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ELECTRONICS!

December 2000

Vol. 21 No. 12

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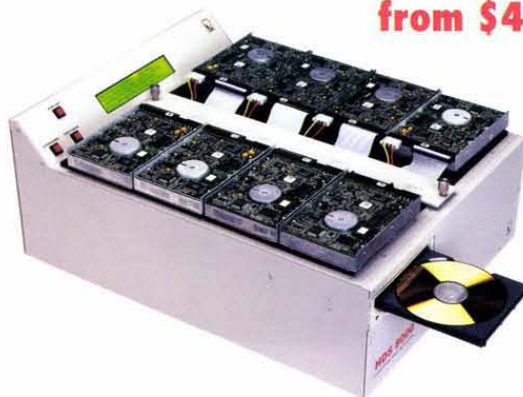
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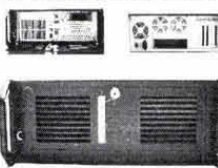
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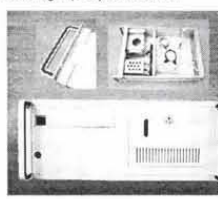


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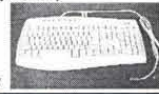
- ◆ "Voice Express - Mobile Pro" (Version 4) by L & H
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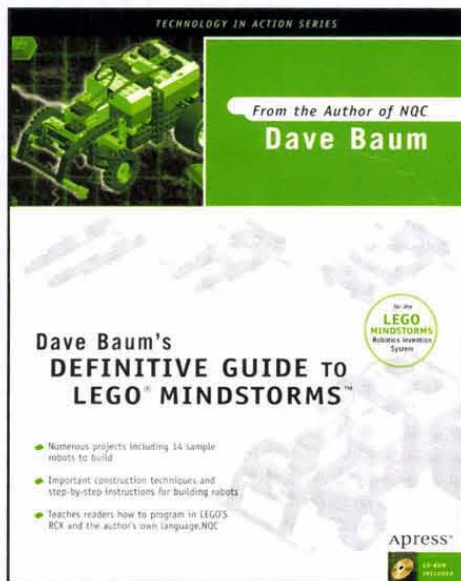
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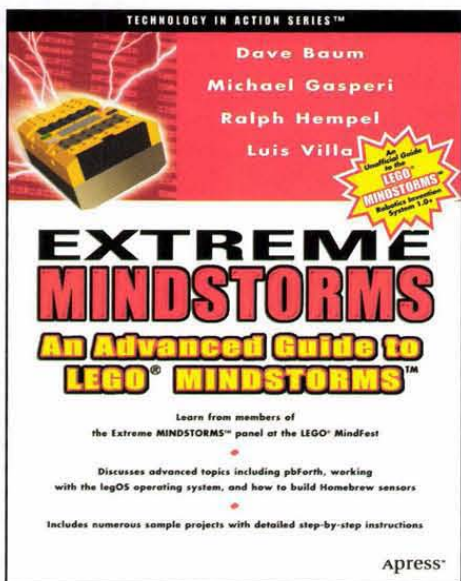


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Note that Baum's book covers not only version 1.0 of the LEGO Robotics Invention System but also the recently released version 1.5. Users of either version will be able to build the sample robots described in this book.



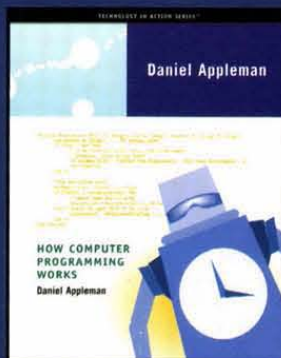
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HOLIDAY PROJECT

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**ELECTRONICS Q & A** 26 **TJ Byers**  
What's Up: The response to TJ's high-pass and notch filters in last month's column was overwhelming, so this month he has added instruments and web-sites that take the concept one step further. Specifically, a sensitive AC voltmeter, sine-wave generator, and three bipolar power supplies. There's also a 3.3V switching supply and a coaxial "bias-tee" power supply.

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## OZTRIP CAR COMPUTER 77

**Robert Priestly**

Whether on land or sea, the OzTrip Computer can be used to display trip info on 27 functions of speed, fuel, time, and distance of your "vehicle." It also includes a sprint timer which is ideal for timing a standing quarter mile, plus it can be used as a general-purpose data logger not even related to vehicles.

## BUILD YOUR OWN VOICE RECOGNITION X-10 CONTROL SYSTEM 87

**Dennis Shepard**

Man as long sought convenience and versatility in remotely controlling his world. A very popular format for doing this is with the X-10 protocol. Voice recognition has now made it possible to control these X-10 modules with your own voice and, with the project discussed here, for just around \$100.00.







## Holiday Project

# Sequencing and Dimming - Add Some Pizazz to Your Holiday Lights

by Eric Gunnerson

A few years ago, my wife and I accidentally won third place in a holiday light contest in our development. In an attempt to win the rarely coveted first prize, I decided to do a microcontroller-based project. In the years since I first got into electronics (when we — to paraphrase Douglass Adams — thought that digital watches were a neat idea), the amount of equipment needed to do microcontroller work has decreased by quite a bit, so it was a good fit with my first project, an animated Santa, sleigh, and reindeer. In this context, “animated” means lights that are sequenced, not moving parts. At least for this year.

The project discussed in this article is the outgrowth of that first project, and it supports dimming of lights in addition to sequencing them. With two animations in the yard, the general illumination of the house in white lights had become a bit boring, so a change was in order. Rather than use a single string to outline the house, I'll use four (in red, green, blue, and white) and use my dimmer to slowly dim between them. The idea came from somebody who used X-10 dimmers and a computer to do this, but my implementation will be a bit cheaper and will operate stand-alone. It can also do chaser lights and fine (per cycle) control, which I've implemented, but which may not meet aesthetic standards.

This project involves potentially lethal AC voltages. It's not particularly dangerous, but please keep that in mind when you're working with the AC circuitry. If you use this project outside, you'll need to protect it from the weather.

### Switching and Dimming AC Lights

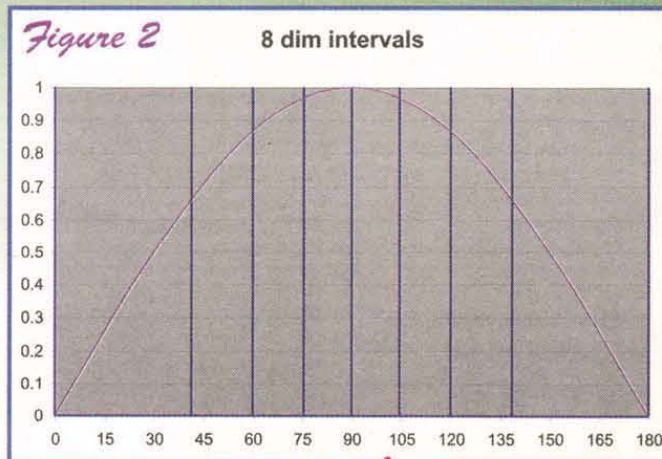
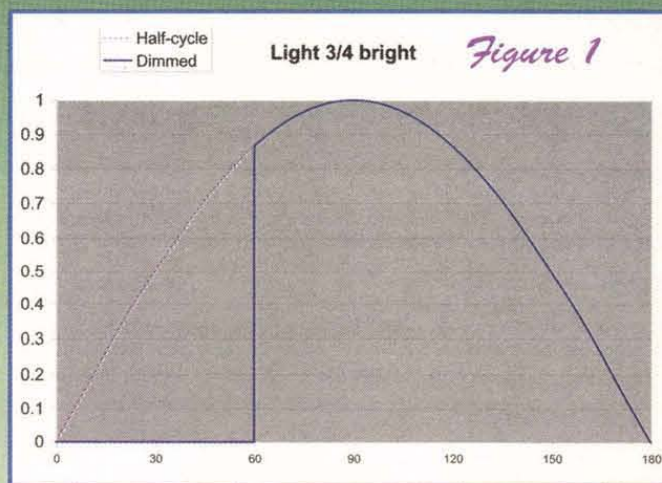
There are two ways to dim AC lights. The most obvious one is to simply reduce the voltage, which can be done either with a resistor divider,

or an autotransformer (also known as a variac). Neither of these are good solutions in this case, because they aren't easy to control electronically.

Though incandescent light bulbs have very thin filaments, there is still some thermal mass in the filament, as evidenced by the fact that you don't see a 60Hz flash from them. Even though the current is switching on and off 120 times a second, the filament maintains a constant brightness. We can take advantage of this for dimming by controlling the duty cycle of the waveform rather than the voltage of the waveform. To do so requires that we delay our turn-on from the zero-crossing of the waveform.

As you can see in Figure 1, we can get the effect of three-quarters of the voltage by only turning the power on for the appropriate part of the cycle. To get other dim levels, we simply vary the time at which we turn on the power. Since the light output of the bulb depends upon the amount of power we send to it, we need to choose our intervals so that they represent intervals of equal power. The power is represented by the area under the waveform, which is why the line isn't at the quarter point.

It's easy enough to calculate this for as many



dim levels as you want; the important point is that the intervals are not equally spaced. See Figure 2. This approach is fairly common in the DC world, as well; a heater can be nicely “dimmed” by varying



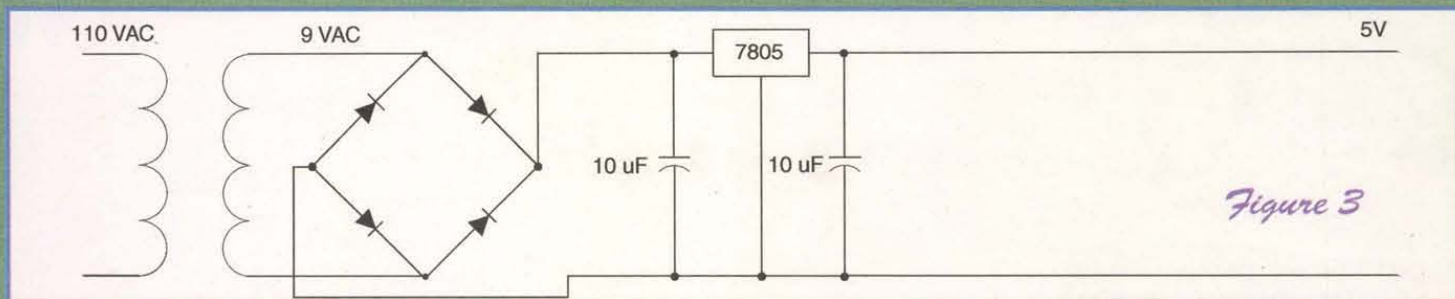


Figure 3

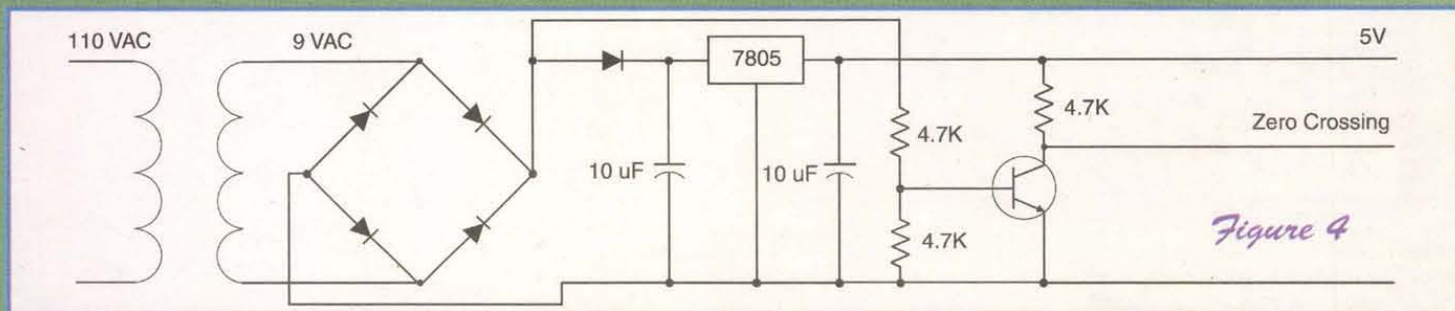
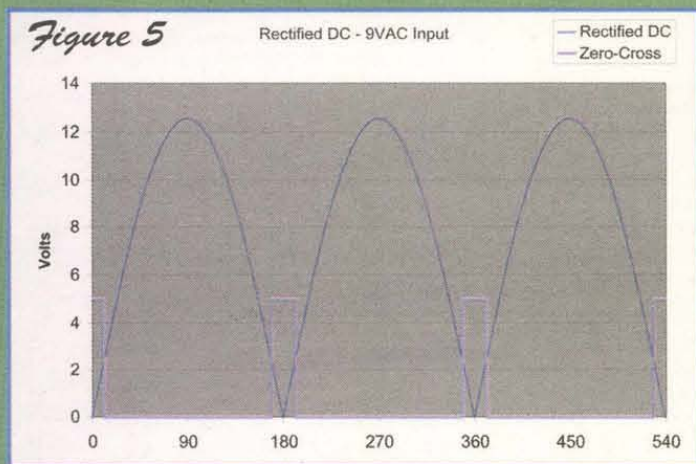


Figure 4



doesn't work. I've chosen to use a solid-state relay without zero-crossing circuitry, though they are less common, and doing this has limited the amount of current I can switch. You can build your own solid-state relays if you wish to control larger amounts of current; see the references for a good starting point.

### Hardware and Circuitry

Now that we understand how to do dimming, we need to choose the hardware we'll use to

do it. I broke the circuitry into three modules: the zero-crossing circuit/power supply, the microcontroller, and the AC box. All of this will be contained in something sufficiently waterproof; I've found plastic toolboxes a good choice.

### Zero-crossing Circuit/Power Supply

The zero-crossing circuit/power supply is quite simple. It starts as a standard 5V power supply using a 7805 regulator and a 9VAC transformer. This will provide power for the microcontroller and the solid-state relays. See Figure 3.

To generate the zero-crossing signal, we need to tap into the power supply after the bridge rectifier, so we get the pulsating DC at this point. The initial filter capacitor's job is to get rid of this signal, so we need to insert a diode in between the bridge rectifier and the capacitor.

Now that we have this signal, we want to generate a pulse when the signal is zero. We add a transistor with pull-up resistor and a voltage divider to the circuit. See Figure 4.

Figure 5 shows the pulsating DC and zero-crossing signals.

As long as the base voltage is greater than the

turn-on voltage of the transistor, the transistor will pull the output to ground. When the voltage drops below the turn-on voltage, the transistor will turn off, and the output will be pulled high by the resistor. Since the pull-up is to the 5V supply, we get a nice pulse that is nearly symmetrical around the zero cross point. This signal is connected to an input pin on the microcontroller.

The width of the pulse is determined by the input voltage, the resistors used in the voltage divider, the diode drops in the rectifier, and the voltage at which the transistor turns on. Rather than try to measure this, I put the signal on the scope, zoomed in, and made a reasonable estimate to the width of the signal. This value is used later.

### Microcontroller

For this project, I chose a Motorola 68HC11 controller (a 68HC811E2, to be precise). In my earlier projects, I chose this controller because it was fairly inexpensive, easy to deal with, and I had a local resource who had used them, and could provide technical support. It stores its program in EEPROM, and can be programmed over a serial link. It also lets me keep my assembly skills tuned up. For this project, the HC11 is especially nice, because of a feature known as output compare. More about that in the algorithms section.

The HC11 is built using Marvin Green's excellent BotBoard (see references). Though this board was targeted towards robotics, it's perfect for this project because it has a small prototype area for additional circuitry. Construction is very simple as long as you have a fine soldering tip and a magnifier (or young eyes).

### AC Box

Putting all the AC components in a separate box makes life a lot easier; you can't shock yourself when working on the BotBoard. I use a standard dual-gang blue plastic box for my AC control. In it live two duplex outlets, giving me four circuits, and the solid-state relays glued to the backs of the outlets. Control signals are carried to the AC box via

its duty cycle.

### Doing the Switching

Now that we know how to do the dimming, we need to figure out how to actually switch the AC circuit. A triac is by far the most popular choice for controlling AC circuits. They are simple to use and interface, but they do have one interesting feature; once you turn a triac on, it doesn't turn off until the voltage across the load goes to zero. This makes them nicely suited to AC control, because the voltage goes to zero each half-cycle.

In most applications, it's easier to use a solid-state relay rather than a triac. A solid-state relay contains a triac, and can be thought of as an AC-switching black box; it isolates the AC world from the DC world (very important for safety), and switches with logic-level inputs. Most are also zero-crossing devices, which means they only switch as the waveform crosses zero, when voltage and current are low. This is nicer on the load (no sudden transients), and generates much less RF noise than switching at a random time.

For dimming, however, we have to be able to switch anywhere in the cycle, so zero-crossing



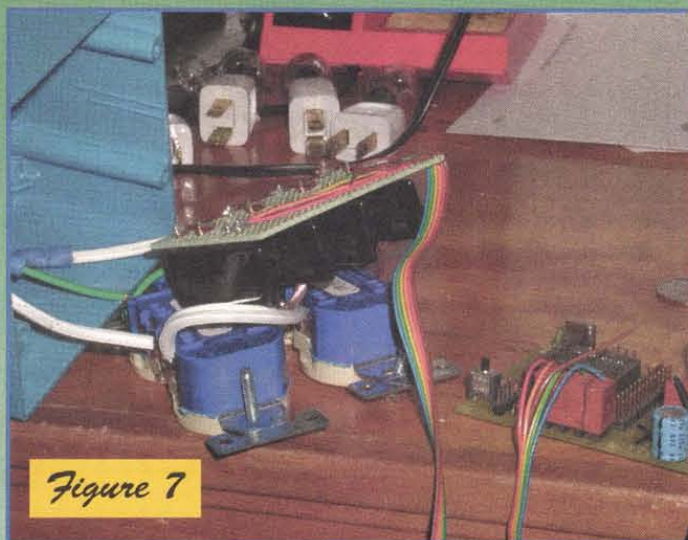


Figure 7

ribbon cable. A 3' grounded extension cord is cut in half; the plug end supplies power to the outlets, and the socket end brings AC power back out, so you have someplace to plug in the transformer.

### Algorithms and Encoding

The HC11 has a sophisticated timer section that is perfect for this application. The timer section has a 16-bit timer that counts at 2 MHz, and a set of four output compare registers that correspond to four output pins. To make an output go high at a point in the future, merely take the current timer count, add in the delay offset, and store it in the appropriate output compare register. The HC11 will then set that output high when the counts match, without any program intervention. This simplifies the code immensely; the code merely has to set up the appropriate offsets for all four channels, store them to the output compare registers, and then have the rest of the half-cycle for housekeeping.

At the default count rate, the timer overflows every 32 (ish) mS, but a half-cycle is only about 8 mS, so there's no chance of overflow in this application.

My current implementation supports 64 dim levels. These dim levels are stored in a table which encodes the offset needed for each dim level. Each count is 0.5µS, so to dim halfway, the count for 4.16mS (half of a half cycle, or 1/240th of a second) would be 8,333.

### The Main Loop

Wait until the zero-crossing signal is received. This is done by polling the input that the zero-crossing signal is connected to. Store the current timer count.

Force all the outputs to low. This insures that when we get to the zero-crossing point, the relays will turn off.

Take the stored time count and add the offset

that will get us to the true zero-cross.

For each channel, add in the offset for the current dim level, and store it to the proper output compare channel.

Figure out the next offset for each channel.  
Go to step 1.

Because we want to be able to have an offset of zero (no wait to turn-on), this code has to finish executing before we hit the true zero-cross. The current implementation is fast enough to do this, but if it wasn't, I'd simply skip dim level 0 (zero offset), and only let dim level 1 be the brightest one. With 64 dim levels, the difference isn't noticeable.

The HC11 handles everything for us once we've finished step 4, so step 5 has until the next zero-crossing signal to get set up for the next half-cycle. This is something on the order of 16,000 clocks, which is a lot of code.

If you were doing this with a microcontroller without output compare – or you wanted to do more than four channels with an HC11 – it would become more complicated. You could use the first period to generate the information for the next cycle (assuming you can get it done in 1,300 clocks; the width of the first period at 64 levels). If that wasn't enough, you could do it piecemeal (yuck), or, if your microcontroller supports timer interrupts, set up a timer interrupt for the first period, and then have the interrupt service routine turn on any channels that needed to be turned on, and set up the next interrupt. This would allow the code for the next channel to run during the non-interrupt times, but would make the code quite a bit more complex.

Running at the same time are some timekeeping functions that handle starting the animation when it gets dark (about 4:30 in the Seattle area), running 4.5 hours, and then turning off until the next day.

All the code is written directly in HC11 assembler. There is an SBASIC compiler available, which you might want to use. I found I could write the assembly code fairly quickly once I got into the

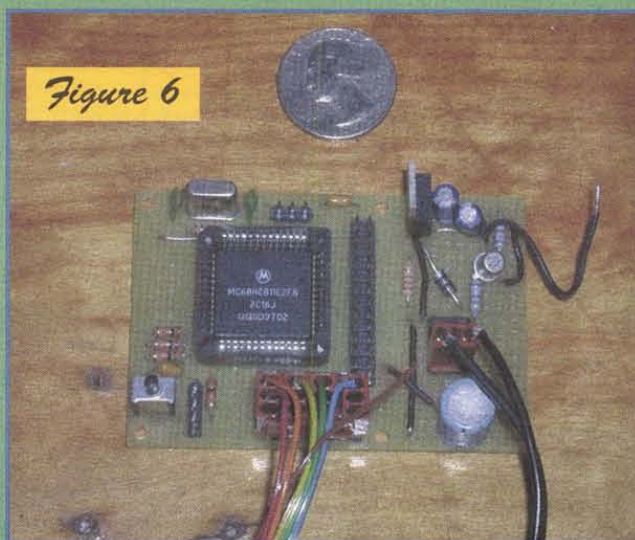


Figure 6

HC11 mindset.

### Encoding

One of the real challenges of this project is coming up with a minimal encoding for the animations. For this project, each step is encoded in seven bytes:

Byte	Description
1	Type of animation (dim or chaser)
2	# of loops for this step
3	Cycles to wait between loops
4-7	Channel information

For a dim animation, a typical encoding would be:

1 3F 14 01 00 FF 00

This means we should do this step for 3F loops, and that each loop should happen after 14 cycles (1/6th of a second). At each loop, we should add 1 to the channel 1 dim level, and add FF to channel 3, which is the same as subtracting 1 from it. So, this encoding will ramp channel 1 from its current dim level (which had better be 0, or we have problems) up to 3F, and channel 3 from 3F down to zero. This will take  $3F * 1/6th = 10.5$  seconds.

### Generating Tables and Encodings

Generating the offset table for the dim levels and the animation encodings isn't something you'd want to do by hand. I've therefore written some Perl scripts that generate both the dimming table and the animation encodings, which are then combined with the code and assembled using `asm11`.

After the code is assembled, it is downloaded to the HC11 with a utility called `DL11`. The interface needed to connect the HC11 to a standard serial port is detailed in the BotBoard documentation.

### Construction

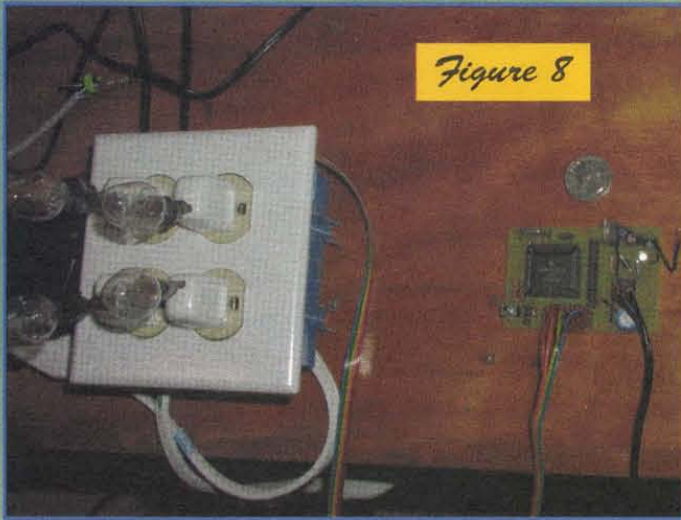
The BotBoard is built following the instructions. I usually populate the board fully even though I

### References

Botboard  
68HC11  
HC11 Reference Manual  
Solid-State Relays

<http://www.rdrop.com/users/marvin/botboard/botboard.htm>  
<http://www.nwlink.com/~kevinro/products.html>  
(68HC11RM/AD) <http://www.motorola.com>  
[http://www.hut.fi/Misc/Electronics/circuits/semiconductor\\_relays.html](http://www.hut.fi/Misc/Electronics/circuits/semiconductor_relays.html)





**Figure 8**

might not be using all the output pins at this time; it's easier to do now than later, and the extra headers are cheap.

In the prototype area next to the BotBoard, the power supply and zero-crossing circuits are built. I didn't breadboard the circuit first, which shows from my layout. It's not pretty, but luckily layout isn't critical for these circuits. The transformer connects to a three-pin header so it can be easily unplugged. See Figure 6.

The AC box holds the duplex outlets, with the bonding tab on the hot side broken off. The neutral wire for both outlets is hooked up, as are the grounds. A ribbon cable is hooked to the solid state relays, and then the whole business is placed in the box.

The appropriate connectors are then added to the ribbon cable. The BotBoard is designed to drive servos through these outputs, so the header locations aren't terribly convenient for this application. This required me to attach four individual three-pin connectors to the ribbon cable, and then use hot glue

to create a single connector. See Figure 7. Figure 8 shows a picture of the whole project. I have night-light bulbs plugged into the outlets for debugging.

## Debugging

Debugging an HC11 is interesting. I built a small status indicator out of a spare LED bar graph display I had lying around, and hooked it to a couple of four-pin headers. This can easily be slipped

over the pins for the B port, so that debugging information can be written there. It's sometimes challenging to do debugging this way, but that's part of the fun.

It's also useful to generate your own signals; I used this to determine closely when the zero-cross pulse starts. A simple loop finds the pulse, and then it's easy to wait for a given number of clocks, and then turn on the B port, and turn it off a short time after. With this signal on the scope along with the DC signal, it was easy to determine the interval to within a few clocks (a couple of microseconds).

## Conclusion

Once you have the project built, you'll need to write the controller code or use mine (available on the Nuts & Volts website). Then you'll have to deal with the lights, which usually takes me more time than the controller.

## Going Further

I've had a few ideas on where to go from here. A four-channel X-10 dimmer seems fairly straightforward, and if you can do that, you could add X-10 relay control easily. I'm also interested in using the A/D capability of the HC11 to do something that responds to people or cars. Perhaps a Santa who turns his head to follow you when you go by ... NV

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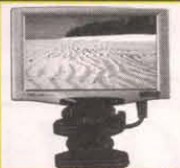


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# BUILD A POCKET-SIZED DIGITAL ALTIMETER

by Anthony J. Caristi

For those who like to drive or hike up mountain roads or trails, this easy-to-build pneumatically-operated electronic altimeter is just what you are looking for.

Unlike store-bought altimeters (which are in reality aneroid barometers calibrated in 200 foot increments of altitude), this digital instrument is a quality unit that is able to resolve changes of altitude as small as one or two feet! Its operating range is zero to 1,999 feet.

An altimeter, as its name implies, is an instrument that measures altitude or elevation above sea level. Pneumatic altimeters — present on every aircraft — use absolute air pressure as a measure of the height of the aircraft. Table 1 illustrates how air pressure varies inversely with altitude.

**An altimeter, as its name implies, is an instrument that measures altitude or elevation above sea level.**

This table assumes standard barometric conditions at sea level, which is defined as zero altitude.

The circuitry of the altimeter is remarkably simple, using one amplifier chip and a 3-1/2 digit A/D converter that drives a liquid crystal display (LCD). The circuit is contained on two small printed circuit boards that permit a compact assembly.

The unit is powered by a common nine-volt transistor radio battery, and is small enough to fit in a pocket. Since an altitude reading is usually taken only intermittently, battery life will be extremely long.

## ALTITUDE FUNDAMENTALS

The most common method of determining altitude — or height above sea level — is to measure absolute air pressure which varies

inversely with altitude. Pressure may be specified in several different ways, such as pounds per square inch, inches of mercury, or inches of water. Most people are familiar with the barometric reading often given in weather reports on TV and radio, usually specified as a quantity measured in inches of mercury.

Absolute air pressure is a quantity that is referenced to a perfect vacuum — zero pounds per square inch absolute (zero PSIA). The accepted level of absolute air pressure at sea level, measured under standard conditions, is 14.696 PSIA, or 29.92126 inches of mercury. When discussing altitude, pressure units in inches of mercury are generally used.

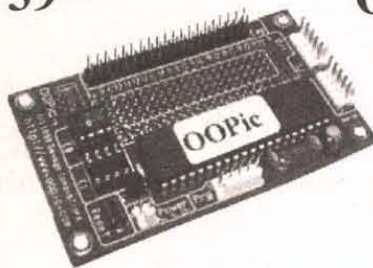
Although absolute air

pressure varies inversely with altitude, the relationship is not linear. Refer to Table 1, a chart illustrating pressure versus altitude. This data, used as a basis for altitude measurement, is part of the accepted altitude/pressure tables used by manufacturers of air-

ALTITUDE IN FEET	ABSOLUTE PRESSURE IN INCHES OF MERCURY
0	29.921
200	29.706
400	29.491
600	29.278
800	29.066
1000	28.856
1200	28.646
1400	28.438
1600	28.231
1800	28.026
2000	27.821

TABLE 1  
ALTITUDE VERSUS  
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craft altimeters for calibration of their production instruments.

Note that the pressure change with an increase of altitude is a non-linear function, due to the compressibility of air. However, over the range of zero to 2,000 feet, the non-linearity is very small and does not result in any appreciable error in the altitude reading.

Note further that pneumatic altimeters are subject to variations of the prevailing barometric reading, since they are absolute pressure measuring devices. At sea level, a change of 0.001 inch of mercury in the barometric pressure translates to a change of one foot in the altitude display. For this reason all pneumatic altimeters, including this one, include a manually operated control which allows the user to set the instrument in accordance with the current barometric reading. This negates the effect of weather conditions which would otherwise cause an error in the display of altitude.

## THE PRESSURE SENSOR

The heart of the altimeter is a solid-state device that is a product of modern integrated circuit technology. It converts the magnitude of ambient air pressure to a meaningful electrical voltage representing the absolute value of the pressure.

The pressure sensor is composed of a ceramic substrate upon which four piezo-resistive elements are ion implanted. The resistors are connected in a Wheatstone bridge configuration that is driven by a voltage applied to pin 3. With no stress on the substrate, the bridge is balanced and its differential output voltage — taken between terminals 2 and 4 — is zero.

The pressure sensor is designed so that the ceramic substrate separates two chambers of the housing. One chamber is sealed and evacuated at the factory to as perfect a vacuum (zero PSIA) that can be obtained by modern manufacturing techniques. The other chamber is exposed to the

atmosphere.

At any altitude, the pressure difference between the two chambers of the pressure sensor causes the ceramic substrate to be stressed. As a result, the values of two of the resistors of the Wheatstone bridge become greater than nominal while the other two are less. This causes an

unbalance of the bridge, which is a function of the pressure difference between the two chambers. Since one chamber is at zero pressure absolute, the electrical output of the bridge is a representation of the absolute pressure in the chamber that is exposed to the atmosphere.

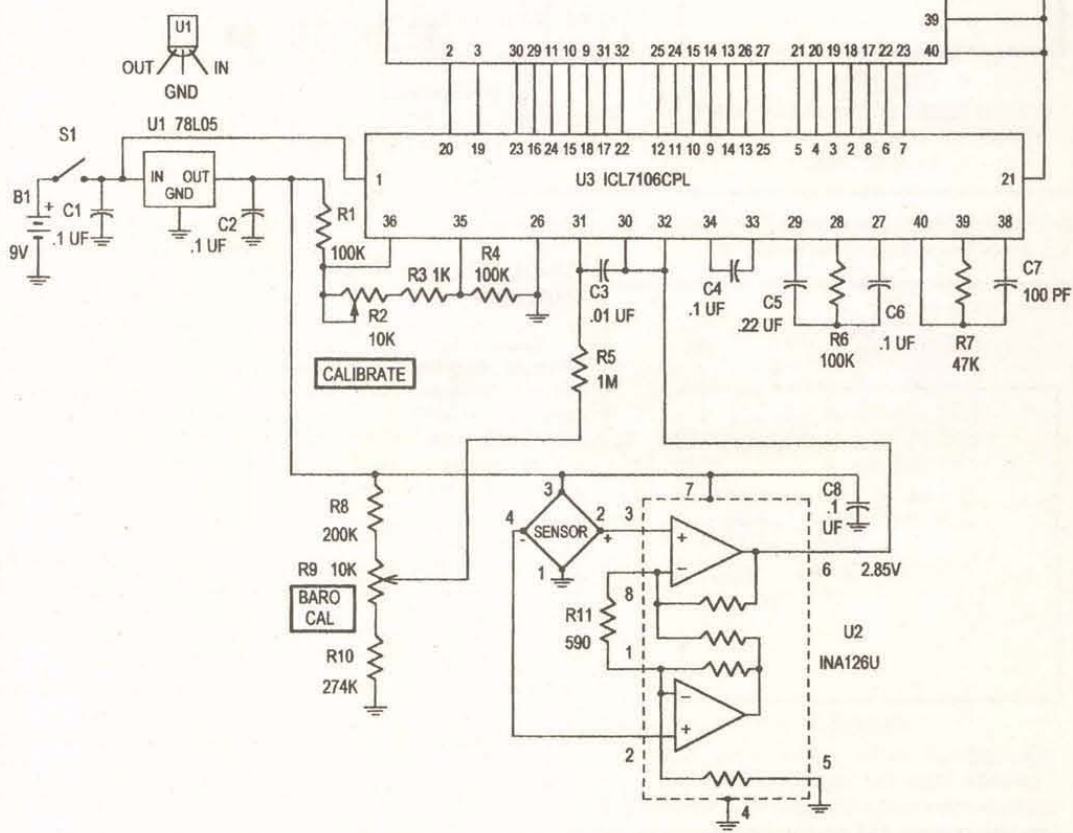
The pressure sensor is designed

- Jumper #1 U3 pin 18 to display pin 9
- Jumper #2 U3 pin 24 to display pin 11
- Jumper #3 U3 pin 26 to circuit common

**TABLE 2**  
**DISPLAY BOARD JUMPER WIRES**

to have a linear response to absolute pressure. At sea level, the nominal differential output of the sensor is about

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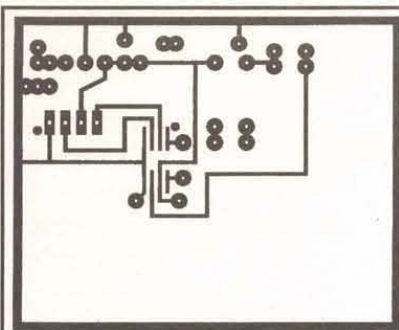
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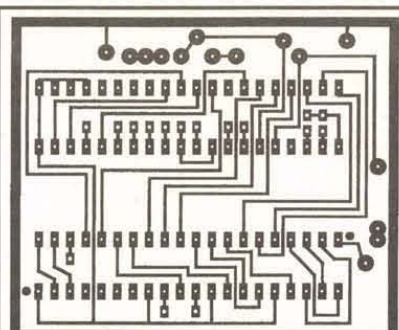






**FIGURE 1**

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



**FIGURE 2**

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

Connection #1	Analog board +5 volts to display board U3, R1
Connection #2	Analog board +9 volts to display board U3, pin 1
Connection #3	Analog board R5 to display board U3, pin 31
Connection #4	Analog board U2 pin 6 to display board U3, pin 30
Connection #5	Analog board GND to display board GND

**TABLE 3**  
**BOARD-TO-BOARD CONNECTIONS**

tor IC that provides +5 volts to power the pressure sensor. The regulated supply is also used to generate a stable reference voltage for the A/D converter, through a voltage divider composed of R1, R2, R3, and R4. This ensures that altimeter calibration is maintained as the battery terminal voltage falls with use.

U2 is an instrumentation amplifier that accepts the differential output of the pressure sensor, amplifies it, and generates a single-ended voltage with respect to circuit common. In this circuit, the gain of the amplifier, as determined by the value of R11, is about 140.5. This will result in a change of 0.2 volts output at pin 6 as the altitude

changes from zero to 2,000 feet.

At zero altitude, the output voltage of U2 at pin 6 is about 2.85 volts.

## ANALOG-TO-DIGITAL CONVERTER

U3 and its associated components form a complete 3-1/2 digit voltage measurement system that drives an LCD. The maximum display reading is 1999, which represents 1,999 feet of altitude. The negative sign of the display is operational, even though it is unlikely that one would ever travel to a location that is below sea level.

U3 measures and displays the analog voltage appearing between terminals 30 and 31 of the chip. Pin 31 is the positive analog input terminal and is driven by a user-operated potentiometer (R9) which acts as a calibrating adjustment. This takes into account variations in pressure sensors, plus the current barometric pressure level which will affect the output voltage of the amplifier. R9 may be adjusted at any time when the altimeter is at a location where the altitude is known. Such adjustment will negate any possible error caused by a change in barometric reading. Note that when the wiper voltage of R9 is equal to the output voltage of U2, the display will read

20.3 millivolts. At an altitude of 2,000 feet, the output voltage of the sensor

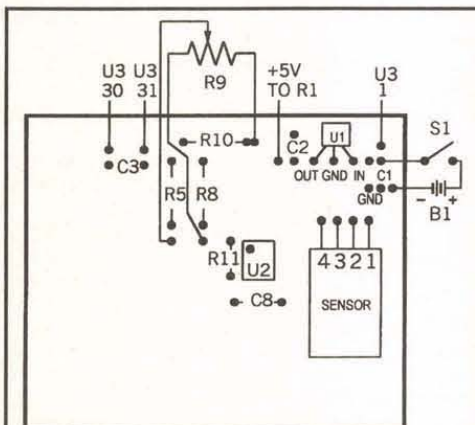
falls to about 18.8 millivolts.

## ABOUT THE CIRCUIT

Refer to the schematic diagram. The circuit is powered by a common nine-volt transistor radio battery. U1 is a fixed voltage regula-

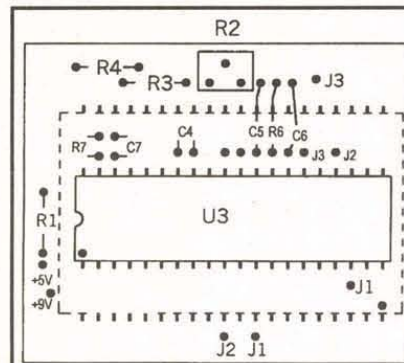
tor IC that provides +5 volts to power the pressure sensor. The regulated supply is also used to generate a stable reference voltage for the A/D converter, through a voltage divider composed of R1, R2, R3, and R4. This ensures that altimeter calibration is maintained as the battery terminal voltage falls with use.

U2 is an instrumentation amplifier that accepts the differential output of the pressure sensor, amplifies it, and generates a single-ended voltage with respect to circuit common. In this circuit, the gain of the amplifier, as determined by the value of R11, is about 140.5. This will result in a change of 0.2 volts output at pin 6 as the altitude



**FIGURE 3**

Component layout of the analog board as seen from the top. Note that U2, a surface-mounted component, is soldered to the copper foil on the bottom side.



**FIGURE 4**  
Parts view of the display board showing the location of components, jumper wires, and interconnections. Note that the LCD module is placed on the opposite side.

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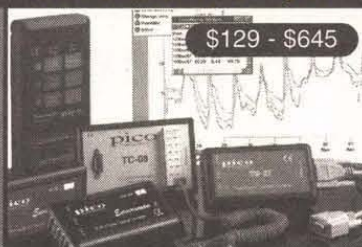
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zero.

Pin 30 is the negative analog input and is driven by the output of the differential amplifier chip, U2. The polarity of the input terminals of U3 is chosen so that increasing altitude will result in an increasing display of feet.

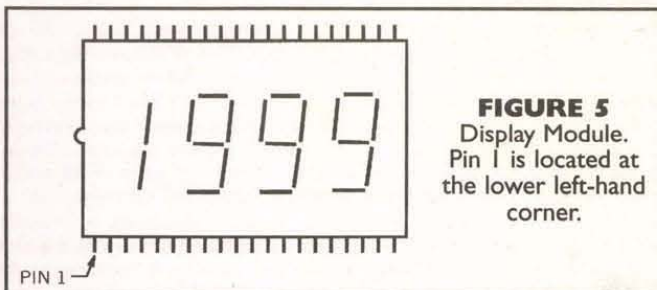
The sensitivity of the A/D converter is determined by the reference voltage appearing between pins 35 and 36. In this circuit, it is necessary that the A/D converter have a full scale (1999) sensitivity of 199.9 (200) millivolts. This is accomplished by using potentiometer R2 to set the reference voltage to 100 millivolts (0.100 volts).

With a reference voltage of 100 millivolts, U3 will generate a display of zero to 1999 when the A/D input voltage varies from zero to 200 millivolts, as the altimeter location changes from zero to 1,999 feet.

## CONSTRUCTION

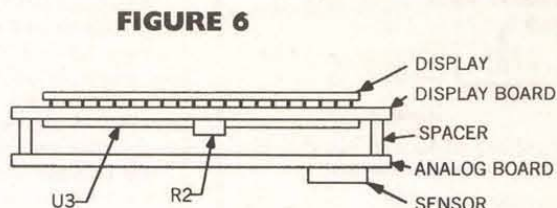
The circuitry of the altimeter is contained on two printed circuit assemblies called the analog board and display board. The analog board contains the pressure sensor, regulator chip U1, and amplifier chip, U2. The





**FIGURE 5**  
Display Module.  
Pin 1 is located at  
the lower left-hand  
corner.

The analog board and display board may be assembled with spacers to make a compact assembly.



**FIGURE 6**

display board contains the LCD, plus the A/D converter, U3. The calibrating adjustment potentiometer for U3 is also located on the display board.

The two boards have been designed so that they may be stacked upon each other, with suitable spacers and hardware, to produce a compact assembly that can be placed into a small enclosure. See Figure 6. The top of the enclosure will have a rectangular cutout to allow viewing the display. The only operating controls are power switch S1, and Baro Set potentiometer R9.

Full size layouts of the printed wiring of the two boards are illustrated in Figures 1 and 2. A source for etched and drilled boards is given in the parts list. Alternatively, the circuit is not critical and may be hardwired on a perfboard, using good construction techniques.

Figures 3 and 4 illustrate the parts placement of the boards as seen from the top or component side. Refer to these illustrations to ensure that all polarized components such as solid-state devices are properly oriented. Just one part placed backwards in the circuit will render the altimeter inoperative and may cause damage to one or more components.

It is recommended that sockets be used for U3 and the display module. A socket for the display may be fabricated by cutting a 40 pin IC socket in half lengthwise. The use of sockets is well worth the slight additional cost and will permit ease of service and troubleshooting should it become necessary. It is very difficult to remove a multipin component soldered into a PC board without damaging the component or board wiring.

Note: As indicated in Figure 4, the LCD module is mounted on the copper side of the board. Pin 1 of the foil pattern for the display is indicated by a small dot.

Do not insert the U3 or the display into its board at this time. This will be done later during checkout of the altimeter.

It is recommended that the first component installed on the analog board be U2, a surface mounted chip. The location of U2 is depicted in Figure 3, but note that this component must be soldered to the copper side of the board. To do this, first locate pin 1 of the chip, which may be identified by a small dot. Pin 1 of the chip will be located at the lower left-hand corner when viewing the IC from the top side, with the legend facing you so you can read it. Then locate pin 1 of the

copper foil, which is also indicated by a small dot. Use the following procedure:

1. Be sure the foil pattern is clean, with no dirt, oil, or oxidation present.
2. Place the chip in position so that it is oriented properly and centered on the foil pattern with all terminals directly over the eight copper foil pads.
3. Gently solder just one corner pin with a small, sharply pointed soldering iron tip. Do not use too much heat or too much solder; to do so may cause the foil pattern to lift off the board.
4. Examine each terminal of the chip and verify that all are located directly over the foil pads. Make any adjustments, if necessary, or remove the chip and repeat steps 2 and 3.
5. When all terminals are properly positioned, solder them in place. Examine the chip for short circuits between terminals. Correct if necessary.

The altimeter circuitry contains several 1% precision metal film resistors to ensure accuracy and stability. Ordinary carbon resistors are not temperature stable and should not be

substituted for metal film types where specified.

Be very careful when handling the pressure sensor. Note that pin 1 is identified by a notch on one terminal, and be sure to follow Figure 3 when placing it into the board. To bend the pins at a right angle, use two long nose pliers. Do not bend the terminals where they emerge from the housing; to do so may damage the sensor.

## DISPLAY BOARD

The display board will require three jumper wires as depicted in Table 2. Place these in the board first, using flexible insulated #24 gauge wire. Be sure to allow sufficient lead length to allow the wires to be routed around U3.

Handle the glass LCD module carefully to avoid breakage. Refer to Figures 4 and 5, which show how this component should be placed into the display PC board on the copper side. Proper orientation is indicated by a small boss at one end of the LCD module.

When both printed circuit boards are completed, examine each of them very carefully for opens, short circuits between closely spaced conductors, and bad solder connections which

may appear as dull blobs of solder. Any solder joint which is suspect should be redone by removing the old solder with desoldering braid, cleaning the joint, and carefully applying new solder. It is far easier to correct problems at this stage rather than later on if you discover that your altimeter does not work.

## INTERCONNECTIONS

Completion of the wiring includes making five connections between the analog and digital boards. Table 3 illustrates the locations of these wires.

Figures 3 and 4 serve to identify the location of the interconnecting wiring between the two boards, plus connections to the external components. Follow these illustrations, along with the schematic diagram, as you go. Use flexible stranded wire for the connections. Do not use solid wire; it will break.

A battery clip may be salvaged from an old nine-volt battery. Solder a red and a black wire to the terminals, noting that the polarity will be opposite to that of a battery. When finished, plug the clip on to a new battery and use a DC voltmeter to verify that the red wire is positive and the

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black one is negative.

Mount S1 and R9 to any convenient location on the enclosure. It is recommended that R9 be a screwdriver adjust potentiometer so as to avoid inadvertent adjustment. Choosing a 10 turn pot for R9 allows ease of precise adjustment.

Use insulated stranded wire of different colors to make the connections between the battery clip, panel controls, and PC boards. Use the schematic diagram as a guide.

When mounting the display board to the enclosure after the checkout procedure is completed, use suitable length spacers to prevent the LCD module from touching the panel. No stress may be placed on this component since it is constructed of glass and can easily fracture.

When the altimeter is fully assembled, examine the wiring very carefully for proper connections. Do not attempt the checkout procedure unless you are satisfied that the assembly and wiring are 100% correct.

## CHECKOUT

Checkout of the altimeter requires the use of a digital voltmeter or VOM with a high input resistance. The use of an oscilloscope should not be necessary unless the circuit is inoperative due to faulty construction.

Before inserting a battery into the clip, measure the resistance across the terminals of the clip with S1 set to the ON position. Normal indication is 50K or more. Then measure the resistance from pin 3 of the sensor to circuit common. Normal indication is about 1,200 ohms. If you obtain resistance readings substantially lower than specified above, there is most likely a short circuit or incorrectly placed component in one of the boards. Troubleshoot the circuit and correct the fault before proceeding.

Insert a fresh nine-volt alkaline battery onto the clip. Turn power on and verify that the voltage at pin 3 of the sensor — measured with respect to circuit common — is between 4.75 and 5.25 volts DC. Do not proceed with the checkout if you do not obtain the proper voltage specified above. Check the battery voltage under load to be sure it is delivering at least +8 volts to the circuit. Check the polarity of the battery and the orientation of U1 and U2. Check the circuit boards for short circuits. Try a new regulator IC.

When you are satisfied that the regulator is operating properly, disconnect power. Insert U3 and the display module into the board, making sure that proper orientation is observed and all pins are seated firmly in the sockets with none inadvertently bent under the body of the component.

Set the Baro Adjust pot, R9, to midposition. Apply power and carefully adjust R2 so that the voltage between pins 35 and 36 of U3 is

between 99 and 101 millivolts, with pin 36 positive with respect to pin 35. If you are not able to obtain the correct reading, check the values of R1 through R4, and check the orientation of U3. Once R2 is properly set, do not readjust it again.

If the altimeter has been properly assembled and wired, you should see a display that can be set to both below and above the prevailing altitude as the front panel Baro Adjust pot, R9, is operated over its range. Verify that all digits are properly formed. Clockwise rotation of the knob should cause an increase in altitude reading. Maximum CCW position may result in a negative number. If the rotation of the pot is backwards, simply swap the two outside wires. Note: If the adjustment range of R9 is not centered on the prevailing altitude, you may trim R8 and/or R10 just a percent or so as required.

Set R9 so that the display reads approximately the correct altitude. Holding the altimeter in a horizontal position, slowly raise it as high as possible and as low as possible while watching the LCD. You should be able to see the change in altitude, just a few feet, as shown by the display. This completes the test.

If the altimeter is not performing as described, review the following paragraphs to locate and correct the fault.

If the display is totally blank, U3 is not functioning or the display module has been placed backwards into the board. Check all components associated with U3. Check the waveform at pin 21 of U3 with an oscilloscope to verify the presence of a squarewave backplane signal. Check the orientation of both U3 and the LCD module by reviewing Figures 4 and 5. Make corrections if necessary.

If any of the display digits are not properly formed or the display is blank, there may be a short or open circuit between one or more of the connections between U3 and the LCD. Any improper digit segment will lead you directly to the fault if you consult the schematic diagram to see which connection controls that segment. Check the jumpers shown in Table 2. Measure the output voltage of U2 at pin 6 to verify that it is about 2.85 volts. Check the analog and display boards visually, and also with an ohmmeter (with power off), to locate

the fault.

