source for them, and attempts at replacing it with a 2N6027 programmable unijunction transistor (PUT) have failed. Can you help?

**I. Adler**  
Highland Park, IL

**A.** Unijunction transistors have been largely replaced with diacs because of their simplicity and low cost. You can buy them from Digi-Key (800-344-4539) for under a dollar. The semiconductor diac is a fullwave or bidirectional thyristor. It's triggered from the blocking state to the conduction state when the amplitude of the applied voltage exceeds the breakover rating of the diac (typically 30 volts). When combined with a capacitor, the diac can be used to trigger an SCR or triac. Here's a typical diac timer circuit that should work for your application.

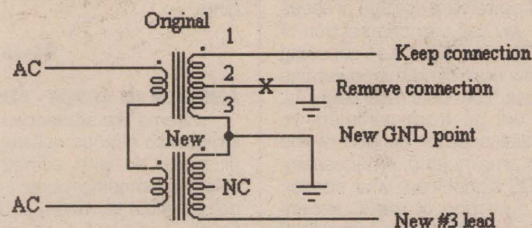


### 400-Hz Surplus Operation

**Q.** Do you know of a circuit that will convert 60-Hz AC to 400-Hz AC, something that can be used with military surplus items that operate on 400 Hz?

**John Janeczko**  
Haddon Heights, NJ

**A.** Here's a trick that we used use back in the 50s when W.W.II surplus was plentiful. Wire two 400-Hz power transformers in series, as shown below, and run them from 60 Hz. The catch is you need two identical power transformers, and you need to find a place to mount the new transformer in the surplus device.



### BASIC Stamp Problem

**Q.** I'm using a Parallax BASIC Stamp 2 with a 4066 analog switch. The Stamp output drives the 4066 control voltage. The 4066 switches are wired in parallel with four keypad switches, so that I can control the keypad from the BS2. Three of the switches work fine, but the fourth doesn't switch reliably. I've checked the BS2 outputs and they're fine. If I apply five volts directly to the 4066 control line the switch works, but it won't always close under program control. Any ideas?

**Andy Zaayenga**  
via Internet

**A.** It sounds like the output pulse of the BS2 isn't wide enough for the 4066 to react. It could be slow rise time, too narrow a pulse width, or a bypass capaci-



tor hung on that control line that's taking longer to charge than the rest. Check your program and increase the amount of time the output stays high, and see if that fixes the problem. If not, replace the 4066.

### Reader's Tip

In the August issue, you sent someone to HP for a test instrument HP manual. My experience is that it's much cheaper to buy them from a used manual dealer. For example, I just bought an HP181 manual, for which HP wanted \$39.00, for \$15.00. Here's where to buy used manuals.

**David DiGiacomo**  
via Internet

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(801) 882-7195 fax

#### Ed Matsuda

Test Equipment Manuals,

P.O. Box 390613, San Diego, CA 92149

(619) 479-0225

(619) 479-1670 fax

#### Deane Kidd

(Tektronics, mostly; some W.W.II military  
test equipment/communications manuals),

27270 NSW Ladd Hill Road, Sherwood, OR 97104

503-625-7363 (after 9 PM PST)

## MAILBAG

Dear Mr. Byers:

Your comment to Kim White in Highland, Illinois about satellite pagers finding her anywhere in the world hasn't proven true for me in Madison, WI and two co-workers in Milwaukee. Our Skytel pagers would not work inside our buildings at all. A metal roof or concrete floors seem to stop the weak radio signal from the satellite. Pagers from local companies work much better.

**Roland Peck**  
Madison, WI

Dear Mr. Byers:

On page 118 of the August issue in the Electronic Q & A column, you gave the phone number for HP as 800-542-2844. I called the number and was informed by a gentleman that he was not HP and that he's not a happy camper because it costs him money for each wrong number. By the way, what is the right number?

**John**

Response:

I gleaned the document number and phone number from an HP Web site (they have more than one). A call to a live person at HP set the record straight. The correct numbers are **800-227-8164** if you have the document number and **916-783-0804** if you only have a model number. HP is in the process of correcting the error, and I assume an apology (at least) to Mr. Kane. I called both of the new numbers and verified them, as I usually do for most published numbers. From now on, I'll call them all!

