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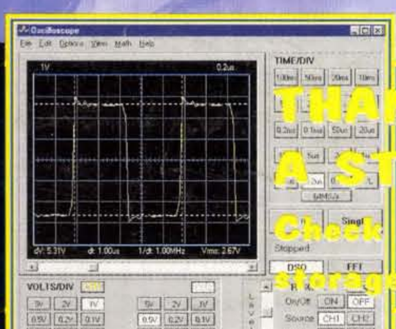

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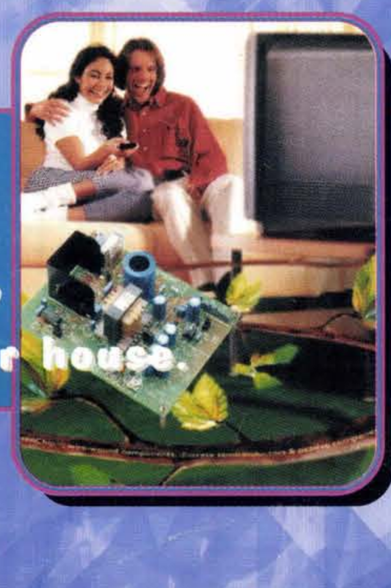

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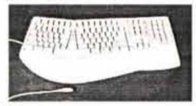

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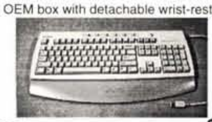

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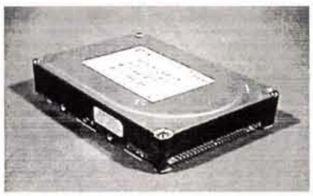

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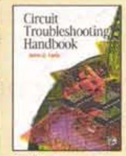

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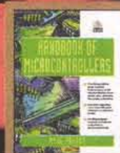

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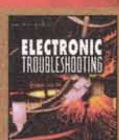

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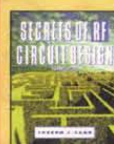

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Thanks for the Memory ...

A Storage Scope for Your PC

The Velleman PCS64i has reasonable performance at a fair price.

When I worked for one of the major semiconductor manufacturers (Motorola, if you must know), I had access to all manner of fancy test equipment. When I struck out on my own, I thought I'd have to do without some of the more exotic gear. True, I don't have access to scanning electron microscopes anymore, but most common gear is now better and cheaper than what I used to use.

Over time, I accumulated scopes, meters, and even a high-speed logic analyzer. One thing I didn't get, however, was a storage scope. The analog storage scopes were not that useful. Digital storage oscilloscopes (a DSO) are nice, but they are often slow, big, and expensive. I could never find a DSO that had a decent bandwidth, at a price I could afford.

As a long-time ham, I always wanted a spectrum analyzer, but couldn't justify it as a business expense. Recently, I picked up a PC-based DSO that doubles as a spectrum analyzer. The Velleman PCS64i has reasonable performance at a fair price. I bought mine on sale for about $300.00, but even at full price you can find them for less than $400.00.

The Specs

Specifying a DSO is different than specifying a normal oscilloscope. With a normal scope, you are primarily concerned with the scope's input bandwidth. With a DSO, this is only part of the equation.

Unlike regular scopes, DSOs don't continuously monitor the input signal. Instead, they sample the signal at a certain rate. Nyquist sampling theorem dictates that if you want to sample a signal changing at frequency f, you must sample at a rate no less than 2f.

Even at twice the signal frequency, the reproduction of the signal will suffer. You can think of the sampling frequency as being similar to resolution on a printer — the higher the sample rate, the better the scope trace will look.

Of course, bandwidth is important, too. Don't forget that a scope's bandwidth indicates the frequency the scope will show a sinewave with minimal loss and distortion. If you look at squarewaves (and other non-sinusoidal waveforms), you can expect a lower useful frequency since squarewaves have many harmonics. If the harmonics are above the scope's bandwidth, the signal reproduction will suffer.

The PCS64i has a rated bandwidth of only 13 MHz. It samples at 32 MHz, although in some cases, you can oversample at 64 MHz.