Check the wiring between R9 and the analog board. Measure the voltage at the wiper of R9 to be sure it covers a range of about 2.8 to 2.9 volts. Note: Many potentiometers have notoriously poor resistance tolerance; if necessary, change the value of R8 and/or R10 to center the operating range of the Baro Set adjustment potentiometer so that the pot may be adjusted for readings both above and below the correct altitude.

## USING THE ALTIMETER

As with all pneumatic altimeters, the instrument must always be corrected for the current barometric pressure before starting out on an excursion. The best way to do this is to learn the actual altitude at your home. This can be done by visiting a nearby airport on a day of steady barometric conditions, and adjusting R9 to obtain the correct altitude reading. This information is available from the control tower. Once the altitude reading is correctly set, immediately come home and record the altitude reading obtained there. This will be your reference altitude.

Before embarking on an excursion, always reset R9 for the correct reading at your home. Do not readjust it again unless you come to another location where the altitude is known, and the reading has changed due to variations in weather conditions.

Should the display reading become erratic or dim, replace the battery. **NV**

## PARTS LIST

B1 Nine-volt transistor radio battery  
C1, C2, C4, C6, C8 0.1 uF 50-volt ceramic disc capacitor  
C3 0.01 uF 50-volt ceramic disc capacitor  
C5 0.22 uF 50-volt ceramic or mylar capacitor  
C7 100 pF 50-volt ceramic disc capacitor  
Display Digi-Key 153-1005  
Pressure Sensor Motorola MPX2100A, 15 PSI absolute  
U1 AN78L05 five-volt regulator  
U2 INA126U Burr-Brown instrumentation amplifier  
U3 ICL7106CPL 3-1/2 digit A/D converter  
R1, R4 100K 1% 1/4 watt metal film resistor  
R2 10K cermet pot, PC mount  
R3 1K 1% 1/4 watt metal film resistor  
R5 1 Megohm 1/4 watt carbon resistor  
R6 100K 1/4 watt carbon resistor  
R7 47K 1/4 watt carbon resistor  
R8 200K 1% 1/4 watt metal film resistor  
R9 10K potentiometer (see text)  
R10 274K 1% 1/4 watt metal film resistor  
R11 590 ohm 1% 1/4 watt metal film resistor  
S1 SPST slide or toggle switch  
Misc: IC sockets, battery clip, hook-up wire, hardware, enclosure

## SOURCES OF SUPPLY

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# reader Feedback

Dear Nuts & Volts:

Last month in my article "RS-232 on a Breadboard," 15V LED was listed in the Parts List, page 47. It should have been one 5V not 15V.

Al Williams

Dear Nuts & Volts:

Regarding the "Solar-Powered Digital Barometer" in the Oct. 2000 issue.

A serious flaw appears to be that it would read correctly only near sea level.

Mechanical barometers are provided with an adjustment screw (electronic ones need an analogous circuit) to compensate for the altitude of the site. Often about 1" of Hg per 1,000 ft. above sea level. It is this "corrected" value reported by the news and weather meteorologists.

Charles D. Geilker  
Liberty, MO

Dear Nuts & Volts:

I had just about given up hope of getting an answer to my question in the August issue about my Rustrak chart recorder. Then I opened the November issue and found not one answer but three!

Sincere thanks to Mr. Calabrese, Mr. Heck, and Mr. Mills for taking the time to write such clear and detailed answers, and to Nuts & Volts for devoting more than half of one of your oversized pages to publishing them.

There might be other magazines that would do this, but I haven't heard of them. I very much doubt they have subscribers as helpful as yours and I'm very pleased to be among them.

Thanks again to all of you.

Richard W. Flaws  
Oswego, IL

Dear Nuts and Volts:

I read Bob's hint about using an AM radio to test an infrared remote in the November issue. Not to burst any-

one's bubble but, it really doesn't work. As a technician I have repaired a number of these devices and often the problem is the infrared LED. Since the signals picked up by the AM radio are the encoder harmonics you will get the signal even if the transmitter doesn't work because the LED is bad.

The easiest way to test the remote is to buy an infrared phototransistor from Radio Shack (part # 276-145) for 99 cents and connect its negative lead (emitter) to the negative lead of your ohmmeter and its positive lead (collector) to the ohmmeter positive lead. When infrared light hits the phototransistor, the ohmmeter shows a drop in resistance of several thousand ohms because the transistor begins to conduct. Enclose the transistor in the tip of an old felt tip marker case so light other than that from the remote is shielded. It works great on every ohmmeter I have tried it with. With a meter which has an analog bar display (such as the Fluke 66) you can see the remote output code pulse.

Joe Sloop  
Ararat, VA

Dear Nuts & Volts:

The answer given to the question entitled "Are you Reeling in the Feet?" in the "Electronics Q & A" column (page 27, Nov. 2000 issue) is grossly in error.

Pure copper #12 AWG wire has a resistance of 0.00162 ohms per foot — about a thousand times less than the 1.67 ohms per foot stated in the article.

Although there are many types of stainless steel, on the average they exhibit a resistance of about 0.0606 ohms per foot — more than a thousand times less than the 76.98 ohms per foot stated in the article.

Bill Johnston  
via Internet

Response from TJ Byers:

Yes, a lot of readers caught this error. The answer is 1.59 ohms per 1,000 feet, not per foot. I will have a correction in the Jan. '01 column.

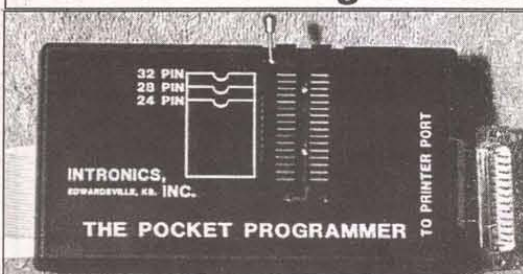
TJ Byers  
Q & A Editor

Since several comments and previous tech questions have concerned various frequency allocations in the US, here's a link to a site where the good old US govt. has a chart for viewing, or where you can buy one for only \$6.00, if you want to hang one on your wall.

<http://www.ntia.doc.gov/osmhome/allochrt.html>

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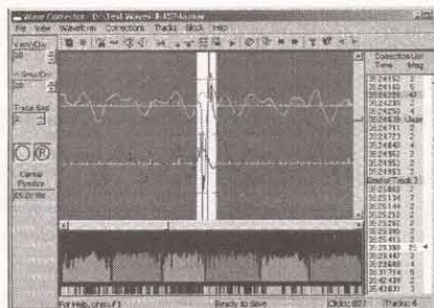
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Ganymede Test & Measurement announces the release of Wave Corrector 2.0. Aimed at the home music

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lover and the professional archivist, Wave Corrector is a true WYSI-WYG audio restoration application that automatically removes clicks and hiss from vinyl and tape/cassette recordings. It also divides album files into separate CD track files.

#### Remove unwanted noise while maintaining maximum fidelity

Wave Corrector takes a new approach to audio restoration, giving the user much greater control than has previously been available. The program uses a powerful click concealment algorithm to generate corrections for each individual vinyl click. The computer-generated corrections are based on the musical content surrounding each click to ensure the maximum fidelity to the original sound.

Wave Corrector provides a graphical overlay of the corrected and uncorrected waveforms and allows interactive adjustment and auditioning of corrections. By these means, even the most difficult corrections can be manually refined to the point of inaudibility.

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Wave Corrector also automatically finds track changes and assembles separate wave files representing each track of an album. Tracks can be easily split or merged and track boundaries can be manually manipulated to suit the user's requirements.

New in version 2.0 are a range of digital filters for the reduction of continuous noise (e.g., hiss) and for tonal correction of the original recording. There are also new tools for adjusting the volume and channel balance and there is an improved user interface.

#### Availability & Further Information

Wave Corrector runs on the Windows 95/98/NT/2000 platforms and can be downloaded from the Wave Corrector website at [www.ganymede.hemscott.net/wavecor.htm](http://www.ganymede.hemscott.net/wavecor.htm). Single user licences cost just UK£28 or US\$45. Registrations can be processed online at the same location. Until it is registered, the program runs in demo mode and limits processing to the first two minutes of a recording and only allows the first track of an album to be saved.

#### CONVERT SCANNED PAPER DRAWINGS INTO YOUR CAD-PROGRAM

RasterVect Software has released vectorizer RasterVect 3.0 for Windows, a program that lets users quickly convert uneditable scanned paper drawings into accurate vector files for editing in any CAD program.

RasterVect is a useful program for those who work with scanned

drawings. With this program, you can transform raster drawings into vector format. Raster drawings can be imported by scanning original paper drawings. The target vector format (DXF) is supported by most CAD applications that use vector graphics, such as AutoCAD, Corel Draw and many others.

There are viewing tools like zooming, scrolling and color selection. RasterVect has: TWIN support for importing from many scanners; the ability to automatically recognize orthogonal and inclined lines, as well as arches and circles; and the ability to maintain the scale of the initial paper drawing. RasterVect can transform grey and colored images into black-and-white for subsequent recognition; can change a turn of the raster image; and can correct union points of lines, arches and circles. There is also support for lines, arches and circles alignment.

The list below summarizes the process of transformation of a paper drawing to a CAD drawing using RasterVect:

- Create a raster file by scanning the paper drawing into RasterVect using a scanner.
- Use RasterVect to convert the raster file into a vector DXF file.
- Import the DXF file into your CAD program and edit the drawing.

Designed to work on all Windows platforms, vectorizer RasterVect saves a lot of time. It's a replacement for traditional tracing and digitizing.

RasterVect 3.0 for Windows costs \$79.95(US) for a single-user license. Network and site licenses are available.

Web - [www.rastervect.com](http://www.rastervect.com)

#### DUAL CIRCUITS IN A SINGLE SURFACE-MOUNT PACKAGE SAVES SPACE, LOWERS COST

Microsemi Corp. announced that its Power Management Division has developed a new dual-circuit low dropout regulator (LDO) for its line-up of power management integrated circuits. Designated the LX8815 Series, the device, which combines two 1-amp regulator circuits in a single package, is used to regulate power on circuit boards of applications that include: computer peripheral devices, battery charging circuits and instrumentation. "We work closely with customer design groups to identify ways to help them meet their ever-more-demanding space and cost targets," said James J. Peterson, president of Microsemi's Power Management business. "In this case, we initiated the dual LDO concept to serve a major disk drive manufacturer — Seagate — for a digital VCR application. They're already using the

new devices in very large volume. In their highly competitive environment, every opportunity for savings is significant." Manuel Lynch, Microsemi vice president of Marketing and Business Development, points out that offering a breadth of power management solutions having unique design characteristics is fundamental to the company's new product development strategy. "Now that power management is Microsemi's largest business, we're focusing more and more on expanding this part of our product portfolio through new and enhanced process developments, coupled with Microsemi's exceptional packaging capabilities," Lynch said. Assembly process enhancements enabled Microsemi designers to package its new LDO circuits in a manner that provides superior thermal characteristics, improved operating margin, as well as saving space. Most importantly, the resulting five-pin S-Pak surface-mount package is believed to be the most robust in the industry. Microsemi's new surface-mount regulator is thin, measuring less than 2 mm tall with a footprint of 9.52 mm x 10.67 mm, which replaces two regulators, saving 70 percent board space compared to the TO-263, which requires 10.67 mm x 15.87 mm each. The LX8815 costs \$0.94 in OEM quantities of 1,000, providing a savings of more than 20 percent over two conventional single-circuit LDOs, and an overall savings of more than 30 percent, including a reduction in external capacitors. Component reduction also helps customers to reduce costs associated with parts inventory, assembly and testing operations.

#### LX8815 Key Features

- Dual channel positive-voltage linear regulator
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  - Each channel supplies up to one amp independently
  - Consumes minimal ground current and directs quiescent current to the load
  - On-chip trimming of internal voltage reference: precise output, typically  $\pm 1$  percent of specified value
  - Low dropout voltage at full output current (VDO less than 1.1V typ @ 1A)
  - Independent thermal and current limit protection
  - Low tolerance line (0.2 percent) and Load (0.4 percent) regulation
  - Wide DC supply voltage, 4.0V - 12.0V
  - Loop stability independent of output capacitor type
  - Low profile surface-mount packaging
- Additional information and technical data sheets can be found on the company's Web site at [www.Microsemi.com](http://www.Microsemi.com)

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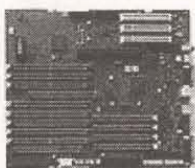
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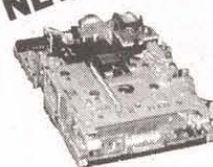
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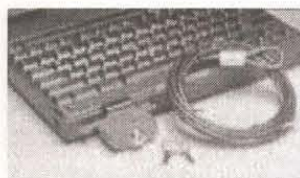
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# '555' ASTABLE CIRCUITS

by Ray Marston

In this '555 timer IC' application article, Ray Marston shows ways of using the IC in a variety of astable waveform generator circuits.

The '555 timer' is a popular and versatile bipolar IC that is specifically designed to generate accurate and stable C-R — defined timing periods, for use in a variety of monostable 'one-shot' pulse generator and astable square-wave generator applications. This article shows practical ways of using the IC in a variety of useful astable multivibrator or squarewave generator applications.

## 555 ASTABLE OPERATION

The eight-pin bipolar 555 IC can be used as a free-running astable multivibrator by wiring it in the basic configuration of Figure 1, with TRIGGER pin 2 shorted to the pin 6 THRESHOLD terminal, and timing resistor R2 wired between pin 6 and DISCHARGE pin 7. To understand the circuit operation, relate the following explanation to the 555 func-

tional block diagram of Figure 2.

When power is first applied to this circuit C1 starts to charge exponentially via R1-R2 until eventually the C1 voltage rises to  $2/3 V_{CC}$ , at which point DISCHARGE pin 7 switches low and starts to discharge C1 exponentially via R2 until eventually the C1 voltage falls to  $1/3 V_{CC}$ , and TRIGGER pin 2 is activated, thus initiating a whole new timing sequence, which repeats *ad infinitum*, with C1 alternately charging towards  $2/3 V_{CC}$  via R1-R2 and discharging towards  $1/3 V_{CC}$  via R2 only.

Note that if R2 is very large relative to R1 the operating frequency is set by R2 and C1, and an almost symmetrical squarewave output is

developed on pin 3 and a non-linear triangle waveform appears across C1; Figure 3 shows the consequent relationship between frequency and the C1-R2 values. In practice, the R1 and R2 values can be varied from 1k $\Omega$  to many megohms; note, howev-

er, that R1 affects the circuit's current consumption, since pin 7 is effectively grounded during half of each cycle. Also note that the waveform's duty cycle or mark-space ratio can be varied by suitable choice of the R1 and R2 ratios.

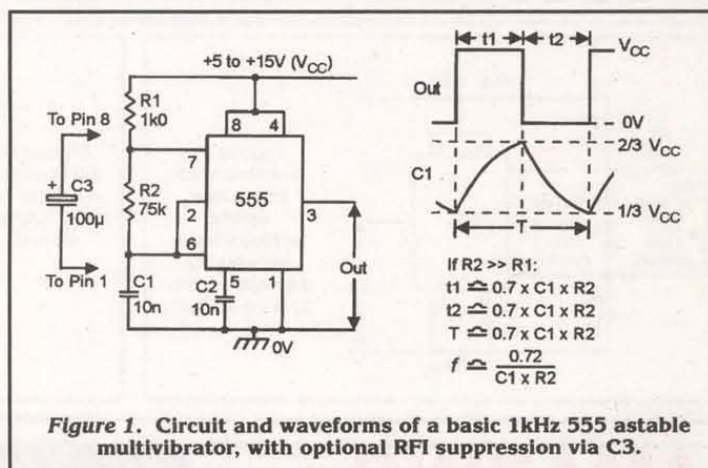


Figure 1. Circuit and waveforms of a basic 1kHz 555 astable multivibrator, with optional RFI suppression via C3.

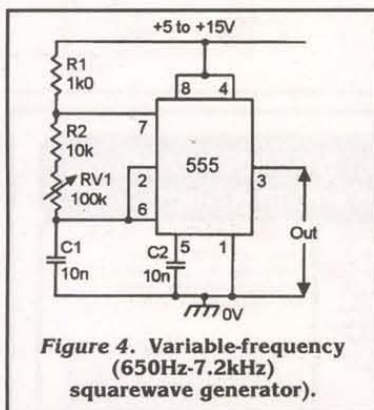


Figure 4. Variable-frequency (650Hz-7.2kHz) squarewave generator.

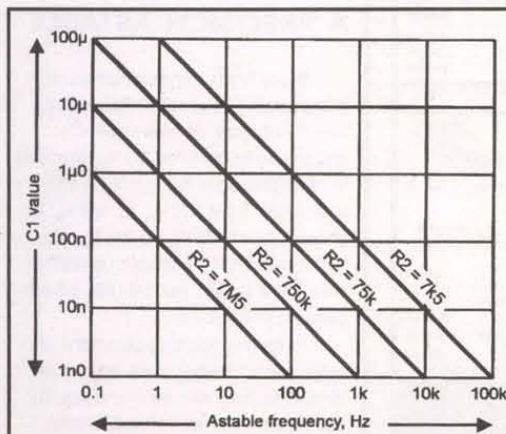


Figure 3. Relationship between C1, R2, and 555 astable frequency when R2 is large relative to R1.

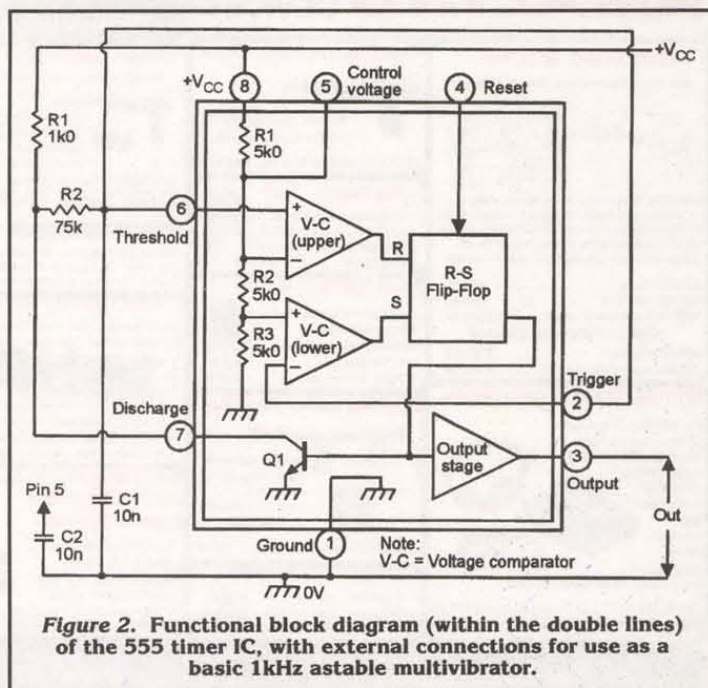


Figure 2. Functional block diagram (within the double lines) of the 555 timer IC, with external connections for use as a basic 1kHz astable multivibrator.



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Figure 4 shows how the operating frequency can be made variable by replacing R2 with a series-wired fixed and a variable resistor. With the component values shown, the frequency can be varied from about 650Hz to 7.2kHz via RV1; the frequency span can be further increased by selecting alternative values of C1.

## MARK-SPACE CONTROL

In each operating cycle of the Figure 1 circuit, C1 alternately charges via R1-R2 and discharges via only R2. Consequently, the circuit can be made to generate a non-symmetrical waveform with any desired mark/space (M/S) ratio by suitably selecting the R1 and R2 values. Figures 5 to 8 show ways of making the M/S ratios fully variable.

Figures 5 and 6 give independent control of the mark and space periods. In Figure 5, C1 alternately charges via R1-D1 and RV1, and discharges via RV2-D2 and R2. In Figure 6, C1 charges via R1-RV1 and D1, and discharges via RV2-D2 and R2. In both cases, the mark and space periods can each be varied over a 100:1 range; the frequency varies as the M/S ratio is altered.

Figures 7 and 8 show ways of altering the M/S ratio without significantly altering frequency; here, the mark period increases as the space period decreases, and vice versa, so the total period of each cycle is constant. The most important waveform feature of these circuits is their 'duty cycle' (the relationship between the mark and total periods of each cycle), and this is variable from 1 to 99 percent via RV1.

In Figure 7, C1 alternately charges via R1-D1 and the upper half of RV1, and discharges via D2-R2 and the lower half of RV1. In Figure 8, C1 charges via R1-D1 and the right-hand half of RV1, and discharges via D2-R2 and the left-hand half of RV1. Each circuit operates at about 1.2kHz with the C1 value shown.

## A 'PRECISION' ASTABLE

Note from the description of basic astable operation that in the initial half-cycle of operation, C1 charges from zero to 2/3 V<sub>cc</sub>, but that in all subsequent half-cycles it either discharges from 2/3 V<sub>cc</sub> to 1/3 V<sub>cc</sub> or charges from 1/3 V<sub>cc</sub> to 2/3 V<sub>cc</sub>; the initial half-cycle of astable operation thus has a longer period than all subsequent half-cycles.

In some special applications, this large period discrepancy may cause problems; they can be overcome by adding an external voltage divider

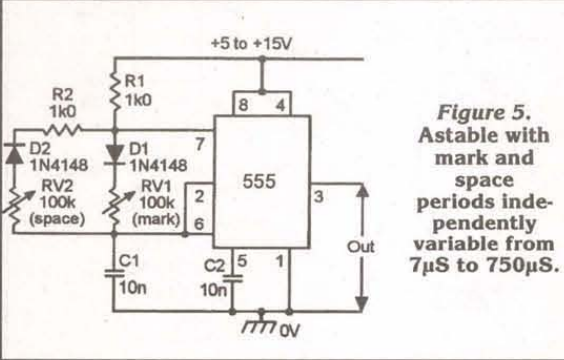


Figure 5. Astable with mark and space periods independently variable from 7µs to 750µs.

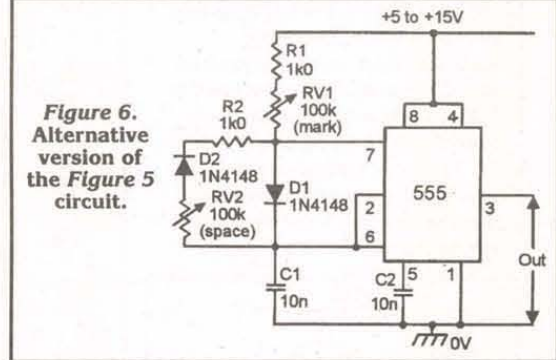


Figure 6. Alternative version of the Figure 5 circuit.

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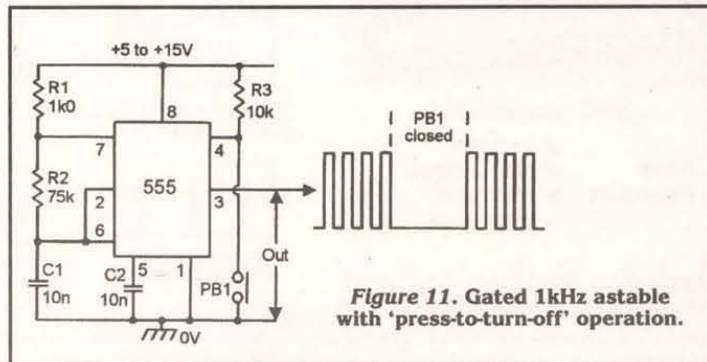
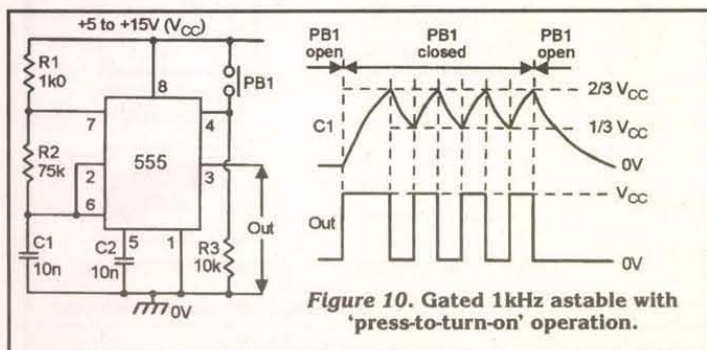
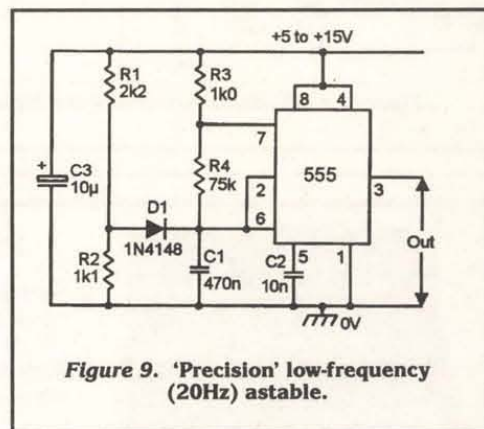
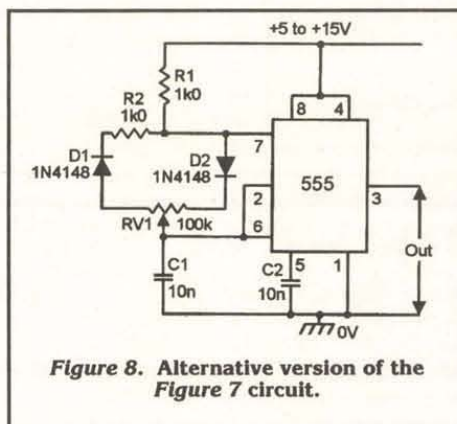
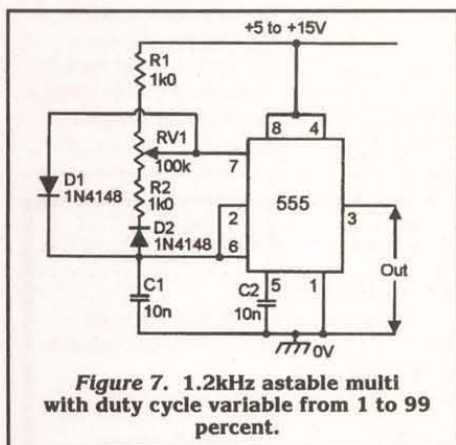
and diode to bias C1 to slightly below  $1/3 V_{cc}$  (rather than to zero volts) at the moment of switch-on, as shown in Figure 9. Here, R1 rapidly

charges C1 to  $1/3 V_{cc}$  via D1 at initial switch-on, but all C1 charging is subsequently controlled by R3 and/or R4 only.

## ASTABLE GATING

The 555 astable can be gated on

and off, via either a switch or an electronic signal, in several ways. One way is via the pin 4 RESET terminal, and Figures 10 and 11 show ways of





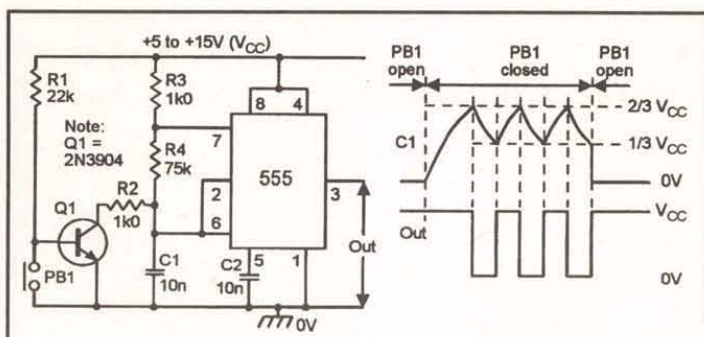


Figure 12. Alternative gated 1kHz astable with 'press-to-turn-on' operation.

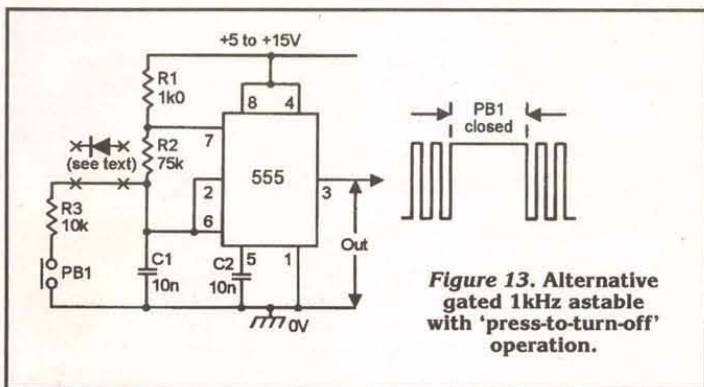


Figure 13. Alternative gated 1kHz astable with 'press-to-turn-off' operation.

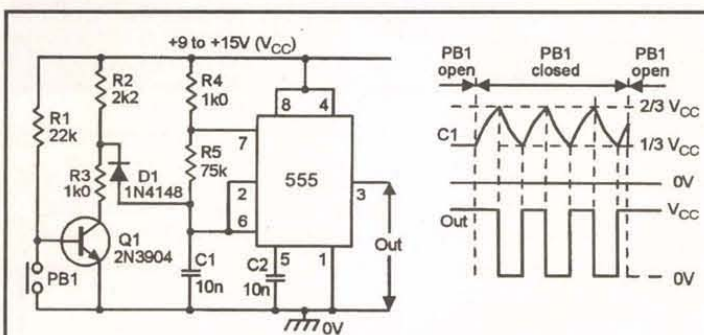


Figure 14. 'Precision' version of the Figure 12 circuit.

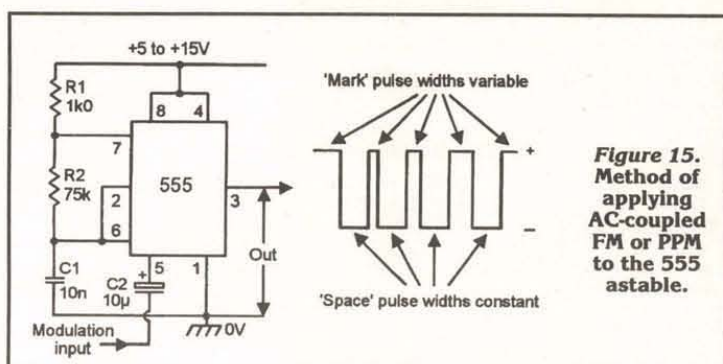


Figure 15. Method of applying AC-coupled FM or PPM to the 555 astable.

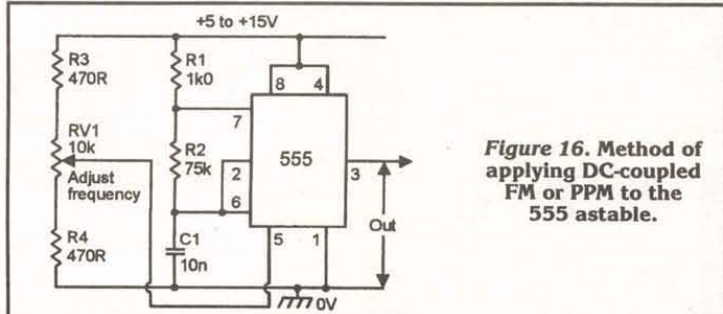


Figure 16. Method of applying DC-coupled FM or PPM to the 555 astable.

gating the astable via this pin and a push-button switch. The 555 action is such that the astable is enabled if pin 4 is biased above 0.7V, but is disabled (with its output low) if pin 4 is pulled below 0.7V by a current greater than about 0.1mA (by grounding pin 4 via 10k or less).

Thus, Figure 10 is normally gated off by R3, but can be turned on by closing PB1, and Figure 11 is normally on, but can be gated off by closing PB1; these circuits can also be gated electronically via pin 4.

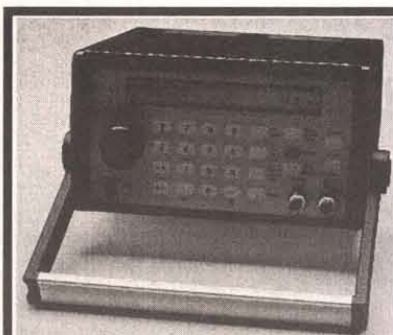
Note in Figure 10 that precise circuit waveforms are shown, and that the duration of the initial half-cycle is far longer than all others, and that C1 takes a fairly long time to decay to zero when the astable is first gated off again (the Figure 11 circuit has similar

characteristics).

Figure 12 shows another way of gating the 555 astable. Q1 is normally biased on via R1 and thus acts like a closed switch that (via R2) pulls the C1-R4 junction low and stops the astable operating, but when PB1 is closed, Q1 is turned off and the astable operates in the normal way.

Note that when the astable is gated on, the initial half-cycle is again far longer than all others, etc., and that the pin 3 output terminal is high when the astable is off.

Figure 13 shows the above circuit modified to give 'press-to-turn-off' operation by replacing Q1 with a push-button switch. A digital signal can be used to gate this circuit by wiring a diode as shown and removing PB1, in which case, the circuit will turn off



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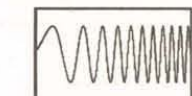
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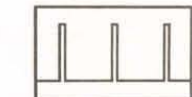
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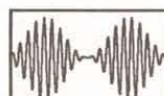
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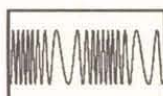
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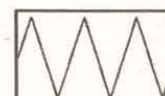
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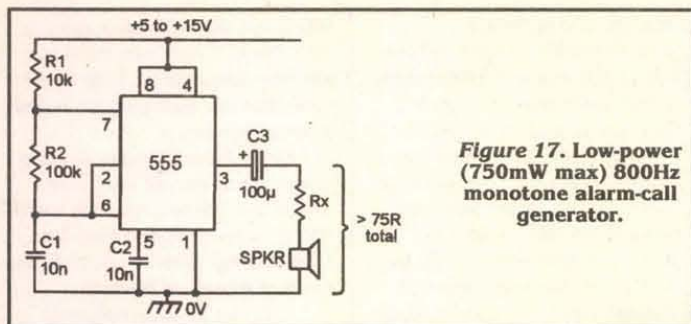
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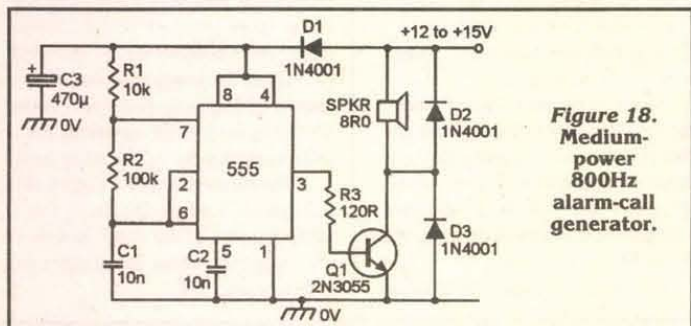
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**Figure 17. Low-power (750mW max) 800Hz monotone alarm-call generator.**



**Figure 18. Medium-power 800Hz alarm-call generator.**

when the gate signal is below  $1/3 V_{cc}$ .

To complete this look at gating techniques, Figure 14 shows the Figure 12 circuit modified to give 'precision' operation.

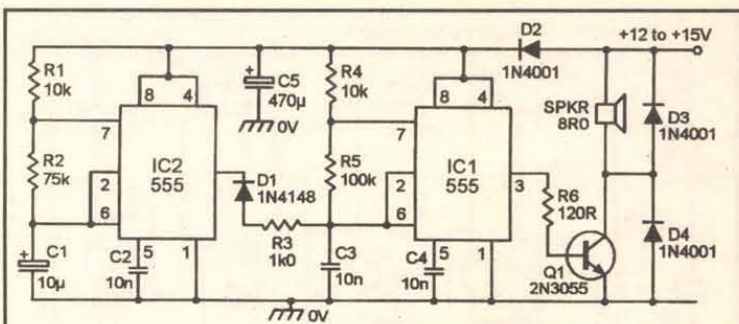
Here, when PBI is open Q1 is saturated, so R2-R3 pulls the R5-C1 junction to just below  $1/3 V_{cc}$  via D1, thus gating the astable off, but when PBI is closed, Q1 turns off and D1 is reverse-biased via R2, and the astable is thus free to operate.

Note that when PBI is first closed C1 charges from an initial value of almost  $1/3 V_{cc}$ , and the duration of the initial half-cycle is thus similar to all others.

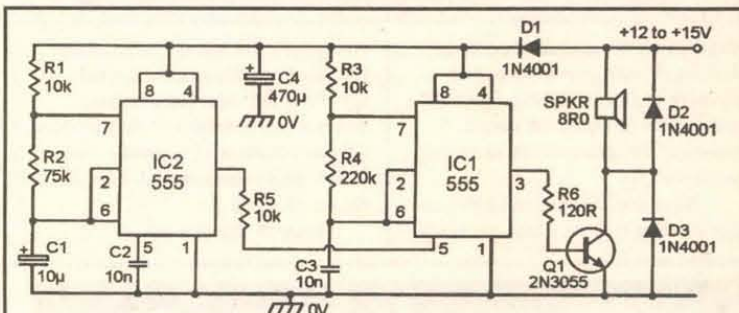
selection of circuits of this type.

Figure 17 shows an 800Hz monotone alarm-call generator circuit that can be used with a 5V to 15V supply and with any speaker impedance; note that Rx is wired in series with the speaker, to give a total load impedance of 75 ohms (to limit peak output currents to 200mA).

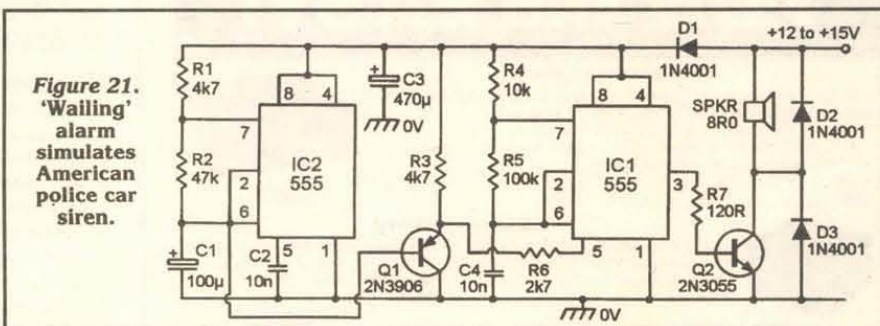
Available alarm output power



**Figure 19. Pulsed-tone (800Hz) alarm-call generator.**



**Figure 20. Warble-tone alarm-call generator simulates British police car siren.**



**Figure 21. 'Wailing' alarm simulates American police car siren.**

## FM AND PPM

All the 555 astable circuits shown so far can be subjected to frequency modulation (FM) or to pulse-position modulation (PPM) by simply feeding the modulation signal to pin 5 (which connects to the IC's internal divider chain); this modulation signal may be an AC signal that is coupled to pin 5 via a blocking capacitor, as shown in Figure 15, or it may be a direct-coupled DC signal, as in Figure 16.

The 555's astable action is such that the pin 5 voltage influences the width of the mark, but not the space part of each cycle, and thus provides both PPM and FM actions.

These types of modulation are useful in special waveform generator applications, as in various electronic siren and alarm-call generator circuits.

## '555' SIRENS AND ALARMS

One very popular application of the 555 astable circuit is as a speaker-driving siren or alarm-call generator, and Figures 17 to 22 show a



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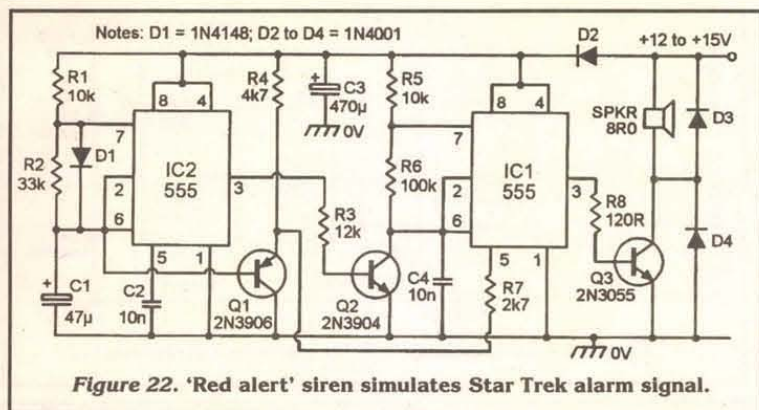
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depends on the speaker impedance and supply voltage values; i.e., it is 750mW at 75R at 15V, etc. Figure 18 shows how to boost the output power of the above circuit to several watts via Q1.

Note that the resulting high output currents may modulate the supply

voltage, and D1 and C3 help isolate the 555 from this modulation; D2 and D3 clamp the inductive switching spikes of the speaker and thus protect Q1 from damage. This booster circuit is also used in the alarm circuits of Figures 19 to 22.

Figure 19 shows a pair of 555

astables used to make a pulsed-tone 800Hz alarm-call generator; IC1 acts as the 800Hz generator, and is gated on and off once per second via IC2 and D1.

Figure 20 shows a warble-tone alarm-call generator that simulates the sound of a British police car siren. IC1 is again wired as an alarm tone generator and IC2 as a 1Hz astable but, in this case IC2 output is used to frequency modulate IC1 via R5, the action being such that IC1's frequency alternates between 440Hz and 550Hz at a 1Hz cyclic rate.

Figure 21 shows a 'wailing' alarm that simulates an American police car siren. IC2 is a low-frequency (6s) astable that generates a 'ramp' waveform that is buffered via Q1 and used to frequency modulate tone generator IC1 via R6.

IC1 has a mid-frequency of about

800Hz, and the modulation action is such that its output tone starts at a low frequency, rises for 3s to a peak value, then falls back again for 3s, and so on *ad infinitum*.

Finally, Figure 22 shows an alarm that simulates the 'red alert' sound used in *Star Trek* programs; this sound starts at a low frequency, rises for 1.15s to a high tone, ceases for 0.35s, and then repeats *ad infinitum*.

IC2 is a 1.5s non-symmetrical astable that generates a fast rising, but slowly falling sawtooth across C1; this waveform is buffered via Q1 and used (via R7) to frequency modulate IC1, making its frequency rise slowly during the falling parts of the sawtooth, but collapse rapidly during the rising part.

The rectangular pin 3 output of IC2 gates IC1 off via Q2 during the collapsing part of the signal, so only the rising parts of the alarm signal are, in fact, heard. **NV**

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## 'SX-ISD-100' Debugger+Programmer

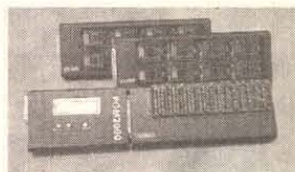
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# ELECTRONICS Q & A

With TJ Byers

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

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

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

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

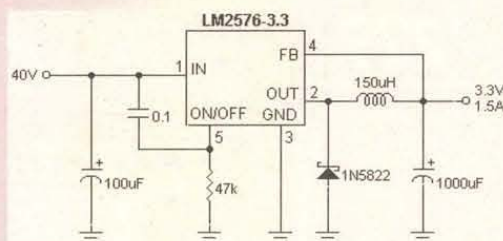
The response to my high-pass and notch filters in last month's column was overwhelming, so this month I've added instruments and websites that take the concept one step further. Specifically, a sensitive AC voltmeter, sinewave generator, and three bipolar power supplies. There's also a 3.3V switching supply and a coaxial "bias-tee" power supply.

### Switching 3.3-Volt Voltage Regulator

**Q** - I have a RadioShack fluorescent lamp that works off three volts at 1.5 amps. I have a 13 VDC, two-amp wall adapter that I'd like to use to power the lamp. What is the most efficient way to bring the transformer down to three volts? I prefer a method which doesn't waste power or produce excessive heat.

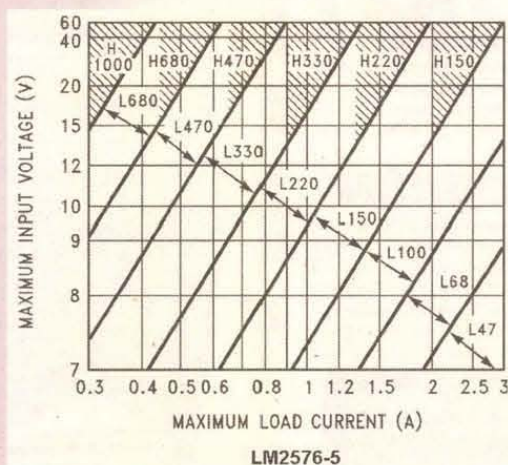
**Sumeth Kongsuwan**  
via Internet

**A** - The best design for a power supply of this type should be based on a step-down voltage regulator, like the LM2576 from National Semiconductor.



The regulator comes in four fixed voltages (3.3V, 5V, 12V, and 15V), plus an adjustable version (1.23V to 37V), and is capable of supplying up to three amps of output current. At 3.3 volts, the circuit is 75% efficient, and 88% efficient at five volts. The 47k resistor and 0.1uF capacitor combination provides soft-start for the regulator. Essentially, the output voltage gradually increases to full-output voltage, preventing heavy surge currents from rushing through the load on startup.

The only critical component is the inductor, which must match the input voltage, output voltage, and output current. Here is the inductor selection chart for the LM2576-5.0 (five volts fixed output).



To find the correct value, simply locate the area where your input voltage and output current intersect; the values are in uH. When purchasing an inductor for this chip, make sure it can handle the output current.

### Surge Protection For CATV

**Q** - Do you have a schematic diagram for a surge suppression circuit that can protect the cable TV input from lightning strikes, voltage surges, etc.? My TV

is protected by an APC surge suppressor for the AC line and I'd like to protect the cable TV as well.

**Tony Tantay**  
via Internet

**A** - Yes I have, but it will cost you more to build than buy. Many manufacturers make combination AC-line/cable-TV surge protection devices, most of which sell for under \$20.00. I'm partial to the Curtis SP4100, which you can find for as cheap as \$15.95 — plus it comes with \$50,000.00 of equipment warranty protection should the surge protector fail to do its job.



### Sorry, But This Ricoh Printer Has No Parents

**Q** - I have a Ricoh LP4081 EX printer with a 50-pin printer cable that I need to interface with my PC. The 50-pin connector is similar to the one used on Apple computers, but I don't know if it's a SCSI interface or not. Furthermore, I haven't been able to get any information from Ricoh. Any info you can furnish would be greatly appreciated.

**Thomas Bristol**  
Granada Hills, CA

**A** - I'm not sure I can be of much help, but let me give you the excuses as to why not. Yes, it is probably a SCSI port made for the Wang PC, which means it's very unlikely you'll find a driver for it even if you can find an interface card. The problem of finding software drivers for the LP4081 has inundated Ricoh so much that they published a public response at [www.ricoh-red.com/support/printer/lp4081.htm](http://www.ricoh-red.com/support/printer/lp4081.htm). Here is an excerpt from that message.

Dear LP4081 Owner,

The LP4081 has not been sold for almost 10 years now and we are sorry to inform you, but we do not make drivers for this printer anymore.

#### Reason:

The LP4080, LP4081, and PC6000 used a printer language that was based on an extended Diablo 630 language which added additional graphics and downloadable fonts to the already existing daisy wheel printer language Diablo 630 ECS.

Although we tried, this language did not become a standard and most of the LP4081s were sold with at least one emulation card, the "LaserJet Plus" emulation being the most popular. Since then Ricoh has started using, as almost everyone else, "hp-pcl5" compatibility.

#### Solution:

Your best bet is if you have either the HP-Laser Jet Plus emulation card (R1 LJP), the Epson Fx80 emulation (R1 F80), or the IBM ProPrinter emulation (R1 PRO). Then you should choose these drivers for usage with your application. See previous information above!

If you have older software, you can choose a Diablo 630 ECS driver for text only applications.

We also have a collection of old drivers for the PC6000 on our House BBS. But this is limited to some drivers for older Dos applications and a Win 3.0 driver, "which does not work with 3.1 or Win 95".



BBS +49 (0) 211 6546 - 341 / 342.

It might be possible to use these for your LP4081 also, however, most older applications already had an LP4081 or LP4080 driver included with the application.

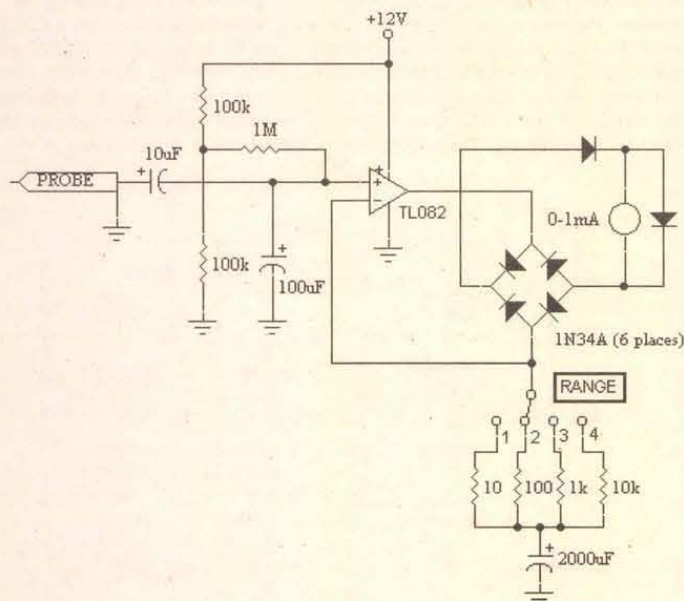
Again, we are sorry and hope that you have one of the emulation cards.  
Best Regards,  
printer-support@ricoh-red.com

## Sensitive AC Voltmeter

**Q** I'm trying to measure AC audio signals in the 30 millivolt (mV) range, but my DMM isn't sensitive enough. Do you have a circuit for a sensitive AC voltmeter or know of an inexpensive test instrument that will meet my needs?

Earl Smith  
via Internet

**A** Here's a simple circuit that can be constructed for under \$20.00. The voltmeter is essentially a precision rectifier built around a TL082 op-amp. (Actually, any 741-type op-amp will work; it's not critical.) The gain of the amplifier is set by the value of the feedback resistors, which are selected via S1. The output is rectified by the 1N34A germanium diodes and sent to the analog panel meter.