**TJ Byers**  
Q & A Editor

Dear TJ:

I have a bone to pick with you on the subject of EDO SIMMs. In your Q & A column in the August '96 Nuts & Volts you state: "EDO memory sells for the same price as non-parity SIMMs, and can be used in all 72-pin non-parity systems." Well, according to my personal experience and my local computer guru, you are wrong — I was not able to use EDO SIMMs in my Acer 72-pin non-parity system. In the future, please refrain from making statements like this unless you've checked it out thoroughly for yourself.

**Chuck Olson**  
Washington Island, WI


Response:

Actually, this answer came from an EDO supplier, so I took it at face value. Sorry your Acer didn't accept it. I don't know why. Repeated phone calls to Acer gave me no answers. It's possible that the 4 MB of built-in RAM is causing the problem, but I can't see how. I have tried it since, and EDO memory works in my old 486 motherboard. I wonder if other readers are experiencing similar problems? If so, please contact me.

**TJ Byers**  
Q & A Editor

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P015K	5K Ω	.69	.66	.59
P0110K	10K Ω	.69	.66	.59
P0120K	20K Ω	.69	.66	.59
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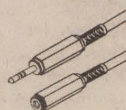
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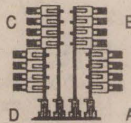
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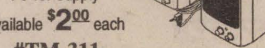
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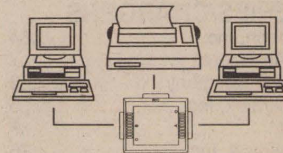


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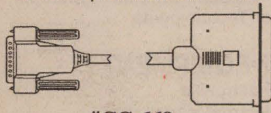
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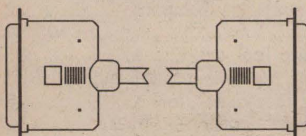


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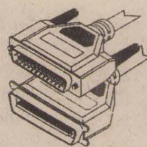


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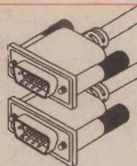
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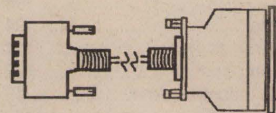
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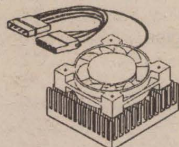
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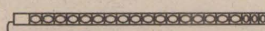
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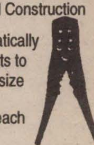
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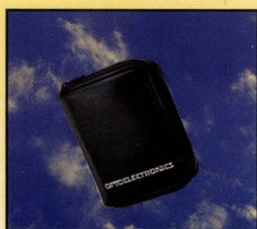
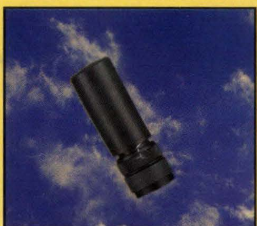
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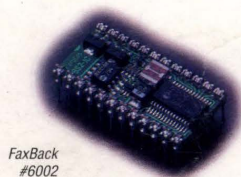
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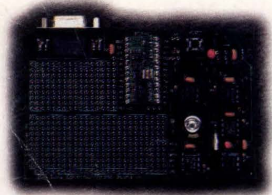
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Charles Walsh and his students in Great Falls, Montana, use BASIC Stamps in robotics projects.



Marvin Green and his students in Hillsboro, Oregon, use BASIC Stamps to make small robots.



John McLean uses BASIC Stamps to gather data in Lechuguilla Cave (America's deepest cave, located in Carlsbad Caverns National Park).



Issac Kurtz and John Bishop use BASIC Stamps in artificial hands at the Bloorview MacMillan Centre in Toronto, Canada.

Although it may be difficult to see here, that's a BS1-IC next to the white wires.

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The list works like this: lots of people (currently 900) subscribe to the list, and then all questions and answers to the list are distributed to all members. It's a fun, fast, and free way to discuss BASIC Stamp issues.

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ADDRESS CORRECTION REQUEST

BULK RATE  
U.S. POSTAGE  
**PAID**  
V.Q.S.  
ENTERPRISES