The scope comes with DOS and Windows software. You connect the scope to a printer port. There is no pass through so if you want to keep your printer connected, you'll need a second printer port. While you could get an inexpensive PC and dedicate it to the scope, you'd be wise to use a relatively fast machine with a modern, fast printer port. Also, you need a math coprocessor to measure RMS voltage and do spectral analysis, so that rules out 386 and 486SX machines unless they have external

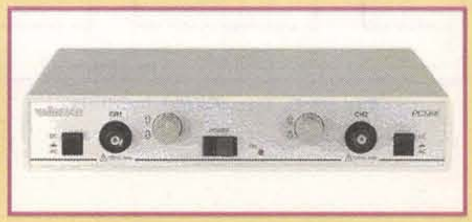

Figure 1. The PCS64i Oscilloscope

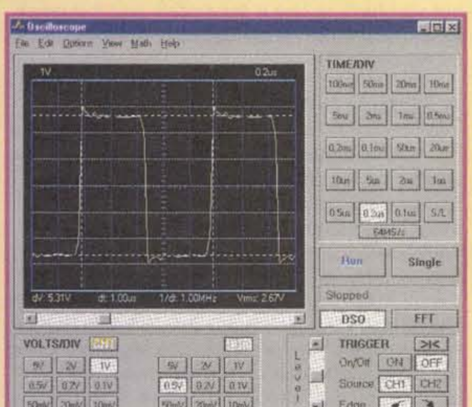

Figure 2. A 1MHz Squarewave

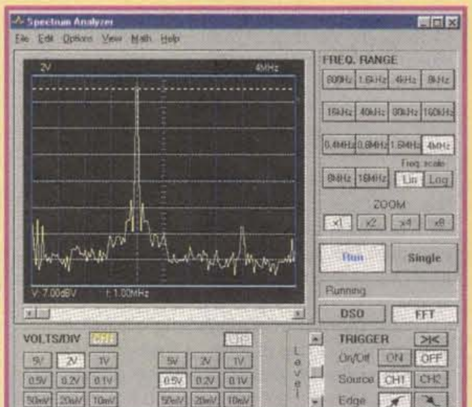

Figure 3. Spectrum Analysis

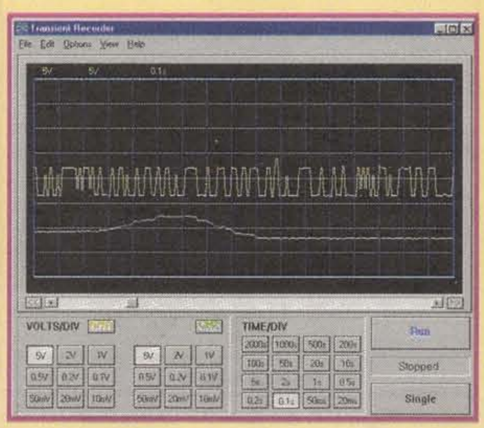

Figure 4. The Transient Recorder

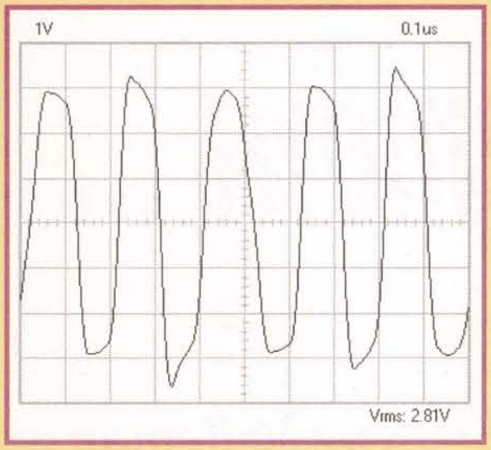

Figure 5. A 5MHz Squarewave

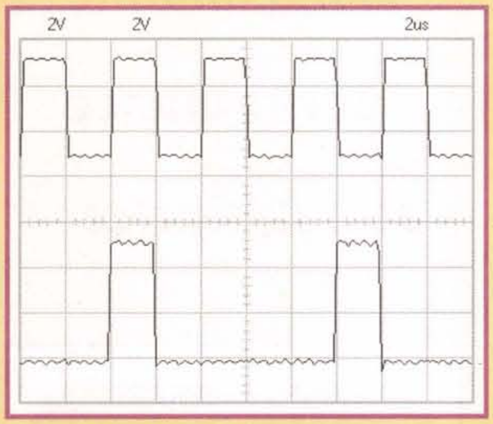

Figure 6. Two PWM Channels

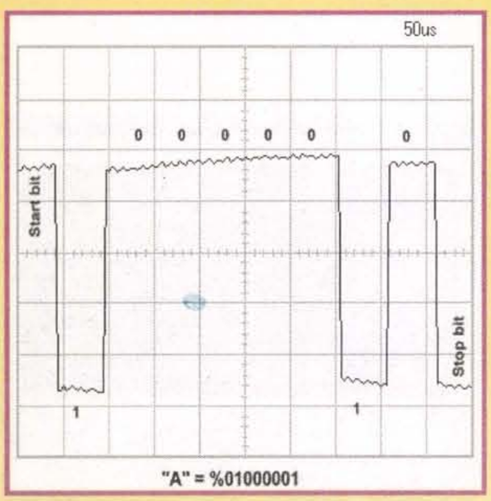

Figure 7. An RS-232 Character

coprocessor chips.

In Practice

Since the scope has no CRT or big transformers, it is lightweight. An AC adapter powers the unit (not always included, by the way — check before you buy). The front panel (see Figure 1) has a power switch, two BNC jacks, and the controls for each input. Each input has a switch to select AC or DC coupling. You can also ground the input (useful for setting a 0 reference point). There is also a knob for each input to adjust the trace position. All other settings are on the computer. Like many scopes, the PCS64i has a calibration point that delivers a known squarewave. However, the manual barely mentions it, and it is inconspicuously located on the rear panel (not the best location for it). The only marking near it is a picture of a squarewave.

Like a regular scope, you can set the PCS64i to use a trigger or run continuously. You can trigger on the rising or falling edge of either channel. A small mark on the screen shows the trigger level. When the scope detects a trigger event, it stores 4K samples for each channel. The scope stores a small number of samples ahead of the trigger and then reads the rest of the buffer. This allows you to examine the signal before the trigger and also peek at what happened just after the instrument recorded the current screen. You can also select single mode (usually when using the trigger). This causes the scope to record a single screen and stop.

If you plan to oversample, you have to use the trigger to get any sort of meaningful results. That's because oversampling looks at the waveform twice. If you don't start at the same spot each time (or if the waveform is not repetitive), oversampling is useless.