This circuit has a flat frequency response from 8 Hz to 50 kHz on the 10 mV range. The lower frequency limit is 0.1 Hz on the higher ranges. Input impedance is one megohm, and the accuracy of the instrument is directly related to the tolerance of the resistors, which should be 1% or better.

S1	RANGE
1	10 mV
2	100 mV
3	1 V
4	10 V

It's important that you use a shielded test probe to prevent stray AC hum from affecting the signal under test. Such probes are popularly used with oscilloscopes and are readily available, or you can make your own using a six-foot length of coax cable and a BNC connector.

## Sending DC Volts Through Coax

**Q** I am looking for a way to send nine volts DC down an RG-59 coaxial cable to power a CCTV camera. I have seen it done with mast mounted TV preamplifiers, but short of buying a VHF/UHF boost amplifier and reverse engineering it, I don't know how to mix RF and DC — or how to separate them at the camera.

BLMartin  
via Internet

**A** What you need is a device called a "bias tee." This passive device permits the mixing of RF and DC voltage without affecting the quality of either. Bias tees are commercially available from several sources, including Down East Microwave Inc. (908-996-3584; <http://www.downeastmi>)

# Go Wireless With Our Modules

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The TXM and SILRX modules are a transmitter and receiver pair which can achieve a one-way radio data link-up to a distance of 200m over open ground.

Both units are supplied in space-saving single-in-line packages and offer SAW controlled, wide band FM transmission/reception.

The modules are particularly suited to battery-powered, portable applications where low power and small size are critical design criteria.



## TX2/RX2

The TX2 and RX2 radio transmitter and receiver pair enable the simple implementation of a data link at up to 40kbit/s at distances up to 75m in-building and 300m open ground. Both modules combine full screening with extensive internal filtering to ensure EMC compliance by minimizing spurious radiations and susceptibilities. The TX2 and RX2 modules will suit one-to-one and multinode wireless links in applications including car and building security, EPOS and inventory tracking, remote industrial process monitoring, and computer networking. Because of their small size and low power requirements, both modules are ideal for use in portable, battery-powered applications such as hand-held terminals.



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## RPC

The RPC module is an intelligent transceiver which enables a radio network link to be simply implemented between a number of digital devices. The module combines an RF circuit with processor-intensive low-level packet formatting and recovery functionality, requiring only a simple antenna and 5V supply to operate with a microcontroller or a PC.



## BiM

The BiM module integrates a low-power UHF FM transmitter and matching superhet receiver together with data recovery and TX/RX change over circuits to provide a low-cost solution to implementing a bi-directional short-range radio data link.

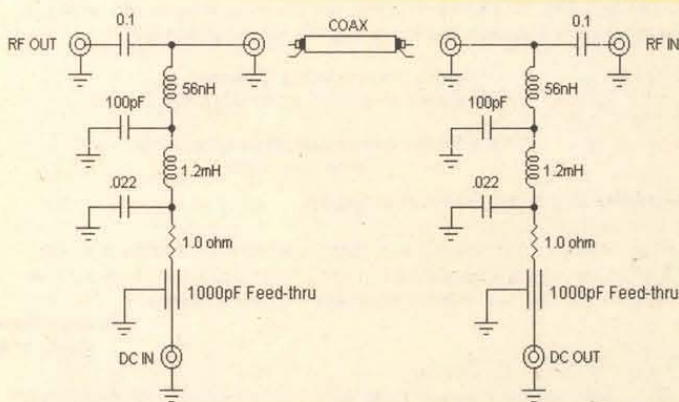


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**crowave.com**) and **Mini-Circuits** (1-800-654-7949; <http://www.minicircuits.com/znb60-1w.pdf>). Prices range from \$35.00 to \$100.00. Fortunately, they're cheap and easy to build, as shown below.



The 0.1 capacitor blocks the DC voltage but allows the RF to pass, whereas the two chokes block the RF signal and allow the DC to pass. Use point-to-point wiring, keeping the leads as short as possible, and enclose the circuit inside a metal box to prevent EMI/RFI interference. A gutted CATV splitter makes an excellent enclosure.

## Simple Sinewave Generator

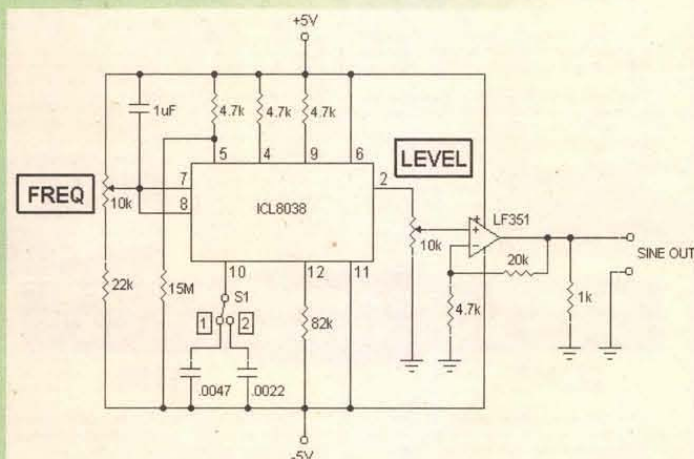
**Q** I've been experimenting with the hum filters you described in the Nov. 2000 column, and find them to work as advertised. Now I'd like to take my experiments farther and investigate other types of filters. But to do so, I need a variable frequency sinewave generator. Do you have a simple one that won't cost me an arm and a leg to build?

G. Phillips  
via Internet

**A** I'm glad to hear that you're interested in playing with filters. Personally, I find them both interesting and frustrating (far too many variables) —



yet indispensable. Which is why a good signal generator and a sensitive AC voltmeter can take a lot of the pain out of the design process. The AC voltmeter is described in the answer above ("Sensitive AC Voltmeter") and the signal generator is shown below.



Instead of reinventing the wheel, and possibly introducing glitches in the test equipment, I used a venerable and very stable function generator chip available from **Jameco Electronics** (1-800-831-4242; [www.jameco.com](http://www.jameco.com)). Basically, it's a squarewave multivibrator with internal shaping circuits to generate sawtooth and sinewave outputs. The output frequency is controlled by the voltage on pins 7 and 8, which is adjustable via the FREQ potentiometer, and the timing capacitor on pin 10. Using the values indicated, the frequency is adjustable from 20 Hz to 20 kHz and 10 kHz to 100 kHz.

SI	RANGE
1	20 Hz to 20kHz
2	10 kHz to 100 kHz

The output is buffered through an LF351 op-amp, and the output voltage is adjustable via the LEVEL control. I opted to use a bipolar power source so that the waveform moves symmetrically above and below ground, instead of an offset voltage that would be present with a single-ended power source. A suitable power supply can be built using the circuit shown in the answer below, "Simple Bipolar Power Supply." Replace the 7812 and 7912 with 78L05 and 79L05, respectively, and lower the input voltage to 12 volts using a RadioShack 273-1366 power transformer. For more information on filters, their design, and applications, check out the following sources:

**Audio Design With Opamps**  
<http://www.sound.au.com/dwopa2.htm>

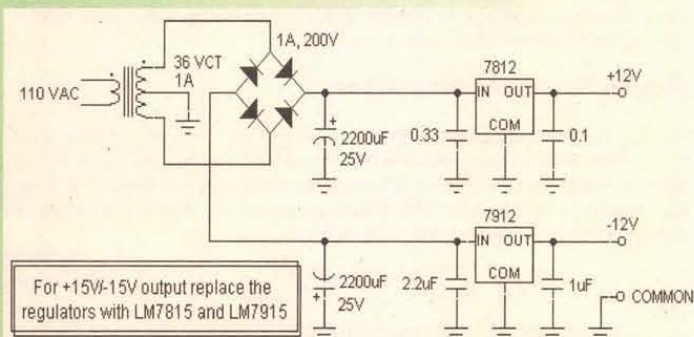
**Active Filter Cookbook, Don Lancaster**  
<http://www.amazon.com>

### Simple Bipolar Power Supply

**Q** - Many of the circuits I find of interest require a +12V and a -12V power supply, especially those using op-amps. Do you have a power supply circuit that will let me experiment with these designs?

**George Simon**  
 via Internet

**A** - Although the industry is migrating to single-source op-amps like the LM324, these chips won't work for all applications — particularly in circuits where CMR (common-mode rejection) is critical. Here's a simple circuit that you can throw together for about \$30.00.



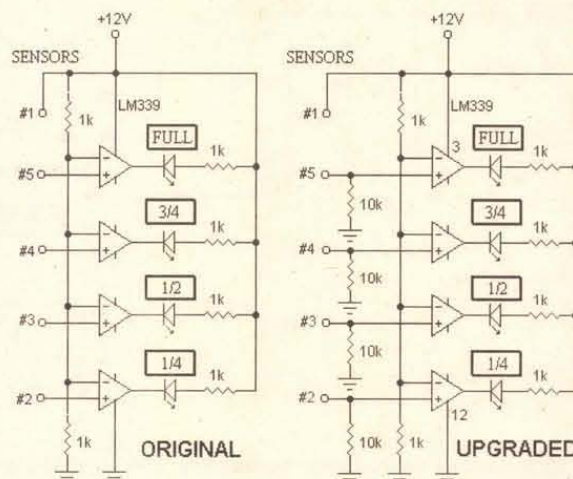
This bench power supply provides bipolar 12 volts at up to 1A. Moreover, the design is easily modified to accommodate other bipolar voltages and currents. For example, replacing the 7812 and 7912 with a 7815 and 7915, respectively, creates a +15V/-15V power supply, again at 1A. Unlike the switching power supply in "Switching 3.3-Volt Voltage Regulator," the regulators need a heatsink. If your experiments tend toward one and two op-amp designs, i.e., no high-power output devices, replacing the 7812 and 7912 with their low-power 78L12 and 79L12 counterparts will provide tighter regulation — and dissipate less heat — when the output current is less than 100 mA.

### Suspect: A CMOS Ringer

**Q** - The circuit you describe in your Jul. 2000 column is just what I need to monitor my RV water supply — if I could make it work! I have breadboarded this thing six or eight times using RadioShack LM339s, resistors, and LEDs. I have even switched comparator  $\pm$  leads, all to no avail. I'm getting power from a metered regulated power supply, so that can't be the problem. Is there an error in the published circuit or am I missing something?

**P. J. Hicks**  
 via Internet

**A** - Over the past years, I've built this circuit many times with never a problem. So I went to RadioShack, bought their parts, and guess what? It didn't work. I've had this happen before using RadioShack parts, and it's not because their parts are defective. It's because RadioShack often sells a CMOS equivalent of a popular part, most notably is the Texas Instrument CMOS version of the 555 timer, and they aren't the same as their TTL equivalents. First and foremost, the input impedances are MUCH higher. Consequently, the sensor inputs act like a radio antenna, picking up signals from hither and yon. The solution is to add a pull-down resistor, as shown in the circuit below.



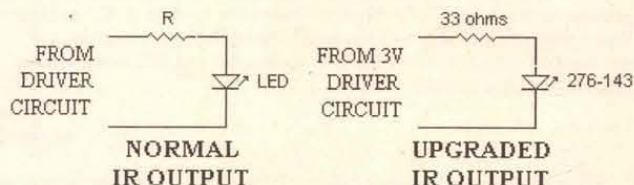
(Reader's response: "Your suggestion solved the problem. Thanks a lot; I appreciate all your trouble and interest in solving the mystery. Regards, PJH")

### Supercharge That Bot Link

**Q** - Do you know of a simple 40-kHz amplifier circuit — preferably one IC? I'd like to extend the range of my robot's detectors.

**Wally Good**  
 via Internet

**A** - I assume you're using an IR receiver module, like the RadioShack 236-137, and feeding its output to a PIC or BASIC Stamp chip. In which case a 40-kHz amp won't help because the output is TTL logic. To increase the operating range, you have to up the light output from the IR transmitter. If you're using a handheld remote, you need to open the case and locate the LED diode and its series resistor. One or both have to be upgraded.



The LED is behind the filter lens and the current limiting resistor will be in series with one of the LED's leads, as shown above.



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## MAILBAG

Mr. Byers,

I am in the design stages of building a high-current, PWM DC-motor speed controller. I noticed in your Sept. 2000 column a circuit similar to the one that I had in mind. It seems to me that there may be a problem with the circuit that you printed. Maybe I am wrong, but should there be a 1K resistor between pins 7 and 8 of the NE555 timer? I'm not an electronics engineer, just a hobbyist, 40-year ham radio licensee, and 51 years young. Would you please explain how this circuit will work as printed? I'd appreciate it.

Alan Schneiderman  
Chancellor, SD

Response:

Well, the 1k resistor is simply a current limiter. If the wiper of the 1M pot were turned all the way up (to the pin 8 position) the only device between the +12-volt source and the timing capacitor is a 1N4148 steering diode, which has a current rating of 100 mA. Without the resistor, the surge current could destroy the diode. The circuit is a classic PWM (pulse-width modulated) multivibrator where the frequency remains stable while the duty cycle is variable from about 3% to 97%; you've seen me use this design for DC light dimmers, too. Focus on the 1M pot. As the wiper goes toward pin 8 (+12V), it takes less time to charge the 0.1 uF capacitor, but more time for it to discharge through pin 7. Moving the wiper to the other extreme reverses the scenario, where the charging time is long and the discharge time is short. Midway, the duty cycle is 50%.

Mr. Byers,

I was looking through some old Nuts & Volts issues. In the spring of 1999, you answered a question about telephone ring generators. Have you seen the Black Magic LBM12? It's a little overpriced, but it works fine. Jameco Electronics sells it for \$24.95, stock no. 145816. I have used one and it works fine and draws very little input current. It's a little black box, potted, with four wires sticking out. I bought mine when All Electronics had them on close-out for \$5.00. I should have bought one or two more and done a little reverse engineering to see what's under that potting compound!

Bill Stiles, CET  
via Internet

Hi Mr. Byers,

I read your answer to the defective AC lamp dimmer in the July 2000 issue. I find that spraying the pot in the Torchieri lamp with a tuner cleaner (RadioShack 64-4315) corrects the problem most of the time.

Robert Eshoo  
Santa Monica, CA

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27C64-15	4.79	4.55	4.10
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27C512-25	2.99	2.84	2.56
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LM317T	.49	.47	.42
LM3846-1	.33	.31	.28
NE555N	.24	.23	.21
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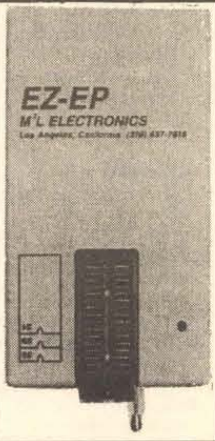
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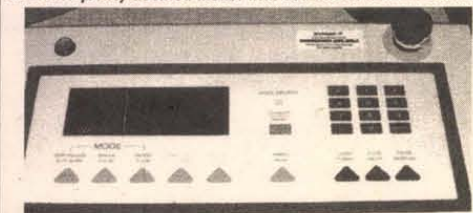
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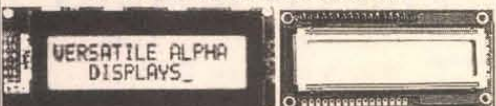
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**WIRELESS MOBILE WORKSTATION, a Hackers Bonanza! Itronix T5000 mobile terminal & 2Meg. PCMCIA SRAM**

Well this is a device we would really like to know more about. Our people are working on it and this is what we know so far. This unit is built like a brick pizza. Polycarbonate case sealed from rain, dust and repeated drops. It has a 75 key QWERTY keyboard which curiously does not have the correct overlay identification of the keys. Actually they simply need a new key text overlay. They were just replaced by a fortune 500 company that was using them daily. A flip up cover holds a transactive Samtron UG2402 monochrome LCD display that we think is 640 x 240 pixels. Size: 7.3"W x 2.75"H and displays 16 shades of gray also has a white E/L backlight. The unit has an internal Motorola type RPM4051 Radio Packet Modem with built in flip up antenna. We believe it operates on the ARDIS or similar network. There is also an RS-232 serial port / bar code wand port. Also there is a port for a hand held laser scanner. Power through the std. DC connector with 10VDC @ 2V to 800mA. The unit only draws about 175ma after boot. The external 7.2V NiCAD battery packs have been removed. An alternate power source could easily be accommodated. We believe there is an internal modem as the unit sports an RJ-11 style connector as well tip and ring connections. The 80C552 processor boots MS DOS ROM Version 5.00 to an A: prompt. Internal memory of 640K. Operating temp from -4 to +140F. From there on your own. All units are tested for boot up otherwise sold as an experimenters package.  
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# Open Channel

by Joseph J. Carr

## Large Loop Antennas

### In this Quad Loop

month's column, we will take a look at the large loop antennas such as the quad loop, delta loop, and bi-square loop. These loops share certain characteristics in common, such as the approximate pattern. First, let's take a look at the conventional quad loop antenna.

Figures 1 and 2 show the basic quad loop antenna. The antenna has been likened to a folded dipole that has been "pulled open." The nice thing about this antenna is that a full performance antenna can be built in a limited space. The only thing required is at least a quarter wavelength at the operating frequency. This antenna has a maximum gain of 1.4 dBd (dB over a dipole) or 3.4 dBi (dB over isotropic). The antenna has a figure-8 pattern in and out of the page as you view Figures 1 and 2.

The quad antenna was originally built as a beam antenna (more later). It was created by engineers at radio station HCJB in Quito, Ecuador after they experienced losses to their Yagi antennas due to corona arcing off the ends. The thin air in Quito made the use of Yagis — or any half wavelength antennas — somewhat problematical because of the arcing at the high voltage tips of the antenna. The quad loop solves that problem by putting the current loops and voltage loops (which cause the trouble) in the center of the radiator element's vertical and horizontal sides.

The big loop antenna shown here consist of one wavelength of wire formed into a square, that is to say it is a quarter wavelength on a side. The dimensions of the antenna

MegaHertz.

The overall length is four times the length of the individual sides.

### Impedance Matching

The feedpoint impedance of the quad loop is around 100 ohms, with 140 ohms being given for the free space impedance. The impedance closer to the earth's surface is probably the smaller number, as is the impedance for antennas with a large length-to-diameter ratio. This is not a good match to either 75-ohm or 52-ohm coaxial cable, so some sort

are:

$$A = \frac{251}{F_{MHz}} \quad (1)$$

Or, for the overall length:

$$Overall = \frac{998}{F_{MHz}} \quad (2)$$

where:

A and Overall are the lengths in feet (ft)  
FMHz is the frequency in

of impedance matching is needed. Perhaps the best approach is to use the quarter wavelength matching stub in series with the transmission line. The length of the quarter wavelength stub should be:

$$L = \frac{246 V}{F_{MHz}} \quad (3)$$

where:

L is the length of the matching stub in feet (ft)  
FMHz is the frequency in MegaHertz

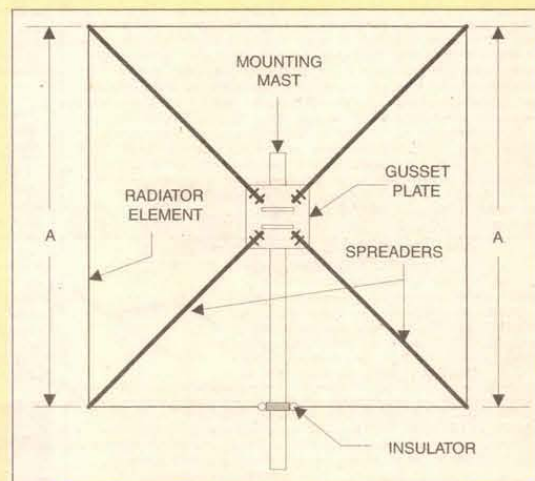
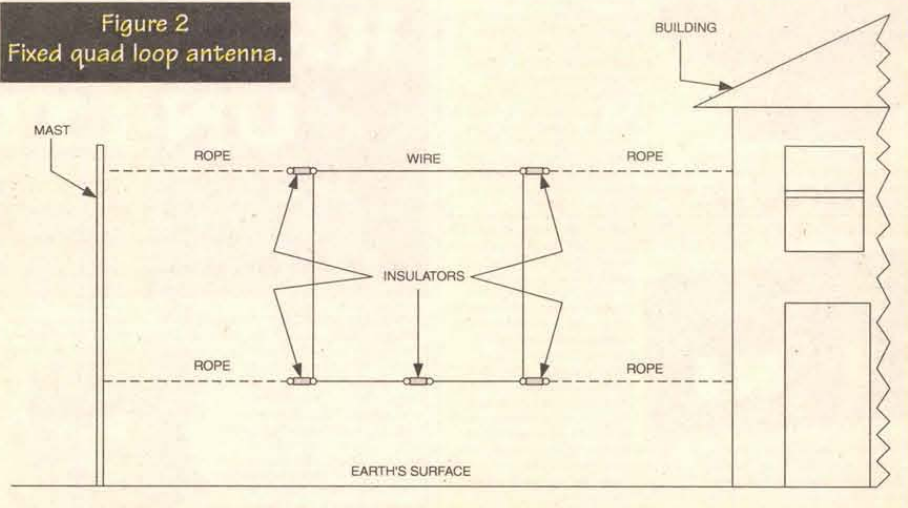


Figure 1 - Rotatable quad loop antenna.

Figure 2  
Fixed quad loop antenna.



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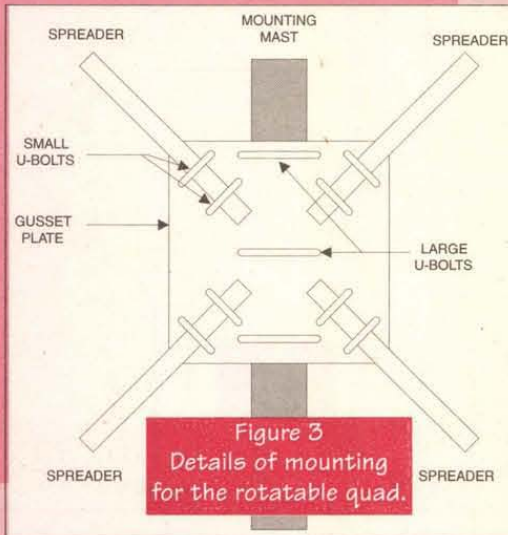
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## Open Channel Large Loop Antennas



**Figure 3**  
Details of mounting  
for the rotatable quad.

V is the velocity factor of the coaxial cable.

The term V in Equation 3 depends upon the type of coaxial cable that you use. You can use 0.66 for standard polyethylene coaxial cable, or 0.78 to 0.80 for polyfoam coaxial cable. Alternatively, you can measure the velocity factor of the coaxial cable and use that number. I have seen substantial variation in the actual velocity factor, so prefer this latter method myself.

The impedance of the transmission line used for the quarter wavelength matching stub is found by taking the square root of the product of the impedances:

$$Z_1 = \sqrt{Z_o Z_L} \quad (4)$$

where:

Z<sub>1</sub> is the characteristic impedance required of the matching stub

Z<sub>o</sub> is the impedance of the feedline to the receiver or the rig

Z<sub>L</sub> is the load impedance (i.e., the antenna feedpoint impedance)

### Example

Take as our example the case where the feedpoint impedance is 140 ohms, and the receiver

uses 52-ohm polyfoam coaxial cable with a measured velocity factor of 0.80. The frequency of operation is 14.25 MHz.

Overall Length:

$$\text{Overall} = \frac{998}{F_{\text{MHz}}} \\ = \frac{998}{14.25} = 70 \text{ feet}$$

Length of each side:

$$A = \text{Overall}/4 = 70/4 = 17.5 \text{ feet}$$

Length of the matching stub:

$$L = \frac{246 V}{F_{\text{MHz}}} \\ = \frac{(246)(0.80)}{14.25} = 13.81 \text{ feet}$$

Impedance of the matching stub:

$$Z_1 = \sqrt{Z_o Z_L} \\ = \sqrt{(52)(140)} = \sqrt{7280} = 85 \text{ ohms}$$

The impedance of the matching section is supposed to be 85 ohms. One can buy 90-ohm coaxial cable but, in practice, the user will be able to obtain 75-ohm coaxial cable far more easily. This cable forms a good match when used as the matching stub, especially considering the fact that the antenna will be used closer to the ground than the free space impedance value indicates. This means the impedance of the load will be closer to 100 ohms, and that translates into an impedance of SQRT(52 (100) = 72 ohms.

### Construction

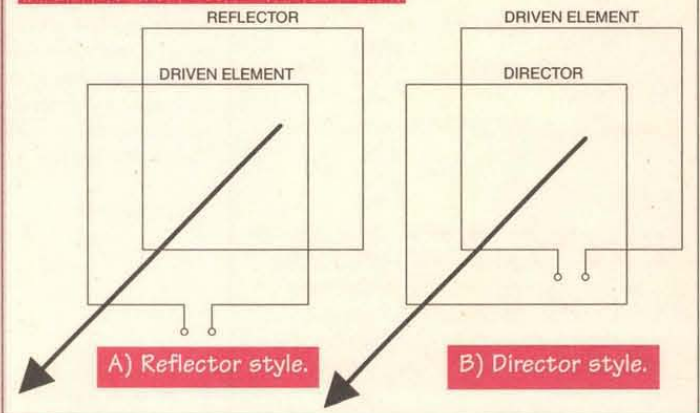
The quad loop antenna can be built in either a rotatable format such as shown in Figure 1, or it can be built fixed in a manner such as Figure 2. The advantage of the rotatable version should be obvious. One can send signals in any direction. More to the point, one can null interfering stations from any quarter.

The rotatable version shown in Figure 1 is mounted on a pole or mast that is, in turn, rotated either by hand or by an electrical antenna rotator. The antenna is built using fiberglass (or other insulating) spreaders connected to a gusset plate. The spreaders are connected to the gusset plate by a set or two or three U-bolts (Figure 3). The gusset plate is held to the mounting mast by larger U-bolts. The gusset plate is typically 10 to 24 inches square, and made of wood or fiberglass.

The mounting version shown in Figure 2 is fixed, but has the advantage of being able to be installed in an existing location, without the need for a rotatable mast. For example, the two supports shown in Figure 3 as a building and a mast, could be any combination of buildings, masts, trees, or other forms. Ropes are used to hold the antenna, which is about in the center of the distance between the supporting structures.

Although it is fed at the bottom in the case

**Figure 4 Cubical quad antennas:**



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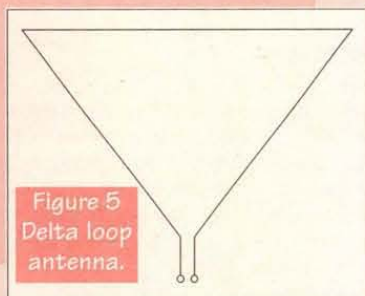
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# Open Channel

## Large Loop Antennas



of Figures 1 and 2, giving it horizontal polarization, the antenna can also be fed along either vertical wire radiator segment for vertical polarization.

### Quad Beam Antennas

The quad loop antenna can be formed into a beam antenna (Figure 4), giving a unidirectional pattern. The nice thing about the quad antenna is that close to the earth's surface it behaves better than a Yagi beam antenna. The antenna can be built in either of two ways: a driven element and either a reflector or a director. The driven element overall length is found from Equation 2, but the director and reflector element overall lengths are found from Equations 5 and 6:

Director:

$$\text{Overall} = \frac{976}{F_{\text{MHz}}} \quad (5)$$

Reflector:

$$\text{Overall} = \frac{1030}{F_{\text{MHz}}} \quad (6)$$

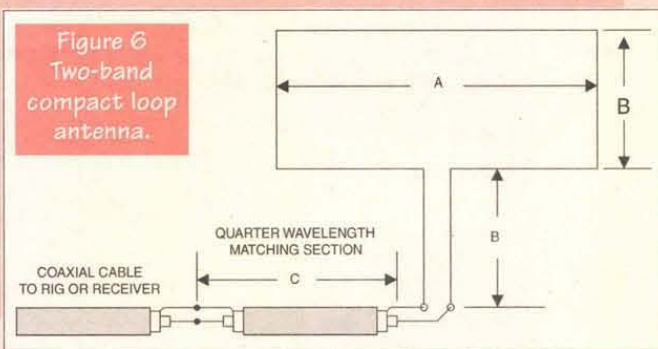
Spacing (0.13λ):

$$S = \frac{128}{F_{\text{MHz}}} \quad (7)$$

For a spacing of  $0.13\lambda$ , the maximum gain of the two element quad beam antenna is 7.3 dBd, or 9.2 dBi. At a spacing of  $0.13\lambda$ , the feedpoint impedance is about 60 ohms, which is a good match to either 52-ohm or 75-ohm coaxial cable (the VSWR when used with 52-ohm cable is only 1.15:1).

### Delta Loop Antennas

The Delta loop antenna (Figure 5) gets its name from the resemblance to the Greek upper case letter "delta" (Δ). The characteristic of this



loop is that it is triangular shaped, which makes mounting and installation easier in some cases. Each side of the Delta loop is one-third of a wavelength ( $\lambda/3$ ), but the overall length is found from Equation 2. The antenna can be fed at any corner. The antenna can also be inverted (sharp point up) and it will work approximately the same as for the case shown.

### Two-Band Compact Loop

Most of the loops discussed thus far are basically monobanders, unless multiple loops are built on the same frame and fed in parallel. The loop in Figure 6, however, operates on two bands that are harmonically related to each other. For example, if FL is the lower band, and FH is the higher band, then  $FH = 2 \times FL$ .

The overall length of the loop is half wavelength, but it is arranged not into a square, but rather a rectangle in which the horizontal sides are twice as long as the vertical sides, i.e., the horizontal elements are quarter wavelength and the vertical sections are one-eighth wavelength. The section lengths are:

Horizontal:

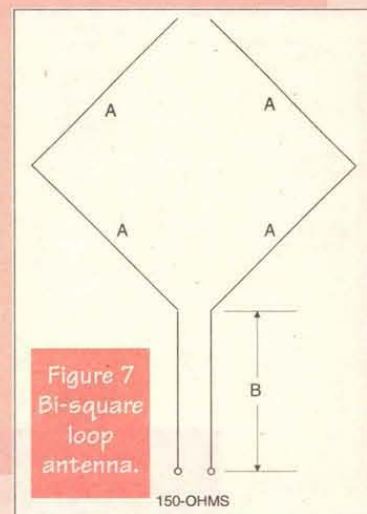
$$A = \frac{246}{F_{\text{MHz}}} \text{ feet} \quad (8)$$

Vertical:

$$B = \frac{123}{F_{\text{MHz}}} \text{ feet} \quad (9)$$

In both equations, the frequency is the center frequency of the lower band of operation.

The vertical stub is made of 600-ohm parallel open wire transmission line, although 450-ohm twin-lead could also be used. The length of the stub is found from the same equation (above) as the vertical segment if open wire line is used. If



twin-lead is used, then multiply that distance by the velocity factor of the transmission line.

The coaxial line is a Q-section made of 75-ohm transmission line. It is cut to a quarter wavelength of the upper band, i.e., twice FMHz used in the calculations above.

### The Bi-Square Loop

The bi-square loop in Figure 7 is twice as large as the quad loop. The overall length of the wire is two wavelengths, so each side is half wavelength long. The overall length is calculated from:

$$L_{\text{Meters}} = \frac{1919}{F_{\text{MHz}}} \text{ feet} \quad (10)$$

while each side is:

$$L_{\text{Meters}} = \frac{480}{F_{\text{MHz}}} \text{ feet} \quad (11)$$

The bi-square antenna can be used on its design frequency, and also at one-half its design frequency (although the patterns change). At the design frequency, the azimuthal pattern is a clover leaf perpendicular to the plane of the loop, and is horizontally polarized. At one-half the design frequency, the radiation is vertically polarized and the directivity is end fire.

The feedpoint impedance of the bi-square is on the order of 150 ohms. This means that some form of impedance matching will be needed to match the impedance to 52 or 75 ohms used by most receivers.

### Conclusion

The large loop antennas offer gain over a dipole, and can be built on smaller sized lots than a host of other antennas. They are easy to build and use. NV

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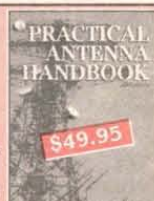
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December 2-3

**FL - PALMETTO** - Hamfest. Manatee County Convention and Civic Center, 1 Haben Blvd. Talk-in: 146.730. FGCARC, Jean Endicott KC4KZU, 727-525-5178. Email: kr4yl@arri.net Web: http://www.fgcarc.org

December 3

**IN - GREENFIELD** - Hamfest. Greenfield High School Pavilion, Broadway St. 8am-2pm. HARC, Tom Donaldson N9LFU. Email: tomd@freeweb.com General info: 317-326-3168. Web: www.w9atg.org  
**MI - MT. CLEMENS** - Hamfest. L'Anse Creuse High School. 8am-2pm. FCC exams. Talk-in: 147.080+, simplex 146.520. L'Anse Creuse ARC, Donna Luh KA8QBD, 248-651-7387. Email: jrluh@aol.com Web: http://www.ameritech.net/users/lc-arc/index.html

December 9

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**SC - UNION** - Hamfest. Union National Guard Armory. 8am-2pm. Union County ARC, Roger Gregory W4RWG, 864-427-1462. Email: rgregory@carol.net

## JANUARY 2001

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January 12-13

**FL - FT. MYERS** - Hamfest. Shady Oaks Community Center, 3280 Marion St. Fri: 4pm-9pm, Sat: 9am-3pm. Talk-in: 146.880. Ft. Myers ARC, Earl Spencer K4FQU, 941-332-1503. Email: k4fqu@juno.com

January 13

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January 14

**IN - GOSHEN** - Hamfest. Michiana Valley Hamfest Assn., Denny Denniston KA9WNR, 219-291-0252 (7-10 PM EST).  
**OH - NELSONVILLE** - Hamfest. Sunday Creek ARC Federation, Russ Ellis N8MWK, 740-767-2226. Email: scarf@hocking.edu

January 20

**LA - HAMMOND** - Hamfest. SLU University Center, Columbus Dr. Ve testing. Talk-in: 147.000-. Southeast LA ARC, Bill Borstel KB5SKW, 225-695-6414. Email: wborstel@aol.com Web: http://www.selarc.org  
**MO - ST. JOSEPH** - Hamfest. Ramada Inn, I-29 & Frederick Ave. FCC exams. Talk-in: 146.85 & 444.925. MO Valley & Ray-Clay ARCS, Carlene Makawski KA0IKS, 816-279-

# CALENDAR

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

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

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

All listing information should be sent to:

**Nuts & Volts Magazine**

**Events Calendar**

430 Princland Court

Corona, CA 92879

Phone 909-371-8497

Fax 909-371-3052

E-mail events@nutsvolts.com

3406. Email: nem3238@ccp.com

Web: http://www.kc.net/~oconnor

**TN - GALLATIN** - Hamfest. Gallatin Civic Center. Sumner County ARA, John Hermon WB5OOL, 615-451-0213. Email: hamfest@scara.net Web: http://www.scara.net

January 20-21

**FL - SARASOTA** - Hamfest. Sarasota ARA, Eddie Martin K14ZJ, 941-378-8371. Email: k14zj@hotmail.com

January 21

**MI - HAZEL PARK** - Hamfest. Hazel Park High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64-. Hazel Park ARC, Inc., Tom Krausnick WC9F, email: wc9f@arri.org Web: http://www.qsl.net/w8hp  
**NY - NORTH BABYLON** - NLI Section Convention. Babylon Town Hall Annex, Phelps Ln. 9am-4pm. VE testing. Great South Bay ARC, Phil Lewis N2MUN, 631-226-0698. Email: n2mun@optonline.net Web: http://www.arrihudson.org/nli/hr2001.htm  
**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. Email: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

**VA - RICHMOND** - VA Section Convention. The Showplace, 3000 Mechanicsville Turnpike (Rt. 360). 8:30am-3:30pm. Richmond Amateur Radio Communications Society, Pat Wilson K4OW, 804-932-9424. Email: k4ow@arri.net Web: http://frostfest.rats.net

January 27

**FL - ARCADIA** - Hamfest. DeSoto ARC, Doug Christ KN4YT, Email: kn4yt@cyberstreet.com

January 28

**IL - CICERO** - Hamfest. Sportsmans Park Race Track, 3301 S. Laramie Ave. 8am-1pm. VE testing. WCRA, 630-545-9950. Email: info@wheatonhamfest.org Web: http://www.wheatonhamfest.org  
**MD - ODENTON** - Hamfest. Maryland Mobiles ARC, Tom Ostrosky W3NI, 410-766-9414. Email: ostrosky@erols.com Web: http://www.space4less.com/mmamc  
**OH - DOVER** - Hamfest. Tusco ARC, Gary Green KB8WFM, 740-922-4454. Email: kb8wfm@tusco.net

## FEBRUARY 2001

February 2-3

**MS - JACKSON** - Convention. Trade Mart Bldg., Fairgrounds. Fri: 5pm-8pm, Sat: 8am-4pm. VE testing. Talk-in: 146.76-. Jackson ARC, Ron Brown AB5WF, 601-956-1448. Email: ab5wf@arri.net Web: http://www.jxnarc.org

## COMPUTER SHOWS

**AGI Shows**, 317-299-8827.

E-Mail: info@agishows.com  
http://www.agishows.com

**Blue Star Productions**

612-788-1901.  
http://www.supercomputersale.com

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

**Computer Central Shows**

847-412-1900 & 1-888-296-6066.  
E-Mail: compcent@meginet.net  
www.computercentralshows.com

**Computer Country Expo**

847-662-0811 Web: www.ccxpo.com

**Five Star Productions**

810-379-3333. E-Mail: jeff@fivestar  
www.fivestars.com

**Georgia Mountain Productions**

706-838-4827.  
E-Mail: gamtnpro@blrg.tds.net  
georgiamountain.com

**Gibraltar Trade Center, Inc.**

612-287-2000. Taylor, MI.  
E-Mail: taylor@gibraltartrade.com  
www.gibraltartrade.com

February 3

**SC - NORTH CHARLESTON** - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. Email: brycemyers@aol.com Web: http://www.qsl.net/wa4usn/ind ex.html

February 3-4

**FL - MIAMI** - Southeastern Division Convention. Fair Expo Center, 10901 SW 24th St. (Coral Way). Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139. Email: w4wyr@arri.net Web: http://www.hamboree.org

February 4

**TX - GEORGETOWN** - Hamfest. Williamson County ARC, Mike Evans KD5AAD, Email: mlevans@mail.utexas.edu

February 5

**AZ - PHOENIX** - Auction. St. Clement of Rome Catholic Church Social Hall, 15800 Del Webb Blvd. Talk-in: 147.30+. West Valley ARC, Ron K6OP, 623-546-5710. Email: ronk6op@juno.com

February 9-10-11

**FL - ORLANDO** - Northern FL Section Convention. Central Florida Fairgrounds, 4603 W. Colonial Dr. Exams. Talk-in: 146.760 down 600, 145.110 down 600. Orlando ARC, Ken Christenson AF4ZI, 407-291-2465. Email: kd4jr@juno.com

**Gibraltar Trade Center, Inc.**

810-465-6440. Mt. Clemens, MI.  
E-Mail: mtclmens@gibraltartrade.com  
www.gibraltartrade.com

**KGP Productions**

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

**MarketPro, Inc.**, 201-825-2229.  
http://www.marketpro.com

**MarketPro, Inc.**, 301-984-0880.

E-Mail: md@marketpro.com  
http://marketpro.com

**Narisaam Computer Show**

770-663-0983.  
E-Mail: narisaam@aol.com  
Web: http://www.showsale.com

**Northern Computer Shows**

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

**Peter Trapp Computer Shows**

603-272-5008.  
Web: www.petertrapp.com

Web: http://www.oarc.org/hamcat.html

February 10-11

**TN - MEMPHIS** - Convention. Shelby Co. Bldg., Mid-south Fairgrounds. Sat: 9am-5pm, Sun: 9am-2pm. Dixie Fest Committee, Ben Troughton KU4AW, 901-372-8031. Email: ku4aw@arri.net Web: http://www.dixiefest.org

February 11

**OH - MANSFIELD** - Hamfest. InterCity ARC & MASER, Dean Wrasse KB8MG, 419-522-9893. Email: deanwrasse@yahoo.com Web: http://www.maser.org

February 17

**CA - MONTEREY** - Hamfest. Naval Postgraduate School ARC, Max Cornell K0MC, 831-883-0491. Email: cornell@redshift.com Web: http://k6ly.org/radiofest  
**MA - MARLBOROUGH** - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988. Email: annweldon@aol.com

February 18

**CO - BRIGHTON** - Hamfest. Aurora Repeater Assn., Wayne Heinen N0POH, 303-699-6335. Email: n0poh@arri.net Web: http://www.qsl.net/n0ara  
**MI - FARMINGTON HILLS** - Hamfest. William Costick Activity Center, 28600 W. 11 Mile Rd. 8am-1:30pm. LARC, 734-261-5486. Email: swap@larc.mi.org Web: http://larc.mi.org



# Events CALENDAR

**NY - CHEEKTOWAGA** - Hamfest. Leonard Post VFW, 2450 Walden Ave. Talk-in: 147.255. Lancaster ARC, Luke Calliano N2GDU, 716-634-4667 or 716-683-8880. Email: luke@towncountryflorist.com Web: http://hamgate1.sunyerie.edu/~larc

February 24

**IN - LA PORTE** - Hamfest. La Porte Civic Auditorium, 1001 Ridge St. 7am-1pm. LPARC, Neil Straub W29N, 219-324-7525. Email: nstraub@nla.net Web: www.geocities.com/k9jsi/

**VT - MILTON** - Hamfest. Radio Amateurs

of Northern VT, Mitch Stern W1SJ, 802-879-6589. Email: w1sj@arri.net Web: http://www.ranv.together.com

February 25

**NY - HICKSVILLE** - Hamfest. Levittown Hall, 201 Levittown Pkwy. Talk-in: 146.850 PL 136.5. Long Island Mobile ARC, Eddie Muro KC2AYC, 516-520-9311. Email: hamfest@limarc.org

Web: http://www.limarc.org

**OH - CINCINNATI** - Hamfest. Hartwell Recreation Center, May St. off Caldwell Dr. 9am-4pm. ARPSC, 513-661-1805.

Email: gldivision@juno.com Web: www.arpac.com

**VA - ANNANDALE** - Hamfest. Northern VA Community College. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021. Email: k3mt@erols.com Web: http://win-terfest.home.att.net

MARCH 2001

March 2-3

**FL - NEW PORT RICHEY** - Hamfest. Fred K. Marchman Technical Education Center, 7825 Campus Dr. 8am-5pm. Talk-in:

146.670. Gulf Coast ARC, Rick Brown KF4GXS, 727-863-1457. Email: richar@gte.net Web: http://gcarc.cjb.net

March 3

**AR - RUSSELLVILLE** - Hamfest. Hughes Community Center, Knoxville & Parkway. 8am-4pm. Talk-in: 146.820. AR River Valley AR Foundation, Margaret Alexander KC5MCS, 501-968-7270. Email: ealexand@cswnet.com Web: http://www.cswnet.com/~arvarf/hamfest.htm

March 4

**NY - LINDENHURST** - Hamfest. GSBARC & SCRC, Phil Lewis N2MUN, 631-226-0698. Email: info@gsbarc.org Web: http://www.gsbarc.org

March 10

**WA - PUYALLUP** - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 425-867-4797. Email: mwdink@eskimmo.com

March 10-11

**NC - CHARLOTTE** - Hamfest & ComputerFair. Charlotte Merchandise Mart, 2500 E. Independence Blvd. The Mecklenburg ARS, Tom Hunt KA3VVJ, 704-948-7373 day & eves. Until 9pm EST. Email: dealers@w4bfb.org Web: www.w4bfb.org/hamfest.html

March 17

**CT - POMFRET** - Hamfest. Eastern Connecticut ARA, Paul Rollinson KE1LI, 860-928-2456. Email: kelli@arri.net

**FL - FT. WALTON BEACH** - Hamfest. Playground ARC, Louis Carter KF4HRM, 850-243-4315. Email: parcest@aol.com Web: http://www.bsc.net/playground/

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

March 17-18

**TX - MIDLAND** - State Convention. Midland ARC, Pete Stull WB7AMP, 915-686-6755 or 915-362-6644. Email: W5QGG@arri.net

March 18

**OH - MAUMEE** - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+. TMRA Hamfest, POB 273, Toledo, OH 43697-0273. Web: www.tmrhamradio.org

March 24

**MN - ST. PAUL** - Hamfest. Robbinsdale ARC, Harriet Johanson KB0UPH, 763-537-1722. Email: k0lrc@visi.com Web: http://www.visi.com/~k0lrc

**WV - BECKLEY** - Hamfest. Plateau ARA & Black Diamond ARC, James Martin KC8JSZ, 304-465-1428. Email: w373@inetone.net

March 25

**NC - KINSTON** - Hamfest. Down East Hamfest Assn., Doug Burt W40FO, 252-524-5724. Email: jeanhnd@icomnet.com

March 30-31

**NE - NORFOLK** - Convention. Elkhorn Valley ARC, Sam Seikaly WA6BRE, 402-379-4073. Email: sseikaly@compnet.com Web: http://www.qsl.net/evarc/

March 31

**MD - TIMONIUM** - Greater Baltimore Hamboree & Computerfest/MD State ARRL

## Invitation

### The first electronics portal on the net www.electronikx.com

Electronikx.com is the first portal dedicated for everything electronics. Starting from doing the big business to the hobby and fun. Our portal built with everything you need for business including a powerful Search Engine, Auctions, Classifieds, News and Information, Discussion boards, Chats, Products Alerts, Free emails, and many other services. The best of all, it is free, check it now.

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The screenshot shows the Electronikx.com website. At the top, there's a navigation bar with links: Home, Auctions, Classifieds, Free Email. Below this is a search bar and a date indicator: October 24, 2000. The main content area is divided into several sections: Business & Economy, Consumer Electronics, Education, Inventions & Ideas, Microwave & RF, Science, Computers, Distributors, Hobbies & Interests, Manufacturers, References, Software, News Channels, Community, and Services. Each section contains sub-links related to that category. For example, under Business & Economy, there are links for Economy, News, Opportunities, etc. The website has a clean, functional design typical of early 2000s web portals.

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Check our online live demo and customers sites

www.mewsoft.com



# Events CALENDAR

Convention. Timonium Fairgrounds, York Rd. Baltimore ARC, Sharon Dobson N3QCQ, 410-HAM-FEST or 800-HAM-FEST. Email: k3duh@amsat.org Web: http://www.gbhc.org

## APRIL 2001

April 6-7

**WI - MILWAUKEE** - AES Superfest 2001. Amateur Electronic Supply, Ray Grenier K9KHW, email: rayk9khw@aol.com

April 7

**MO - LEBANON** - Hamfest. Lebanon ARC, Chuck Sears AA0RK, 417-589-8122. Email: freedom1@advertisinet.com

April 8

**NC - RALEIGH** - Hamfest. Raleigh ARS, Chuck Littlewood K4HF, 919-872-6555. Email: k4hf@arri.net

**WI - STOUTTOWN** - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. Email: n9vwh@arri.net Web: http://www.qsl.net/mara/

April 28

**SC - WINDSOR** - Hamfest. Salkehatchie ARS, Adam Hoffman AF4QZ, 803-245-4673. Email: af4qz@arri.net Web: http://www.qsl.net/kf4cvo

April 29

**IL - ARTHUR** - Hamfest. Moultrie ARK, Ralph Zancha WC9V, 217-543-2178 days or 217-873-5287 eves. Email: rzancha@one-eleven.net

**OH - CANFIELD** - Hamfest. Twenty Over Nine Radio Club, Don Stoddard N8LNE, 330-793-7072. Email: n8lne1@juno.com

## MAY 2001

May 5

**AZ - SIERRA VISTA** - Hamfest. Cochise ARS, Robert Warren KF7TJ, 520-803-1453. Email: warrnel@juno.com Web: http://www.qsl.net/k7rdg

**SC - GREENVILLE** - Hamfest. Blue Ridge ARS, Bob Watson W4RGW, 864-833-2204. Email: w4rgw@arri.net Web: http://www.brars.org

**WI - CEDARBURG** - Hamfest. Ozaukee Radio Club, Gene Szudwag KB9VJP, 262-377-6792. Email: szudwag@msn.com

May 5-6

**AL - BIRMINGHAM** - Hamfest. Glenn Glass KE4YZK, 205-681-5019. Email: ke4yzk@bellsouth.net

**TX - ABILENE** - West TX State Convention. Key City ARC, Peggy Richard KA4UPA, 915-672-8889. Email: ka4upa@arri.net Web: http://www.angelfire.com/tx/kcar76/hamfest.html

May 6

**MD - HAGERSTOWN** - Hamfest. Antietam Radio Assn., Carl Morris WB3DUG, 717-267-3411. Email: morrisw@cnv.net Web: http://www.qsl.net/w3cwc

**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. Email: wb2slq@juno.com Web: http://www.metro70cm.net

**PA - WRIGHTSTOWN** - Hamfest. Warmminster ARC, Tony Simek N3YNH, 215-674-5218. Email: tsimek@aol.com Web: www.voicenet.com/~juno.com

May 12

**WA - STANWOOD** - Hamfest. Stanwood-Camano ARC, Dave Huppert KA7FDC, 360-387-6123. Email: huppert@whidbey.net

May 18-19-20

**OH - DAYTON** - Hamvention. Dayton ARA, Jim Graver KB8PSO, 937-276-6930. Email: info@hamvention.org Web: http://www.hamvention.org/

## JUNE 2001

June 1-2-3

**NY - ROCHESTER** - Atlantic Division Convention. Monroe County Fairgrounds, Rt. 15A. Fri: 6am-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Rochester ARA, Harold Smith K2HC, 716-424-7184. Email: harold@rochesterhamfest.org Web: http://www.rochesterhamfest.org

**OR - SEASIDE** - Northwestern Division ARRL Convention. Convention Center. SEAPAC, Randy Stimson K2ZT, 503-297-1175. Web: www.seapac.org

June 2

**IL - SPRINGFIELD** - Hamfest. Sangamon Valley RC, Edmund Gaffney KA9ETP, 217-628-3697. Email: egaffney@family-net.net Web: http://www.w9dua.net

June 3

**IL - PRINCETON** - Hamfest. Starved Rock RC, Jerry Hagemann N9ZJK, 815-538-6932. Email: w9mkshamfest@hotmail.com Web: http://www.qsl.net/w9mks  
**VA - MANASSAS** - Hamfest. Ole Virginia Hams ARC, Mary Lu Blaslend KB4EFB, 703-369-2877. Email: mblaslend1638@aol.com

Web: http://www.qsl.net/olevahams

June 9

**PA - BLOOMSBURG** - Eastern PA Section Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.bafn.org/~cmarc  
**WI - EAU CLAIRE** - Hamfest. Eau Claire ARC, Jim Staats KG9RA, 715-838-9108. Email: w9eau@ecarc.org Web: http://www.ecarc.org

June 10

**IL - WHEATON** - Hamfest. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. Email: wa9rij@mc.net Web: http://www.cyberconnect.com/orion/smcchtml

### RAMSEY Doppler Direction Finder

Track down jammers and hidden transmitters with ease! This is the famous WAZEBY DF'er featured in April 99 QST. Shows direct bearing to transmitter on compass style LED display, easy to hook up to any FM receiver. The transmitter - the object of your DF'ing - need not be FM. It can be AM, FM or CW. Easily connects to receiver's speaker jack and antenna. Unit runs on 12 VDC. We even include 4 handy home-brew "mag mount" antennas and cable for quick set up and operation! Whips can be cut and optimized for any frequency from 130-1000 MHz. Track down that jammer, win that fox hunt, zero in on that downed Cessna - this is an easy to build, reliable kit that compares most favorably to commercial units costing upwards of \$1000.00! This is a neat kit!

DDF-1, Doppler Direction Finder Kit ..... \$149.95

### Wireless RF Data Link Modules

RF link boards are perfect for any wireless control application; alarms, data transmission, electronic monitoring...you name it. Very stable SAW resonator transmitter, crystal controlled receiver - no frequency drift! Range up to 600 feet, license free 433 MHz band. Encoder/decoder units have 12 bit Holtek HT-12 series chips allowing multiple units all individually addressable, see web site for full details. Super small size - that's a quarter in the picture! Run on 3-12 VDC. Fully wired and tested, ready to go and easy to use!

RX-433 Data Receiver.....\$16.95 TX-433 Data Transmitter.....\$14.95  
RXD-433 Receiver/Decoder.....\$21.95 TXE-433 Transmitter/Encoder.....\$19.95

### World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies - that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Their very light weight and size make them ideal for balloon and rocket launches, RC models, robots - you name it! Units run on 9 volts and hook-up to most any CCD camera or standard video source. In fact, all of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air! One customer even put one on his dog!

C-2000, Basic Video Transmitter.....\$89.95 C-2001, High Power Video Transmitter.....\$179.95

### CCD Video Cameras

Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infrared) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80°) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our B-1 interface board kit for super easy direct hook-up to any video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens .....\$69.95  
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens .....\$69.95  
CCDCC-1, Color CCD Camera, wide-angle lens .....\$129.95  
IR-1, IR Illuminator Kit for B&W cameras .....\$24.95  
IB-1, Interface Board Kit .....\$14.95

### AM Radio Transmitter

Operates in standard AM broadcast band. Pro version, AM-25, is synthesized for stable, no-drift frequency and is settable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 is tunable, runs FCC maximum 100 mW, range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set that dresses up the unit. Great sound, easy to build - you can be on the air in an evening!

AM-25, Professional AM Radio Transmitter Kit.....\$129.95  
AM-1, Entry level AM Radio Transmitter Kit.....\$29.95  
CAM, Matching Case Set for AM-1.....\$14.95

### Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWW National Time Standard radio bands. Pick the receiver of your choice, easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast receiver which has subcarrier output for hook-up to our SCA adapter. The SCA-1 will tune in commercial-free music and other 'hidden' special services when connected to FM receiver. Add our squelch matching case and knob set for that smart finished look!

AR-1, Airband 108-138 MHz Kit.....\$29.95  
HFRC-1, VVVV 10 MHz (crystal controlled) Kit.....\$34.95  
FR-1, FM Broadcast Band 88-108 MHz Kit.....\$24.95  
SR-1, Shortwave 4-11 MHz Band Kit.....\$29.95  
SCA-1 SCA Subcarrier Adapter Kit for FM radio.....\$27.95

FR-6, 6 Meter FM Ham Band Kit.....\$34.95  
FR-10, 10 Meter FM Ham Band Kit.....\$34.95  
FR-146, 2 Meter FM Ham Band Kit.....\$34.95  
FR-220, 220 MHz FM Ham Band Kit.....\$34.95  
Matching Case Set (specify for which kit).....\$14.95

### PIC-Pro Pic Chip Programmer

Easy to use programmer for the PIC16C84, 16F84, 16F83 microcontrollers by Microchip. All software - editor, assembler, run and program - as well as free updates available on Ramsey download site! This is the popular unit designed by Michael Covington and featured in Electronics Now, September 1998. Connects to your parallel port and includes the great looking matching case, knob set and AC power supply. Start programming those really neat microcontrollers now...order your PICPRO today!

PIC-1, PICPRO PIC Chip Programmer Kit.....\$59.95

**Order Toll-free: 800-446-2295**  
Sorry, no tech info, or order status at 800 number  
**For Technical Info, Order Status**  
**Call Factory direct: 716-924-4560**

**RAMSEY ELECTRONICS, INC.**  
793 Canning Parkway Victor, NY 14564  
See our complete catalog and order on-line with our secure server at:  
**www.ramseyelectronics.com**

### 1 GHz RF Signal Generator

A super price on a full featured RF signal generator! Covers 100 KHz to 999.9999 MHz in 10 Hz steps. Tons of features; calibrated AM and FM modulation, 90 front panel memories, built-in RS-232 interface, +10 to -130 dBm output and more! Fast and easy to use, its bench and the handy "smart-knob" has great analog feel and is intelligently enabled when entering or changing parameters in any field - a real time saver! All functions can be continuously varied without the need for a shift or second function key. In short, this is the generator you'll want on your bench, you won't find a harder working RF signal generator - and you'll save almost \$3,000 over competitive units!

RS-1000B RF Signal Generator.....\$1995.00

### Super Pro FM Stereo Transmitter

Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or whistling from cheap CD inputs!) Limiters for max "punch" in audio - without over mod. LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. We also offer a high power export version of the FM-100 fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped if accompanied by a signed statement that the unit will be exported.

FM-100, Pro FM Stereo Transmitter Kit.....\$249.95  
FM-100WT, Fully Wired High Power FM-100.....\$399.95

### FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Great audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strappable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes squelch case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized Stereo Transmitter Kit.....\$129.95

Lower cost alternative to our high performance transmitters. Great value, easily tunable, fun to build. Manual goes into great detail about antennas, range and FCC rules. Handy for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or 5 to 15 VDC. Add matching case and whip antenna set for nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit.....\$34.95  
CFM, Matching Case and Antenna Set.....\$14.95  
FMAC, 12 Volt DC Wall Plug Adapter.....\$9.95

### RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set. Outdoor unit attaches right at the antenna for best signal - receiving or transmitting, weatherproof, too!

LPA-1, Power Booster Amplifier Kit.....\$39.95  
CLPA, Matching Case Set for LPA-1 Kit.....\$14.95  
LPA-1WT, Fully Wired LPA-1 with Case.....\$99.95  
FMBA-1, Outdoor Mast Mount Version of LPA-1.....\$59.95

### FM Station Antennas

For maximum performance, a good antenna is needed. Choose our very popular dipole kit or the Comet, a factory made 5/8 wave colinear model with 3.4 dB gain. Both work great with any FM receiver or transmitter.

TM-100, FM Antenna Kit.....\$39.95  
FMA-200, Vertical Antenna.....\$114.95

**VISA MasterCard AMERICAN EXPRESS DISCOVER**  
ORDERING INFO: Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add \$6.95 for shipping, handling and insurance. Orders under \$20, add \$3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.





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Orders 800-538-1493

2701 Westland Court, Unit B, Cheyenne, Wyoming 82001

## OSCILLOSCOPES & ACCESSORIES

### OSCILLOSCOPES

TEK 7104 1 GHz 2-Channel Oscilloscope, w/7A29,7A29-04,7B10,7B15 .....\$2,000.00

### PROBES

TEK 7904 Oscilloscope with plug-ins: 7A19; 7A26; 7B80; 7B85 .....\$850.00  
TEK 1101 Accessory Power Supply, for FET probes .....\$175.00  
TEK A6902B Voltage Isolator, DC-20 MHz, 20 mV-500 V/div. ....\$500.00  
TEK P6046 100 MHz Differential Probe .....\$400.00  
TEK P6101A pair 1X 34 MHz Probe pair, 10 Megohm/32pF, new in plastic .....\$50.00  
TEK P6201 900 MHz 1X/10X/100X FET Probe .....\$400.00  
TEK P6202 500 MHz 10X FET Probe .....\$150.00  
TEK P6205 750 MHz 10X FET Probe, for TDS series .....\$325.00  
TEK P6701-opt.02 O/E Converter, 450-1050 nm/0-1 mW; DC-700 MHz, ST conn. ....\$175.00

## WAVEFORM GENERATORS

### FUNCTION

HP 3310A 5 MHz Function Generator .....\$250.00  
HP 3312A 13 MHz Function Generator .....\$500.00  
HP 3314A-001 Function Generator, 0.001 Hz-19.99 MHz, 30 Vp-p, HPIB .....\$1,200.00  
HP 3325A-002 21 MHz Synthesized Function Generator, HV output option .....\$1,200.00  
TEK AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz .....\$650.00  
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option .....\$800.00  
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's .....\$200.00  
TEK FG5010 Programmable 20 MHz Function Generator, TM5000 series .....\$800.00  
TEK FG501A 2 MHz Function Generator, TM500 series .....\$275.00  
TEK FG502 11 MHz Function Generator, TM500 series .....\$275.00  
TEK FG503 3 MHz Function Generator, TM500 series .....\$250.00  
TEK RG501 Ramp Generator, TM500 series .....\$175.00  
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB .....\$650.00

### PULSE

BERKELEY NUCLEONICS 7085B Digital Delay Generator, 0-100 mS, 1 nS res., 5 Hz-5 MHz .....\$550.00  
HP 8007B 100 MHz Pulse Generator .....\$450.00  
HP 8012B 50 MHz Pulse Generator, variable transition time .....\$600.00  
HP 8013A 50 MHz Dual Output Pulse Generator .....\$500.00  
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series .....\$500.00  
TEK PG508 50 MHz Pulse Generator, TM500 series .....\$350.00  
WAVETEK 802 50 MHz Pulse Generator .....\$250.00

## VOLTAGE & CURRENT

### VOLTMETERS

FLUKE 845AR High Impedance Voltmeter / Null Detector .....\$400.00  
HP 3456A 6-1/2 Digit Voltmeter, HPIB .....\$450.00  
HP 3478A 5-1/2 digit Multimeter, HPIB .....\$450.00  
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB .....\$675.00  
SOLARTRON 7081 8-1/2 digit Voltmeter .....\$3,000.00  
TEK DM5010 4-1/2 digit Multimeter, TM5000 series plug-in .....\$300.00  
TEK DM501A 4-1/2 digit Multimeter, TM500 series plug-in .....\$225.00

### CALIBRATION

FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA .....\$450.00  
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power .....\$900.00

### VOLTAGE SOURCES

FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A .....\$1,900.00  
HP 6114A Precision Power Supply, 0-20 V 0-2 A / 20-40 V 1 A .....\$850.00  
HP 6115A Precision Power Supply, 0-50V 0-0.8A / 0-100V 0-0.4A .....\$750.00  
KEITHLEY 228 Programmable Voltage/Current Source .....\$1,900.00

### CURRENT METERS & SOURCES

FLUKE Y5020 Current Shunt, 20 V / 20 A max., 1 milliohm value .....\$450.00  
HP 6177C DC Current Source, to 50 V, 500 mA .....\$500.00  
HP 6181C DC Current Source, to 100 V, 250 mA .....\$500.00  
HP 6186C DC Current Source, to 300 V, 100 mA .....\$750.00  
KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance .....\$450.00  
TEK CT-5 High Current Transformer for P6021/A6302, to 1000A .....\$375.00  
TEK P6022 AC Current Probe w/termination, 935 Hz-120 MHz, 6 A pk .....\$250.00

## IMPEDANCE & COMPONENT TEST

### L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 pH .....\$550.00

BOONTON 72BD 1 MHz Capacitance Meter, 3-1/2 digit display .....\$650.00  
BOONTON 72C 1 MHz Capacitance Meter, 1-3000 pF full scale .....\$800.00  
GR 1658 RLC Digibridge, 120 Hz/ 1 kHz .....\$1,000.00  
GR 1659 RLC Digibridge, 120 Hz/ 1 kHz/ 10 kHz .....\$1,100.00  
HP 4275A 5-1/2 digit LCR Meter, 10 kHz-10 MHz, HPIB .....\$3,500.00

### STANDARDS

E.S.I. SR-1 Standard Resistor, various values .....\$125.00  
E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step .....\$550.00  
GENERAL RADIO 1409-SERIES Standard Capacitors .....\$150.00  
GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc. ....\$275.00  
GR 1413 6-Decade Precision Capacitor, 0-1 uF, 1 pF resolution .....\$1,500.00  
GR 1432-U 4-Decade Resistor, 0-111, 10 Ohms, 0.01 Ohm resolution .....\$100.00  
GR 1433-J 4-Decade Resistor, 0-11, 110 Ohms, 1 Ohm resolution .....\$150.00  
GR 1433-K 4-Decade Resistor, 0-1, 110 Ohms, 0.1 Ohm resolution .....\$150.00  
GR 1433-P 5-Decade Resistor, 0-1, 1111 Megohm, 10 Ohm resolution .....\$500.00

### T.D.R.

TEK 1503B-03,04 T.D.R., 0-50,000 ft., chart recorder & battery power .....\$3,000.00  
TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder .....\$1,400.00

## POWER SUPPLIES

### SINGLE OUTPUT

HP 6024A 0-60 V / 0-10 A / 200 Watts max. CV/CC Power Supply .....\$600.00  
HP 6033A Power Supply, 0-20 V / 0-30 A / 200 Watts max., HPIB .....\$1,200.00  
HP 6110A 0-3000 V 0-6 mA CV/CL Power Supply .....\$250.00  
HP 6201B 0-20 V 0-1.5 A CV/CC Power Supply .....\$175.00  
HP 6203B 0-7.5 V 0-3 A CV/CC Power Supply .....\$175.00  
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply .....\$200.00  
HP 6263B 0-20 V 0-10 A CV/CC Power Supply .....\$375.00  
HP 6266B 0-40 V 0-5 A CV/CC Power Supply .....\$375.00  
HP 6267B 0-40 V 0-10 A CV/CC Power Supply .....\$550.00  
HP 6271B 0-60 V 0-3 A CV/CC Power Supply .....\$375.00  
HP 6274B 0-60 V 0-15 A CV/CC Power Supply .....\$650.00  
HP 6282A 0-10 V 0-10 A CV/CC Power Supply .....\$200.00  
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply .....\$200.00  
HP 6384A 0-4-5.5 V at 8 A CV/CL Power Supply .....\$125.00  
HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply .....\$450.00  
HP 6643A 0-35 V 0-6 A CV/CC Power Supply, HPIB .....\$1,200.00  
HP 6652A 0-20 V 0-25 A 500 Watt Programmable Power Supply, HPIB .....\$1,875.00  
KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply .....\$900.00  
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply .....\$375.00  
LAMBDA LK-352-FM 0-60 V 0-15 A CV/CC Power Supply .....\$600.00  
SORENSEN DCR 600-0.75B 0-600 V 0-750 mA CV/CC Power Supply .....\$550.00  
SORENSEN DCS 40-25 0-40 V 0-25 A CV/CC Power Supply .....\$650.00  
SORENSEN SRL 20-12 0-20 V 0-12 A CV/CC Power Supply .....\$350.00

### MULTIPLE OUTPUT

SORENSEN SRL 60-8 0-60 V 0-8 A CV/CC Power Supply .....\$500.00  
HP 6205C Dual Power Supply, 0-40 V 300 mA & 0-20 V 600 mA, CV/CL .....\$300.00  
HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply .....\$375.00  
HP 6236B Triple Output Power Supply, +/- 0-20V 0.5A & 0-6V 2.5A .....\$375.00  
HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply .....\$375.00  
HP 6255A Dual 0-40 V 0-1.5 A CV/CC Power Supply .....\$375.00  
KEPCO MPS-620M Triple Output Supply, dual 0-20V 1A tracking & 0-6V 5A .....\$200.00  
TEK P55010 Programmable Triple Power Supply, TM5000 series .....\$450.00  
TEK P5503A Dual Power Supply, TM500 series .....\$200.00

### MISCELLANEOUS

ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max. ....\$350.00  
BEHLMAN 25-C-D/OSCD-1 AC Power Source, 250 VA, 0-130 VAC, 45-2000 Hz .....\$850.00  
HP 59501B HPIB Isolated DAC/Power Supply Programmer .....\$175.00  
HP 6060A 300 Watt Programmable Load, 0-60 A / 3-60 V, HPIB .....\$950.00  
KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, to 50 V 2 A .....\$400.00  
TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max. ....\$200.00

## TIME & FREQUENCY

### UNIVERSAL COUNTERS

HP 5314A 100 MHz/ 100 nS Universal Counter .....\$175.00  
HP 5315A 100 MHz/100 nS Universal Counter .....\$350.00  
HP 5315A-001 100 MHz / 100 nS Universal Counter, TCXO reference .....\$400.00

HP 5315A-002,003 100 MHz/100 nS Univ. Counter; batt. power & 1 GHz C-ch. ....\$550.00  
HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option .....\$450.00  
HP 5316A 100 MHz/100 nS Universal Counter, HPIB .....\$450.00  
HP 5370B 100 MHz/ 20 pS Universal Counter, 11 digits .....\$1,200.00  
PHILIPS PM6672/411 120 MHz/100 nS Universal Counter, C-channel 70-1000 MHz .....\$375.00  
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series .....\$200.00  
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series .....\$350.00  
TEK DC503A 125 MHz/100 nS Universal Counter, TM5000 series .....\$275.00  
TEK DC509 135 MHz/ 10 nS Universal Counter, TM5000 series .....\$275.00

### FREQUENCY COUNTERS

FLUKE 7220A-010,131,351 1.3 GHz Counter; battery power, OCXO, and res. mult. ....\$500.00  
HP 5342A 18 GHz Frequency Counter .....\$900.00  
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference .....\$3,000.00  
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter .....\$3,500.00  
HP 5364A Microwave Mixer / Detector, for modulation domain an .....\$2,000.00  
HP 5386A-004 3 GHz Frequency Counter, HPIB; OCXO reference option .....\$1,000.00

### STANDARDS

HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power .....\$1,100.00

## AUDIO & BASEBAND

### SPECTRUM ANALYSIS

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

### DISTORTION ANALYSIS

HP 8903A Audio Analyzer, 20 Hz-100 kHz .....\$1,200.00

### RMS VOLTMETERS

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

### OSCILLATORS

HP 3336C-004,005 21 MHz Synthesizer/ Level Gen., OCXO & hi accuracy att. ....\$1,400.00  
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500 .....\$200.00  
WAVETEK 98 1 MHz Synthesized Power Oscillator, GPIB .....\$950.00

### MISCELLANEOUS

HP 3575A Phase-Gain Meter, 1 Hz-13 MHz, single display .....\$600.00  
HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display .....\$850.00  
HP 467A Power Amplifier, X1/X2/X5/X10, DC-1 MHz, 10 W output .....\$375.00  
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave .....\$350.00  
KROHN-HITE 3200 High Pass / Low Pass Filter, 20 Hz-2 MHz, 24 dB/octave .....\$275.00  
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave .....\$450.00  
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz .....\$650.00  
WAVETEK 716 Brickwall Filter .....\$1,500.00

## RF & MICROWAVE

### SPECTRUM ANALYSIS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A .....\$500.00  
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz .....\$1,100.00  
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz .....\$1,100.00  
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz .....\$1,400.00  
HP 11971A WR28 Harmonic Mixer, for HP 8569B .....\$800.00  
HP 11971K WR42 Harmonic Mixer, for HP 8569B .....\$800.00  
HP 8449B Preamplifier, 1.0-26.5 GHz .....\$4,500.00  
HP 8559A/853A-001 Spectrum An., 0.01-21 GHz, 1 kHz res., w/rackmount frame .....\$3,500.00  
HP 8564A Tracking Generator, 300 kHz-2.9 GHz, for HP 8560 series .....\$5,000.00  
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. bw. ....\$3,000.00  
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res. ....\$8,500.00  
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. ....\$5,500.00  
TEK 492-opt.02 Spectrum Analyzer, 50 kHz-18 GHz, 1 kHz res. ....\$4,250.00  
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz .....\$1,500.00

### NETWORK ANALYSIS

HP 11650A Network Analyzer Accessory Kit, APC7 .....\$600.00  
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 .....\$250.00  
HP 4815A Type Impedance Meter, 0.5-108 MHz, 1 Ohm-10 kilohm .....\$1,200.00  
HP 8502A Transmission/ Reflection Test Unit, 0.5-1300 MHz .....\$675.00  
HP 85054A Type N Calibration Kit, for HP 8510 series .....\$1,800.00





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HP 8511A Frequency Converter, 45 MHz-26.5 GHz, for HP 8510	\$6,500.00
HP 8717A Transistor Bias Supply	\$500.00
HP 8756A Scalar Network Analyzer, HP1B	\$1,375.00
HP 885026A WR28 Detector, 26.5-40 GHz, for HP 8757 series	\$1,200.00

## SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res.	\$1,500.00
FLUKE 6060B/AAK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res.	\$1,900.00
GIGATRONICS 1026 Synthesized Signal Sweep Gen., 50 MHz-26 GHz, +5 dBm	\$5,000.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 MHz res., GPIB	\$1,800.00
GIGATRONICS 6000/8-16 Synthesized CW Gen., 8-16 GHz, 1 MHz res., +10 dBm	\$2,250.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$2,500.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res., GPIB	\$2,000.00
HP 11707A Test Plug-in for HP 8660 series	\$500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio	\$450.00
HP 3335A-001 Synthesizer/Level Gen., 200 Hz-81 MHz, -87 to +13 dBm	\$3,500.00
HP 8656A-001 Signal Generator, 0.1-990 MHz, 100 Hz res., HP1B, COXO	\$1,600.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HP1B	\$2,750.00
HP 8660C/86603A/86632B Synthesized Signal Generator, 1-2600 MHz, AM, FM	\$3,250.00
HP 8671B Synthesized CW Gen., 2-18 GHz, 1-3 kHz res., +8 dBm	\$4,250.00
HP 8672A Synthesized Signal Generator, 2-18 GHz, +3 dBm output	\$4,500.00
HP 8673H-212 Synthesized Signal Generator, 2.0-12.4 GHz, 1 kHz res.	\$8,750.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM/ WBFM/ Pulse	\$3,000.00
WAVETEK 954 Signal Generator, 3.7-7.6 GHz, +10 dBm, AM, FM	\$750.00

## SWEEP GENERATORS

HP 8350B/83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled	\$3,900.00
HP 8350B/83540A-002,004 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step attenuator	\$3,900.00
HP 8350B/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator	\$3,900.00
HP 83570A RF Plug-in, 18.0-26.5 GHz, +10 dBm levelled	\$6,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$400.00
HP 8620C Sweep Oscillator Frame	\$550.00
HP 8622B-002 RF Plug-in, 10-2400 MHz, +13 dBm lvd., 70 dB step att.	\$1,250.00
HP 8622B-E69/8620C Sweep Oscillator, 0.01-2 GHz & 2-4 GHz, +10 dBm, w/frame	\$1,500.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$300.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm unlevelled	\$400.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$300.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$400.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,200.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$1,650.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$1,850.00
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB step atten.	\$900.00
WAVETEK 2002A Sweep Generator, 1-2500 MHz, +10 dBm, 70 dB step atten.	\$1,200.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld.	\$950.00
WILTRON 6171B-20 Freq. Synth/ Sweeper, 10 MHz-8.4 GHz, +13 dBm, AM, FM	\$6,500.00

## POWER METERS

BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$450.00
HP 432A/478A Power Meter, -30 to +10 dBm, 10 MHz-10 GHz	\$300.00
HP 435B/481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz	\$900.00
HP 435B/482B Power Meter, 0 to +43 dBm, 100 kHz-4.2 GHz	\$1,500.00
HP 436A-022/481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HP1B	\$1,200.00
HP 436A-022/484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HP1B	\$1,200.00
HP Q8488A Power Sensor, 33.0-50.0 GHz, WR22, for 435B/778	\$1,500.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435B/778	\$1,500.00

## RF MILLIVOLTMETERS

BOONTON 92C RF Millivoltmeter, 3 mV-3 V f.s., 10 kHz-12 GHz	\$500.00
RACAL-DANA 9303 RF Millivoltmeter, 10 kHz-2 GHz, -70 to +20 dBm	\$750.00

## AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz	\$950.00
BOONTON 82AD Modulation Meter, AM / FM, 10-1200 MHz	\$650.00
ENI 2100L Amplifier, 50 dB gain, 10 kHz-12 MHz, 100 Watts output	\$2,750.00
ENI 310L Amplifier, 50 dB gain, 250 kHz-110 MHz, 10 Watts output	\$1,200.00

10 Watts output	\$1,200.00
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz	\$2,250.00
HP 415E SWR Meter	\$200.00
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5 GHz	\$500.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output	\$375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output	\$750.00
HP 8447F-H64 Dual Amp., 9 kHz-50 MHz 28 dB & 0.1-1300 MHz 25 dB	\$900.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz	\$1,500.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, COXO, ext.LO	\$2,000.00
HUGHES 1177H01F000 TWT Amplifier, >30 dB gain, 2-4 GHz, 10 Watts output	\$1,750.00
HUGHES 1177H10F000 TWT Amplifier, >30 dB gain, 1.4-2.4 GHz, 20 Watts	\$2,500.00
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts	\$2,500.00
RF POWER LABS M50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V	\$275.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz	\$3,750.00

## COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$300.00
AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LNC, 2-18 GHz, TNC(f) "NEW"	\$95.00
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in/ +10 dBm out 26-40 GHz	\$450.00
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter	\$650.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz, N(f)	\$350.00
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(mf)	\$75.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC?	\$450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(mf)	\$300.00
HP 11691D-001 Directional Coupler, 22 dB, 2-18 GHz, N(f)-all ports	\$450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP 33321K Programmable Step Attenuator, 0-70 dB, DC-26.5 GHz, 3.5mm	\$475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm	\$1,000.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 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-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC? test port	\$450.00
HP 779D Directional Coupler, 20 dB, 1.7-12.4 GHz	\$400.00
HP 8431A 2-4 GHz Band Pass Filter, N(mf)	\$150.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA	\$350.00
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA	\$375.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz	\$450.00
HP K752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz	\$450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz	\$450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz	\$275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz	\$300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz	\$400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz	\$450.00
HP R914B WR28 Moving Load, 26.5-40 GHz	\$250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz	\$750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz	\$650.00
HP X870A WR90 Slide Screw Tuner	\$150.00
HUGHES 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz	\$350.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz	\$750.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz	\$900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	\$1,000.00
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	\$1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz	\$1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz	\$250.00
HUGHES 45752H-1000 WR22 Direct Reading Phase Shifter, 0-360 deg., 33-50 GHz	\$1,400.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz	\$400.00
HUGHES 45773H-1100 WR19 Thermistor Mount, -20 to +10 dBm, 40-60 GHz	\$650.00
HUGHES 45774H-1100 WR15 Thermistor Mount, -20 to +10 dBm, 50-75 GHz	\$750.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity	\$600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.00 GHz, +18 dBm	\$2,000.00

HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.00 GHz, +18 dBm	\$2,750.00
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f)/SMC	\$200.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f)/SMC	\$200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f)/m/m	\$75.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)	\$25.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz, N	\$500.00
NARDA 3022 Bi-Directional Coupler, 20 dB, 1-4 GHz	\$400.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$375.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 3688NM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m)	\$500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz	\$1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz	\$1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f)	\$325.00
NARDA 4242-20 Directional Coupler, 20 dB, 0.5-2.0 GHz, SMA(f)	\$100.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f)	\$200.00
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NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(mf)	\$65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(mf)	\$165.00
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz	\$600.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
NARDA 793FM Direct Reading Variable Attenuator, 0-20 dB, 4-8 GHz	\$225.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz	\$375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(mf)	\$50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$75.00
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TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	\$900.00
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WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB	\$200.00
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WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(mf)	\$150.00
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FLUKE 2180A RTD Digital Thermometer	\$500.00
HP 59307A HP1B VHF Switch	\$200.00
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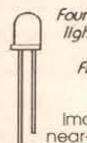
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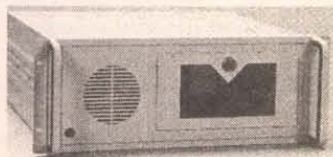
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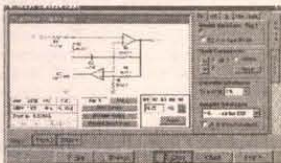


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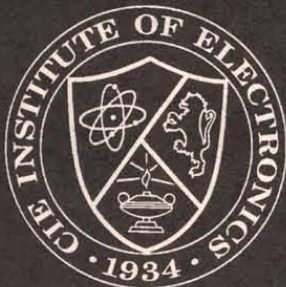


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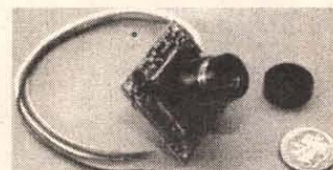
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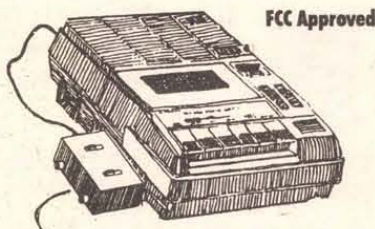
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# AMATEUR ROBOTICS

# NOTEBOOK

by Robert Nansel

I should start keeping a count of how many times I begin this column with the words "I had intended to do [insert project] this month ...", but I'm afraid if I did I'd never live down the embarrassment. I'm lousy at predicting the future, even just a month in advance, though I have lots of reasons why my foresight isn't 20/20.

This last month in particular demonstrates this abundantly. I had intended to cover rebuilding Jiffy, as well as some real software for the 'bot, but other stuff came up. I do have a couple pictures of a spiffy red, white, and blue Jiffy built by Michael Evens of Rancho Santa Fe, CA (see Photos 1 and 2). Way to go Michael! Sorry to disappoint, though; no Jiffy software this month. Photo 3 shows Jiffy's current state (actually, it's worse than that now because I've taken it apart for rebuilding).

I will talk about some books that would make great gifts for robot builders, though (get your highlighters ready, guys).

But first, here's the other stuff that came up:

First of all, Yonatan is almost two years old; not only is he a toddler, in the past month he became a toddler who runs. Zooms. Sprints, even. Being just 1/8th the mass of his Abba, it stands to reason his mechanical time constant is correspondingly eight times faster than mine. What this means is that I spend much more time chasing after him than I used to. Sorta like an aircraft carrier pursuing a Zodiac.

Second, our sole car,

my '88 Nissan Stanza wagon (known variously as "the Smurfmobile," "Putt-putt," and "that @#%& car!") is, at 150,000 miles, dying the death of a thousand oil leaks. With the second baby so soon to arrive — January 2001, God willing — Shoshana and I felt the primal urge to buy a new used car, something with a few more hamsters under the hood so it can get out of its own way. Something maneuverable enough to fit in our narrow driveway, yet with enough room to carry a sheet of plywood without taking out an extra insurance policy, a vehicle in which it would be possible —mirabile dictu! — to place two kids in completely separate rows where neither can touch the other should sibling politics demand this harsh step.

In short, we wanted a minivan. In the past, shopping for a car had never been a big deal. Test drives were carefree (especially at

dealerships where they let you try out cars without a salesman licking your ear from the back seat). But until last month, I had never gone car shopping with a child in tow, had rarely had to fuss with all the backup and support that a child requires to go for a 10-minute ride in a strange car.

There's the diaper bag, of course, and the toys and the books and snacks and security blanket, all the little things that keep an outing with a toddler from turning into scenes from Deliverance. But then you have the stroller and the carseat and its pad and straps and buckles and clips, and now we're talking infrastructure. Add to this one thing I had never sus-

pected, the irresistible allure all those shiny cars in a row would have for a wide-eyed toddler, a crafty toddler who's only ever seen the Smurfmobile — last washed in 1996, definitely not shiny — and how quickly this toddler could disappear among the shiny cars. Did I mention that Yonatan runs? He also likes to hide.

Having no other choice, we grimly overcame these adversities, and joined the ranks of the bourgeoisie with the purchase of a '98 Ford Windstar, Robin-egg-blue,

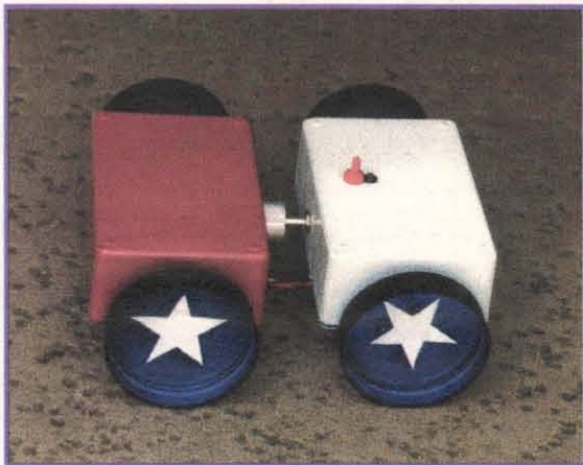
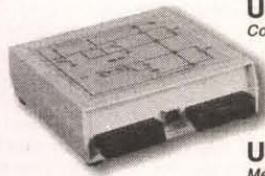


Photo 1: An excellent example of a Jiffy built by Michael Evans of Rancho Santa Fe, CA.



Photo 2: "Don't try this at home!" Another view of Michael's Jiffy.

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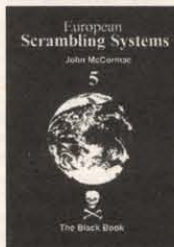
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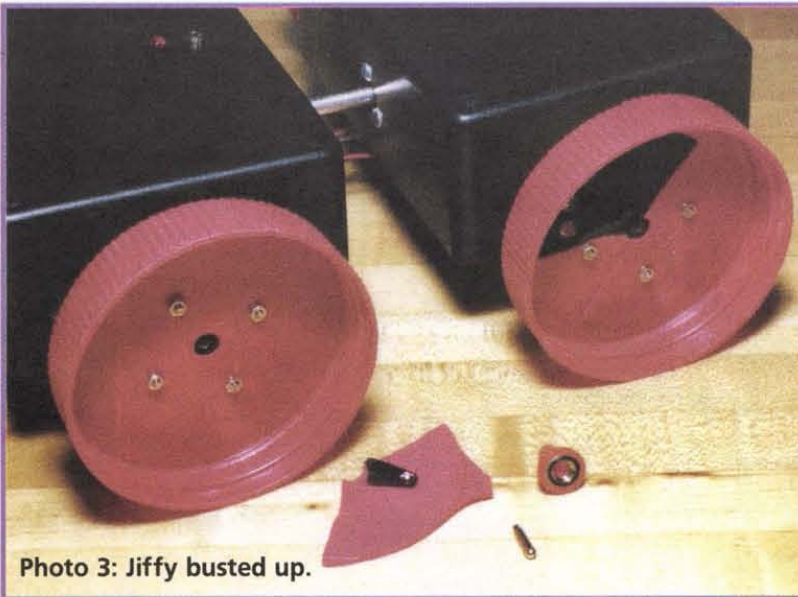


Photo 3: Jiffy busted up.

loaded, with only 26,000 miles. We even got a good deal.

We hope to be over the Post Traumatic Stress by spring.

## Pumping Iron

Here I must come clean. For the past two months, I've also been very busy on another big robotics project, the first hints of which you can see in Photos 4 through 6. I'm building a three-axis CNC Mill/Drill machine. With a lot of behind-the-scenes help from Dan Mauch (who has presented several fine articles on his own CNC projects in this magazine), I think I've come up

with a pretty good basic design. You'll see the full construction plans starting in February, but for now I'll just say you should be able to build it for under \$600.00, substantially less if you are a talented scrounger.

In its early stages, it will use a Dremel-style motorized tool for the spindle, good enough for drilling printed circuit boards and light-duty routing of thin panels of wood, plastic, or aluminum. However, the design uses heavy-duty mechanical components to allow upgrading to a full CNC milling machine just by adding a more powerful spindle drive. Those machinist files I was talking about last month will get a

good workout on this project.

The horizontal axes, X and Y, will be built up from an Enco Heavy-duty Mill & Drill Table (Model #201-2536). This thing is made of 56 pounds of cast iron; it's five inches tall, has a T-slotted table measuring 8" x 10.5". It's a nice unit, well-machined. The lead-screws are 10 TPI, so one full turn advances the table by .100". The Enco catalog claims it has a travel of 11" longitudinally (side to side), and 7.5" cross (front to back); the longitudinal travel is accurate, but the cross travel is 7.5" only if you run the table the full travel of the leadscrew. When you do that, the table is half way off the dovetail slides at each extreme of travel. You can actually rock the

table from side to side in these positions.

The table's fully-supported cross travel is something more like 2.25", so some work is needed here to increase that range. Still, it's a bargain at \$99.95 (sale price, normally \$189.95, but Dan tells me this thing seems to be perpetually on sale at Enco). You couldn't buy the materials you'd need to make it at that price. (Check out [www.use-enco.com](http://www.use-enco.com) to order parts; be sure to request a catalog.)

Photos 5 and 6 show the 6" cross-slide vise from Harbor Freight Tools that will become the Z-axis (Model #32997). I'll be removing

the vise and using just the base slide and bolting it to a vertical steel column. The vise is quite roughly machined compared to the Enco table, so I don't feel bad at all about sacrificing the vise portion. Also, the bearing brackets are crude and will have to be entirely redone. Still, my main requirements are that it be rugged, and that means lots of cast iron, which this vise has — it weighs over 38 pounds — and that it be cheap. The vise is \$64.94 including shipping and handling ([www.harborfreight.com](http://www.harborfreight.com)).

For anyone wanting more precision with less rework, Enco has another, smaller Milling & Drilling table (model #201-2826) that looks like just the ticket for the Z-axis. It's normally \$99.95, but is on sale until Dec 31st for \$66.95. I might have gotten it rather than the Harbor Freight vise had I known it would go on sale. It looks similar to the larger Enco X-Y table and also uses 10 TPI Acme leadscrews, but the base is oval-shaped and it has hand cranks instead of hand wheels.

I plan to use this machine extensively in upcoming projects (hint: some robots, such as walkers, robot arms, grippers, etc., require a lot of identical machined parts).

Anyway, I'll have lots more to say about this project in coming months. On to the book reviews.

## Service Robots

*Service Robots: Products, Scenarios, Visions* by Rolf Dieter Schraft and Gernot Schmierer (A K Peters, 2000, ISBN 1-56881-109-8) is about, well, service robots, but what are these? The International Federation of Robotics defines a service robot as "a robot that operates partially or fully autonomously to perform services useful to the well-being ... of humans and equipment. They are mobile or manipulative or a combination of both." If that definition still doesn't tell you precisely what a service robot is, think of service robotics as amateur robotics being done by professionals with money.

I realize that's a pretty broad scope, but that's what this book attempts to do, to cover the gamut of mobile and manipulative robots (basically any robot that's not bolted to some factory floor).

But what this book really is, is a drool book for people like you and me, a glorious coffee-table book with sensational photos and illustrations — over 250 of them — of just about every kind of robot imaginable. You think the only killer applications for robots are the robo-vac and robomower? Think again.

The authors show robots designed to refuel cars, to work in forestry, agriculture, and the construction industry, to perform tasks too dangerous, awkward, or impossible for humans in industrial reno-

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vation and maintenance. They show robots cleaning, surveilling, scuttling about offices, sorting recyclables, and fighting fires. They show robots in hotels, robots cooking, robots tending bar, and robots serving espresso.

Not enough for you? Well, how about robots that climb the sides of skyscrapers to display advertisements — or to clean the glass; how about robots assisting the disabled, delivering meals and medications, or robots performing precision orthopedic surgery? Then there are robots doing jobs underwater, in space, and in active volcanoes, and robots just for the fun and entertainment of it.

And, yes, there are robot floor cleaners and lawn mowers in the book, too.

In 215 pages, even with over 250 photos and illustrations, it's impossible for a book this broad to cover any one system in depth. You won't find plans to build the robot espresso bar, for instance (you probably couldn't afford to build it anyway), nor will you get more than an overview of robot navigation and path planning.

No, I see the value of this book as a vivid source of inspiration to gearheads. We too easily get into ruts: take two wheels, two motors, a caster, and bolt them onto a disk of plywood; slap on a microprocessor and a few sensors, and, bam, you've got robot. *Service Robots* reminds us, to paraphrase Kipling, that there are nine and forty ways to construct the tribal lays, and each of them is right. There is so much essential rightness in so many of the designs that you can't help but come up with exciting new robot projects when browsing through this book. Like any coffee table book, this one is a bit on the pricey side at \$47.50. Still, I think it's worth the price for the inspiration to be derived. This book cries out to be seen by as many robot builders as possible.

If it's just too expensive for you, though, maybe go in with some buddies or make a club purchase and share the book around. And you can always request your local library to include it on their buy list.

## The Engines of Our Ingenuity

In *The Engines of Our Ingenuity: An Engineer Looks at Technology and Culture* (Oxford University Press, 2000, ISBN 0-19-513583), John Lienhard reflects on the nature of technology, culture, human inventiveness, and the history of engineering. This series of 17 essays had their genesis in

Lienhard's daily essays on creativity produced by KUHF-FM Houston and heard nationally on Public Radio. *The Engines of Our Ingenuity* gives an intriguing collection of glimpses into technology, the way it mirrors human psychology, the dangers and opportunities it presents, and how often inventions are more product of idiosyncratic ego rather than actual need or market. People sometimes build stuff for no other reason than because it's cool; only later does it become useful.

Lots of people write books these days with the theme of how technology shapes culture and vice versa, and most of them, frankly, aren't worth the paper and ink.

They too often go off on deconstructionist rants having less to do with technology than the author's own lack of understanding of technology. But Lienhard doesn't go down that path, preferring to show how the co-evolution of technology and culture, warts and gems, is basic to the human condition. For Lienhard, the history of technology is the history of humankind, and in a profound sense we are defined by the technologies we've created through the ages.

Lienhard makes the persuasive argument in essay two that the great emergence of Western technology can be traced directly from the medieval church, something

that seems so unlikely today that most people would dismiss it as nonsense. After all, we often use the term "medieval" to describe things so hopelessly crude, inefficient, or barbaric that no possible connection could exist with modern science and technology. The medieval church, and the religious sensibilities it embodied, are often simplistically seen as the antithesis of the modern scientific ideals of detachment and objectivity.

## "Scientific" Detachment

The ideal of objective detachment is a relatively new idea, causing us to mistakenly disassociate

technology from the passions that drive the human heart. The medieval artisans building cathedrals were no less passionate technologists than we, and were unashamed in their refusal to separate the work of their hands from the work of their souls. Even human flight, the technology most easily associated with freedom and spirit, had its antecedents among these medieval artisans and monks.

According to the account of another monk, sometime just after the year 1000 A.D., Eilmer, a Benedictine monk at Wiltshire Abbey, built a sort of hang glider for himself and flew perhaps 200 yards before a wind gust ended his

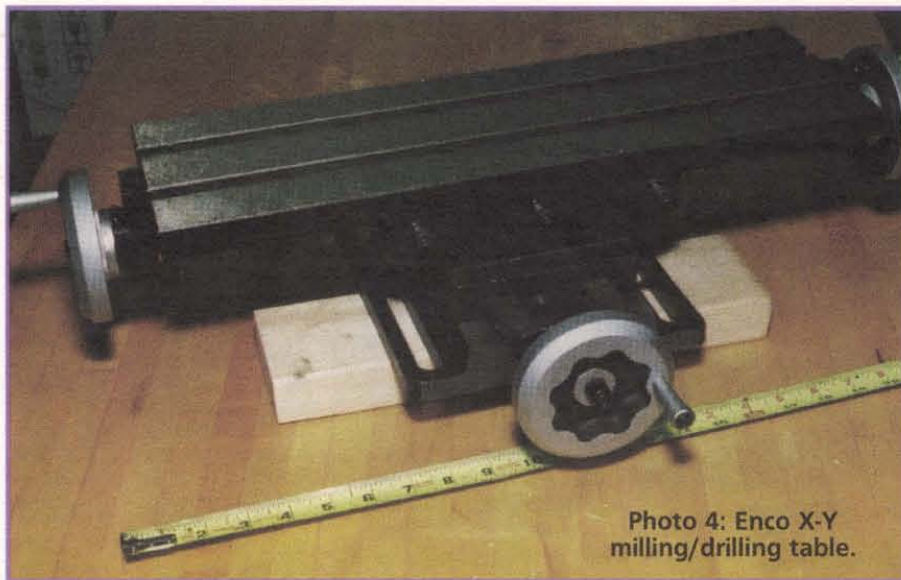
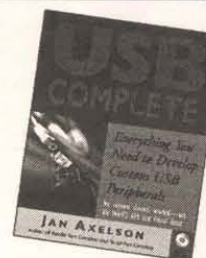


Photo 4: Enco X-Y milling/drilling table.

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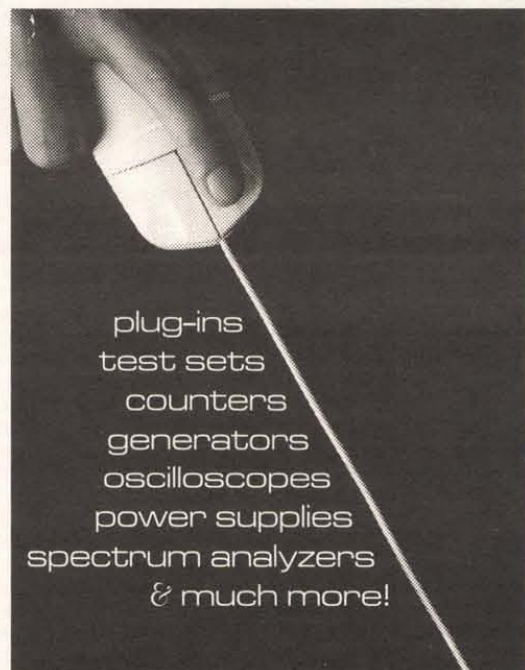
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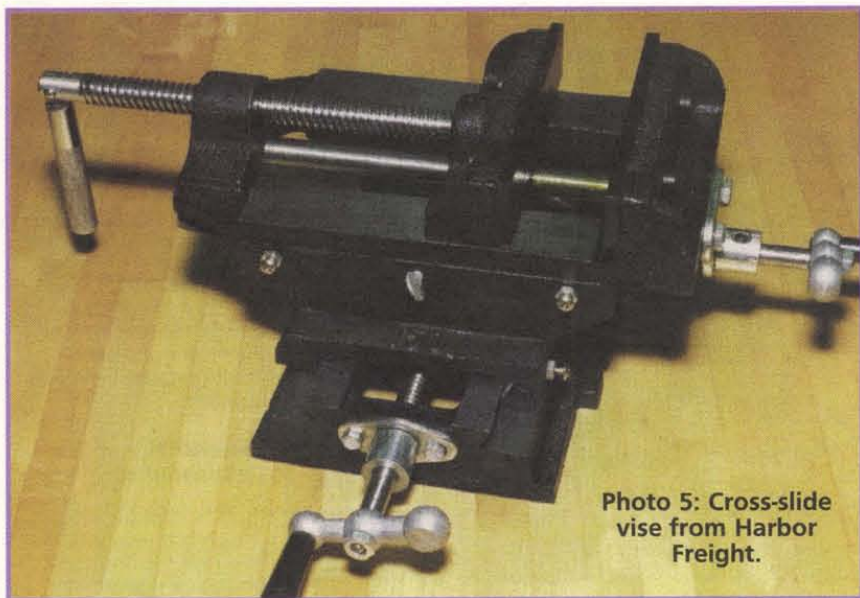
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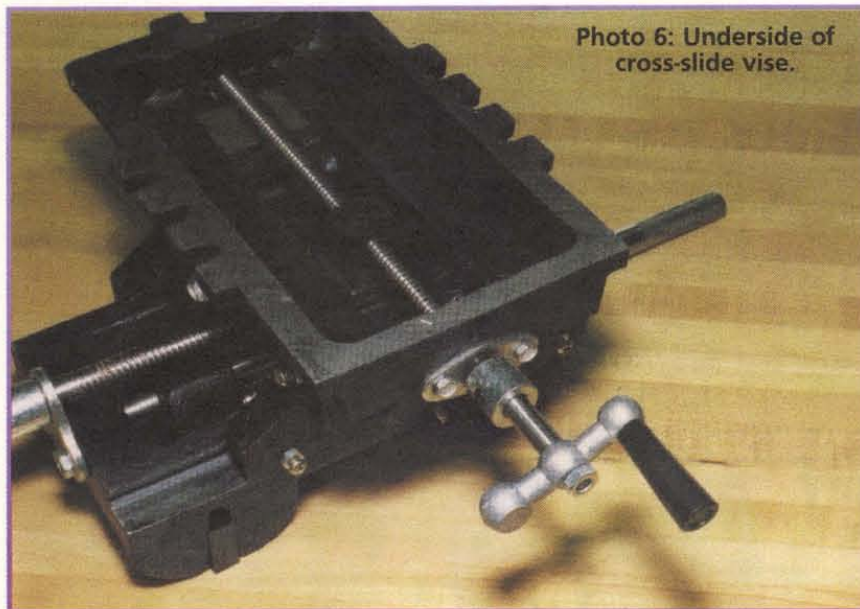
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**Photo 5: Cross-slide vise from Harbor Freight.**



**Photo 6: Underside of cross-slide vise.**

flight. The same thing happened to Otto Lillenthal at the end of the 19th century, causing him to fall to his death; Eilmer merely broke his legs and walked with a limp thereafter.