Once you have the waveform either locked on the screen or frozen, you can call up cursors to measure the voltage between points and the time between two points. The display also shows the frequency that corresponds to that time. Figure 2 shows a 1 MHz squarewave with the markers set. The scope also shows the RMS voltage at the lower right.

Notice that I'm using x10 scope probes. The software does not adjust for this, so the screen shot says the signal is about .45V. This is actually 4.5V because of the probe attenuation.

Spectrum Analysis

The spectrum analyzer works very much like the scope (see Figure 3). You can select a frequency range and use the zoom buttons to magnify an area of interest. You can also select a linear or logarithmic frequency scale. Like the scope, you can place markers on the screen. These markers measure frequency and amplitude (either absolute or relative in dB).

You can switch between the scope and the spectrum analyzer using the DSO and FFT buttons. This is handy because you can compare the signal's trace with the spectrum analysis — even after you've captured a static signal.

One thing that is confusing about the spectrum analysis display is that you don't see the entire frequency range on one screen (even at the x1 zoom factor). So if you select, for example, the 16MHz range, the right edge of the screen is really 10MHz. You'll have to use the scroll bar beneath the screen to see the rest of the frequency range.

Transient Recorder

The scope and spectrum analyzer are really the same program. However, Velleman also provides another program that they call a transient recorder (see Figure 4). This is a misleading name at best. It is really a strip chart recorder.

The idea is that this program samples the input and stores the result. Unlike the scope, it just produces a long trace for the time you specify. You can specify times as short as 20mS per division, and as long as 2,000 seconds per division. When the screen fills up, the program can automatically save the data in a file and start over.

The problem here is that the sample time is relatively slow. The exact time depends on your PC and how long you want the recorder to capture. However, the fastest you can sample in the Windows program is every 10mS. That makes it useless for all but the slowest tasks. For example, suppose you wanted to eavesdrop on a 9600 baud serial data stream. Each bit requires 104uS, so you'd need to sample at 50uS or so — several orders of magnitude less than the transient recorder can handle.

What's Missing?

While the transient recorder is useful in some cases, it isn't nearly as useful as you'd like it to be. However, the digital storage scope and spectrum analyzer are very useful — about as useful as a traditional instrument with similar specifications.