He claimed — very likely correctly — that the fault with his invention lay in not adding a stabilizing tail, something the Wright brothers themselves had to re-learn 900 years later.

And Eilmer was not the only one. I don't want to spoil it for you, but Lienhard cites other unsung medieval pioneers of aviation and other technologies. Indeed, the dream of flight is old, but the fact of aeronautical experimentation is, surprisingly, just as old.

## A Matter of Degree

I don't agree with everything he says, though. Most notably, in

essay 10 he argues that war doesn't fuel invention, that the technical achievements most associated with World War II — jet aircraft, guided missiles, digital computers, and radar — all emerged before the war. He believes war may encourage refinement of pre-existing technologies, and it surely demands miracles of production and organization, but nothing fundamentally new comes out of wartime development. For Lienhard, solving problems of organization, logistics, and production don't really qualify as innovation.

I disagree. Whenever you change the scale of any system by orders of magnitude, you get not just a quantitative change, but also an inevitable qualitative change. In principle, a computer is nothing more than a collection of NAND gates wired up to form a CPU and memory. But what you can do with a machine made of a million NAND

gates is radically different from what you can do with one made of just a hundred NAND gates. The former can calculate spreadsheets, play Doom, surf the internet, and control robots, whereas the latter would be taxed to handle much more than a fire alarm or an elevator.

Or consider today's space boosters: all are direct descendants of the German V-2 rocket, not Robert Goddard's rockets, despite the fact that Goddard had developed virtually every detail of liquid-fueled rocket propulsion and guidance here in America in the 20s and 30s. Still, even though I disagree with the core idea of this particular essay, the argument he presents fascinates me, and it was the first time I'd read a defense for the position intelligent enough to be worthy of comment.

I admit, I'm a sucker for this type of book. It helps that Lienhard is a real engineer with obvious delight in his subject material. As he shows, the history of technology abounds in surprises, and we learn much from the failures of obscure pioneers — perhaps more than from the famous

successes.

I enjoyed this book, and if you are as interested in questions of the why and when of technology as you are about the how, you'll enjoy it too.

## Practical Electronics for Inventors

I've saved the best for last. *Practical Electronics for Inventors* (McGraw Hill, 2000, ISBN 0-07-058078-2) by Paul Scherz is just what the title says. It's a practical guide to doing electronics aimed at technically-minded people not necessarily conversant in electronics theory, but it is in no way dumbed down.

Amateur robotics can be quite intimidating to the newcomer because of all the different areas of technical knowledge that must be dealt with, one way or another.

Electronics, one of the three pillars of robotics (the other two being computation and mechanics), is itself a huge field that blows beginners away more often than not.

Partly this is because the field is so big and diverse, but it's also true that most electronics books oriented toward beginners are either too elementary or depend on cookie-cutter recipes lacking the depth of information to make them really useful. If they do have the depth, they often fall on the side of too much theory and not enough practical examples and are thus worthless as beginner's references.

Scherz's book is a delightful exception. He shows you first what a given electronic device is good for, with only the essential information you need to get it working in a real circuit. If you then need the detailed theory of operation and design, he provides that, too, in sections arranged so you can read until you know enough. His philosophy is that you shouldn't have to read the whole chapter to find out whether, say, a JFET is good for making power switches for motors (probably not). Instead, his style and organization encourage you to read a little here, a little there, to jump around until you find what you do need (maybe bipolar transistors or MOSFETs).

## Analogies that Hold Water

The classic illustration used in most beginner's books on electrical theory is that of a water tank with various size holes punched at various heights in the side of the tank to show the analogies of water pressure and flow rates to voltage and current.

If the hole punched is tiny and has little pressure behind it, only a small amount of water will flow; if the hole is located further down the tank, there will be higher pressure and more water will flow through the same size hole. Or, for different size holes at the same height, more water will flow, naturally, through the larger hole.

That's as much as the typical text does with the water analogy, but Scherz takes it to a whole new level and makes it his own. First of all, he has lots of these prepossessing little hand-drawn diagrams that show you how to think of the actions of various electronic components as being analogous to collections of water pipes, valves, springs, and other easily understood gizmos, including the oft-slighted water balloon. His illustration of how a capacitor passes an AC current is nothing less than inspired.

The illustration style reminds me a bit of Forrest Mimms, one of the other rare technical writers who communicates effectively with both beginner and pro.

Scherz does his best to make this book a practical reference that



## NOTEBOOK

clears up common misconceptions and shows you subtle tricks not taught in many more conventional electronics books. It's filled with worked-out examples and built circuits you can use right away, with enough background theory given to allow you to modify and extend the circuits.

He goes further and tells you nitty gritty details on how to build circuits, how to decipher transistor and IC labels, how to use test equipment, where to go for more information, and even how and where to buy electronic components. And how to avoid getting shocked.

I'd place this book somewhere midway between Mimms' various books and Horowitz and Hill's indispensable *The Art of Electronics*. If you are a complete beginner, you won't understand everything contained in the book at first, but that's okay.

It's got plenty to get you going in electronics. As you gain experience, the book will grow into a valuable, ongoing reference. This book belongs on any robot builder's bookshelf, beginner or advanced.

### Saddling Up

Well, I'm out of space and literally saddling up for a trip: I'm dri-

ving to D.C. to attend the Eighth Foresight Conference on Molecular Nanotechnology. It's being held on the East Coast for the first time, so I couldn't pass up this opportunity (especially since my in-laws live just a few blocks from the hotel where it's being held).

Most of you have probably heard of nanotechnology, if only on Star Trek, but I'll wager few of you realize just how much progress has been made in the last year alone toward realizing the dream of molecular robotics. Next time, I'll talk all about that. Further than that, I promise nothing specific (I've learned my lesson), but it will be about robots, and it will be fun.

NV

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

Robert Nansel  
Box 228  
Ambridge, PA 15003

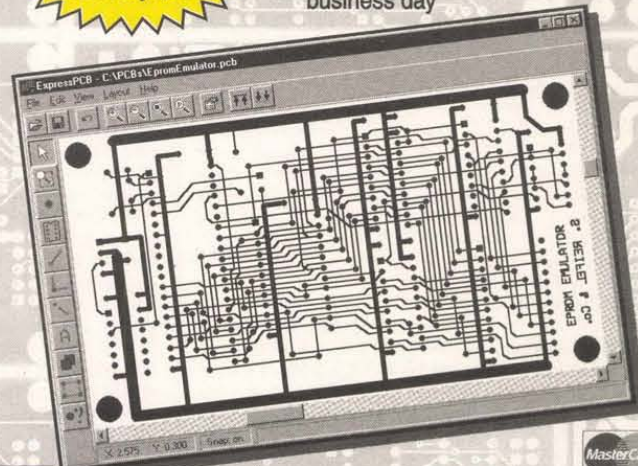
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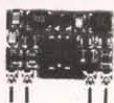
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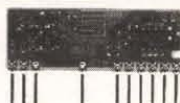
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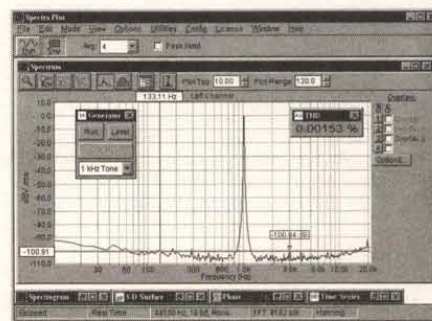
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## by Al Williams

48 DECEMBER 2000/Nuts &amp; Volts Magazine



this switch on reset, so it will never be a problem as long as you can slip it right back in the holes it belongs in.

## Getting to Work

Programming the HC11 depends on a special test mode that is active when you set pin 24 and pin 25 to ground. That's the purpose of the toggle switch. You can close the switch and reset the processor to enter bootstrap mode. In bootstrap mode, the processor runs a simple loader that lets you write a program — usually a program known as a talker — into the processor's memory.

After the talker is running, you can run a monitor program that uses the talker to load more programs, execute them, and even debug them. There are several loaders that you can use, but one of the best is PCBUG11, which was written by Motorola and is free.

PCBUG11 has several talkers that you can use depending on the processor you are using. For the 68HC811E2, you can use one of the built-in talkers (specified with the -a option). However, the default talker has a problem. It loads into RAM. There are only 256 bytes of RAM to begin with, so that leaves you with very little room to experiment. If you don't need RAM, that's fine. But if you do, you'll wind up having to use PCBUG11 to write your program to EEPROM and then reset the computer in normal mode. That runs your program, but doesn't allow you to perform any debugging.

I decided to write a new talker just for the 68HC811E2. It loads into EEPROM and uses just a small amount of RAM. As long as you keep your program from using the small part of EEPROM and RAM that my talker uses, you'll be able to debug your program. You can download my talker online (see Online Resources).

Exactly how you write and compile your program will depend on the tools you select (again, see Online Resources). The general idea is you will use an assembler or compiler to generate an S19 file. Then you reset the HC11 in bootstrap mode and load PCBUG11. Once PCBUG11 starts, you can load the S19 file and execute it. If you've set the program up to run stand-alone, you can flip the bootstrap switch to normal mode and reset the processor to run it without PCBUG11. If you are running with PCBUG11, you can read registers and memory locations. You can also set breakpoints. All of these features are interrupt-driven, so they work even when the program is executing.

## An Example

To show you how versatile this set-up can be, I decided to write a simple voltmeter program using SBasic (see Listing 1). The voltmeter uses the HC11's internal A/D converter and writes the result out to a PC connected to the RS-232 converter.

The voltmeter uses the built-in serial port (the same one PCBUG11 uses). The pokeb and peekb commands allow you to directly access the A/D registers in the HC11. Each A/D result is eight bits wide and represents up to 5V. Therefore, each count is worth 5/256 volts. I wanted resolution to the tenth of a volt, so I compute the total voltage as the count times 50 and then divide by 256. So for a 1.3V input, for example, the final result is 13. Then it is simple to print the first digit of the result, a decimal point, and the fractional portion.

It is possible to use references other than 5V with the device. The circuit connects ground and 5V to Vrl and Vrh (pins 21 and 22). However, you could use an external reference. A 4.096V reference, for example,

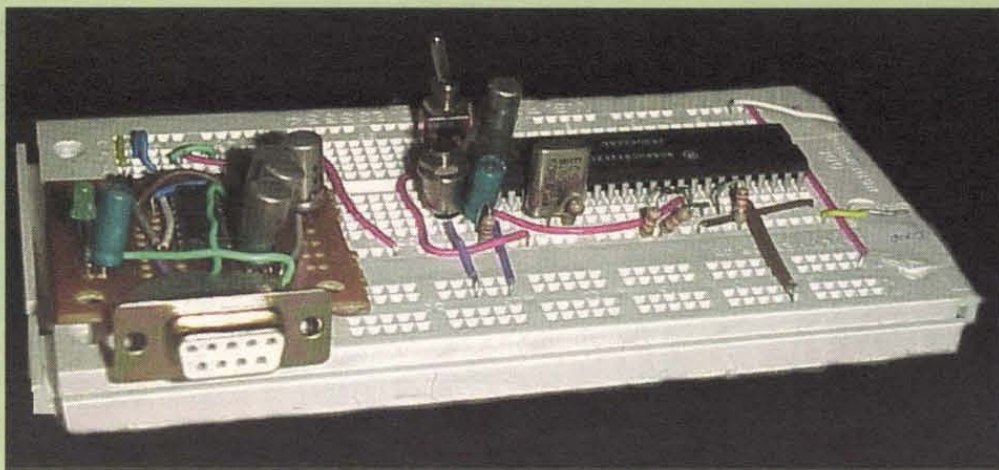


Figure 2. A completed breadboard.

sets each count to exactly 16mV.

The entire conversion and printing cycle takes about 30mS, so the program delays an additional 470mS before starting another cycle. You can connect the analog voltages to pins 17, 18, 19, and 20 of the microprocessor.

Building the program is simple using SBasic. Your command line can look like this:

```
SBasic volts.bas /CF920 /V0000 /S009D /M6811
```

This will start the program at \$F920, variables at \$0000, and the stack at \$009D. The EEPROM starts at \$F800, but my EEPROM talker uses from \$F800 to \$F91F. Unfortunately, since the talker and this program both use the serial port, you won't really be able to debug it easily with PCBUG11 anyway.

SBasic generates assembly language that you can build using the assembler supplied. Just run:

```
ASMHC11 volts
```

The ASMHC11 program assumes your file is on the C drive. If it isn't, try prefixing the file name with the drive letter. In other words, use D:volts instead of volts. Once you have a S19 file, you can close S1 and press S2 to reset the HC11.

Make sure your PC is connected to the RS232 converter. Start PCBUG11 using the -a option. If you are using COM2 instead of COM1, add port=2 to the command line. You'll want to issue at least three commands:

```
CONTROL BASE HEX
MS 1035 10
EEPROM F800 FFFF
```

The first command allows you to enter hex numbers at the command prompt. The second command enables the EEPROM on the chip. Without this command, the EEPROM will remain write-protected. The third command tells PCBUG11 to use its EEPROM writing algorithm. If you are using my talker, you won't need this third command.

Once you have the initial set-up complete, you can use the LOADS command to load the S19 file into the chip

(for example, LOADS volts). If you set up your program to avoid the talker's memory (and other resources like the serial port) you are using, you can run the program using PCBUG11 commands. Even if you are using some of the talker's area, you can probably start the program (use G F920) and even use the TERM command to see the output. However, you won't be able to view registers or set breakpoints. Otherwise, open S1 and push S2 to reset the chip and run your program.

## Finding 68HC811E2CP2 Chips

Several of the larger distributors sell these parts, but they are not as readily available as the PLCC parts. The good news is that the Internet has made these parts easier to find, and also easier to order since most distributors now accept Internet orders with low or no minimum order required.

A good way to locate chips of any sort is to use a search engine just for that purpose. My favorite is [www.findchips.com](http://www.findchips.com). You can find a few others in the Online Resources section. NV

## Parts List

- C1** - 10uF 35V electrolytic capacitor (RadioShack 272-1025)
- C2** - 4.7uF 35V electrolytic capacitor (RadioShack 272-1024)
- C3, C4** - See text
- IC1** - MC68HC811E2CP2
- R1-R4, R6** - 10K resistor
- R5** - 1M resistor (optional; see text)
- S1** - SPST switch (RadioShack 275-645)
- S2** - Momentary pushbutton switch (RadioShack 275-1571)
- Converter** - RS-232 converter from last month's article

## Online Resources

- [http://home1.gte.net/tickens/68hc11/my\\_tools.html](http://home1.gte.net/tickens/68hc11/my_tools.html)  
All the tools you'll need
- <http://www.seanet.com/~karllunt/index.htm> - SBasic home page
- <http://www.rdrop.com/users/marvin/sbasic/sbasic.htm>  
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- <http://www.al-williams.com/wd5gnr/hc11.htm> - Home page for my talker
- <http://www.osa.com.au/~cjh/electronics/db11.html>  
A Linux program similar to PCBUG11
- <http://www.findchips.com> - Locate chips in stock
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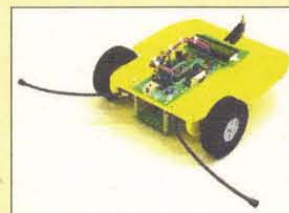
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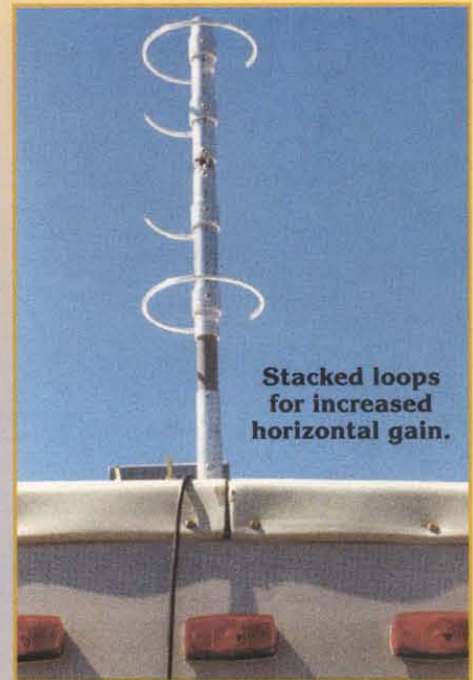
Thousands of amateur radio operators have purchased the popular ICOM IC-706 multi-mode HF/VHF/UHF transceiver, but few have ever operated it on two-meter and 70 cm single sideband for weak signal DXing. There are thousands of Yaesu FT-100 owners, but only a handful have listened into the weak signal DX coming in on 144.200 upper sideband and 432.100 upper sideband.

And Yaesu has just announced the FT-817, a QRP version of the FT-100. The FT-817 runs HF, VHF, and UHF with multi-mode weak signal SSB capabilities on both two meters, as well as 432 MHz.

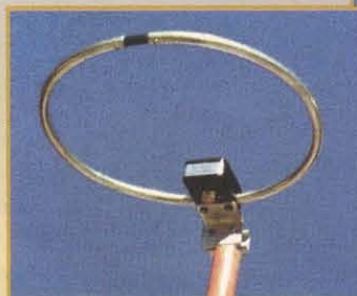
"The reason we don't have more SSB activity on 144.200 MHz and 432.100 MHz from these radio operators is the misconception that VHF and UHF long-range tropospheric ducting requires major-sized, horizontally polarized, beam antennas," comments Norm Pedersen KB6KQ, Education Chairman for the Western

States Weak Signal Society (WSWSS, P.O. Box 332, Midway City, CA 92655; \$10.00 for membership and newsletter; web [www.wswss.org](http://www.wswss.org)).

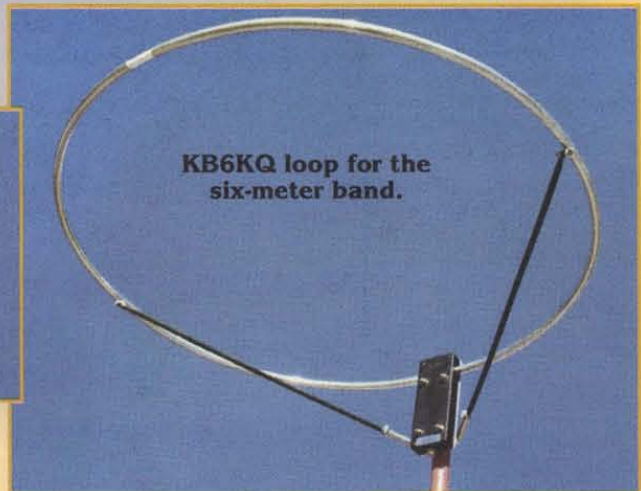
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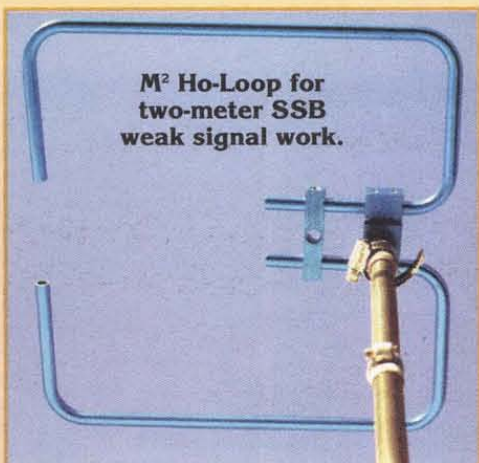
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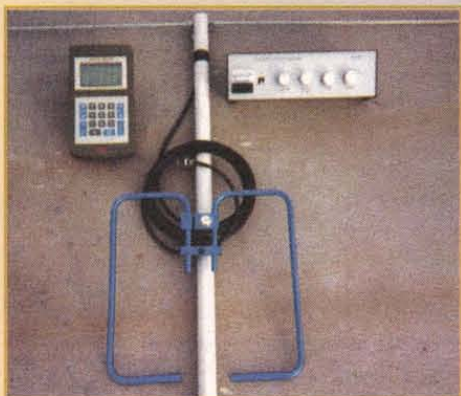
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### M<sup>2</sup> Ho-Loop for two-meter SSB weak signal work.



### Par Electronics triangle loop.



M<sup>2</sup> Ho-Loop (blue) next to antenna testing equipment.

VHF and UHF bands is a dual-band vertical whip is cross-polarized and they miss out on any significant DX," adds Pedersen.

Yes, these little transceivers for both mobile and base, and the new Yaesu FT-817 for portable, indeed need to go into a horizontal antenna system in order to work the regular DX found down on 144.200 and 432.100, predominantly tropo scatter and tropospheric ducting. There could be as much as a 20 dB loss in performance when trying to work these weak signal portions of the bands with just a mobile vertical antenna.

### THE LOOP ANSWER

A single compact VHF or UHF mobile loop antenna puts you on 144.200 SSB or 432.100 SSB with a horizontally polarized signal that may surprise the daylighters out of you when you are out on the flat lands, up on a hill, or driving along the shore of a lake or ocean.

What kind of results might you expect mobile to mobile using two meters or 432 MHz SSB, horizontally polarized? During recent summertime VHF and UHF operating events, two-meter SSB mobile-to-mobile contacts over 50 to 75 miles were quite common, and mobile-to-base on two-meter SSB exceeded 100 miles to a maximum of 300 miles. Pat Coker N6RMJ, Vice-President of the Western States Weak Signal Society, has many times made two-meter SSB contact between his mobile in Los Angeles and base stations with horizontal beams in the San Francisco Bay area.

What's happening on 432.100 MHz? This frequency, three times higher than the two-meter band, yields almost the SAME DX as on two meters — especially when common tropospheric ducting caps the signals and tunnels them in an inversion layer over hundreds of miles.

Larry Hogue W6OMF, in Vacaville reports consistent long-range, mobile-to-mobile contacts on both two meters and 432 using single sideband and horizontally polarized loops, and extraordinary base-to-mobile, hundreds-of-miles contacts down on 144.200 upper sideband and 432.100 upper sideband.

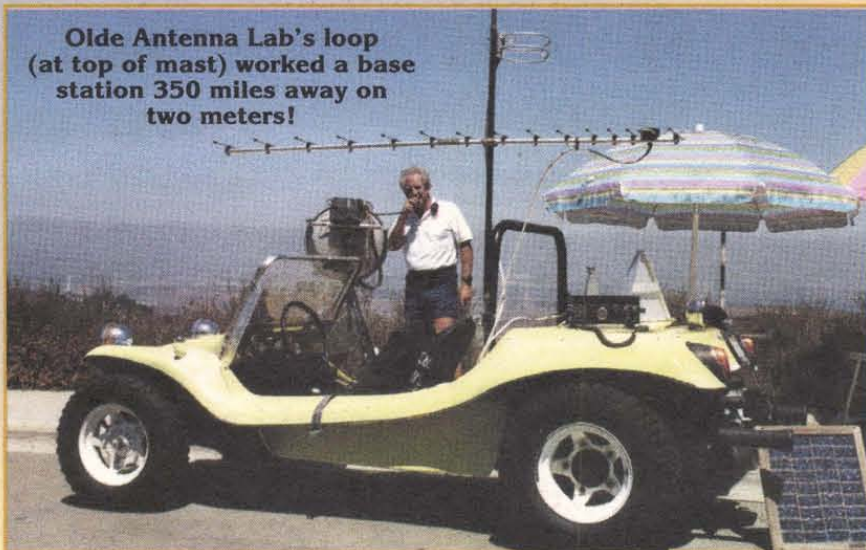
The small loop antenna is also the answer for those weak signal VHF/UHF operators who may live in a housing development where no external antennas are allowed.

"I run a two-meter loop and a 432 MHz loop in the attic, and I am talking VHF/UHF single sideband over hundreds of miles without anything showing on the roof," comments Bill Alber WA6CAX, a pal of Larry W6OMF. "I even heard about a mobile-to-mobile, loop-to-loop contact between Southern California and Paul Lieb KH6HME, driving up the slopes of a volcano in Hawaii!" adds Alber. I can confirm this contact that occurred about two years ago during the regular California-to-Hawaii tropo opening in August.

### WHOSE LOOP IS BEST?

The horizontally polarized two-meter, 432 MHz, and 1.2 GHz loops are commercially available from about six different antenna

### Olde Antenna Lab's loop (at top of mast) worked a base station 350 miles away on two meters!



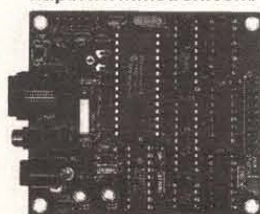
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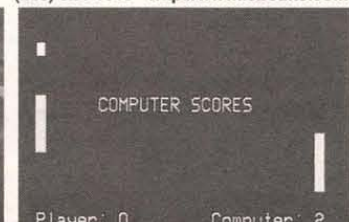
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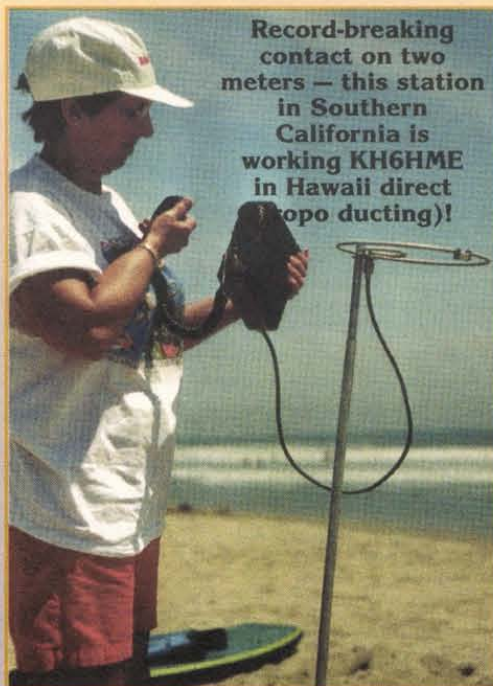
If I left out any current VHF/UHF loop manufacturers, someone let me know! There are also some classic "halo" loops occasionally showing up at ham swapmeets, including loops from Hygain, Cushcraft, and High Par Products. I can remember my first "Saturn" loop.

About a year ago, Chip Margelli K7JA, and I did a series of mobile loop comparisons down at the seashore. We tested the difference between individual loops at different heights above our roof, and then tested the increase of signal strength by stacking loops with the manufacturer-supplied phasing harnesses. The results were interesting.

Individual loops compared between themselves all did remarkably well for extremely low SWR at 144.200 or 432.100. The SWR settled down nicely as long as they were mounted a halfwave or higher over the metal top of our vehicle. During range tests to a distant station 80 miles away, all loops were put in a relatively close matching signal strength, and each loop was relatively omnidirectional as we did donuts in the parking lot.

Indeed phasing and stacking a pair of loops will help increase signal strength, but the stacked pair didn't open up any new DX, but rather made our signal strength increase slightly. It was not like distant signals would magically appear when we stacked the loops as opposed to just working a single loop. Distant stations would simply increase slightly in signal strength when we switched over to the stacked pair versus the single loop. For the weak signal operator wanting the absolute strongest signal possible, stacked loops are a good way to go — but a weak signal operator just wanting a good distant signal that's going to go 99 percent as far as dual loops, the single loop will work just great.

All of the loop manufacturers continue to refine their two-meter, 432, and 1296 MHz loops.



**Record-breaking contact on two meters — this station in Southern California is working KH6HME in Hawaii direct loop ducting!**



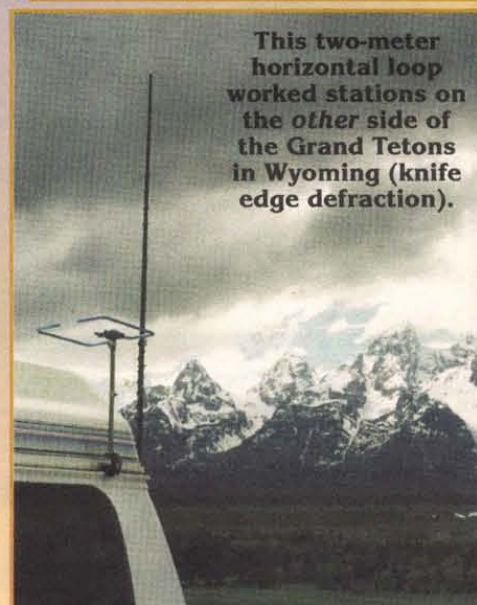
**Author West putting a stack of KB6KQ loops on their Funmobile!**

Slight redesigns from almost every loop manufacturer have dramatically improved the performance of the loops when water accumulates at their feedpoint. Each manufacturer has their own ideas on exactly how they feed the loop for a perfect match, and we really couldn't see any major difference in performance although each loop had its own characteristic tight or loose bandwidth.

So which loop for you? I suggest going with one that most easily mounts on your particular mobile installation. Some mount with a relatively large mast because of their large surface area, yet others mount to a very narrow rod because they are relatively aerodynamic and small. Some are round, some are square, and some look like triangles. Again, they all seem to work about the same over the airwaves.

Go for a loop and add the capabilities to your two-meter or 432 MHz multi-mode mobile or base station using upper sideband. 144.200, upper sideband, is the calling frequency and meeting spot for new operators. 432.100 MHz is the calling frequency and meeting spot for new operators. Both frequencies using upper sideband mode only — no FM!

These loops will make a world of difference of getting some contacts on VHF and UHF SSB. Give a loop a try! **NV**



**This two-meter horizontal loop worked stations on the other side of the Grand Tetons in Wyoming (knife edge defraction).**

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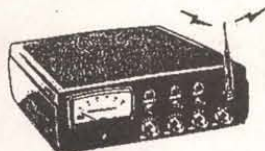
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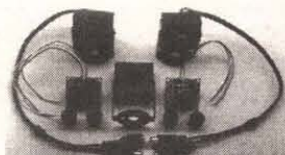
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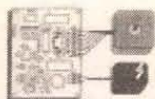
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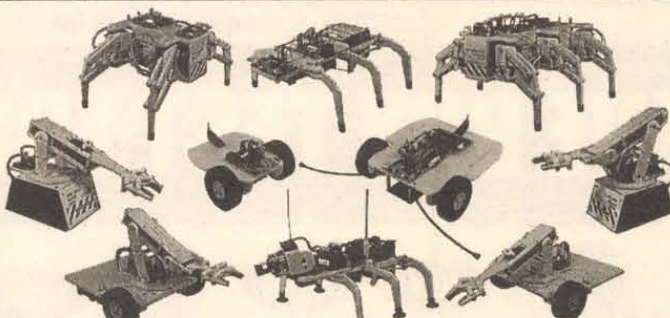
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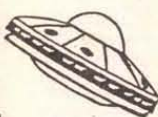
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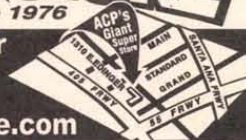
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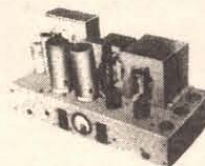
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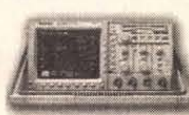
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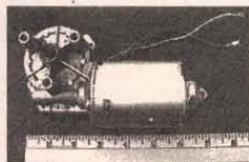
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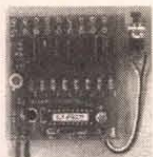
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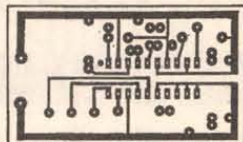
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### Fuzzball's Pick of the Week



Fuzzball has been working hard to build up his "Best Picks" library of articles and projects. He's been adding a new selected reprint each week and now has quite a collection. (Inside tip - He has been known to do requests. His email address is [fuzzball@nutsvolts.com](mailto:fuzzball@nutsvolts.com)) His new pick is usually posted on Wednesday or Thursday of each week. Check em out!

## Electronics Forums

The bulletin board is starting to see some action, but still needs more participation from all you techies out there, to really take off. C'mon guys, let's hear some of those great ideas and that awesome techno advice the *Nuts & Volts* readers are famous for. You want a forum dedicated to a special topic? Tell us and we'll start it!

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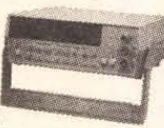
- Cushion Grip Handle
- Soldering Iron (optional) with Grounded Tip for Soldering Static-Sensitive Devices. Easily Replacable. Uses Long-Life, Plated Conical Tip.
- Heavy Steel, Non-Slip Base.
- Iron Holder Funnel - Reversible, left or right side.
- Steel Tray for Sponge Pad.
- Sponge Pad.

## Test Equipment

### 10 Function 1.3GHz Universal Counter Elenco Model F-1300

- Frequency .05Hz - 1.3GHz 3 Ranges
- Period - Can read 60Hz to 60.000000 F=1/T
- Totalize - Counts to 199,999,999
- RPM - 3 to 2099994 RPM
- Duty Cycle
- Max/Min/AVG with Time
- Stop-watch set 2 sec. to 100 hrs.
- Math Functions
- Timer - 2 sec. to 99 days
- Pulse Width - 0.1ms to 66666.6ms

**\$229.95**



### Elenco 3MHz Sweep Function Generator with built-in 60MHz Frequency Counter Model GF-8046

**\$195.95**



This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulses over a frequency range from 0.5Hz to 3MHz. GF-8025 - Without Counter **\$139.95**

### 20MHz Sweep / Function Generator with Frequency Counter Model 4040

- 0.2Hz to 20MHz
- AM & FM Modulation
- Burst Operation
- External Frequency Counter to 30MHz
- Linear and Log Sweep



21.5MHz Model 4070 **\$1295**  
10MHz Model 4017 **\$325**  
5MHz Model 4011 **\$255**

**\$445**  
BK PRECISION

### Elenco Handheld Universal Counter 1MHz - 2.8GHz Model F-2800



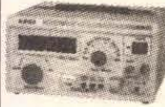
**\$99**

- Sensitivity:
- <1.5mV @ 100MHz
- <5mV @ 250MHz
- <5mV @ 1GHz
- <100mV @ 2.4GHz

Features 10 digit display, 16 segment and RF signal strength bargraph. Includes antenna, NiCad battery, and AC adapter.

C-2800 Case w/ Belt Clip.....**\$14.95**

### Elenco RF Generator with Counter (100kHz - 150MHz) Model SG-9500



**\$225**

Features internal AM mod. of 1kHz, RF output 100mV - 35mHz. Audio output 1kHz @ 1V RMS. SG-9000 (analog, w/o counter) **\$124**

### Elenco Quad Power Supply Model XP-581



**\$85**

4 Fully Regulated Power Supplies in 1 Unit

4 DC Voltages: 3 fixed: +5V @ 3A, +12V @ 1A, 1 variable: 2.5 - 20V @ 2A • Fully Regulated & Short Protected • Voltage & Current Meters • All Metal Case

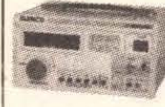
### Elenco Power Supply Model XP-603



**\$85**

- 0-30VDC @ 3A Output
- 3A Fused Current Protection
- Current Limiting Short Protection
- 0.025Ω Output Impedance

### Elenco 10Hz - 1MHz Digital Audio Generator Model SG-9300



**\$225**

Features built-in 150MHz frequency counter, low distortion and sine/square waves. SG-9200 (w/o counter) **\$124**

## Ordering Information:

- Model SL-5 - No iron. (Kit SL-5K) **\$29.95**
- Model SL-5-40 - Includes 40W UL iron. (Kit SL-5K-40) **\$35.95**
- Model SL-5-60 - Includes 60W UL iron. (Kit SL-5K-60) **\$36.95**

Limited Time Offer: **FREE SP-1A Solder Practice Kit w/ Kit Order!**

Weller WLC-100 - Variable Power Control 5 - 40 watts **\$34.95**

### Elenco Model SL-30



**\$84.95**

- Tip temperature changeable from 300°F (150°C) to 900°F (450°C).
- Temperature is maintained within +10°F of its preset temperature.
- The tip is isolated from the AC line by a 24V transformer.
- The tip is grounded to eliminate static charges.

SL-10 - Same as SL-30 w/o digital display **\$59.95**

### Weller Model WTCPT

#### Controlled Output Soldering Station

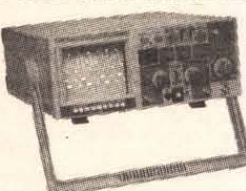
- Transformer powered soldering station complete w/macro style, low voltage, temperature controlled soldering iron.
- PT Series soldering tips come in a variety of shapes and sizes in three standard temperature ranges: 600°F, 700°F, & 800°F.
- 0-24V output - 60 watts.
- Special "closed loop" method of controlling maximum tip temperature.



**\$125**

## Elenco Oscilloscopes

Free Dust Cover and 2 Probes



- S-1325 25MHz Dual Trace **\$325**
- S-1345 40MHz Delayed Sweep **\$569**
- S-1330 25MHz Delayed Sweep **\$439**
- S-1360 60MHz Delayed Sweep **\$725**
- S-1340 40MHz Dual Trace **\$475**
- S-1390 100MHz Delayed Sweep **\$895**

### DIGITAL SCOPE SUPER SPECIALS

- DS-203 20MHz/10Ms/s Analog/Digital .....**\$695**
- DS-303 40MHz/20Ms/s Analog/Digital .....**\$850**
- DS-603 60MHz/20Ms/s Analog/Digital .....**\$950**

## Elenco Educational Kits

### Model XK-150

Digital / Analog Trainer

**\$89.95**



- 830-pin Breadboard
- 8 Data Switches
- 8 LED Buffered Readouts
- Built-In Function Generator (sine and square wave)
- Built-In Clock Generator
- Variable Power Supply
- +1.25V to 15VDC @ 25A
- +1.25V to 15VDC @ 25A
- +5VDC @ 25A
- +30VAC center-tapped at 15VAC @ 25A

### Model AR-2N6K

2 Meter / 6 Meter Amateur Radio Kit

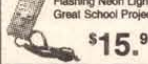
**\$34.95**



### Model AK-700

Pulse/Tone Telephone Kit

**\$15.95**



### Model M-1005K

DMM Kit

**\$15.95**



### Model AM-780K

Two IC Radio Kit

**\$11.95**



### Model AK-870

Radio Control Car Kit

**\$24.95**



### Model MX-901

Electronic Crystal Radio

**\$6.95**



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Cameras have 420 lines (360 color) of resolution, 0.08 Lux, 3.6mm/F2 90° field of view. Power requirement is 12VDC @ 100mA (order SC-1).

### MONOCHROME CAMERAS

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SC-12 - 35mm Lens (1.25"x1.25") **\$69**

SC-15 - Pin Lens (1.25"x1.25") **\$69**

SC-20 Pin Lens **\$109**

SC-21 3.6mm Lens **\$109**

360 Lines 1.25" x 1.25" Infrared Sensitive, Audio Included

Add \$10 for lens • Add \$10 for audio

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- SC-2 - 50' cable w/ connectors

**\$6.95** Add \$10 for case  
**\$19.95** Call for complete catalog.

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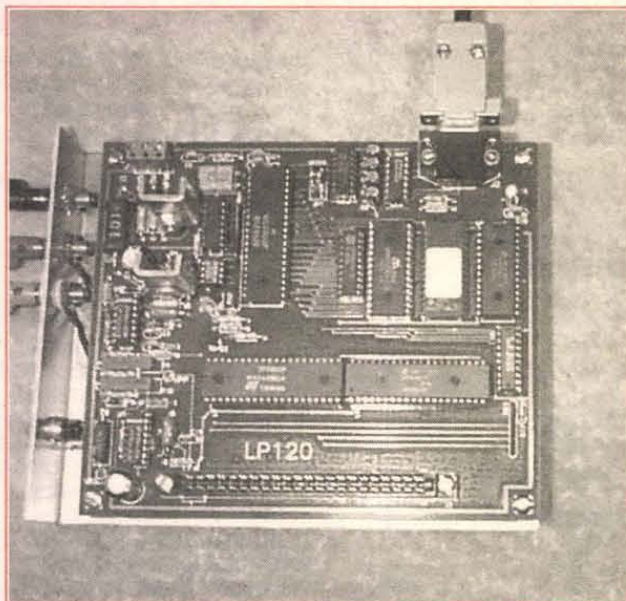
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# DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM

## Part 1

### INTRODUCTION

Since I started working with microcontrollers and other programmable devices, I've collected over a dozen programmers for use with different chips. I thought about purchasing an expensive "universal" programmer but found that even they require software upgrades, or personality modules, for new parts, and socket adapters for various packages, such as: SO, PLCC, PGA, etc. Plus, while a "universal" programmer may program a wide variety of chips, it may not universally work with all computers.

Some programmers require an ISA or PCI expansion slot, most require a particular operating system. As computer design and operating systems change, you may find your "universal" programmer is useless, not because it can't program the devices, but because it's not compatible with your new PC.

Then, I started looking at all my programmers and realized much of

the same circuitry was duplicated in every programmer. That's not surprising since all programmers perform similar basic functions. Those basic functions are: communication with a host system, generating the programming-pulse voltage, generating any unique supply voltage required by the device, and controlling the digital interface to the device.

### DESIGN GOALS

I decided to build a general-purpose programmer that incorporated all the basic functions, yet was versatile enough to program any part I might ever use in a project. Since I work with lots of computers, I also wanted it to work with Windows PCs, Macs, laptops, and desktops; both old and new. I called this design the LP120.

The interface with the host PC is via an RS-232 COM-port rather

than via the parallel printer-port. This allows me to use existing terminal software — like Procomm or Hyperterm — to communicate with the LP120 rather than writing a unique driver for the printer-port. It also means the host can be any computer with an RS-232 port and terminal software; this makes the host interface independent of the type of computer and operating

system.

Programming-pulse voltages can vary from 25V, for some of the older EPROMs, to 5V, for some of the new flash devices. Typically, the tolerance on the programming-pulse voltage is  $\pm 0.25V$ . Therefore, the programming-pulse voltage ( $V_{pp}$ ) should cover at least 5 to 25 volts with better than 0.25V accuracy.

To fully comply with published programming algorithms, the device's supply voltage also has to vary. For example, some 5V EPROMs are programmed while powered at 6.5V, and PIC microcontrollers are verified at the min and max supply voltages. Typically, the tolerance on supply voltages is  $\pm 0.1V$ . Therefore, the LP120 should be able to power the device being programmed with voltages from 3 to 6.5 volts with better than 0.1V accuracy. I use the symbol  $V_{ps}$  for this voltage since it is the Voltage supplied to the Programming Socket.

Including address, data, and control lines, an EPROM may need 26 digital interface lines for proper pro-

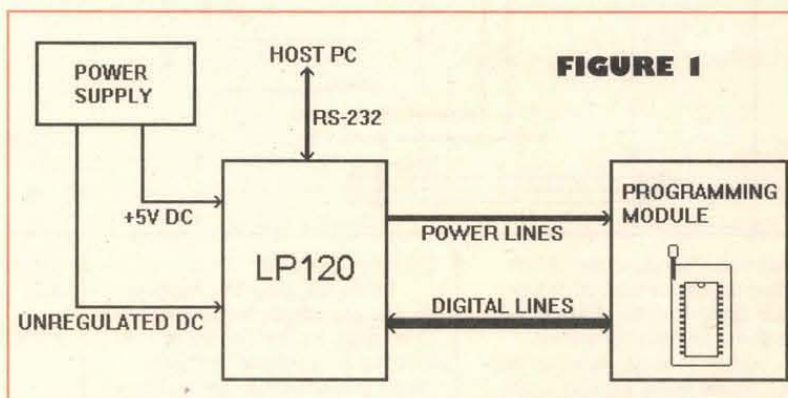


FIGURE 1

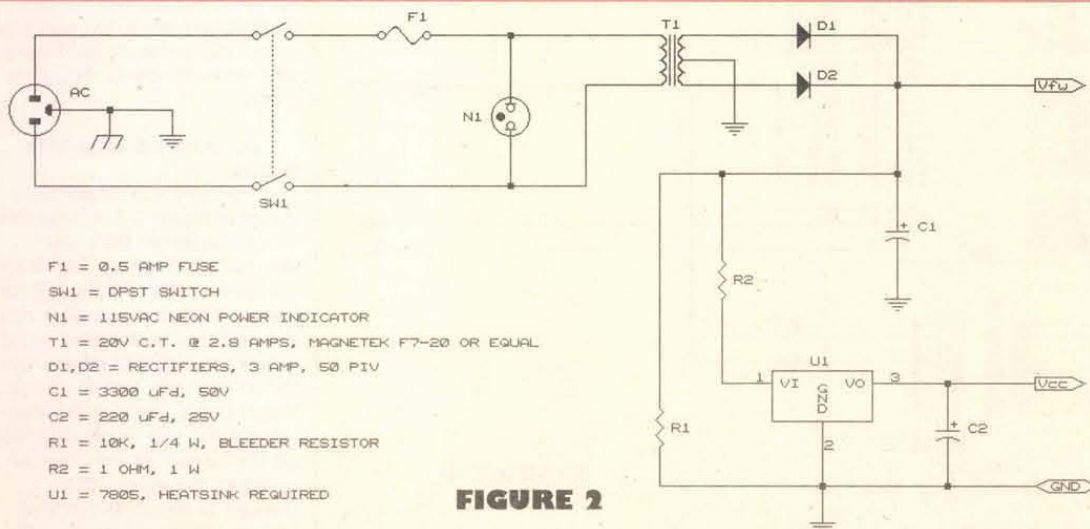


FIGURE 2

- F1 = 0.5 AMP FUSE
- SW1 = DPST SWITCH
- N1 = 115VAC NEON POWER INDICATOR
- T1 = 20V C.T. @ 2.8 AMPS, MAGNETEK F7-20 OR EQUAL
- D1, D2 = RECTIFIERS, 3 AMP, 50 PIV
- C1 = 3300  $\mu F$ , 50V
- C2 = 220  $\mu F$ , 25V
- R1 = 10K, 1/4 W, BLEEDER RESISTOR
- R2 = 1 OHM, 1 W
- U1 = 7805, HEATSINK REQUIRED



## DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM

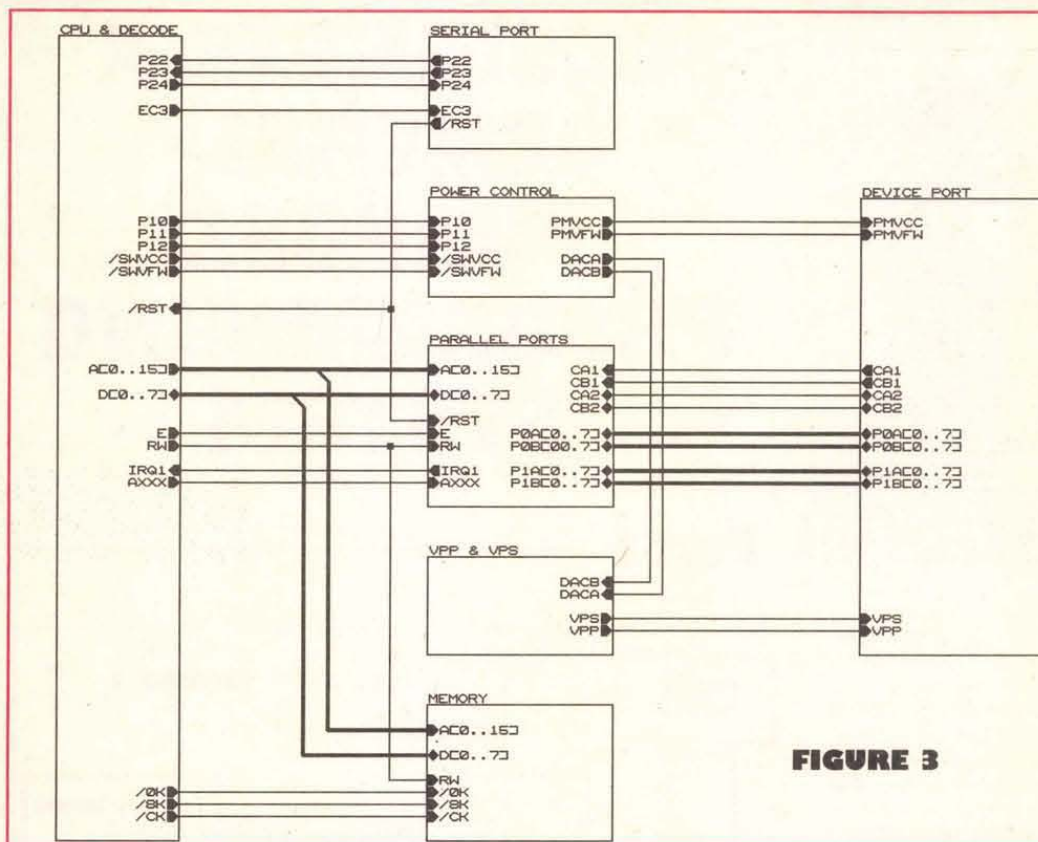


FIGURE 3

gramming. Therefore, the LP120 should provide at least 26 bidirectional digital lines to interface with the device being programmed.

I prefer to reuse my power supplies, so the primary power supply was not included as part of the

LP120 circuit board.

Finally, the programming socket, and any unique circuitry required to program a particular device, are included on a separate programming-module for that device. Figure 1 shows the block diagram for the

general-purpose programming system.

### POWER SUPPLY

I hate to build a power supply for every single project, so the main

power supply for the LP120 is external. The power supply I use with my own LP120 is shown in Figure 2. Originally, it was a +5V supply I built years ago; I simply added a connection to the filtered full-wave-rectified voltage (Vfw). The voltage at Vfw should be the RMS value of the transformer's secondary, or approximately 14V in this case.

**WARNING: BUILDING A POWER SUPPLY THAT CONNECTS TO HOUSEHOLD AC CURRENT IS POTENTIALLY DANGEROUS AND SHOULD ONLY BE ATTEMPTED BY KNOWLEDGEABLE AND EXPERIENCED PERSONNEL. EXPOSED AC VOLTAGES ARE A POTENTIALLY LETHAL SHOCK HAZARD! INCORRECT CONSTRUCTION TECHNIQUES CAN RESULT IN A FIRE HAZARD! IF YOU ARE UNCOMFORTABLE WITH BUILDING YOUR OWN POWER SUPPLY, DO NOT ATTEMPT THIS PROJECT!**

### LP120 CIRCUITRY

Figure 3 shows the functional blocks on the LP120 circuit board and how they interconnect.

#### CPU and Address Decode

The LP120 is an eight-bit micro-computer system with its own RAM, EPROM, and I/O. Figure 4 is the CPU block with the 6803 micro-processor (U1), address latch (U2), and address decoder (U6). The 6803 provides a 64K byte-wide address space, an asynchronous Serial Communications Interface (Motorola calls this a SCI instead of UART), clock oscillator, and a parallel port; all in one chip. The E-clock output of the 6803 (pin 40) is a squarewave at one-fourth the crystal frequency or 921.6kHz. In addition to address decoding, the PAL16R4's registers are configured to divide the E-clock by three, producing an asymmetric pulse-train of 307.2kHz at EC3. This is important because EC3 is an exact binary multiple of the standard baud rates while the crystal frequency is not.

#### Serial Port & Baud Rate Selection

The serial port schematic is shown in Figure 5. The serial connector is a female DB-9 type, wired as a DCE device. This mates directly with the nine-pin DTE connectors found on most IBMs and compatibles. The MAX232 (U13) contains two RS-232 drivers, two RS-232 receivers, and an on-chip charge-pump. The charge-pump uses the five-volt supply to generate the bipolar voltages needed by the RS-232 drivers. RTS is received, buffered, and looped back to CTS, so CTS tracks RTS.

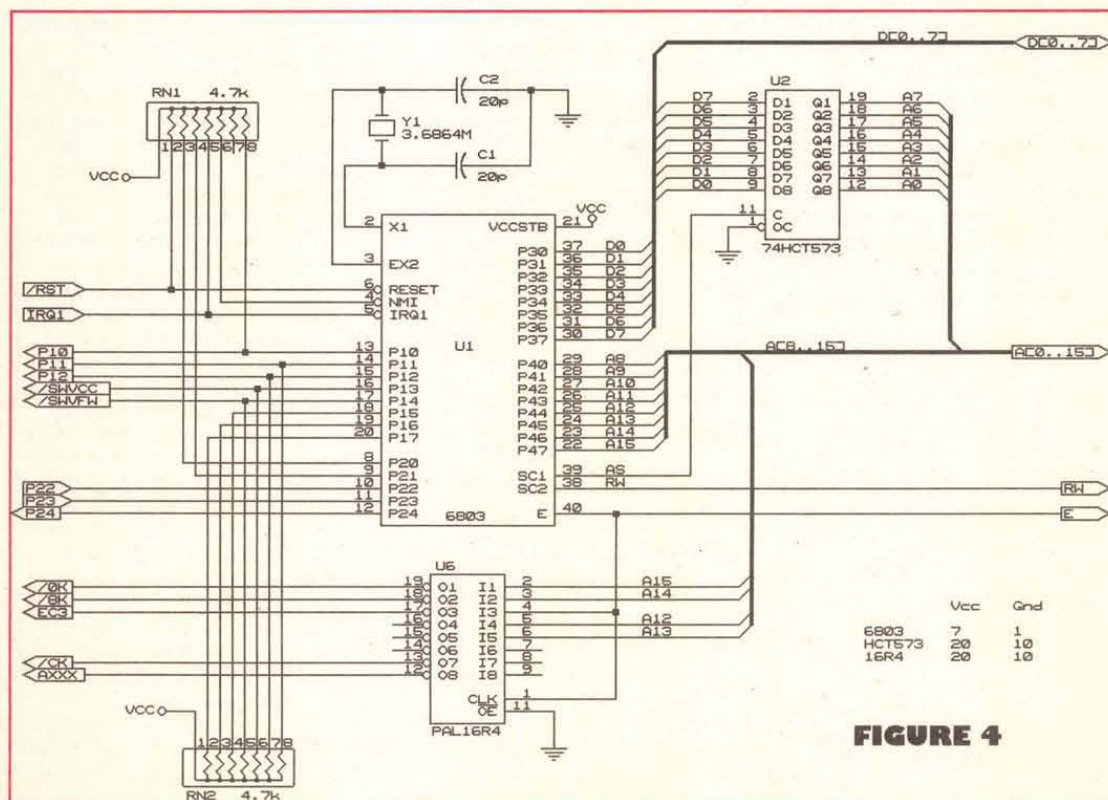


FIGURE 4



## DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM

DCD and DSR are both held in the ON condition.

Even though the 6803 has an internal SCI, its programmable baud rate selection is very limited. However, the SCI can run at any baud rate if a squarewave of eight times that rate is connected to P22 (pin 10 of the 6803). The 74HCT393, dual four-stage binary counter (U9), squares up the asymmetric clock on EC3 and divides the frequency to provide a selection of standard rates. A single jumper on header JP1 can select any rate from 1200 to 19200 baud.

### Memory

Figure 6 shows the schematic for the LP120's memory. The LP120's firmware is stored in a 27128 EPROM (U4). The 62256 and 6264 chips (U3 and U5, respectively) form 40K of continuous RAM. The firmware doesn't have the code to program all the devices the LP120 is capable of programming, it only contains the operating system, test routines, and hooks to lots of subroutines. To program a specific device, "driver" software must be uploaded to the LP120 and executed out of RAM.

### Power Control

Figure 7 shows the power control circuitry, Vcc, Vfw, and ground from the external power supply connect to J1.

Transistor Q3 can switch Vcc to the programming-module where it is called PMVcc. Circuitry on the programming-module should draw no more than 100 milliamps from PMVcc.

Transistor Q2 can switch Vfw to the programming-module where it is called PMVfw. Circuitry on the programming-module should draw no more than 500 milliamps from PMVfw.

The MAX522 (U14) is a serial-input voltage-output dual eight-bit DAC. The serial interface is handled by three lines from the parallel port on the 6803. The output range for both DAC channels is zero to the reference voltage on pin 7. The TL431 (U15) provides a 2.5V reference for the DAC. The resolution of the DACs is  $(2.5V/255) = 9.8mV$  per count.

### Vpp & Vps

The DC-to-DC converter circuits for Vpp and Vps are shown in Figure 8. Both converters are powered by Vfw and both are controlled by voltages from the MAX522 dual eight-bit DAC. The DAC voltages go to the reference inputs (pin 9) of the 78S40 switching voltage regulators (U11 and U12). The 78S40s will change their output voltage to make the feedback voltage (pin 6) equal the reference input (pin 9). Both circuits use the on-chip 1.25V

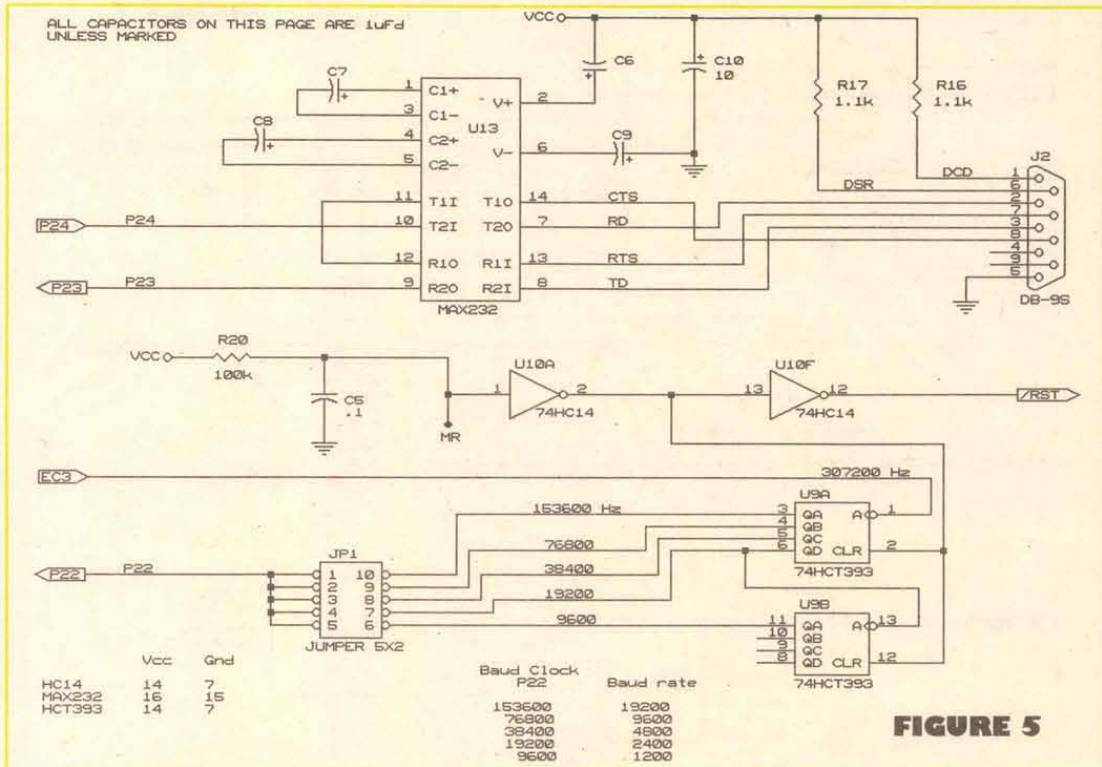


FIGURE 5

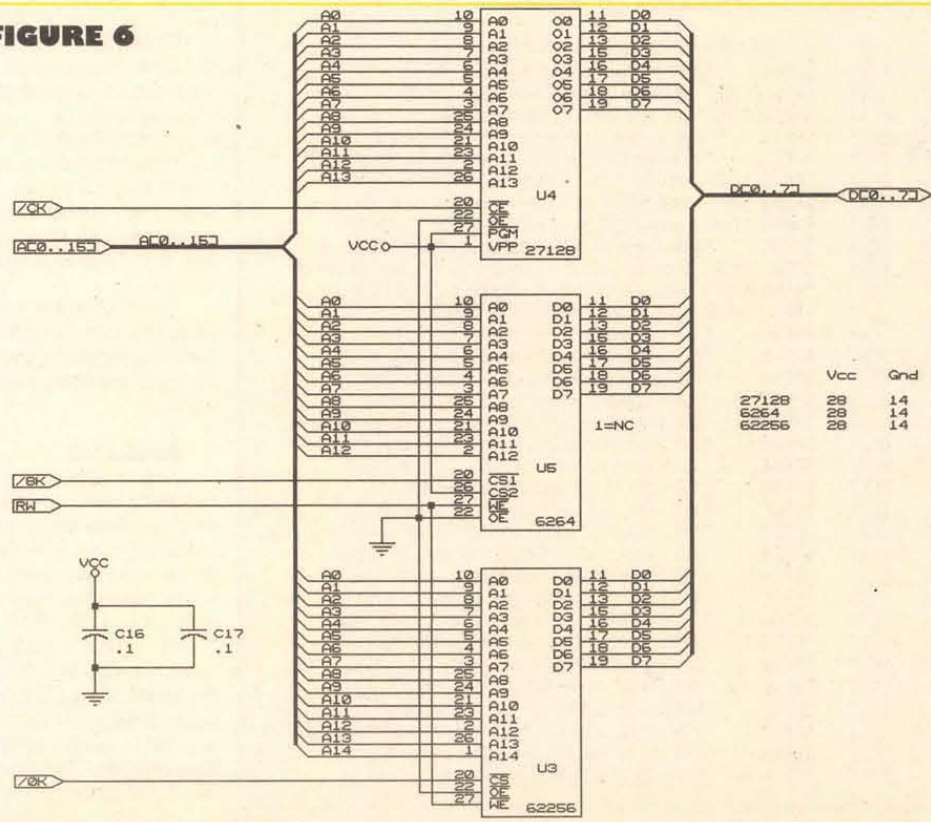
reference (pin 8) and diode (pins 1, 2) to bias the feedback network slightly above ground. Without this bias, the regulators would switch erratically when the DAC voltage went to zero; with the bias, the regulators switch off completely when the DAC voltage goes to zero.

The Vpp regulator is the upper

part of Figure 8. U11 is configured as a step up/down switching regulator. This configuration allows Vpp to be above or below the nominal 14V on Vfw. To meet the design goals, Vpp must span 5 to 25 volts. I decided to let one DAC step equal 100 mV of output; for example, if DACA is set to 210 (D2 hex) Vpp

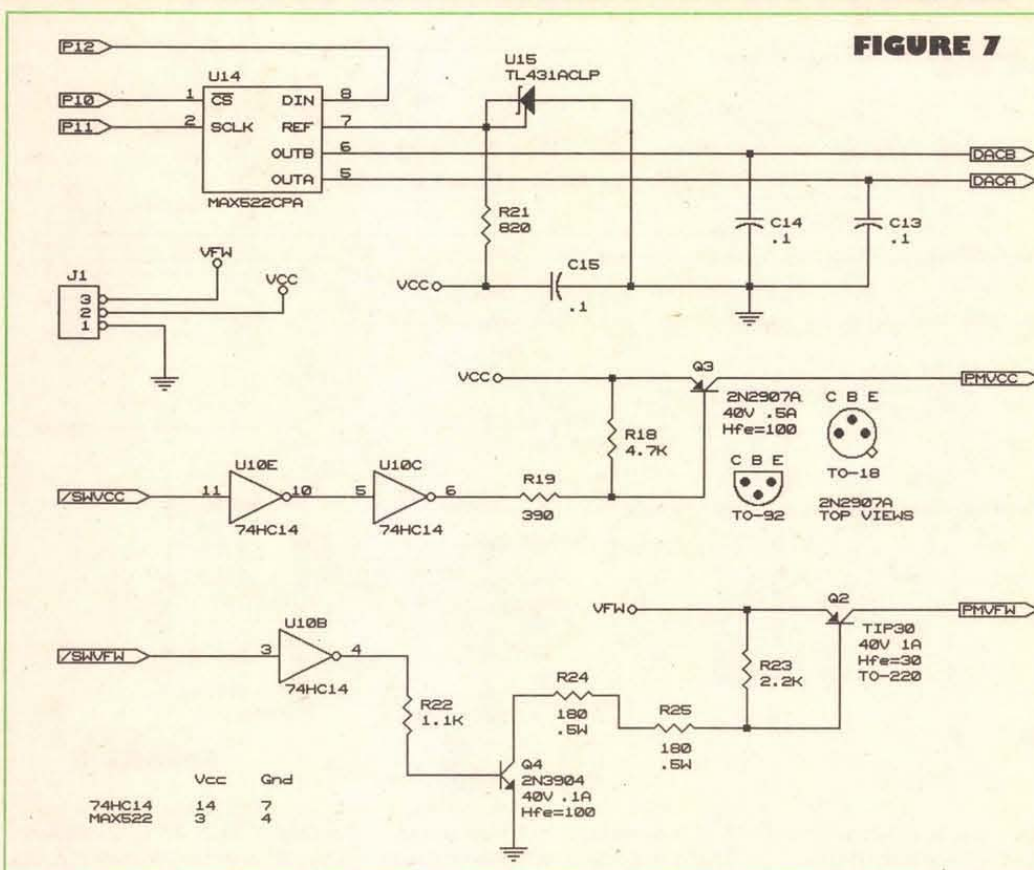
should go to 21.0V. To accomplish this, the feedback network (R7, R9, R11, R13) gain must be  $(2.5/255) \times 10 = 0.098$ . The circuit shown allows Vpp to be set from 4.8 to 25.5 volts in 0.1V steps, which meets the design goals. Below 4.8V the regulator begins to cut off and settings are unreliable.

FIGURE 6





## DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM



The measured current capacity is non-linear, but can be approximated by the equation  $I_{pp} \text{ (amps)} = -0.263 + 0.298 \cdot e^{(4.8/V_{pp})} - 23 \cdot e^{(-V_{pp})}$ . At 25V,  $V_{pp}$  can supply approxi-

mately 100 mA and, at 5V, approximately 350 mA.

The Vps regulator is the lower part of Figure 8. U12 is configured as a step-down switching regulator.

Vps powers the programming socket and any other circuitry on the programming module that must operate at the same voltage.

To meet the design goal of 3 to 6.5 volts, I decided to let one DAC step equal 30 mV of output. For example, if DACB is set to 167 (A7 hex), Vps should go to 5.01V. To accomplish this, the feedback network (R8, R10, R12) gain must be  $(2.5/255)*33 = 0.327$ . The circuit shown allows Vps to be set from 1.8 to 7.2 volts in 0.03V steps. The measured current capacity is 0.5A for Vps<6V and  $0.5 - 0.72*(Vps-6)$  amps for Vps>6V.

For an excellent tutorial on designing with the 78S40 switching regulator, see Motorola application note AN920.

## Parallel I/O

Address and data lines to the device being programmed must be steady during any programming pulse. This means the device being programmed cannot be connected to the address or data bus of the 6803.

Therefore, parallel ports are used to set the address and data for the device being programmed. Figure 9 shows U7 and U8, the two 6821 parallel interface adapters (PIAs). The PIAs' four bi-directional parallel ports, two bi-

directional control lines, and two control inputs are all routed to the programming connector.

### Programming Connector

The connections to the programming connector (J3) are shown in Figure 10. J3 is an edge connector with 44 contacts (22 per side) at 0.156 inch spacing. The programming module for the specific device being programmed plugs into J3.

## PROGRAMMING MODULES

The next article in this series will cover the programming module for mid-range PIC microcontrollers. This month, I'll just talk about programming modules in general. In addition to the device being programmed, the programming module contains any required circuitry not provided by the LP120. This might be: glue logic, a transistor switch controlled by the device being programmed, a level translator, etc. The device being programmed should be powered by Vps while the programming pulse voltage should be supplied by Vpp. Data, control, and address lines on the device being programmed should be connected to the bi-directional parallel ports from the LP120.

If a particular device doesn't use all the digital lines or voltages, it is only connected to those it needs. Programming modules are small and can easily be built using wire-wrap. Many vendors sell 44 contact plug-in boards that are perfect for the job.

## LP120 SOFTWARE

All microprocessor-based instruments have software in some form or another. There are three parts to the software associated with the LP120: the host's communication program, the LP120 firmware, and the device driver. As mentioned earlier, the host system must run a communication program that will do terminal emulation and ASCII file transfer. Most operating systems include such an application, like HyperTerminal under Windows. Many terminal emulation/communication programs can be found for free on the Internet. Any of these programs that will run on your machine should work since terminal emulation and ASCII file transfer are the lowest common denominators for all communications programs.

## LP120 FIRMWARE

### Opening Menu

Whenever the LP120 is turned on, the firmware operating system will initialize the hardware and send an opening menu, like that shown below, to the host. Menu selections are made by typing the character in brackets. Any other character will

## TOOLBOX EQUATES

RESET	EQU	\$C000	*JMP HERE TO TERMINATE DRIVER
DLY_B	EQU	\$FF6C	*JSR - short software delay
GETVPP	EQU	\$FF70	*JSR - get Vpp setting from user input
GETVPS	EQU	\$FF74	*JSR - get Vps setting from user input
DWNMOT	EQU	\$FF78	*JSR - send hex data as an ASCII S-record
DWNHEX	EQU	\$FF7C	*JSR - send hex data as an ASCII Hex-record
RX4HEX	EQU	\$FF80	*JSR - receive 4 hex values as ASCII characters
RX3HEX	EQU	\$FF84	*JSR - receive 3 hex values as ASCII characters
RX2HEX	EQU	\$FF88	*JSR - receive 2 hex values as ASCII characters
RX1HEX	EQU	\$FF8C	*JSR - receive 1 hex value as ASCII character
TX2ASC	EQU	\$FF90	*JSR - send byte (2 hex values) as ASCII characters
TX4ASC	EQU	\$FF94	*JSR - send word (4 hex values) as ASCII characters
EXITMM	EQU	\$FF98	*JMP HERE FOR LP120 MAIN MENU
BINBCD	EQU	\$FF9C	*JSR - convert 16-bit binary to BCD
UPMOT	EQU	\$FFA0	*JSR - upload an S-record from host
ADRMOT	EQU	\$FFA4	*JSR - return address of S-record buffer
UPHEX	EQU	\$FFA8	*JSR - upload a Hex-record from host
ADRHEX	EQU	\$FFAC	*JSR - return address of Hex-record buffer
VPPSET E	QU	\$FFB0	*JSR - set Vpp using linear correction
VPS_NC	EQU	\$FFB4	*JSR - set Vps without linear correction
VPSSET	EQU	\$FFB8	*JSR - set Vps using linear correction
VPS_NC	EQU	\$FFBC	*JSR - set Vps without linear correction
PWROFF	EQU	\$FFC0	*JSR - turn off all power to programming-module
PIAOFF	EQU	\$FFC4	*JSR - make all PIA ports outputs and zero
PIADAT	EQU	\$FFC8	*JSR - select data registers on both PIAs
PIADDR	EQU	\$FFCC	*JSR - select data direction registers on both PIAs
ASCHEX	EQU	\$FFD0	*JSR - convert ASCII character to hex nibble
HEXASC	EQU	\$FFD4	*JSR - convert byte to two ASCII characters
MSGOUT	EQU	\$FFD8	*JSR - send message to host
SCITX	EQU	\$FFDC	*JSR - wait while SCI sends a byte
SCIRX	EQU	\$FFE0	*JSR - wait while SCI receives a byte
RXECHO	EQU	\$FFE4	*JSR - wait while SCI receives a byte then echo it
RXWAIT	EQU	\$FFE8	*JSR - wait for SCI incoming data to end
DLY_A	EQU	\$FFEC	*JSR - long software delay



## DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM

cause the menu screen to be retransmitted. All inputs to the LP120 are case sensitive.

### LP120 OPENING MENU

[U]pload driver program  
[J]ump to driver at 0100 hex  
[D]isplay system memory  
[T]est static RAM  
[C]alibrate Vpp and Vps  
?

### [U]pload driver program

This option is used to upload the driver for the device you want to program. Drivers are stored as ASCII files in the Motorola S-record format. The upload is accomplished via the ASCII file transfer facility of whatever terminal/communication program you are using on the host. After uploading, control should automatically transfer to the driver program and its menu screen should appear. If the LP120 OPENING MENU reappears, use the [J]ump option to start the driver.

### [J]ump to driver at 0100 hex

Use this option to transfer control to 0100 hex which is the starting address for driver programs.

### [D]isplay system memory

This option is included as a debugging aid for users who write their own device driver programs. Any portion of the LP120 memory space can be displayed.

### [T]est static RAM

This test checks all available RAM, from 0020 to 9FFF. Each memory scan writes the same test byte at every address, then goes back and reads every address to confirm the data is correct. The test byte is incremented with each new scan. An "\*" is printed on the screen every 256 scans. If an error is encountered, the test will halt and the address of the bad byte will be displayed. The test may be stopped at any time by pressing the ESCape key.

### [C]alibrate Vpp and Vps

Use this option to calibrate the DC-to-DC converter circuits. This calibration trims the gain of the DC-DC converters so that their outputs match the voltages called for by the microprocessor.

## DEVICE DRIVER PROGRAMS

The device driver is a necessary part of the software for programming any device. The LP120 firmware alone is not capable of programming anything. Device driver programs are transient programs loaded into the LP120's RAM. The first step in programming any device is to upload the device driver for that part. The

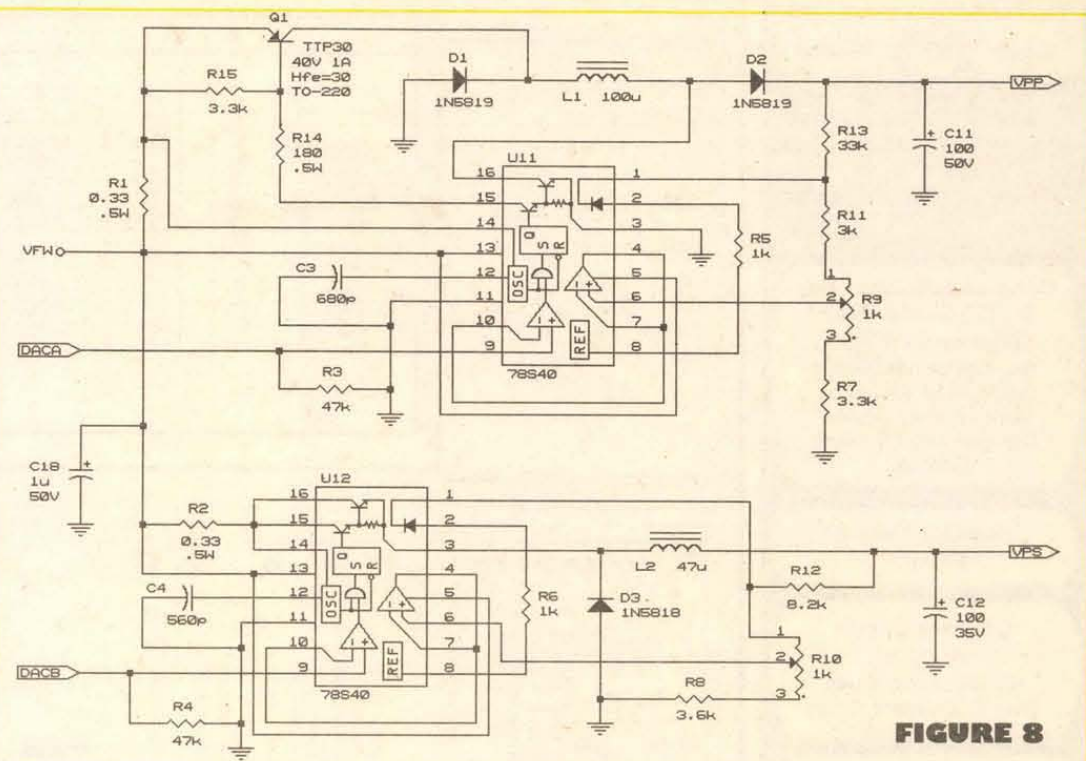


FIGURE 8

device driver will present its own menu, usually with another upload option for the data to be programmed into the device.

### Writing Device Drivers

I have written device drivers for

2716-27256 EPROMs, 68705P/R/U microcontrollers, 68701/U4 microcomputers, and PIC mid-range microcontrollers. All the device drivers are written in 6803 assembly language due to the limited memory resources. A freeware DOS cross-

assembler is available on the Lucid Technologies website. Writing the device drivers isn't really that hard and the assembly language Toolbox that comes with the LP120 handles many of the tedious details. In my experience, the hardest part is find-

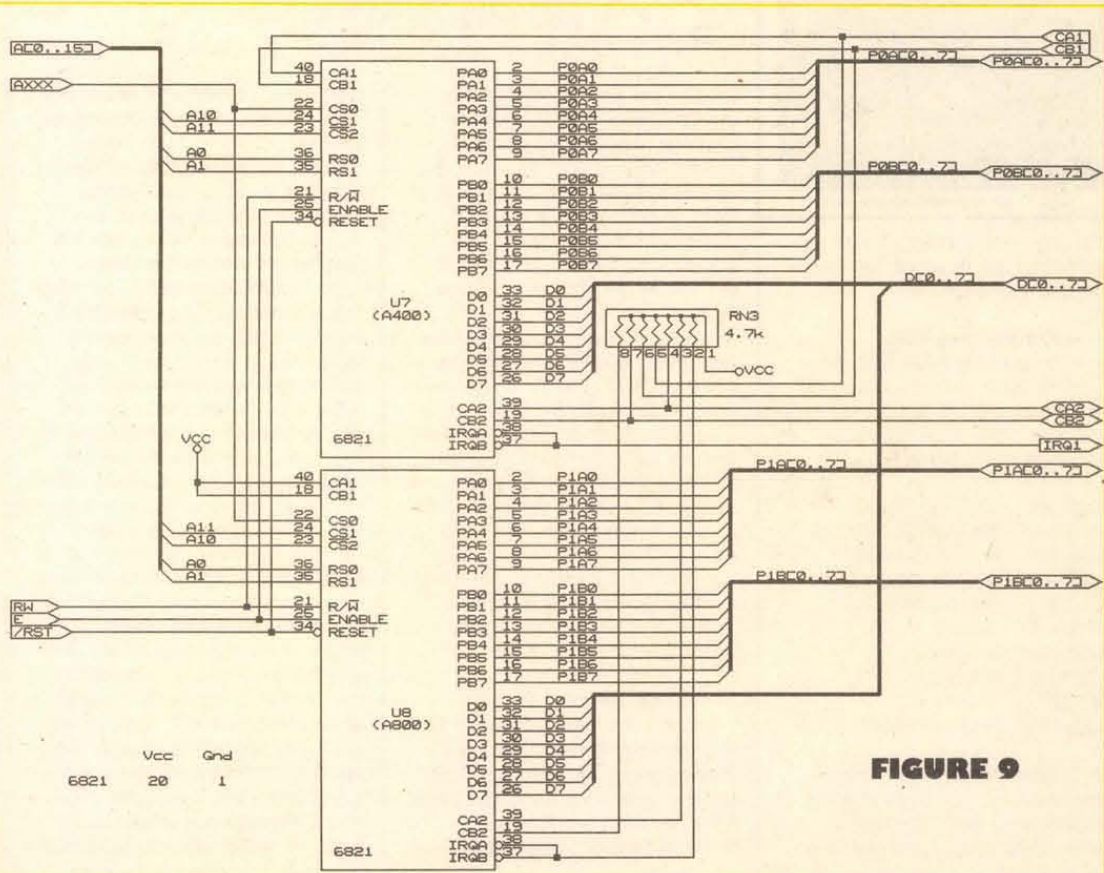


FIGURE 9



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ing, and understanding, the programming specifications from different chip manufacturers.

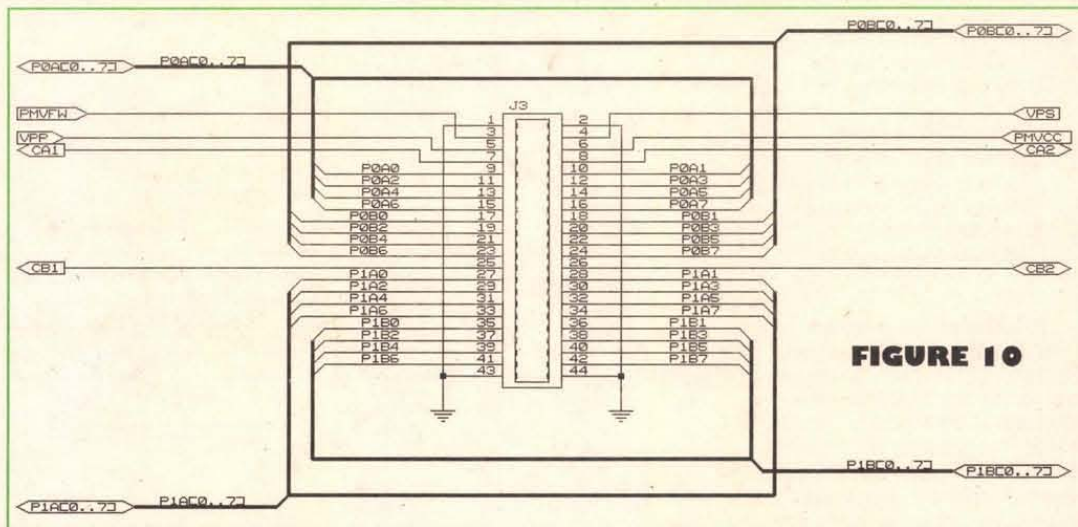
## LP120 Memory Map

The available RAM is of prime concern when writing a device driver. The memory map for the LP120 is shown in the table below. All addresses are in hexadecimal.

0000-001F	6803 Registers
0020-007F	External RAM, 62256
0080-00FF	Internal RAM, 6803
0100-7FFF	External RAM, 62256
8000-9FFF	External RAM, 6264
A000-A3FF	Unused
A400-A7FF	PIA Zero
A800-ABFF	PIA One
AC00-BFFF	Unused
C000-FFFF	External EPROM, 27128

Although not all of it is available, there are 40k bytes of RAM, from 0000 to 9FFF. The first 32 bytes, 0000 to 001F, are registers

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## DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM

Quan.	Reference	Part
<b>Semiconductors</b>		
2	D1,D2	1N5819, 40V Schottky diode
1	D3	1N5818, 30V Schottky diode
2	Q1,Q2	TIP30, TO-220, PNP
1	Q3	2N2907A, TO-18 or TO-92, PNP
1	Q4	2N3904, TO-92, NPN
1	U1	MC6803, microcomputer
1	U2	74HCT573, octal transparent latch
1	U3	62256, 32k x 8 CMOS RAM
1	U4	27128, 16k x 8 EPROM
1	U5	6264, 8k x 8 CMOS RAM
1	U6	PAL16R4, address decoder
2	U7,U8	6821, peripheral interface adapter
1	U9	74HCT393, dual 4-bit binary counter
1	U10	74HC14, hex inverter
2	U11,U12	78S40, switching regulator
1	U13	MAX232, RS-232 interface
1	U14	MAX522CPA, dual 8-bit DAC
1	U15	TL431ACL, TO-92, voltage reference
<b>Capacitors</b>		
2	C1,C2	20p disk
1	C3	680p
1	C4	560p
6	C5,C13-C17	0.1u disk
4	C6,C7,C8,C9	1u, 16V radial
1	C10	10u, 16V radial
1	C11	100u, 50V radial
1	C12	100u, 35V radial
1	C18	1u, 50V radial
<b>Resistors (0.25W, 5% unless noted otherwise)</b>		
2	R1,R2	0.33 ohm (or less), 0.5W
2	R3,R4	47k (yellow-violet-orange-gold)
2	R5,R6	1k (brown-black-red-gold)
2	R7,R15	3.3k (orange-orange-red-gold)
1	R8	3.6k (orange-blue-red-gold)

Quan.	Reference	Part
2	R9,R10	1k 3/4" trimmer
1	R11	3k (orange-black-red-gold)
1	R12	8.2k (gray-red-red-gold)
1	R13	33k (orange-orange-orange-gold)
3	R14,R24,R25	180, 0.5W (brown-gray-brown-gold)
3	R16,R17,R22	1.1k (brown-brown-red-gold)
1	R18	4.7k (yellow-violet-red-gold)
1	R19	390 (orange-white-black-gold)
1	R20	100k (brown-black-yellow-gold)
1	R21	820 (gray-red-black-gold)
1	R23	2.2k (red-red-red-gold)
3	RN1,RN2,RN3	4.7k, 8-pin SIP, pin 1 common
<b>Sockets</b>		
1	U14	8 pin
2	U9,U10	14 pin
3	U11,U12,U13	16 pin
2	U2,U6	20 pin
3	U3,U4,U5	28 pin
3	U1,U7,U8	40 pin
<b>Miscellaneous</b>		
1	J1	3 x 5mm terminal strip
1	J2	DB-9S, right angle, PC mount
1	J3	22/44 edge connector, 0.156" contact x 0.20" row spacing
1	JP1	Double row jumper header, 5 x 2
1	L1	100 uH coil
1	L2	47 uH coil
1	Y1	3.6864 MHz crystal, HC-18 or HC-49
1	JP1	Shorting jumper

The LP120 kit is available from **Lucid Technologies**, see the web site at [www.cs.net/lucid/](http://www.cs.net/lucid/). Send questions or comments to [lucid@cs.net](mailto:lucid@cs.net).

### LP120 PARTS LIST

assembly instructions are included with the kit. As with all kits, you should check the circuit board carefully before you start soldering. Hold the board up to a lamp so that the light shines through the board. This backlighting makes it easy to examine the traces on the near side. Look for breaks in the traces or shorts caused by incomplete etching of the copper. Pay particular attention to the areas where the traces run between the pins of the ICs. If you have any doubts, use an ohmmeter to double-check your visual inspection. Bridge any breaks and cut any shorts you find. Remember to check both sides of the board.

I recommend organic core solder rather than acid core. Organic flux can be cleaned with warm water unlike the strong solvents required for acid flux. I've seen too many projects that were never cleaned just because the acid flux was hard to get off.

Start by installing the sockets for the ICs, but don't plug the ICs into the sockets yet. Next, install the resistor networks noting the correct orientation of pin one. Continue by installing the discrete resistors, capacitors, crystal, inductors, and jumper pins. Be sure the electrolytic capacitors are properly polarized before soldering them in place. Now the transistors and diodes can be installed. Again, be sure they are

properly oriented before soldering any leads.

Before you solder the connectors (J1, J2, J3), give some thought to how you are going to mount the board. You can use standoffs as simple legs at each corner or you can get fancy and mount both the board and power supply in a nice chassis; it's entirely up to you. If you do use a closed chassis, you might want to run wires from the board to J2, J3, or both. This would allow you to mount the connectors on the chassis. Be sure to ground the chassis properly.

#### LP120 Checkout

With no ICs installed, attach the common lead of your ohmmeter to a convenient ground point. Check continuity at the ground pin of all the IC sockets. Next, attach ground and +5V (Vcc) to J1. Turn on the power supply and touch the positive probe of your voltmeter to the Vcc pin of all the IC sockets. The power pins for all ICs are shown on the schematics. If you don't read five volts at all these points, power down the circuit and carefully check all wiring, soldering, and component installation. Do not proceed until you have corrected the problem.

Measure the no-load voltage on Vfw at the power supply. Turn the power supply off and add Vfw, the third connection, to J1. Turn the

power supply back on and check for Vfw at the following points:

U11 - pins 5,13,14,15  
U12 - pins 5,13,14,15,16  
Q2 - emitter

If you don't read Vfw at all these points, power down the circuit and carefully check all wiring, soldering, and component installation. Do not proceed until you have corrected the problem.

Remove power and install all the ICs. Make certain each chip is in the correct socket, oriented properly, and has no pins folded under the IC. Attach +5V, Vfw, and ground to the designated positions on J1.

Further checkout requires communication between the host system and the LP120. Connect an RS-232 cable from the LP120 to your computer's serial port. Start your host's communications program and insure it is set for the correct COM port and baud rate. Confirm jumper JP1 on the LP120 is set for the same baud rate.

Turn on the power supply and observe your computer screen. If the characters on the screen are gibberish there is probably a baud rate mismatch. If nothing appears, there are several potential problems. Be sure your RS-232 cable is wired correctly for the LP120. If possible, check the operation of the host's serial port. Confirm the settings for the communications program are correct. Recheck all the voltages on the LP120, a shorted line may be pulling one of them down. Check the 6803 clock for correct operation, a 921.6 kHz TTL

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squarewave on U1 pin 40.

If one of the ICs on the LP120 is exceptionally hot, it may be installed backwards, have a shorted data line, or just be a bad chip. Remove all ICs and run board continuity checks for all the pins of the suspect IC. Be sure the pins connect to all of the points they should and nowhere else! If you have some way of testing the chip do so, and replace, if necessary.

If the initial screen is a legible menu, it should indicate a calibration option. Select the calibration option. Measure Vpp and Vps at the test points indicated on the LP120. Adjust Vpp to the voltage indicated on the screen with trimmer R9.

Adjust Vps to the voltage indicated on the screen with trimmer R10. Press ESCape when both voltages are correct. Turn power off, the LP120 is now ready for use.

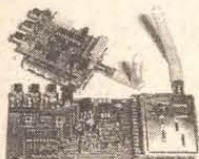
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**Table 1**

HELLO	LDX #MSG1	*load X immediate, address of message
	JSR MSGOUT	*send the message
	RTS	*return from subroutine
MSG1 FCC	'Hi there-world!	*form character data, message text
	FCB 0	*form byte data, end of message



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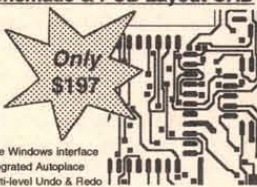
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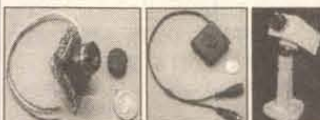
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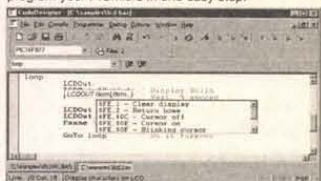
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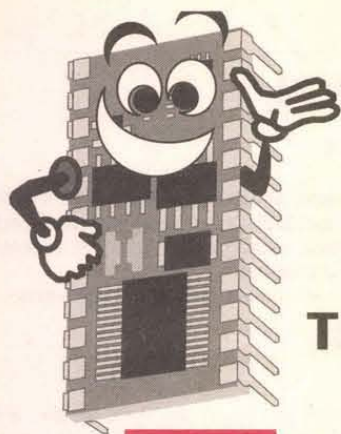
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by Jon Williams

# Stamp

## Applications

### THERE'S A NEW STAMP IN TOWN



**T**he BSP takes all the really good stuff of the BASIC Stamp IISX, makes it better, and adds some really great features. Here's an overview:

Wow, 2001 is just around the corner. The first time I saw the movie that made the year famous, 2001 seemed like it was an eternity away ... but here it is. Arthur C. Clarke is an incredibly bright man and yet, it seems he over-predicted the ability of computers in the year 2001. Or, perhaps, he under-predicted ... I guess it depends on one's point-of-view. No, we don't have HAL this year, what we have is the very well-mannered BASIC Stamp IISX+ (BSP).

- Parallel LCD routines for the Hitachi HD44780
- Dallas 1-Wire™ routines
- Philips I2C routines
- Firmware interrupts
- 24-pin (16 I/Os) and 40-pin (32 I/Os) versions
- Double the scratchpad RAM of the BS2-SX (now 127 bytes)
- 20% faster than the BS2-SX (about 12,000 instructions per second)
- Uses less power (about 30%) than the BS2-SX — operates near 40 mA

If you've used the BS2 or BS2-SX for any length of time, you'll recognize that this is a very cool list of features and goes a long way toward extending the Stamp's versatility. This month, we'll focus on LCD, 1-Wire™, and I2C routines since they bring us the most bang. Next month, we'll cover expanded I/O on the 40-pin version and the use of firmware interrupts.

You know me, I learn by doing and teach by having you do. Let's jump right in.

There is a commonality among the LCD, 1-Wire™, and I2C routines: they have an input/output structure that is identical to **SERIN** and **SEROUT**. And even though several Stamp programmers have been successful at implementing LCD (easy) and I2C (not so easy) routines, the code is often slow and bulky. Until the BSP, 1-Wire™ support was not possible without external support, and even then it was

difficult and clumsy.

#### LCD Support

The BSP has native support for the popular Hitachi HD44780 LCD controller. The routines that support LCD control are:

**LCDCMD** E-pin, command  
**LCDOUT** E-pin, command, [output data]  
**LCDIN** E-pin, location, [input data]

These routines require that the LCD be configured in four-bit mode and have specific requirements as to where the connections can be. The syntax of each statement (specifically the control pin for LCD.E) tells the BSP how the LCD is connected.

Connections:

LCD	Option 1	Option 2
LCD.E	BSP.0 or BSP.1	BSP.8 or BSP.9
LCD.R/W	BSP.2	BSP.10
LCD.RS	BSP.3	BSP.11
LCD.DB4	BSP.4	BSP.12
LCD.DB5	BSP.5	BSP.13
LCD.DB6	BSP.6	BSP.14
LCD.DB7	BSP.7	BSP.15

This table shows that the LCD can be connected to the pins at OutL (0-7) or the pins at OutH (8-15), and specific requirements as to where E, R/W, RS, and the data lines need to be connected. Keep in mind that you don't have to use the LCD's R/W line if you are not going to read from its RAM. In this case, you can simply ground the LCD.R/W pin and use the Stamp control pin for other duties. Note that the Parallax documentation suggests that the LCD.E line be pulled down to ground through a 4.7K resistor.

The first of the LCD commands is **LCDCMD** and is used to send a command control code to the LCD. This command will be used during initialization and for moving the cursor home, clearing the LCD, etc. Here's a few typical commands:

Clear the LCD	\$01
Move cursor home	\$02
Move cursor left	\$10
Move cursor right	\$14

There are others. Consult the program listings here and the Hitachi documentation for the HD44780.

Writing data to the LCD has been made very easy with **LCDOUT**. There are two nice things about this new command: you can send the LCD a command byte (i.e., clear the LCD) before the write, and the output data is structured just like **SEROUT**. This means you can use the typical **SEROUT** modifiers like BIN, DEC, STR, and REP.

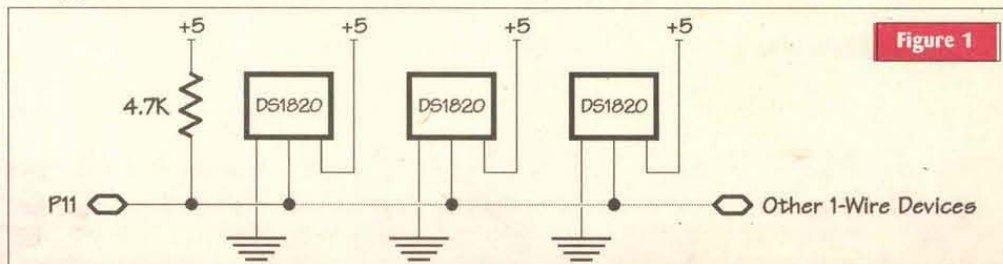


Figure 1



# STAMP APPLICATIONS

## THERE'S A NEW STAMP IN TOWN

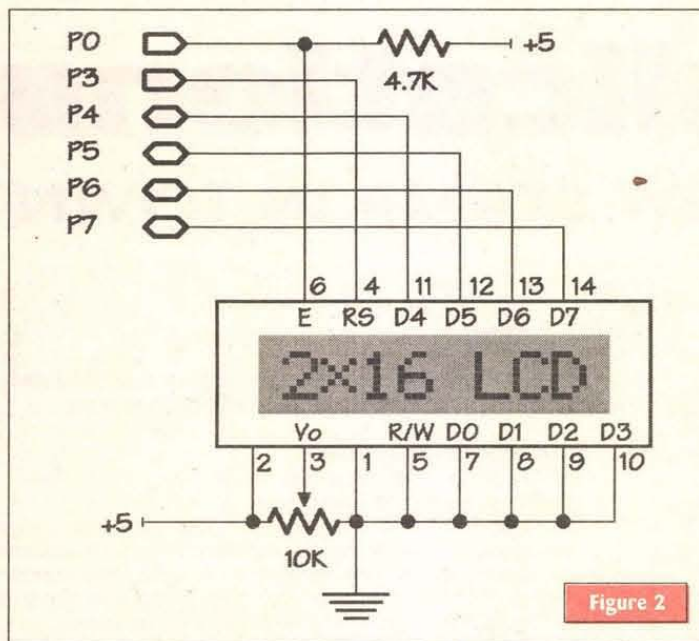


Figure 2

Reading information back from the LCD is just as easy with **LCDIN**. Its syntax is identical to **LCDOUT**. With **LCDIN**, the location byte needs to point to the starting memory location to read. The following constants are useful in programs that use the LCD commands:

DDRam	CON	\$80
CGRam	CON	\$40

DDRam is the memory that holds the characters being displayed. CGRam is the 64-byte memory area where custom character patterns are stored. If your program doesn't use this memory for custom characters, it can be used as off-board RAM with **LCDOUT** and **LCDIN**. The **STR** modifier can be used to transfer a block of bytes to or from the LCD.

### Dallas 1-Wire™ Support

The Dallas 1-Wire™ bus is a system which has a single bus master and one or more slaves. In this case, the BSP acts as the bus master. Each device on the 1-Wire™ bus has a unique serial number (used for addressing) that is manufactured right into the device.

1-Wire™ devices are supported with two easy-to-use commands:

**OWOUT** pin, reset, [output data]  
**OWIN** pin, reset, [input data]

Communication to 1-Wire™ devices can be on any available pin. This pin should be pulled up to Vdd (+5) through a 4.7K resistor. The reset parameter has four options:

- No reset or presence pulses
- Reset and presence pulses only before data initiation
- Reset and presence pulses only after data termination
- Reset and presence pulses before data initiation and after data termination

Resets shown are for byte input data running at regular speed. Add four for bit input data and add eight for overdrive speed. You should consult the Dallas 1-Wire™ documentation for specifics on the reset option.

### Philips I2C Support

The Philips I2C bus is a two-wire, bi-directional bus. The two lines are SDA (serial data) and SCL (serial clock). Like the 1-Wire™ line, the SDA and SCL lines must be pulled up to Vdd (+5) through 4.7K resistors.

I2C devices are supported with:

**I2COUT** pin, slave addr, word addr\extra byte, [output data]  
**I2CIN** pin, slave addr, word addr\extra byte, [input data]

The I2C devices can only be connected to group pins 0 & 1 or 8 & 9.

I2C Bus	Option 1	Option 2
SDA	BSP.0	BSP.8
SCL	BSP.1	BSP.9

Listing 1  
 Nuts & Volts - December 2000

```

' -----[ Title ]-----
'
' File..... DS1820.BSP
' Purpose... BASIC Stamp SX Plus <--> DS1820 Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 04 NOV 2000
' Updated... 04 NOV 2000
'
' -----[ Program Description ]-----
'
' This program reads and displays the ROM code and temperature data from
' a DS1820 (1-wire) sensor.
'
' Program requires 2x16 LCD
' - LCD.E --> Pin0 (pulled down [to ground] through 4.7K)
' - LCD.R/W --> Pin2 (or grounded for write-only operation)
' - LCD.RS --> Pin3
' - LCD.D4 --> Pin4
' - LCD.D5 --> Pin5
' - LCD.D6 --> Pin6
' - LCD.D7 --> Pin7
  
```

-----[ Revision History ]-----

```

' -----[ I/O Definitions ]-----
'
LCDpin      CON    0
DS1820pin   CON    11
  
```

-----[ Constants ]-----

' LCD control characters

NoCmd	CON	\$00	' just print
ClrLCD	CON	\$01	' clear the LCD
CrsrHm	CON	\$02	' cursor home
CrsrLf	CON	\$10	' cursor left
CrsrRt	CON	\$14	' move cursor right
Displf	CON	\$18	' shift display left
Disprt	CON	\$1C	' shift displayright
DDRam	CON	\$80	' Display Data RAM control
Line1	CON	\$80	' address of line 1
Line2	CON	\$C0	' address of line 2
DegSym	CON	223	' degrees symbol

' DS1820 control

ReadROM	CON	\$33	' read ID, serial num, CRC
MatchROMCON	CON	\$55	' look for specific device
SkipROM	CON	\$CC	' skip rom (one device)
ConvertTemp	CON	\$44	' do temperature conversion
ReadScratch	CON	\$BE	' read DS1820 scratchpad

-----[ Variables ]-----

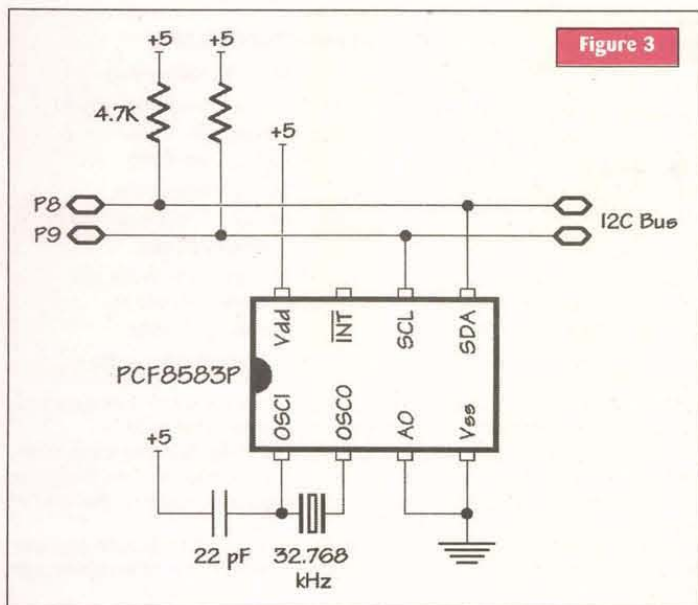
idx	VAR	Byte	' loop counter
romData	VAR	Byte(8)	' ROM data from DS1820
tempIn	VAR	Word	' raw temperature
sign	VAR	tempIn.Bit8	' 1 = negative temperature
tInLow	VAR	tempIn.LowByte	
tInHigh	VAR	tempIn.HighByte	
tSign	VAR	Bit	
tempC	VAR	Word	' Celsius
tempF	VAR	Word	' Fahrenheit

Listing 1



# STAMP APPLICATIONS

## THERE'S A NEW STAMP IN TOWN



The pin parameter of each command specifies the SDA pin. The slave addr is the I2C device to connect with. The word addr is the location the I2C device writes to or reads from. The use of the backslash allows two-byte addressing for those devices that support it.

### Demo Programs

Okay, enough chit-chat ... let's write a few programs that demonstrate these new features.

Listing 1 (DS1820.BSP) is a program that reads and displays the temperature from a single Dallas DS1820 1-Wire™ thermometer (do not run this program with more than one device on the 1-Wire™ bus). The output of the DS1820 is the same as the DS1620. The current temperature is returned in half-degrees Celsius. Negative numbers are returned in two's complement format.

```

' -----[ EEPROM Data ]-----
'
' -----[ Initialization ]-----
'
LCD_Setup:
  LCDCMD LCDpin,%00110000 : PAUSE 5      ' 8-bit mode
  LCDCMD LCDpin,%00110000 : PAUSE 0
  LCDCMD LCDpin,%00110000 : PAUSE 0
  LCDCMD LCDpin,%00100000 : PAUSE 0      ' 4-bit mode
  LCDCMD LCDpin,%00100000 : PAUSE 0      ' 2-line mode
  LCDCMD LCDpin,%00101000 : PAUSE 0      ' no crsr, no blink
  LCDCMD LCDpin,%00001100 : PAUSE 0      ' inc crsr, no disp
  LCDCMD LCDpin,%00000110
shift

' -----[ Main Code ]-----
'
Main:
  LCDOUT LCDpin,CtrlLCD,["BSP <----> DS1820"] ' splash screen
  PAUSE 2000

DisplayROM:
  LCDOUT LCDpin,CtrlLCD,["DS1820 ROM:"]
  OWOUT DS1820pin,1,[ReadROM]              ' send Read ROM command
  OWIN DS1820pin,2,[STR romData\8]         ' read serial number &
CRC
  LCDCMD LCDpin,Line2
  FOR idx = 0 TO 7
    LCDOUT LCDpin,NoCmd,[HEX2 romData[idx]] ' show ID, serial num,
CRC
  NEXT
  PAUSE 5000
  
```

After defining I/O pins, constants, and variables used in the program, we initialize the LCD. The Hitachi guidelines for a four-bit interface are followed. What you'll notice is a **PAUSE 0** between each of the **LCDCMD** statements. This small delay is necessary because of the increased speed of the BSP.

With the LCD initialized, a splash screen is displayed with **LCDOUT**. Notice how easy this command is to use, with the **CtrlLCD** command embedded in the same statement. This is a far cry easier than the old days of using **LOOKUP** or loops to read strings from **DATA** statements.

The first active process in the program is reading back the ROM code from the DS1820. We'll need this information later if we want to individually address the DS1820. Each DS1820 contains a 64-bit (eight bytes) ROM code. The first eight bits are the 1-Wire™ family code (\$10 for the DS1820), the next 48 bits are a unique serial number. The final eight bits are the CRC of the first 58 bits.

Using **OWOUT**, the ReadROM command is issued to the DS1820. The next line of code uses **OWIN** to retrieve the data from the DS1820. The **STR** modifier and **\8** specification make it very easy to read all eight ROM bytes into the array called **romData**. With the ROM data in memory, we use a loop and the **HEX2** modifier to display the data as hex bytes on line 2 of the LCD. Be sure to write down this code so you can use it later.

Finally, we get to read the temperature. The DS1820 is a bit easier to use than its cousin, the DS1620, in that we only have to tell it to take a temperature reading; there are no other configuration requirements. In this program, we've only placed one device on the 1-Wire™ bus so we don't need to match ROM contents. This is accomplished by issuing the **SkipROM** command, followed by the **ConvertTemp** command (done in one statement).

The DS1820 needs about half a second to take a reading. After the **PAUSE 500**, the temperature reading is retrieved by sending the **ReadScratch** (after **SkipROM**, of course) command. Since we're only interested in the temperature, we'll just grab the first two bytes. There is more information available, including data that will allow higher resolution temperature readings. I'll leave that experimenting to you.

Once we have the raw temperature reading, we drop the half-degree bit and convert to Fahrenheit, as well. A couple of **LCDCMD** commands using **SDEC** (signed decimal — allows negative numbers) displays the temperature neatly. Easy, huh? Yep, I like this new Stamp.

If you've got more than one DS1820, you can enter (or download) Listing 2 (DS1820-x.BSP) and cycle through all of them. Before you do

```

TempDemo:
  LCDOUT LCDpin,CtrlLCD,["CURRENT TEMP:"]

ShowTemp:
  ' * send conversion command
  ' * allow time for conversion
  ' * send read scratch ram command
  ' * grab the data

  OWOUT DS1820pin,1,[SkipROM,ConvertTemp] ' start conversion
  PAUSE 500                                ' give time for conversion
  OWOUT DS1820pin,1,[SkipROM,ReadScratch]
  OWIN DS1820pin,2,[tInLow,tInHigh]        ' read temperature

  tSign = sign                             ' save sign bit
  tempIn = tempIn/2                         ' round to whole degrees
  IF tSign = 0 THEN NoNeg1
  tempIn = tempIn | $FF00                  ' extend sign bits for negs

NoNeg1:
  tempC = tempIn                           ' save Celsius value
  tempIn = tempIn * / $010C                ' multiply by 1.8
  IF tSign = 0 THEN NoNeg2
  tempIn = tempIn | $FF00                  ' if neg, extend sign bits

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

  ' display temps
  '
  LCDOUT LCDpin,Line2,[SDEC tempC, DegSym, " C"]
  LCDOUT LCDpin,NoCmd,[" / ", SDEC tempF, DegSym, " F"]
  LCDOUT LCDpin,NoCmd,[REP " "\6]

  PAUSE 1500
  GOTO ShowTemp
  ' update temp display
  
```



# STAMP APPLICATIONS

## THERE'S A NEW STAMP IN TOWN

that though, make sure you plug each of them into your circuit and record the ROM data using Listing 1. You'll need this information for the program to work. In fact, the program in Listing 2 will only work with my three DS1820s. You'll need to update the **DATA** statements for your sensors.

The bulk of the program is the same as Listing 1. It differs in reading the temperature data from a specific device. Take a look at the subroutine called **GetTemp**. The address of the first byte of the ROM code is passed in the variable **eeAddr**. A simple loop reads the ROM code bytes from EEPROM and stores it in the array called **romData**.

In this program, the **MatchROM** command is issued, followed by the **romData** string. The **ReadScratch** command is issued in the same manner and the subsequent **OWIN** retrieves the temperature from the specified device.

Keep in mind that different types of devices can exist on this single-wire network. The I/O and expansion options are nearly limitless. Take a look at the Dallas Semiconductor ([www.dalsemi.com](http://www.dalsemi.com)) website for 1-Wire™ devices as new ones are being introduced almost every day.

The final listing, **PCF8583.BSP** listing 3, demonstrates the BSP's I2C routines by connecting to a real-time clock with RAM. In fact, the **PCF8583** is built around a 256-byte RAM and several of the registers are automatically updated.

The **PCF8583** typically uses a 32.768 kHz crystal, but it can be driven by a 50 Hz signal, as well (not very useful here in the US, but still an option). This chip can also be configured as an event counter and features an alarm output pin that can save us the trouble of polling and comparing data.

My middle name is "Simple" (okay, not really, but play along), so that's just how we're going to deal with this program. By letting the device power-up on its own, the time is set to midnight, 24-hour mode, and it expects to be driven by a crystal. We'll use a four-button interface to set the minutes, hours, and day-of-week. The fourth button allows us to decrement these values.

After defining I/O pins, constants, variables, and initializing the LCD, the program displays a short splash screen and then enters the main loop. The loop process is simple: we read the clock and data, update the LCD, then scan the buttons. If a button is pressed, the clock is updated and the loop continues.

Since the **PCF8583** is register-oriented, we can read and write locations individually or in blocks. The subroutine called **GetTimeAndDay** retrieves seven bytes from the **PCF8583**, beginning at address 0. These bytes contain the control, time, and date registers. Most **PCF8583** registers hold their data in BCD format, so we use the **HighNib** and **LowNib** variable modifiers to convert to standard decimal for our program variables. The day-of-week value is stored in the highest three bits of the register that holds the current month. The right shift operator (**>>**) lets us

move this value into the variable called **day**.

Our main time variable is called **rawTime**. This word-sized variable holds the time in minutes past midnight. When updating the clock, we'll actually update **rawTime**, then pass it to the routine that takes care of sending data to the **PCF8583**.

The name of the current day is sent to Line 1 of the LCD with the subroutine **PrintDay**. The day variable is used by a **LOOKUP** table to get the EE address of the zero-terminated string. This technique is nice because you can update your strings without modifying operational code.

The program loops through the BSP's EEPROM, reading each character in the current day name until a zero is encountered. Zero flags the end of the string. Since some strings are longer than others, the end is cleaned up by printing a few spaces.

Printing the time on the LCD is even easier with **LCDOUT** and the **DEC2** modifier. One line of code prints the current time on the right edge of Line 2.

The buttons are scanned and debounced with a loop. The idea behind this code is that a button must start pressed and stay pressed through the entire loop for it to be a valid (debounced) button press. The state of the buttons is returned in a nibble with each bit aliased so we can use it to make the update.

Again, the variable **rawTime** is our master time variable and any updates will be performed on it. This variable holds minutes. When the minutes button is pressed, one is added. When the hours button is pressed, 60 is added. The program uses a trick with the modulus operator (**/**) to keep **rawTime** in the range of 0 to 1439. Using the modulus operator means that we can subtract from **rawTime** by adding (1439 for one minute, 1380 for 60 minutes) and then doing the modulus operation. The day value is handled in the same manner.

The subroutine called **PutRawClock** takes **rawTime** and converts it to the proper BCD format used by the **PCF8583**. The new data is sent to the **PCF8583** with **I2COUT**.

I don't know about you, but I'm really excited about the BASIC Stamp SX1+. More functionality, faster, consumes less current ... it's a winner.

Next month, we'll talk about the firmware interrupts and additional I/O support on the 40-pin version of the chip. Until then, Happy Stamping. **NV**

### Resources:

**Jon Williams**

3718 Valley View Lane, #3040

Irving, TX 75062

(972) 659-9090

[jonwms@aol.com](mailto:jonwms@aol.com)

**Parallax**

599 Menlo Drive, Suite 100

Rocklin, CA 95756

(888) 512-1024

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

**Weeder Technologies**



**RS-232 Stackable**

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

Data Book Available

850-863-5723

**Digital I/O Module** - 14 I/O pins individually configured for input or output. Turn on/off relays. Sense switch transitions, button presses, 4x4 matrix decoding using auto-debounce and repeat. One-shot pulse output with user programmable length. \$49

**Analog Input Module** - 8 input pins. 12-bit plus sign self-calibrating ADC reads voltages from 0 to 4095 mV using 1 mV resolution. Supports single-ended, differential, or pseudo-differential modes. Software programmable alarm trip-points for each input. \$59

**Stepper Motor Driver** - Drives a unipolar stepper motor rated up to 25VDC @ 2A. Uses automatic self-generated parabolic acceleration/deceleration curves for smooth start and stop motion. Software programmable ramp-rate and speed. 24-bit absolute motor position counter. Limit-switch input. \$59

**Pulse Counter/Timer** - Read frequency from 0.50000 to 1,500.00 Hz using floating decimal point and 5-digit resolution throughout range. Measure period, RPM, duty cycle, pulse length, velocity of a projectile using a pair of trip wires. Accumulate pulse count. \$69

**Multi-Drop Peripheral Interface** Plug a third-party RS-232 peripheral into the multi-drop bus. Appended header character allows PC to exclusively communicate with each of up to 32 devices. Supports peripheral baud rates of 75, 150, 300, 600, 1200, 1800, 2400 and 9600. Built-in 122-byte FIFO RAM buffer. \$59

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# OZTRIP CAR COMPUTER

**T**he OzTrip Car Computer can be used to display trip information on 27 functions of speed, fuel, time, and distance of a vehicle. These 27 functions are updated every one-second and can be displayed in three quantity display modes effectively giving 81 display functions!

The OzTrip Computer also contains a sprint timer, which is accurate to 1/10th of a second over any distance. This sprint timer is ideal for timing a standing quarter mile (400m).

The computer can be used as a rally computer or even a boat computer. It has diagnostic functions, an optional serial data interface for telemetry and control, and there is even PC software available for virtual dashboard data logging. It could even be used as a general-purpose data logger not even related to vehicles.

Details of all the functions of the OzTrip Computer are listed in Table 1. Each of the 27 display functions has three readings: Metric, US, and Imperial. One US gallon (3.785L) = 0.833 Imperial gallons (4.546L); one mile = 1.604 km.

Every time a new function is selected, a brief message is shown on the display indicating the function number selected. An eight-LED display is used to indicate the information on the display.

Physically the computer measures 140x110x36mm and contains two small printed circuit boards (PCBs), which mount back to back, connected by wire links and resistors. If a fuel flow sensor or data logging features are required, then a third PCB is used to provide these features.

On the front of the computer, a screen-printed, red acrylic panel is used giving the unit a professional look, hiding all LEDs and LED display underneath until they are lit. The four push buttons used to select the various functions emerge through the front panel.

The OzTrip Computer supports two methods of fuel measurement: electronic fuel injection (EFI) by measuring the pulse width of the injector or by using a fuel flow sensor.

## Block Diagram

Despite the OzTrip Computer's versatility, the computer contains relatively few components, all of the hard work being performed by a Motorola 68HC705C8 microcontroller. This 40-pin, one-time programmable chip is perfect for this application. It has 4 x 8-bit I/O ports, 384 bytes of RAM,

8K EPROM, 16 bit internal timer, serial port, interrupt pin, and a timer input capture pin. Just about every resource of the controller is used in this application.

We will not attempt to describe the internal workings of the software; it is very complex and coded in assembly. Suffice it to say it manages the data presented to it and presents it in an understandable form. Just about every byte of EPROM space is used to achieve this. Perhaps the best way to understand the circuit operation is to refer to the block diagram in Figure 1.

On the left are the inputs to the microcontroller, the distance input, and the fuel input. The microcontroller counts the number of pulses per second from the distance input to derive speed and measures the injector open time to calculate fuel used.

If a fuel flow sensor is used, then the microcontroller simply counts the number of pulses received from the sensor in one second to calculate the fuel used. It is this raw data that the microcontroller uses to give you the various output functions on the right.

The tone generator with its piezo buzzer is used to acknowledge key-board inputs and also warn you that you are traveling faster than your preset speed, among other things.

The 8x status LEDs and 4x seven-segment LED displays provide the user with information in an understandable form.

The four-button keypad is used to select the various functions of the OzTrip Computer and enter numerical values when required.

The optional serial interface (bottom left) is used if you really want to get serious and input and/or extract data from the computer. A typical application here would be a laptop computer, which could be linked by a radio data link or mobile phone. The data rate is 9600 baud.

There is also a five-volt power supply for the controller and most of the circuitry, and a variable supply for the display. The display can be dimmed for night-time driving by making a connection to the

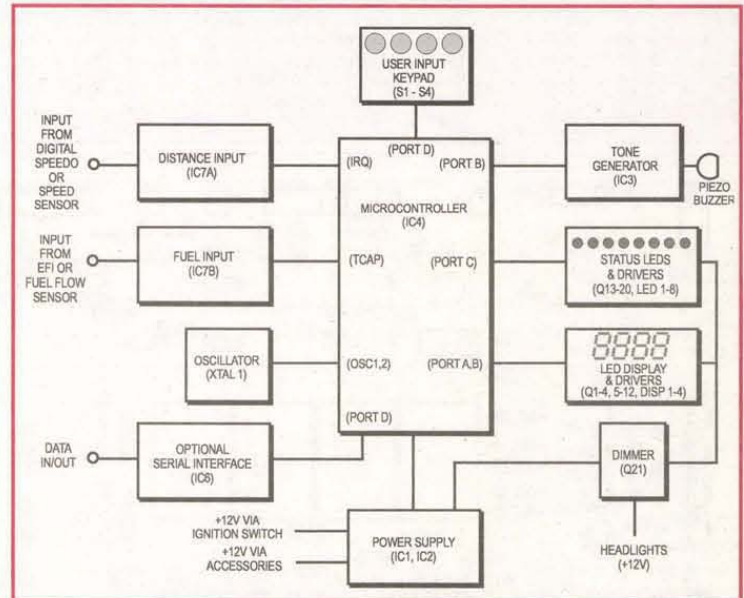
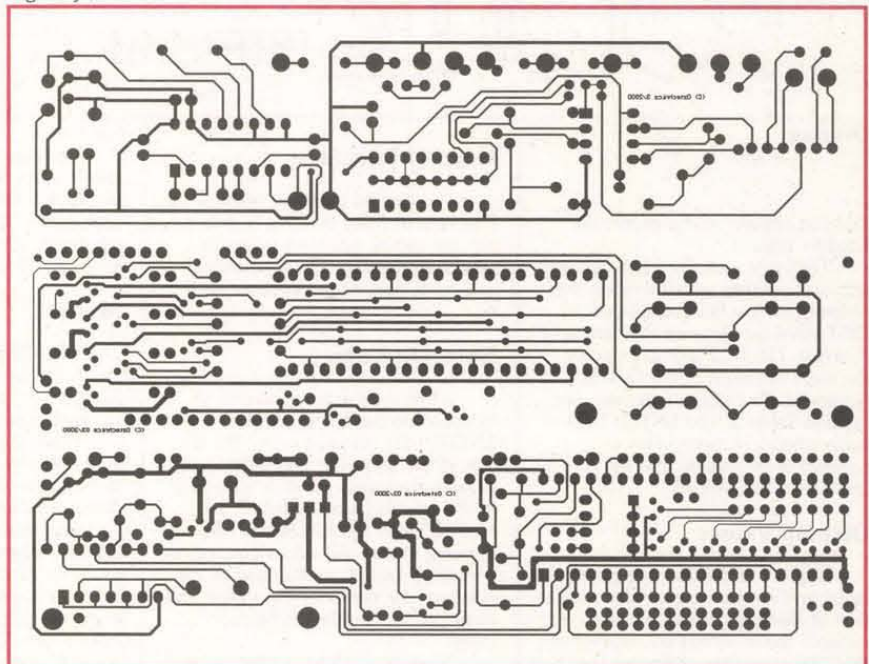


Figure 1 — Despite its versatility, the OzTrip can be broken down into just a few elements.



headlights.

## Display Interface

The display consists of four multiplexed 0.56" seven-segment displays

and eight indicator LEDs. The seven-segment displays are used to display messages and values. The messages

Bot Layer



Metric	US	Imperial	Display
F1	F28	F55	Current Speed
F2	F29	F56	Average Speed
F3	F30	F57	Peak Speed
F4	F31	F58	RPM (only works in EFI Mode)
F5	F32	F59	Trip 1 Up Counter (Journey Counter)
F6	F33	F60	Trip 1 Down Counter
F7	F34	F61	Trip 2 Up Counter
F8	F35	F62	Trip 3 Up Counter
F9	F36	F63	Distance to Empty based on average fuel consumption (Trip1)
F10	F37	F64	Distance to Empty based on current fuel consumption
F11	F38	F65	Fuel Used during Trip1 (Journey)
F12	F39	F66	Fuel Remaining in Tank
F13	F40	F67	Average Fuel Consumption (Km/L, m/g) (Trip1)
F14	F41	F68	Current Fuel Consumption (Km/L, m/g)
F15	F42	F69	Average Fuel Consumption (L/Km, g/m) (Trip1)
F16	F43	F70	Current Fuel Consumption (L/Km, g/m)
F17	F44	F71	Fuel Flow Rate per hour
F18	F45	F72	Fuel Trip1 (Journey) Cost
F19	F46	F73	Fuel Total Cost
F20	F47	F74	Elapsed Time of Trip1 (Journey)
F21	F48	F75	Time Remaining at Average Speed to end of Journey (Trip1)
F22	F49	F76	Time Remaining at Current Speed to end of Journey
F23	F50	F77	Elapsed Time of Trip 2
F24	F51	F78	Elapsed Time of Trip 3
F25	F52	F79	Total Elapsed Time of Engine
F26	F53	F80	Total Fuel Used by Engine
F27	F54	F81	Total Distance Travelled

**Table 1.  
Computer  
Functions.**

7 Segment Display	Description
Rst	Reset Computer
EFI	Electronic Fuel Injection Mode
CAL	Calibrate
Done	Done / complete
Err	Error
Trip	Trip
Fuel	Fuel
CoSt	Fuel Cost
Flo	Flow Sensor Mode
Hold	Freezes Counters
DiAg	Diagnostics
USED	Used
Tach	Tacho
Clr	Clear
In	Fuel Entered Into Tank

**Table 2. Display  
Messages: Here's  
how to decode  
the various LED  
messages.**

FUEL	NOW
DIST	AVG
TIME	REM
SPEED	ENTER

**Table 3. LED  
Functions: The  
eight indicator  
LEDs are split  
into two columns.**

key sequence, a "CAL" message is briefly displayed, then the ENTER LED lights. You must enter a value between 1-7 into the computer to select the appropriate calibration

function. The calibration functions are listed in Table 9.

function. The calibration functions are listed in Table 9.

## Speed Alarm

The speed alarm can be set and cleared when the speed is displayed, i.e., Functions 1, 28, or 55. Pressing the Set/Clear key when the speed is above 40Km/h will set the speed alarm. When this speed is exceeded by 5 Km/hr, the speed alarm is sounded at one second intervals for 500mS and the computer display switches to the Speed Display, Function 1. To disable the speed alarm, press the Set/Clear key when the speed is below 40Km/h.

## Sprint Timer

The sprint timer is used to time the acceleration of the vehicle over any set distance, typically 400m (1/4 mile). When this option is selected from the Cal Menu Option 7, the computer asks for the "Dist" — distance to be timed over — and then a nine-second countdown starts. When the countdown reaches 0000, a BEEP is heard and the timer starts. When the vehicle travels the entered distance, the timer is frozen displaying the time duration down to 1/10th of a second. Press the Mode/Enter key to return to normal operation.

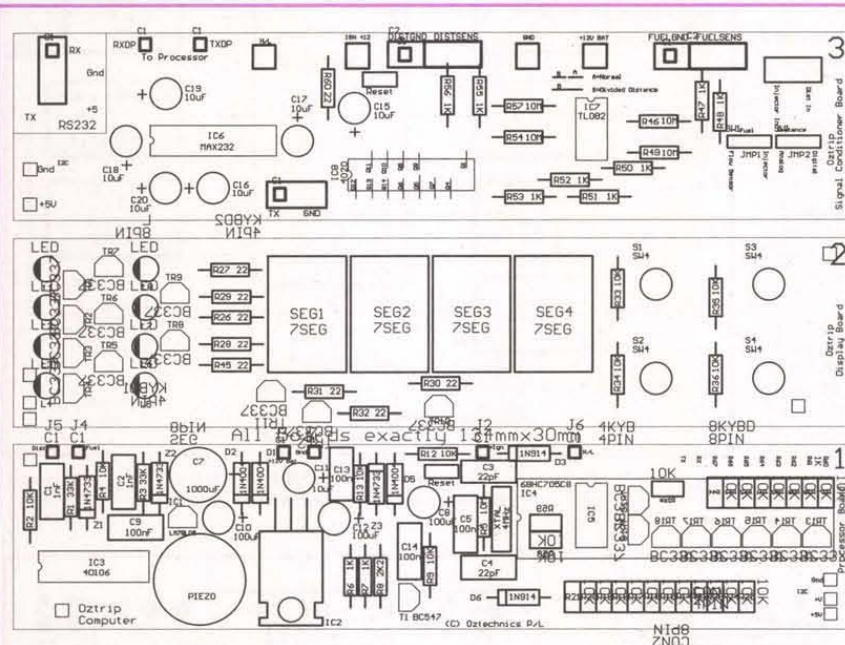
## Journey Counter

The journey counter is the main distance/tour counter and is represented by the Trip 1 Counter, F5 (distance) and F20 (time). The functions which are derived from the journey counter are F2, F9, F11, F13, F15, F18, and F21. When the computer is RESET using the Mode/Enter + Set/Clear combinations, the Distance Traveled on the Trip1 counter is copied to the Distance Remaining Function (F6) and the Trip1 counters are cleared ready for a new journey.

If the same trip is being traveled, then the distance remaining in F6 is already set, otherwise it will have to be entered for correct operation. If the distance remaining of journey is not entered or is incorrect, then the distance remaining of journey (F6) and time remaining at current/average speed to complete journey (F23/F24) will be incorrect.

## EFI Operation

The OzTrip Computer measures



## Overlay

that can appear on the display are listed in Table 2.

The eight indicator LEDs are split into two columns which indicate the current function being displayed, i.e., DIST REM for Distance Remaining of Journey. The LED indicators cover the main functions of the OzTrip Computer. The LED's indicators are listed in Table 3. The ENTER LED lights when a numeric value is required to be entered into the computer from the keypad.

## Display Values

The computer has four physical digits and a maximum display resolution of six digits. When a value exceeds the four-digit physical resolution, the computer alternates the display between the last four least significant digits and the first two most significant digits on a 5:1 second ratio.

The ranges that can be displayed are listed in Table 4.

## Keypad Interface

The keypad interface consists of four keys as listed in Table 5. Some actions require two keys to be simultaneously pressed. The key functions and combinations are listed in Table 6.

## Entering Values

When a value is required to be entered into the computer, the ENTER LED illuminates and the display clears to 0. The computer accepts the values entered according to the function range selected, i.e., F1-F27 metric, F28-F54 US, F55-81 Imperial format. All values entered are converted back to metric, and all calculations are performed in metric and displayed in the selected function range.

To enter a value, use the "+" and "-" keys to select the value of the digit, the Set/Clear key to lock the current digit in and scroll the display to the left for a new digit, and the Mode/Enter key to insert a decimal place. The second time the

function.

The computer can accept input values up to 999.99, even though the first digit scrolls off the display. For example, to enter "19.1" into the computer, you would use the sequence of keys shown in Table 7.

## Menus

In addition to the 27 functions which can be selected, two-sub menus are available for diagnostic and calibration functions.

When the diagnostic menu is accessed with the UP + Set/Clear key sequence, a "diAg" message is briefly displayed, then the ENTER LED lights. You must enter a value between 1-5 into the computer to select the appropriate diagnostic function.

When a menu is accessed, the computer stops some of its periodic calculations. On exiting the menu, some functions may display an incorrect value until the next calculation is performed. Calculations are performed every one-second. The diagnostic functions are listed in Table 8.

When the calibration menu is accessed with the Down + Set/Clear



F1, F2, F3	0 → 999 km/hr
F4	0 → 9999 RPM
F5, F6, F7, F8	00.00 → 4294 Km
F18, F19	00.00 → \$9999
F20, F23, F24	00.00 min/sec → 99.59.59 hrs/min/sec
F25	0 → 999,999 hours
F26	0 → 42,949 litres
F27	0 → 294,967 Km

**Table 4. Display Values: The range of values displayed for the various functions.**

the fuel flow of an EFI engine by measuring the time one injector is open.

At different RPMs and under different engine loads, the time the injector is open is varied by the EMC for maximum operating efficiency.

The main components of the EFI engine fuel delivery system include the fuel pump, pressure regulator, fuel rail, and fuel injector valve.

The pressure in the fuel rail — which feeds the injectors — is kept at a constant by the pressure regulator. Because the pressure is kept at a constant, the fuel flow through each injector on average is the same, so we only need to measure one injector to determine the total fuel flow.

In other words, the fuel flow is directly proportional to the injector open time, and by measuring the injector open time, we can calculate the fuel consumption.

Before we can determine fuel flow, the computer needs to be calibrated so it can relate fuel consumption to injector open time. This is achieved by measuring the total injector open time over a full tank of fuel, then entering the total fuel used during the calibration process into the computer. The OzTrip Computer has a special calibration mode which makes this easy to do. Calibration can be performed over several days, if required. The greater the volume of fuel used during calibration, the more accurate the calibration process is.

This method of fuel measurement is only suitable for EFI engines with one injector per cylinder and constant fuel rail regulation.

The fuel calibration number for a V6, 4.0L engine is around 440. The calibration number is proportional to the fuel burn rate, i.e., increasing the calibration number will show more fuel used.

## EFI Calibration

To calibrate the computer for EFI operation:

1. Fill the fuel tank to full.
2. Ensure the "EFI" Mode is selected (Cal Menu Option 7).

Select the Fuel Calibrate Mode from the Cal Menu Option 3 to start calibration. During calibration the message "Fuel," "CAL," "EFI," "value" will be displayed. The "value" represents the total pulse width time. This value must not exceed "4294." Drive the vehicle for as many trips as required until 80-99% of the fuel tank is used or the value approaches "4294." If you exceed the value of "4294," then an error message will be displayed and you will have to start calibration again.

When the value reaches "3500," the computer will beep to indicate that it is approaching the end of its calibration range. When calibration is complete, fill the tank and note how

+ Mode / Enter  
- Set / Clear

**Table 5. Keypad Arrangement.**

much fuel was used. Press the Mode/Enter key and then the computer will ask you to enter the Fuel Used. Calibration complete!

It is a good idea to take a note of the fuel calibration number using Cal Menu Option 4. If the computer loses its settings, you can manually input the calibration number without having to re-calibrate the computer.

## Fuel Flow Sensor Calibration

To calibrate the computer for Flow Sensor operation, ensure the "FLO" Mode is selected (Cal Menu Option 7). Select the Fuel Calibrate Mode from the Cal Menu Option 3. Enter the flow sensor calibration factor as number of pulses per 0.1L of fuel used. The sensor used by Oztechnics has a fuel calibration factor of 780. Calibration is now complete.

## Speed Sensor

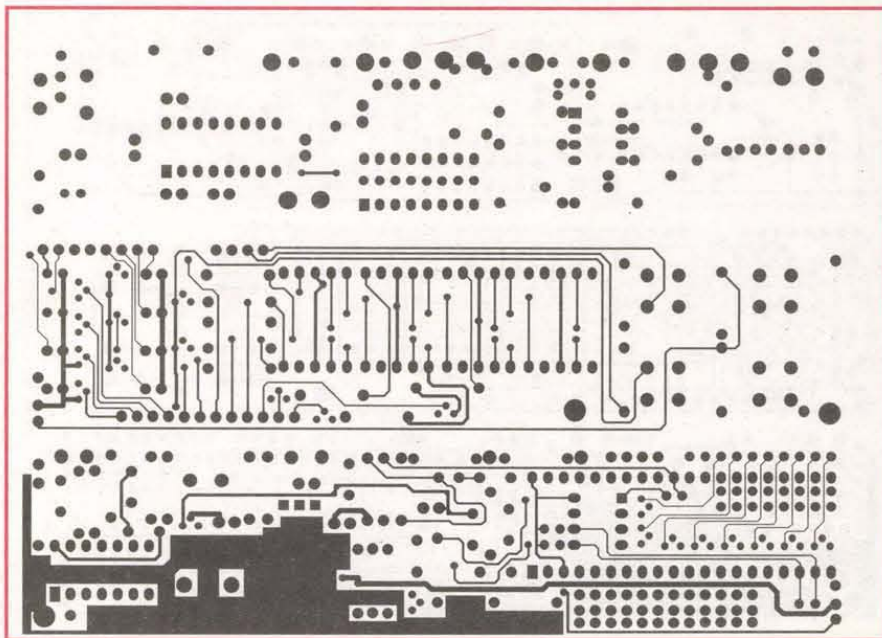
The OzTrip Computer requires a digital (TTL) input from a speed sensor. Most new cars have an electronic speedo fitting, which produces a TTL type signal. If your car has such a speedo, connect the distance input of the computer to the electronic speedo sensor. Most speed sensors typically produce eight pulses per wheel revolution. The computer can operate from 1 to 20 pulses per wheel revolution. Eight pulses per wheel revolution is the optimum number of pulses for the computer.

Speed sensors are available in several types including inductive pick-up (analog output), Hall-Effect (digital output), Proximity switch (digital output), and Speedo Sensor Cable type (both analog and digital outputs).

## Speed Calibration

Speed sensor calibration can be achieved in two ways:

1. By using the Cal Menu Option 1, automatic calibration mode. This requires you to drive a known distance while the computer counts the pulses from the speed sensor. During calibration, the computer displays the message "DiSt," "CAL," "value," where "value" represents the number of pulses received from the speed sensor. Once a known distance

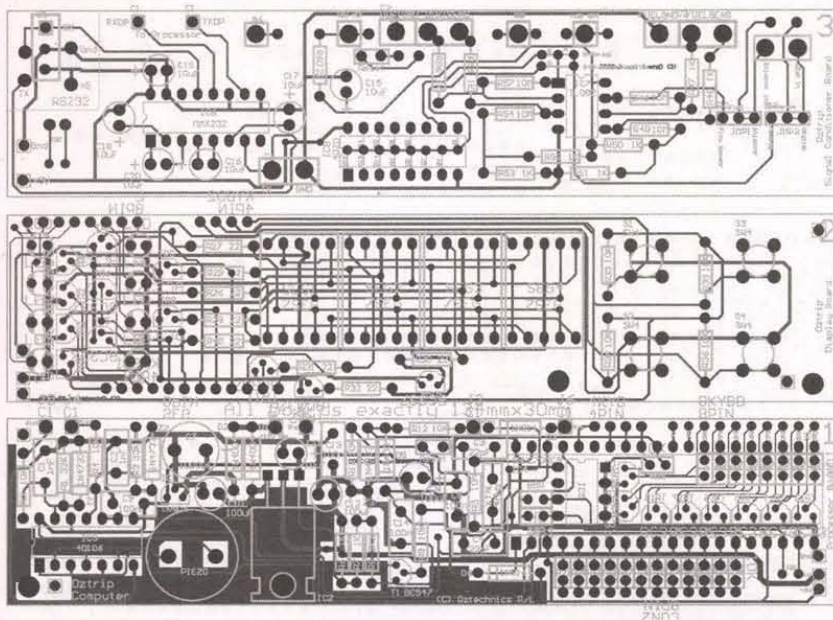


**Top Layer**

Key	Function	Key Value
(+) Up	1. Increment Display Function 2. Increment Keyboard Input	0
(-) Down	1. Decrement Display Function 2. Decrement Keyboard Input	1
Mode/Enter	1. Function + 27, Toggle Metric-> U.S.-> Imperial display format 2. Decimal Point 3. Enter Key	2
Set/Clear 3	1. First Press acts as a Set Function only for the following selected functions: - Functions 1,28,55 (Speed) - Set Speed Alarm - The current speed (+ 5) is stored and when exceeded the speed alarm sounds (same as Up + Mode/Enter). - Functions 6,33,60 (Distance Remaining of Journey) - Enter the journey distance to be undertaken. - Functions 12,39,66 (Fuel Remaining) - Enter the fuel added to the tank and cost. 2. Second Press acts as a Clear Function only for the following selected functions: • Functions 5,32,59 - Zero Trip 1 Counter • Functions 7,34,61 - Zero Trip 2 Counter • Functions 8,35,62 - Zero Trip 3 Counter • Functions 11,38,65 - Zero Fuel used in Trip • Functions 19,46,73 - Zero Fuel Cost • Functions 20,47,74 - Zero Trip 1 Timer • Functions 23,50,77 - Zero Trip 2 Timer • Functions 24,51,78 - Zero Trip 2 Timer • Functions 25,52,79 - Zero Elapsed Time of Engine • Functions 26,53,80 - Zero Total Fuel Used • Functions 27,54,81 - Zero Distance Travelled	
Up + Mode/Enter	Function + 5	4
Down + Mode/Enter	Function - 5	5
Mode/Enter + Set/Clear	Reset Function - Used to start a new journey by Resetting values. The "Rst" message is displayed for 3 seconds during which time the Set/Clear Key must be pressed to Reset the computer. The "Done" message is displayed when correctly Reset.	6
Up + Down	Set Speed Alarm (current speed + 5)	7
Up + Set/Clear	Enter Diagnostics Menu - Enter 1-5 for options, 1. Distance Input Test 2. Fuel Input Test 3. Display Injector Pulse Width 4. Keyboard Test	8
Down + Set/Clear	Enter Calibrate Menu - Enter 1-7 1. Calibrate Fuel 2. Modify Fuel Calibration Number 3. Calibrate Distance 4. Modify Distance Calibration Number 5. Calibrate Tacho (EFI Mode only) 6. Sprint Timer 7. Fuel Mode, EFI or Fuel Sensor 8. Reset Computer, Clear Memory	9
Up + Down + Mode/Enter	Hold - Freezes the counters (Up + Down + Mode/Enter = Normal)	10

**Table 6. Key Combinations and Functions.**





## Composite

has been traveled — typically 1-5 km — the Mode/Enter key is pressed to end counting and the distance traveled is entered. The computer divides the distance traveled by the number of pulses counted and stores the value as a calibration number. It is a good idea to record the distance calibration number using Cal Menu Option 2 — View Modify Speed Sensor

Calibration number, so that if power is lost, you can manually enter the number into the computer without having to repeat the entire calibration process.

2. By manually calculating how many mm's each pulse from the speed sender represents, and entering the value in number of mm's using Cal Menu Option 2. This number can be calculated by determining the

diameter of the tire and dividing it by the number of sensor pulses per wheel revolution.

## Telemetry

A Windows95/98 Virtual Dashboard application is used to display the OzTrip Computer's telemetry. It is also possible to control the OzTrip Computer from this application.

A two-way serial data link is used between the OzTrip Computer and a PC. The data from the microcontroller needs to be RS232 translated. This is achieved on the Signal Conditioning Board 3.

The Virtual Dashboard Visual Basic source code is available so that it can be customized for individual applications.

## Circuit Description

The speed conditioning circuit consists of R2, C1, ZD1, and R1 which are used to protect the input to Schmitt trigger IC3f, which produces a clean digital signal to the interrupt input (pin 2) of the controller, IC4.

Similarly, the fuel input conditioning circuit consists of R4, C2, ZD2, and R3 and is identical to the speed input protection. Two Schmitt triggers are used — IC3e and IC3d — so that pulse is not inverted. The output of IC3d is connected to the timer capture input, pin 37 of the controller.

The microcontroller oscillator circuit consists of C3, C4, a 4MHz crystal (X1), and R5.

The microcontroller RESET and

Accessories sense circuitry is formed around R12, R26, and ZD3. Because of the likelihood of noise coming in from the ignition wiring, these components protect the inputs to the controller by clipping any voltage above 5V. D5 and D6 provide additional protection while R13 and C14 form a delay network to the input of the RESET pin.

When the accessories are switched off, the RESET pin is at 0V, holding the controller in a low power state. When the accessories are switched on, the voltage at the RESET input pin is pulled high by R12 after a short delay while C14 charges. Eventually C14 is charged to +5V, taking the controller out of RESET.

The controller uses PB5 pin 17 to hold the RESET pin high. When PD3 senses the accessories have been switched off, the controller executes a shut down procedure and clears the PB5, causing the voltage at the RESET pin to fall to 0, and placing the controller in RESET. If the accessories input was used to directly control the RESET input, then correct controller shut down could not be guaranteed and data could be lost.

Moving now to the controller's output ports (there are four of them), we can see that PortA is used to drive the individual seven segments of the four seven-segment displays via transistor buffers Q5-Q12. The controller multiplexes all of the segments. To switch all of the segments on, the controller drives the output pins PA low.

Port B0-B3 is used to address the appropriate seven-segment displays via transistor buffers Q1-Q4.

PortB (B4) is used to drive the audible tone generator, formed by IC3A, B, and C, and a piezo buzzer. When IC3A input is pulled low by PB4, the three inverters hold the piezo input high. But when PB4 goes high, the output goes low, allowing the piezo transducer to sound.

PortC is used to drive the eight indicator LEDs via transistor buffers Q13-Q20. Eight 1K resistors are used for current limiting of the LED indicators. These resistors are connected between the two boards, not only forming the circuit elements, but also providing mechanical rigidity.

PortD 7, 5, 4, and 3 are connected to the four push buttons or "keys" (S1-S4). Each of the four inputs is normally pulled high by a 10K resistor, and pressing a key pulls its input low. The controller samples the keyboard inputs 200 times per second, or every 5ms.

PortD 0,1 provides the RX and TX serial communications. This section of the circuit is optional, IC6 and C16-C20.

The power supply is split into two. A permanent +5V supplied by

Step	Key Press	Display	Action
1	(+)	0	Increment
2	SET/CLEAR	1	New digit
3	(-)	10	Decrement
5	Mode/ENTER	19.0	Decimal point
6	(+)	19.1	Increment
7	Mode/ENTER		Finished

Table 7. Example of entering a numerical value into the computer.

## Diagnostic Menu

	Function
1	<b>Distance Input Test</b> The computer displays a count starting from zero of the number of pulses it receives from the Distance Input. The display can be Zeroed by pressing the Set/Clear key. To Exit the test press the Mode/Enter Key.
2	<b>Fuel Input Test</b> The computer displays a count starting from zero of the number of pulses it receives from the Fuel Input. The display can be Zeroed by pressing the Set/Clear key. To Exit the test press the Mode/Enter Key.
3	<b>Injector Pulse Width</b> Only available in EFI mode, the computer measures the injector pulse width presented to the Fuel Input. The display is calibrated in microseconds, for example 4000 represents 4ms. To Exit press the Mode/Enter key. The computer holds the last measured PW on the display.
4	<b>Keyboard &amp; Display Test</b> Selecting the various key combinations displays the appropriate key value and its value is written to the display. To Exit the test, do not press a key for five seconds.

Table 8 — Diagnostic Menu Options

## Calibrate Menu

	Function
1	<b>Calibrate Fuel</b> - Flow Sensor Mode - Enter flow sensor calibration number per 0.1L. The Flow Sensor used by Oztechnics produces 780 pulses per 0.1L of fuel. - EFI Mode - the computer measures the Pulse Width of the injectors over a known quantity of fuel used. While in Fuel Calibrate mode the message "Fuel", "EFI", "Cal", "value" is displayed where "value" is the total PW of the injector. The "value" must not exceed 4294 otherwise an error message "Err" will be displayed and calibration aborted. The Mode/Enter Key ends the EFI calibration then the "Fuel", "Used" message is displayed where the Fuel Used must be entered into the computer. The computer gives warning BEEPS from the 80% calibration point indicating it is time to end fuel calibration before a computer overflow condition occurs.
2	<b>Modify Fuel Calibration Number</b> The Fuel calibration number is first displayed briefly before you input a new calibration number. If you choose not to change the value, only press the Mode/Enter key or let the input routine time out.
3	<b>Calibrate Distance Sensor</b> The "Cal", "Dist", "count" message is displayed where "count" represents the number of pulses from the distance sensor. Once a known distance is travelled (1-5km) the Mode/Enter key is pressed and the "Dist" message is displayed briefly indicating to enter the distance travelled during the calibration process.
4	<b>Modify Distance Sensor Calibration Number</b> The Distance calibration number is first displayed and then you input a new value. If you choose not to change the value, only press the Mode/Enter key or let the input routine time out.
5	<b>Calibrate Tacho</b> For EFI mode only. The default calibration number is 120, which represents the number required to multiply the injector count in 0.5 second to convert to RPM.
6	<b>Sprint Timer</b> Used to measure the time down to 1/10's the vehicle takes to travel a specified distance, typically 400m. Enter the Distance to travel after the "Dist" message is displayed and then a 9 second count down occurs. Once the vehicle has travelled the specified distance the timer is frozen on the display. Pressing a key while the timer is active aborts the timer and freezes the display. Pressing any key exits the function.
7	<b>Select Fuel Operating Mode</b> Use the "+" & "-" keys to select between EFI or Flow Sensor operation. Default "EFI."

Table 9 — Calibrate Menu Options



IC1, a 78L05 regulator, is used to supply the controller and logic while IC2, a LM317 variable regulator, is used to supply the variable display voltage.

When the headlights are switched on, transistor Q21 is turned on via D3 and the 10K resistor. This effectively shorts the 2.2K ohm resistor, which lowers the output of the LM317 voltage regulator. This has the effect of dimming the display for nighttime driving.

Provision has been made on the PC board for six components not used in this version of the computer IC5, IC8.

## Construction

The OzTrip Car Computer is available in two versions depending on engine type, telemetry, and sensors required. The basic unit requires two PCBs and only accepts digital type pulses from the sensors.

If data telemetry, a fuel flow sensor, or an analog speed sensor is used, then a third signal board needs to be added ahead of the main computer to condition the analog signals from the flow sensor/speed sensor or perform RS232 translation.

If a flow sensor with a digital TTL type output is used, then the sig-

mounting IC5 (serial EEPROM), R58, and R59 (10K) on the solder side but it is not used in this application.

A step-by-step assembly manual is available for download from the Oztechnics website.

## Testing

After assembling the computer:

1. Apply +12VDC and ground to the respective inputs. Nothing should happen

2. Apply +12V to the accessory input. You should hear a BEEP out of the computer and a message displayed on the display "tRiP" computer, version "1.2." Disconnecting the accessory input from the +12V should shut the computer down.

3. Check that the keyboard is functioning correctly by pressing every key; a BEEP should be heard every time a key is pressed. Use the Diagnostic Menu Option 4 to check all the key combinations.

4. Check the display and use the Diagnostic Option 4 to cycle through all of the display.

5. Check the speed input by using the Diagnostic Option 1 and pulsing the speed input with a voltage between 5-12VDC. The display should register the pulses. Remember the display might jump up very quickly because the input is very sensitive.

6. Check the fuel input by using the Diagnostic Option 2. If the computer has been configured for EFI operation, pulse the input with a 5-12VDC signal to trip the counter. If the flow sensor is connected, blow into the sensor and it should register on the display.

7. Test the display-dimming feature by connecting +12VDC to the head light input.

8. Testing complete. Install into vehicle.

Note there is a DOS-based application on the Oztechnics website (EFI.EXE) which is used to create pulses on the parallel printer port. You can make a connection from the PC to the computer to test the inputs to the computer. The software allows you to vary the pulse width and frequency

of the signal on the data pins (2-11) on the parallel port.

## Installation

The computer requires:

- Permanent +12VDC (battery) supply.
- Accessories connection (switched +12V).
- Speed sender connection.
- Fuel connection.
- Optional headlight connection so that the display can be automatically dimmed when the headlights are switched on.

The engine type determines the fuel sender connection. For carbureted engines, a fuel flow sensor is

## Parts List

Quantity	Description	Designation
8	22	R26, R27, R28, R29, R30, R31, R32, R45
10	1K	R6, R7, R60, R61, R62, R63, R64, R65, R66, R67
21	2K2	R8, R14-R25, R37-R44
1	4K7	R (pin 1 & 7 of IC3)
10	10K	R2, R4, R9, R12- R13, R26*, R33-R36, 33K R1, R3
2		R5
1	10M	C3, C4
2	22pF	C1, C2
2	1nF (102)	C5, C9, C13, C14
4	100nF (104)	C11
1	10uF	C8, C10, C12,
3	100uF	C7
1	1000uF	D3, D5, D6
3	1N914	D1, D2
2	1N4004	Z1, Z2, Z3
3	1N4733	SEG1, SEG2, SEG3, SEG4
4	SA56-21SRWA	XTAL
1	4MHz	T1
1	BC547	TR1, TR2, TR3, TR4, TR5, TR6, TR7, TR8, TR9, TR10, TR11, TR12, TR13, TR14, TR15, TR16, TR17, TR18, TR19, TR20
20	BC559	L1, L2, L3, L4, L5, L6, L7, L8
8	LED 3mm RED	S1, S2, S3, S4
4	PCB Push buttons	IC3
1	40106 OR 74C14	IC4
1	68HC705C8	IC1
1	LM78L05 (TO-92)	IC2
1	LM317 (TO-220)	PIEZO
1	PCB Piezo	
2	10mm Spacer	
4	Bolts	
1	Instrument Case	
1	Front Filter Panel	
1	TRIP-PCB1	
1	TRIP-PCB2	

Table 10. Note there are 2 x R26 resistors on the PCB. R26\* is a 10K installed on the solder side of the board under the controller.

## Resistor Color Codes

Value	Four-Band Color Code
22	Red Red Black Gold
1K	Brown Black Red Gold
2.2K	Red Red Red Gold
4.7K	Yellow Violet Red Gold
10K	Brown Black Orange Gold
33K	Orange Orange Orange Gold
10M	Brown Black Blue Gold

Table 11. Resistor Color Codes

## Parts List - Signal Board 3

Quantity	Description	Designation
8	1K	R47, R48, R50, R51, R52, R53, R55, R56
1	22	R60
4	10M	R46, R49, R54, R57
7	10uF	C15, C16, C17, C18, C19, C20
1	4020	IC8
1	MAX232	IC6
1	TL082	IC7
2	16 pin IC sockets	
1	8 pin IC socket	
1	TRIP-PCB3	

Table 12. Optional Board 3 components.

nal board is not required. The flow sensor used by Oztechnics is an inductive type, which produces an analog output, which requires signal conditioning to drive the front end of the computer.

Assembling the boards is made easy by following the component mask printed onto the PCBs. Board 2 has components mounted on both sides of the PCB. You must solder the components on the bottom side first as IC1 socket hides resistors R26\*, R37-R44, and transistors TR13-T20, which are mounted on the bottom side of Board 2. Resistors R37-R44 are mounted on their ends.

A 4K7 resistor, R, is soldered on the backside of Board 2 between pins 1 and 7 of IC3.

Note there is provision for

required. The fuel flow sensor selected by Oztechnics is an inductive type, which requires signal conditioning to drive the digital input to the computer. Signal conditioning for the flow sensor is achieved on Board 3.

For EFI engines, a direct connection is required from the OzTrip Computer fuel input to the injector. The injector has two connections: one side of the injector coil is connected to +12VDC and the other side is connected to the engine management computer (EMC).

The OzTrip Computer must be connected to the EMC side of the injector. It is sometimes easier to make the injector connection directly across the EMC computer, which is usually located in the front passenger foot well or under the dashboard.

If installing a fuel flow sensor, mount the sensor

away from ignition noise and heat sources. For best operation, mount the sensor in a vertical position so that the fuel enters from the bottom of the sensor. Screened cable must be used to connect the sensor to the computer and the shield of the cable must be tied to ground. This can be done at the computer end. The flow sensor used by Oztechnics produces 780 pulses for every 0.1 liters of fuel which flows through it. The OzTrip Computer needs the calibration number entered into it so it can calculate the fuel flow. NV

## Electrical Characteristics

Characteristic	Typical
Supply Voltage	12VDC
Supply Current	
1. Operating	150mA
2. Off	11mA
Speed Input Trip Voltage	5V
Injector Trip Voltage	12-0-12V

## Project Details

This project and software is Copyright to Oztechnics Pty Ltd. A full kit can be purchased from Oztechnics. You can place your order on-line from the Oztechnics secure web server or make inquiries via email or FAX. Visa and MasterCard accepted. All components, case, and laser cut screen-printed front panel filters are included in the kit. A comprehensive user and construction manual is available for download, as well as some PC test software from the Oztechnics website.

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## QUESTIONS



Don't forget to check out the new online electronics forums at the *Nuts & Volts* website. There are currently boards for discussing Robotics, Microcontrollers, Radio, Computers, and a General forum for discussing any electronic topic at all. We'll even add new dedicated boards for hot topics. Just let us know!

I have a 10-year-old 27" color TV and the horizontal output is starting to sag.

When there are bright (especially white) areas on the right edge of the screen, the entire scan lines corresponding to the bright areas are shifted to the left.

When venetian blinds are displayed it looks very wavy.

I have examined the 500V flyback primary voltage and the hsync driver transistor waveforms and they look okay.

My question: is this a case of "tired flyback?" Does age affect the coils or just the diodes? I don't have an HV probe, so I can't examine the CRT high voltage, which seems scary, anyway.

It's a great set, and a new flyback and a proalignment/adjust would cost much less than a new one.

**#12001** Greg Morris  
Boulder, CO

I am using an HTX-10 10 meter radio with 25 watts PEP into a Hooker 100 amp. To make it legal, I'm using a low pass filter.

Is the 25 watts too much input? What resistors should I change? Does a schematic of the Hooker 100 exist?

**#12002** Anthony Glen  
via Internet

I need help on how to hook up a "record your own 10-second message" device — operating on four A74 button batteries — on the phone line so that my own recorded message can be heard by both parties and repeated every minute (or less), either getting its entire power supply

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

from the phone line or through an AC adaptor, but not both. Yes, this device has a momentary N.O. switch.

Could someone please help me with a diagram?

**#12003** Dan Ghergher  
via Internet

I'm looking for a circuit for an "automatic on/off" feature that will switch power to a home-brew powered sub-woofer whenever the main audio system is energized.

The circuit should use the speaker wires from the main amplifier as a sense input to control the power to the sub-woofer.

Has anyone got a workable circuit or a pointer to a schematic?

**#12004** Len Kastner  
Moneta, VA

I restore old cars and I am trying to replace a 'seatbelt reminder' timer which is no longer available.

The timer should activate a 12V bulb for approximately 30 seconds and turn off. The simpler the better.

Can someone point me in the right direction to locate a circuit diagram or off-the-shelf solution?

**#12005** David Cavender  
via Internet

What I am wanting to build is a DC six-volt photo cell timing circuit wildlife feeder that will feed dawn and dusk.

**#12006** Robin Williams  
via Internet

I am looking for a delayed paging circuit. This circuit would record a message and play it back over a paging system.

The delay is needed to avoid problems with feedback when a phone near a paging speaker is used.

The input would be a mic-level audio input and a contact closure indicating when record should take place.

When recording is complete (contacts open), the circuit should output a line-level audio signal and a voltage indicating paging is active.

**#12007** Greg Krumrey  
via Internet

I have two AM broadcast stations within a few miles.

I have a very strong overload problem, specifically a 2a+b signal at 3.850 (smack dab in the heart of the 80-meter band).

How about a highpass filter that cuts off the AM broadcast band?

Since I am using a transceiver, it would have to handle about 100 watts.

How about a schematic or a source for this filter?

**#12008** Bill O'Neil  
Cuyahoga Falls, OH

I would like to build an audio CD player display similar to those found at stores like Target, and Barnes and Noble.

These players are disguised behind a panel of photo thumbnails showing which artist's music CDs are available for listening before purchasing.

Each selection is played by pressing a memory-bubble keypad, and listening to a song lasting for 20 seconds or longer.

One store indicated that the hardware is generic and not proprietary.

**#12009** Mike Warner  
via Internet

I have a RadioShack remote control truck which runs at 49.9 MHz. I would like to change the operating frequency. Can this be done?

**#12010** Brett Bailey  
via Internet

Does someone have a flowchart for tracking down service schematics?

Present wish list is a motion sensor schematic — known information on same. Model 52-4076-2 (NW-12) made in China, possibly packaged in Quebec, SA (probably the manufacturer's symbol) LR96805.

The manufacturer is a little elusive. The registered trademark is SA. The SA is inside a circle with a small portion of the circle missing (between two and four o'clock).

**#12011** Ken Schultis  
via Internet

I am looking for specifications and wiring data for a 4012 Travelling Wave Tube made by RCA. This TWT has six color-coded wires attached:

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be sent if your answer is printed. Be sure to include your mailing address if responding by E-Mail.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- The question number and a short summary of the original question will be printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

## QUESTION INFO

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

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

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- 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.

brown [two], orange, blue, yellow, and green.

**#120012** Thomas Peasley  
New Hudson, MI

I'd like to make a float charger to keep my motorcycle battery up to snuff over the winter. Any ideas?

**#120013** Don  
via Internet

I was wondering if anyone knows of a place or vendor who has obso-



lete ICs for sale, and doesn't require a large minimum order?

Two places on the Internet that have them will not sell to individuals or they have a \$100.00 minimum order.

I need an **Analog Device** (ca. 1985) AD7550BD A/D converter IC. #120014

E. Kirk Ellis  
Pikeville, NC

Will someone please explain how VCR+ works?

I have never seen an article or even a mention of the system anywhere, and I read a lot of "stuff."

I have a feeling that if I experiment with the "numbers" that I can find a code that would allow me to produce a set of numbers that would result in any desired programming.

#120015 Orlo Hudson  
Kansas City, MO

## ANSWERS

### ANSWER TO #11009 - NOV. 2000

I haven't found any BCD up/down/presettable counter chips that are compact with multiple stages that drive seven-segment displays [something cascaded at least out to 10 digits].

The Motorola MC14553B (CMOS logic) comes the closest to meeting your requirements.

It has three BCD counters and multiplexing circuitry so you can get nine digits with three 14553s and three BCD to seven-segment decoders (MC14543B). It is not presettable and does not count down.

If you need those features, you are stuck with the 74193 and 7447.

The CMOS units are available from NTE as NTE4553B and NTE4543B.

Russell Kincaid  
Milford, NH

### ANSWER TO #7006 - JULY 2000

I recently bought a cable converter for my TV, but now I can not get closed caption on the set. Any suggestions?

There are two basic types of cable converters out there.

The first type is the frequency conversion type. They shift the incoming signal much like the front end of a communications receiver. The output signal is unaltered except for a shift in frequency.

The second type is the receiver remodulator. This is the style used by most cable descramblers. The signal they send to your TV is highly processed and stripped of all [Vertical Blanking Interval] VBI signals.

Unfortunately, the closed captioning information is embedded in the VBI signal area.

These converters process the

signal by demodulating the video and audio signals, and processing the video to eliminate the effects of scrambling.

Finally, the processed video and audio are sent to an RF modulator to create an RF signal that your TV and VCR can receive.

Many of these styles of converters also have a set of video and audio jacks on the back.

So, if this describes your converter, you're out of luck.

You can always bypass the converter to receive the closed captioning on non-scrambled signals.

Dennis Shelton  
Chesapeake, VA

### ANSWER TO #110011 - NOV. 2000

I have an engine-driven generator for power outage emergencies.

Unfortunately, I have found some references to the unsuitability of the brute force type generator for solid-state devices. I put a scope on the output at load and it seemed to produce 60-cycle power, but with tiny "notches" along the trace lines. Are these concerns valid?

The amplitude of the notches will determine whether they cause any problems. Modern devices based on solid-state electronics are reasonably well protected from surges. Your refrigerator is probably safe from the "notches" (unless it has a control panel).

There are a number of things you can do to improve the quality of the AC line.

1) Put UPSs [Uninterruptible Power Supply] in front items that you want to "ride" through the power outage. UPS units can be expected to filter out AC line glitches that may affect your devices. [www.upsshop.com/](http://www.upsshop.com/).

2) Isolation transformers are good for removing spikes. Sometimes these can be obtained surplus. EMD appears to have isolation transformers for sale. [www.emd-inc.com/surplus.htm](http://www.emd-inc.com/surplus.htm)

The isolation transformer must be sized to carry the max load you expect to put on it.

3) Line filters can help remove high frequency glitches. These are cheaper and not as effective as isolation transformers. They may be adequate in many cases.

This is one site I found [www.elect-spec.com/wire\\_in.htm](http://www.elect-spec.com/wire_in.htm)

Of course, *Nuts & Volts* is a good place to look for surplus items such as the isolation transformers and line filters.

The Internet addresses I gave are suggestions and not a recommendation.

Gus Calabrese  
Denver, CO

### ANSWER TO #110012 - NOV. 2000

Where can I get a cable or

pinout diagram for my Monitorm VK2400? It must be a nine-pin, two-row to 15-pin, three-row cable.

A cable has two ends, so an accurate answer depends on knowing to what video controller the monitor is to be connected.

The VK2400 is said to be a fixed-frequency monochrome monitor.

Its high resolution suggests that it is designed to be driven by an SVGA controller in which case, it would most likely be using the green signal for video. If that is the case, and the controller is indeed a standard SVGA card for a PC, then the cable sounds like a DB9 to HDD15 "multisync" VGA cable.

Such a cable is available at **Dalco** 1-800-445-5342 as catalog numbers 49630 (DB9P/HDD15S) and

49625 (DB9S/HDD15P).

In other words, you need to state which end has pins (P) and which end has sockets (S).

The HDD15P (pins) connector is the one that matches the SVGA card of an IBM compatible PC. The nine-pin end needs pins or sockets to match your monitor.

JDR at 1-800-538-5002 has a multisync cable, catalog number CBL-VGA, described as DB09P-HDB15P that evidently has pins at both ends.

You can find a number of cable connection diagrams at [www.repairfaq.org/REPAIR/F\\_Pinouts1.html](http://www.repairfaq.org/REPAIR/F_Pinouts1.html)

Here is a pinout diagram from that source for the 9-pin D-connector to 15-pin "high-density D" (three row) VGA cable:



### ANSWER TO #100011 - OCT. 2000

I would like to equip a model police car with strobe lights that would flash alternately with a cadence of four rapid flashes for the left and four for the right.

Circuits are available for full-size cars, but no doubt are too big for a model.

This solution uses three ICs which are available in Small Outline (SO) package.

The circuit could be built on a two-square-inch board.

The circuit operates on 6 volts.

The logic ICs are CMOS for low power and to allow me to use RC timing.

This is how it works: The LM556 is a dual 555 timer. Each timer oscillates at 4 Hz with 25% duty cycle.

The 74175 is a quad D flip flop which is used like a shift register to count four pulses. When power is applied, the 7400 whose inputs are connected to VCC puts a negative pulse to the 74175 reset input to start in the right mode. Otherwise, it could get stuck.

The circuit starts off with pin 15 of the 74175 low which inhibits the right section of the 556 from oscillating.

Pin 14 of the 74175 is high which enables pulses from the left side of the 556 to be passed on to the clock input of the 74175.

After four pulses, the high that was on pin 4 of the 74175 has moved down to pin 15 and

the right side of the LM556 starts oscillating.

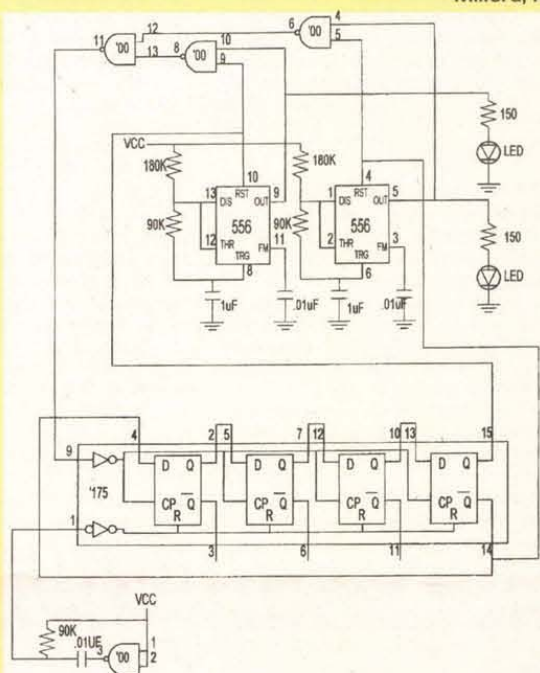
A delay between right side flashing and left side flashing would be desirable, but requires several more ICs.

Email me at [russik@aol.com](mailto:russik@aol.com) if you want to get that complex.

Parts are available from **Digi-Key** [all surface mount]:

Quad nand	74AC00SC-ND
Dual Timer	LM556CM-ND
Quad D FF	74AC175SC-ND
LED	P405-ND (clear lens)
LED	404-ND (diffuse lens)
180K resistor [10]	P180KVCT-ND
90K resistor [10]	P91KVCT-ND
150 ohm [10]	P150VCT-ND
1uF cap [10]	PCC1882CT-ND
.01uF cap [10]	PCC103BCT-ND

Russell Kincaid  
Milford, NH





Jack Dennon  
Warrenton, OR

## 86





# Build Your Own Voice Recognition X-10 Control System

by Dennis Shepard

In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world. We have everything from our TVs, stereos, and VCRs, to our sprinklers, lights, and air conditioning on remote control. A very popular format used for remotely controlling lights and appliances has been the X-10 protocol which transmits signals over your household wiring to facilitate that control. These systems have been around for over 20 years now. The interfaces have developed to the point where you can link through your computer and telephone for controlling these devices.

Voice recognition has now made it possible to control X-10 modules using your own voice. A leading-edge technology company named Sensory has just developed a continuous listening mode, voice-recognition module for \$49.95. It is with this module and an X-10 PL513 interface (available from X-10 for \$19.95) that allows us to construct a complete voice-operated controller for around \$100.00, depending on what you've already got on hand.

## What's a PL513?

It's pretty easy to guess that would be your first question. Because of the popularity of X-10, interface modules were designed to allow others to control the modules, namely, third-party developers and manufacturers. This opened up a whole new arena of outside products which could be compatible with the X-10 system.

To give you a better understanding, let's

redefine what X-10 is. It's a protocol for sending signals over your power wiring to remotely control devices in your home/business. It does this by modulating a 120 kHz signal on the 60 Hz AC cycle. There is a starting sequence code (two cycles) followed by a house code (four cycles) followed by a key or function code (five cycles). So ... an 11-bit code is sent for each command.

The PL513 module has a four-pin RJ11 standard phone jack attached to a small case which plugs into the AC power line. A red LED illuminates when power is present and dims whenever a valid X-10 command is sent. Inside the unit is a 120 KHz oscillator which interfaces to the power wiring plug. Also contained is an opto-isolator which provides an indication of when the AC cycle crosses zero. That's all there is to the interface. For those of you with a true engineering spirit, please visit X-10's website at <http://www.x10.com>. There you will find a 12-page document free for the downloading which covers all the specifications, including schematic, for the PL513. The document is entitled Technical Note for PL513\TW523.

## What's the PIC for?

Another good question. Although the PL513 provides a power line interface and zero-crossing signals, it's a far cry from a smart interface. Let's go a little more in-depth into the protocol and I think you'll see what I mean. Each time a code is sent, you have to send a complementary bit



The PL513

immediately after each bit on each alternating half cycle. For example, the start code which is 1110, is sent as 1 0 1 0 1 0 0 1. This format is true for the house codes and key/function codes, as well. And you have to repeat it twice with three cycles of silence in between. And at least two repeats for each dim and brighten command continuously without any missing cycles.

And for the clincher, each one bit must be sent three times on each cycle. This allows the system to be used on three-phase power systems. Since a power cycle (each half) is 8.33 msec, a one msec burst happens at zero crossing (within 50 usec), and again at 2.778 msec and again at 5.556 msec. This is all available in detail with diagrams and explanations so do your brain a favor and get the spec sheet. I guarantee it'll be a lot easier to understand!

The PIC also decodes the signals from the VoiceDirect 364 module. It has eight output lines which can control up to 15 separate outputs. Outputs 1-8 are verbatim, but outputs 9-15 are output 8 + outputs 1-7. For example, output 12 would be output 8 + output 4. Obviously, some way of deciphering the outputs is needed, as well, so the PIC takes care of both decoding from the VoiceDirect 364 module and encoding the 11-bit code for each X-10 command sent to the PL513 module.

## VoiceDirect to the rescue

Sensory Corporation is a high-tech company based in the silicon valley in California. Their website at <http://www.sensoryinc.com> pro-



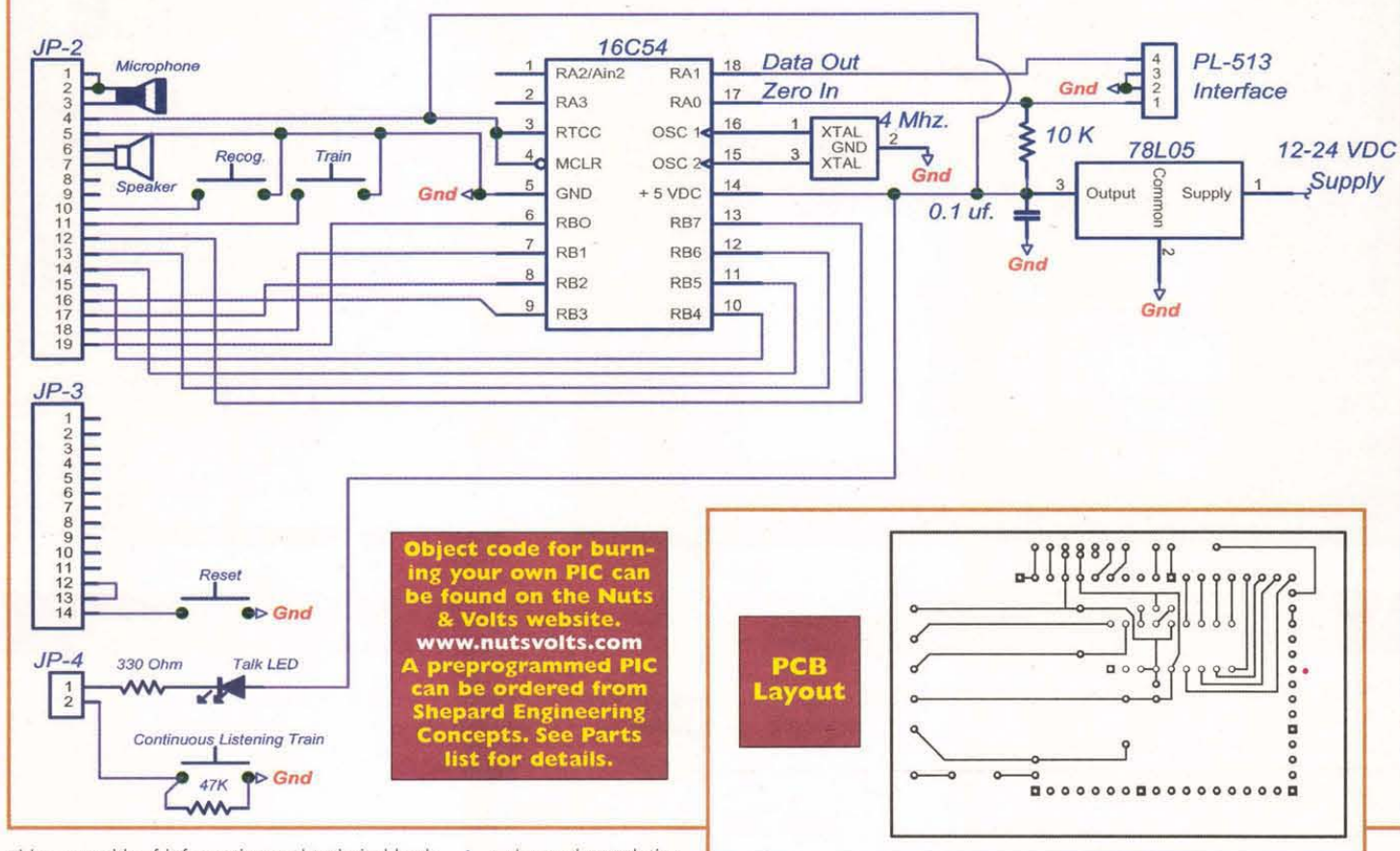
VoiceDirect Module



In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world ...

## Continuous Listening X-10 Voice Recognition System

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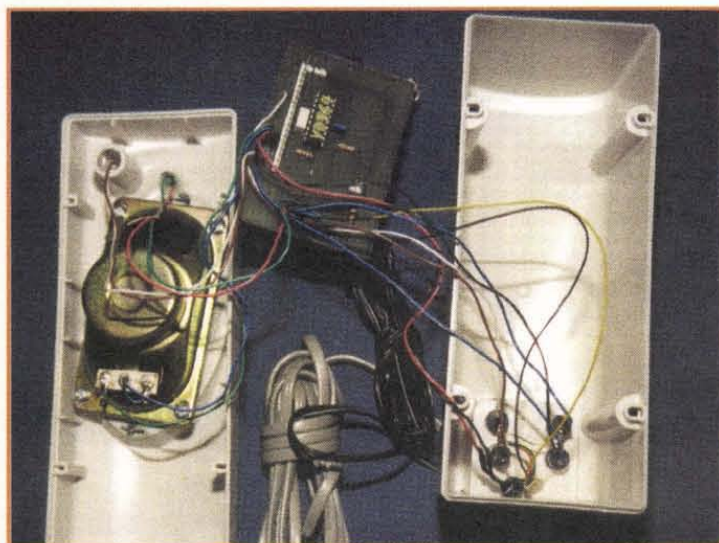


vides a wealth of information and technical background. They are the manufacturers of the VoiceDirect series of voice-recognition modules for whom I am a consultant/developer. They have developed modules which had the necessary support circuitry and firmware to make their modules

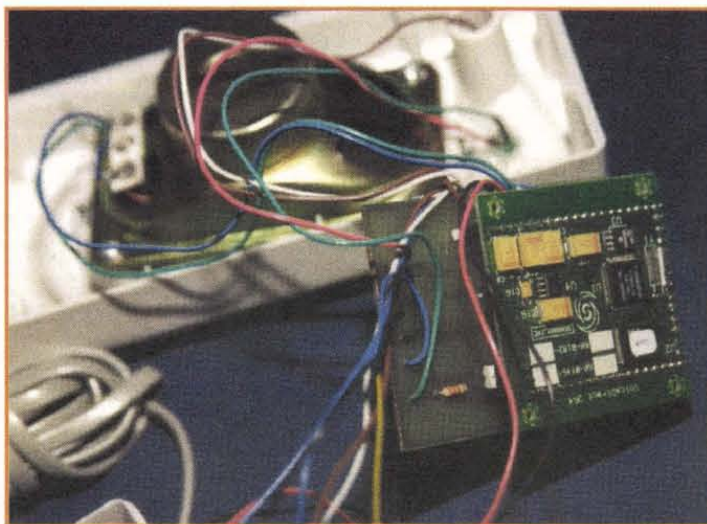
a plug-and-go solution to many needs. The kit contains the microphone, speaker, switches, and resistors necessary for a stand-alone application.

Until recently, however, the units required some form of physical interaction to initiate a

voice-recognition mode. They required a 'recognize' line to be pulled low for 100 msec to initiate that mode. Although this wasn't a major problem, it was somewhat of a nuisance. The newer units have their latest 364 chip which is faster



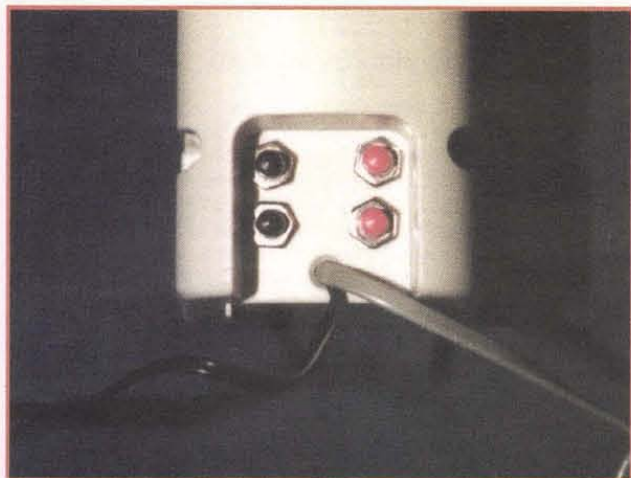
**Our prototype had the microphone mounted in the enclosure with the LED visible from the front. I just drilled a couple of holes and mounted it with some clear adhesive.**



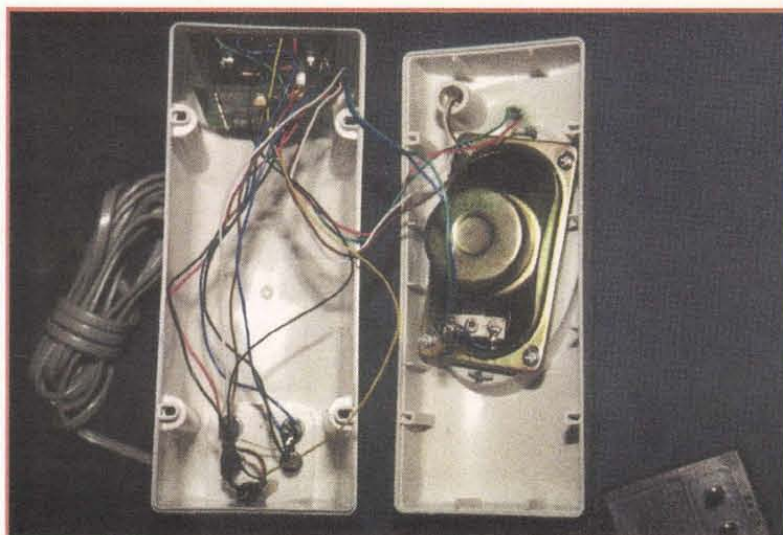
**The VoiceDirect 364 module comes as a 2" x 2" assembly with standard posts to accept 0.1" male headers. This allows the module to be piggybacked on a perf board or PCB for compact installation.**



In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world ...



**A small computer speaker enclosure is a good choice for mounting the unit. Pushbutton switches can be easily installed in the back.**



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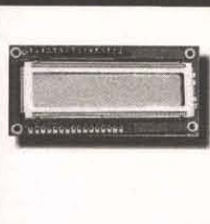
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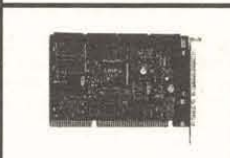
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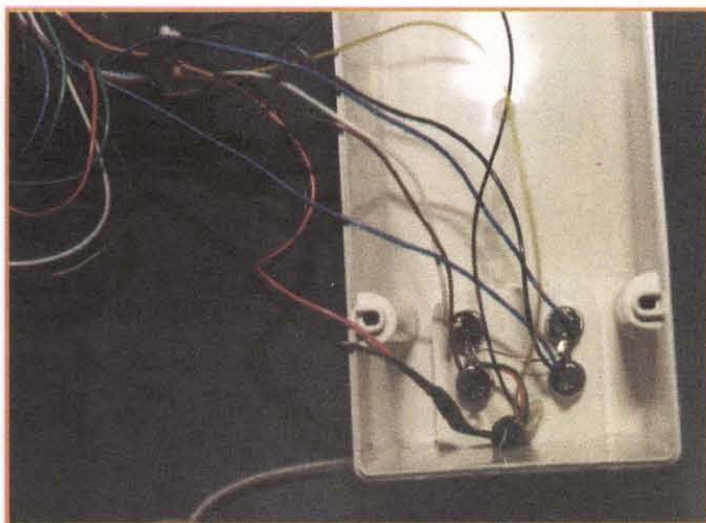
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Nuts & Volts Magazine/DECEMBER 2000 89



In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world ...



**Four SPST momentary contact push-button switches allow you to easily enter and exit the training mode and access system functions.**

and more accurate than its earlier predecessors. It also has a continuous listening mode which can use a 'gateway' word to precede each of the 15 commands it will respond to. This makes it completely voice-operated!

I have actually prototyped an earlier version using a proximity detector located inside the top of a small speaker enclosure to initiate the recognition mode and would pulse the line low every three seconds for continuous voice prompting. Then I used another command to silence the unit after I had spoken whatever commands I needed. This worked quite well, but it required some physical contact to

get the unit to respond.

### The circuitry involved

From a hardware point of view, this is an extremely simple circuit. It consists of a PIC 16C54 microcontroller, 4 MHz ceramic resonator, 78L05 voltage regulator, VoiceDirect 364 module, three resistors, and four switches. The PL513 interface plugs into the wall and attaches through a standard RJ-11 phone cord. An external wall wart power supply completes the circuitry.

### Putting it all together

Now that we've discussed the various pieces of the system, it's time to put it all together. The VoiceDirect 364 module comes as a 2" x 2" assembly with standard posts to accept 0.1" male headers. This allows the module to be piggy-backed on a perf board or PCB for compact installation. A small computer speaker enclosure (without amplifier) is a good choice for mounting the unit. Obviously, you can use your own imagination and mount the unit anywhere you want ... including out of sight! Our prototype had the microphone mounted in the enclosure with the

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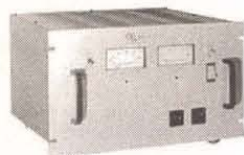
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Stock #STR9900

**\$225.00**

#### MILLIOMETER

HEWLETT PACKARD, Model 4328A. Designed to measure very low resistances. Measurement range 1m ohm to 100 ohms. Resolution 20 u ohms. Analog meter readout. Ideal for measuring contact resistance of switches or relays. This unit is also useful for measuring the resistivity of semiconductor devices. (Requires special 4 terminal probes which are not supplied, but probably are available from Hewlett Packard.) Power input: 115-230 VAC 48-66 Hz, 5 VA max. Dimensions: 5-1/8" wide x 11-1/2" deep x 6-1/2" high.

Stock #TE9812

**\$200.00**

#### PRECISION LINEAR WAY BEARING

This assembly consists of a linear ball bearing track rail and two ball bearing slider elements. 280mm long with 14 countersunk holes for rail mounting. Stainless steel.

Stock #BR2002

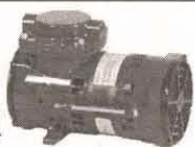
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#### DIAPHRAGM PUMP

THOMAS INDUSTRIES Single diaphragm oil-less pump. Motor rated 115 VAC 60 Hz. Pump output is 0.69 cfm free air. Max. continuous operating pressure 20 psi.

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### REFILL INKS FOR INKJET PRINTERS

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### HARD-TO-GET PRINTER RIBBONS

Gorilla Banana, Commodore 1525 \$8.00; Adam Coloco \$12.00; TI-850/855 \$6.00; Centronics 700 Zip Pack \$5.00; C. Itoh Prowriter Jr., Riteman C+/F \$6.00; Riteman Infomrner \$8.00; Commodore MPS-801 \$5.00; MPS 803 \$5.00; Decwriter LA30/36 \$4.00; Apple Scribe \$4.00; Mannisman Tally Spirit 80, Commodore 1526 \$5.00; Epson JX-80 4-Color \$14.00; Printronix P-1013 \$11.00; Star SJ144 color 3-pack \$29.00. ALSO HEAT & TRANSFER RIBBONS AND PAPER FOR PRINTING T-SHIRTS.

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## In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world ...

LED visible from the front. I just drilled a couple of holes and mounted it with some clear adhesive.

### Setting it up

Once the unit is assembled, we're ready to set it up for proper operation. On power up, the speaker will beep once to let you know the VoiceDirect module is okay. The talk LED will flash but extinguish if no training has occurred. Pressing the CL train (continuous listening mode) button will prompt you to say "word 1" and repeat it a second time. It will also tell you if it got it right, or if it didn't, and even why it didn't! Once you have trained your 'gateway' word, you're ready to train each of the 15 commands.

Each individual command is set up using the train (non-CL) button. It needs to be pressed for each word because the system doesn't know beforehand how many commands it will be responding to. Once training is complete, you can put the system into operation by pressing the recognize button. At that time, the talk LED will light indicating the system has entered the continuous listening mode. Reset will reinitiate the Voice Direct module.

Pressing the recognize button or CL train button will extinguish the LED and take the system out of listening mode. The system can be erased by holding down BOTH the train and recognize buttons together for at least one second. The system will respond with "memory erased." There are lots of other prompts like "spoke too soon," "similar to previous word," "please talk louder." It's all covered in the documentation which accompanies the module and which is also available on Sensory's website.

In operation, the talk LED is lit and will flash to let you know it's recognized the proper 'gateway' word. If it recognizes the next word as well, the appropriate command is sent. It will also tell you which command number was sent. If not, the unit has to recognize the 'gateway' word again before it will recognize another command.

Basically, the system will literally "talk you through it" (no pun intended) on the set-up. Since the commands are hard coded in the PIC, here's the breakdown of actual commands by channel number in the system:

Command Word	Function (X-10)
1	Channel 1
2	Channel 2
3	Channel 3
4	Channel 4
5	Channel 5
6	Channel 6
7	Channel 7
8	Channel 8

9	All Units Off
10	All Lights On
11	On
12	Off
13	Dim
14	Brighten
15	Not used

Well, that pretty well covers the system. We hope you will get as much excitement and enjoyment out of your system as we did ours! I even stayed up all night playing with the system when the prototype was developed.

Of course, I'll have to confess that I do have an espresso machine, so I'm quite sure that helped. **NV**

## Continuous Listening X-10 Voice Recognition System Parts List

C1	0.1 uF 50 WVDC monolithic capacitor, RadioShack #272-109 or equal
*CR1	4.00 MHz ceramic resonator, Digi-Key #PX400-ND or equal
*IC1	Microchip Technology PIC #16C54-XT/P microcontroller Digi-Key PIC#16C54-XT/P-ND (requires programming)
JP-x	see below
LED1	T1 3/4 green LED, RadioShack #276-022 or equal
MIC1	Omnidirectional electret microphone element, RadioShack #270-092 or equal
PS1	Power supply 9-24 VDC 100 mA output, RadioShack #273-1767 or equal
R1	330 ohm 1/4W 5% carbon resistor, RadioShack #271-1342 or equal
R3	10K ohm 1/4W 5% carbon resistor, RadioShack #271-1335 or equal
S1-S4	SPST momentary contact push-button switch, RadioShack #275-1547 or equal
*VR1	78L05 5 VDC 100 mA voltage regulator, Digi-Key #78L05ACZ-ND or equal
*Voice Recognition module	VD364 voice recognition module, sensory #VD364
Misc.	4/c phone cord w/RJ-11 plug attached, small enclosure w/8 ohm speaker, 0.1" male headers, hook-up wire, etc.

\* The following items are available directly from:

**Shepard Engineering Concepts**  
8315 D Laborough Dr., Bakersfield, CA 93311  
web — <http://home.att.net/~dennis.shepard/>  
email — [dennis.shepard@worldnet.att.net](mailto:dennis.shepard@worldnet.att.net)

A kit of programmed IC1, CR1, and VR1 are available for \$20.00 ppd. A kit including these items and the voice recognition module are available for \$70.00 ppd. These prices are for the continental US only. Please make payment to: Dennis Shepard. Payment methods preferred are money orders, certified checks, or Western Union.

Although the house code is set in firmware to House Code 'A,' any single house code will be programmed free of additional charge when requested with your order. Two different kits are available from Shepard Engineering Concepts. The first one consists of the preprogrammed PIC, ceramic resonator, and 78L05 voltage regulator for \$20.00 delivered anywhere in the continental US. The second kit includes the VoiceDirect 364 module ONLY and all components included above for \$70.00 including S&H anywhere in the continental US. See parts list for details.

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The A+ Certification Exam Guide was written by training-education specialists with the experience necessary to guide you through the information that is key to passing the exam. Difficult concepts are clearly explained, and topics and skills stressed on the exam are pointed out. In addition, the volumes include helpful graphics, diagrams, tables and charts.

The CD-ROM disk, which is part of the two volume set, not only contains the entire contents of both volumes, but also, hundreds of very useful sample test questions. There are also Self-Assessment sections at the end of each chapter in the Guide.

This 2-volume set is also a tremendous reference work for anybody who wants to know how PCs work or what to do when they don't work.

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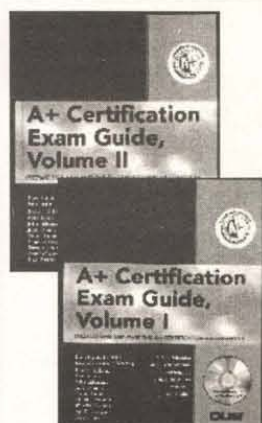
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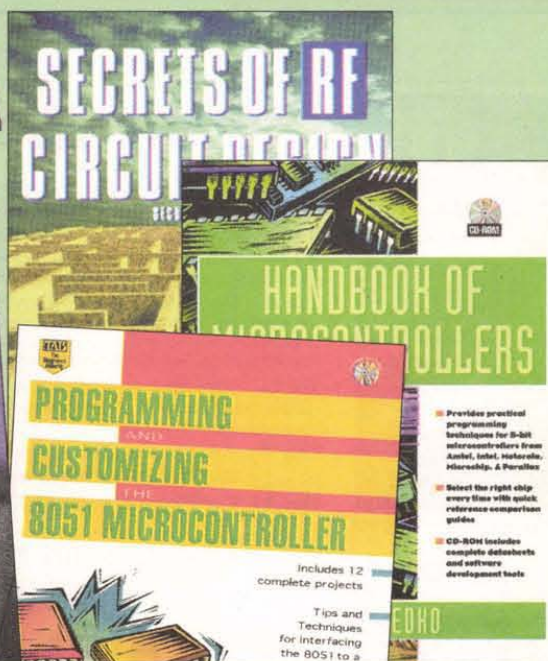
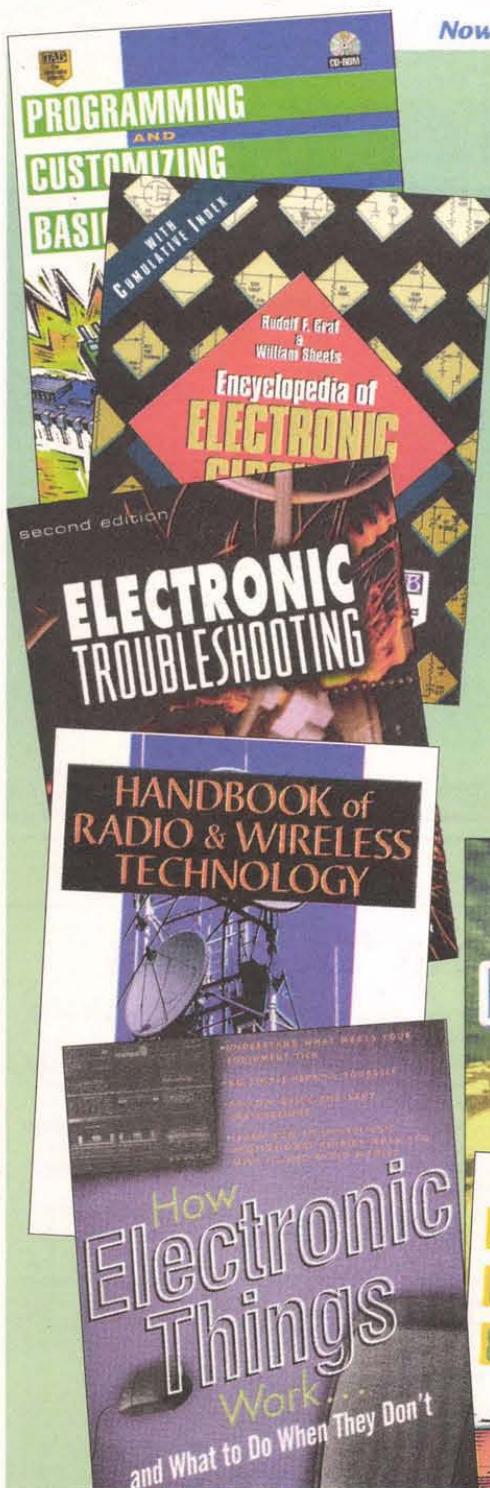
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# New Product News



## ASP275 AUDIO SIGNAL PROCESSOR

The ASP275 high-quality miniature Audio Signal Processor splits the audio spectrum into two frequency bands to optimize the dynamic behavior for each band. This reduces low-frequency distortion due to control signal ripple, phase distortion, high-frequency channel overload, and noise modulation.

The ASP275 analyzes the speaker's voice on an individual basis and modifies the sound for improved speech discrimination while improving normal sound quality and preserving transparency, therefore reduces the ambient noise up to 10dB.

The circuit also maintains the user preset volume level from a whisper to a shout. This approach greatly augments perception for normal or the hearing

impaired in helping to achieve a higher level of sound discrimination, higher levels of speech intelligibility are attained, especially in noisy environments.

Recommended applications are for radio and TV broadcast station and high-end communications. It is a must for military, aviation systems, and law enforcement applications where a misunderstood command could result in the loss of life or equipment.

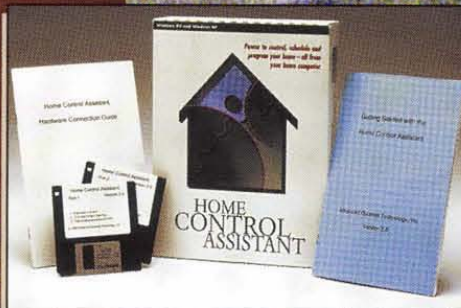
The ASP275 is also ideal for situations where many different operators share the same audio equipment. The miniature size makes it favorable for new design or add-on applications.

The module can be powered from the host equipment or external power source, 7 to 26 VDC @ approximately 20mA.

Single quantity price is \$119.00. Dimensions are 1" x 1" x 0.25".

For more information, contact:

**C & S ELECTRONICS**  
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NORWALK, CT 06850  
203-866-3208 FAX: 203-854-5036  
EMAIL: sszabo@candselect.com



## HOME CONTROL ASSISTANT SOFTWARE

**S**afely come home to a brightly lit Sentryway Save electricity by automatically shutting off appliances when leaving the house. Conveniently control all of your electrical appliances while on vacation.

This easy-to-use, yet powerful program allows you to control your home with the touch of a few buttons, without being a computer software genius!

Though some home control systems can be rather complex, the Home Control Assistant helps you to easily program a schedule for your home with simple-to-follow setup wizards. You can set any program for your home, including brightening and dimming lights, or turning on and off appliances such as coffee makers, aquarium controls, or stereos. You can even set the program to automatically turn off major appliances, reducing the risk of fire in your home.

The setup walks you through an inventory of the devices in your

home, and can even help you assign device addresses for X10 devices based on your needs. But the functionality doesn't stop there.

You can set up powerful schedules to control your home with equal ease. For example, while on vacation, you can set the lights to go on in the evening, and then off after a couple of hours to simulate an "at-home" appearance while on vacation, and to reduce your risk of being burglarized.

You can preset any number of automation schedules, including schedules for weekdays, weekends, or vacations.

There's no need to worry about a power outage, either, because the Home Control Assistant will automatically reset itself, catching up on your preset schedule.

The possibilities are endless with this amazingly simple, convenient, yet powerful program!

The Control Assistant Software is only \$97.90

For more information, contact:

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## DIGIMAX 35 MP3 DIGITAL CAMERA

**S**amsung Opto-Electronics America, Inc., announces the availability of their new Digimax 35 MP3 digital camera with MP3 audio player.

The Digimax 35 MP3, with a suggested retail price tag of \$289.99, is designed with today's Internet generation in mind and takes the category to a new dimension.

The major features of the Digimax 35 MP3 include the ability to use it as a web camera for live Internet video conferencing at up to 15 frames a second. In the digital camera mode, it can capture up to 120 frames of 640 x 480 resolution pictures to the included 8MB compact flash card (up to 300 frames at 320 x 240 resolution).

The Digimax 35 MP3 adds a third dimension to its full-featured compact design — an MP3 player. You can download directly from the Internet MP3 files to the removable compact flash card. With the included headphones and carrying case incorporating a belt loop, it



becomes a portable music player.

The Digimax 35 MP3's sleek design features an aluminum case with blue translucent accents and a large optical viewfinder and a built-in flash. It is USB-compatible and ships with a complete range of accessories and software. Accessories include stereo headphones, 360° tripod stand, and 3D glasses that work with the included 3D-image creator software.

For more information, contact:

**SAMSUNG OPTO-ELECTRONICS AMERICA, INC.**  
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SECAUCUS, NJ 07094  
201-902-0347 FAX: 201-902-1359  
WEB: www.samsungcamerausa.com



## MODEL PB-5 PRECISION PULSE GENERATOR

**T**he model PB-5 provides unprecedented performance in a precision pulse generator. It includes a full-featured, highly flexible ramp generator and complete programmability.

As a precision pulse generator,

the PB-5 surpasses or equals all existing designs in the important performance areas of resolution, linearity, and stability. The pulse repetition rates, which are variable over a broad range, go up to 0.5MHz. The higher rates are required when testing for MCA and PHA linearity because of the high number of data points required for a statistically valid test.

The built-in ramp generator allows you to control ramp duration, the number of ramps, and the ramp limits. Now you can test the entire range of your system or just a portion of that range. This ramp generator and precision pulse generator combination allows you to tackle the most demanding applications.

The new user interface is intuitive and easy to use. Items can be selected and changed by the spinner knob and/or keypad push buttons.

For more information, contact:

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Requires two AAA batteries sold separately.

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#3201

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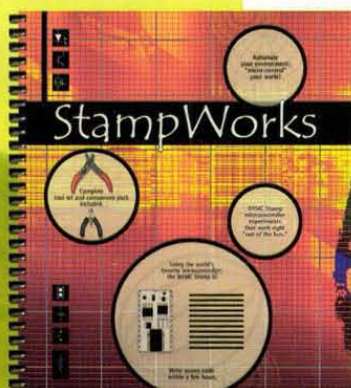
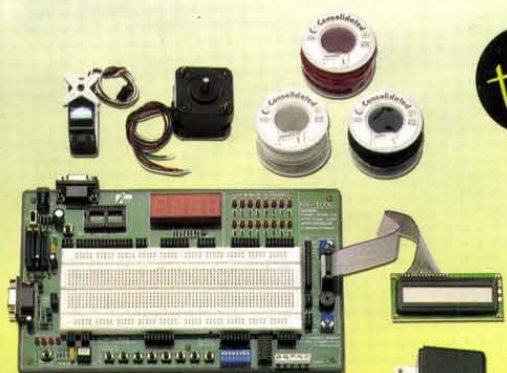
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