One thing I couldn't help but notice, however, is that the scope is very much like a traditional scope. It doesn't take much advantage of the computer that an ordinary scope doesn't have. For example, it'd be interesting to have the computer automatically position markers on request. Another minor annoyance is that the scope doesn't remember settings between sessions. It also doesn't know about x10 probes. There is no reason you couldn't set an option to allow the scope to display the voltage corrected for x10 probes. This is especially annoying when you save the scope's image and the voltage scale appears at the top of the screen.

The good news is that none of this is very serious. Better still, these problems could be corrected with updated software. Unfortunately, Velleman will not release the communications protocol used to talk to the device so you'd have to reverse-engineer the software or wait for Velleman to release what you want. There is a third-party program that supports this instrument called Scope-It (home.box.nl/scope-it/), but you have to buy it separately and it doesn't look much more functional than the included software.

A Picture is Worth ...

You've already seen a few pictures from the scope. In fact, that is one of the PCS64i's best features: you can capture screens and paste them into documents and presentations. You could even E-Mail them to someone else if you like, or include them on a web page. You can save a black and white image of the screen to a file by using the file menu. You can also copy a color image of the screen to the clipboard using the Copy command on the Edit menu. Of course, you can also use the Print Screen key or a screen capture program to take a picture of the entire scope.

Once you have the image, you can use a

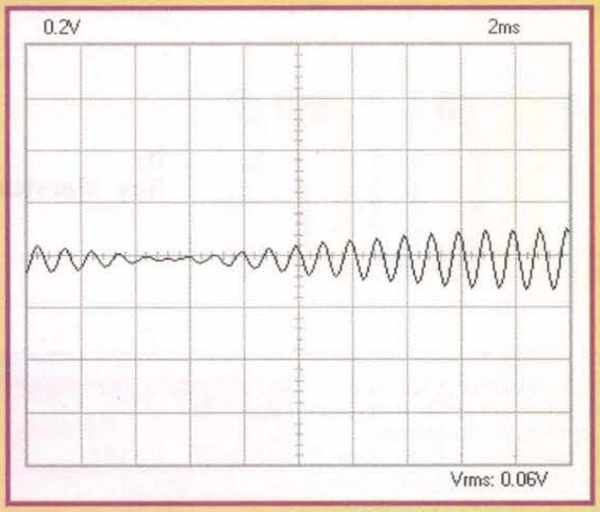

Figure 8. PSK31 Signal

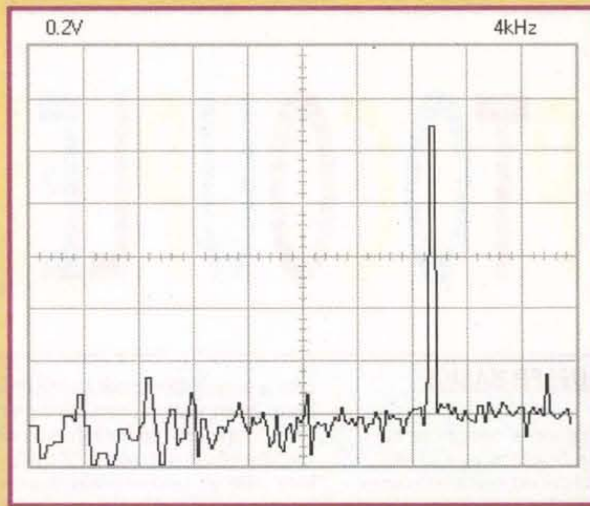

Figure 9. Spectrum of a Good PSK31 Signal

normal paint program to modify the picture. I often put a border around the image, for example. I also erase the 0.1V scale marker and replace it with 1V when I use x10 probes. If I'm using triggering, I usually erase the trigger mark on the left edge of the screen, as well.

Since a picture is worth a thousand words, here are a few to show you some of the scope's capabilities and limitations. Figure 5 shows a squarewave at 5MHz. You can see the scope's bandwidth is clipping the higher harmonics of the signal so it isn't very square anymore. However, you can still make out the signal's essentials.

Figure 6 shows two channels of pulse width modulation. The top trace has a duty cycle of 50%, while the lower trace is a 20% signal. Figure 7 shows an upper case A being sent over an RS-232 line. I annotated the areas of interest using a standard drawing program. Both Figures 6 and 7 also have additional borders drawn around them.

Finally, have a look at Figures 8, 9, and 10. These show a PSK31 signal at 1kHz (PSK31 is a phase shift keying method used by hams). Figure 8 shows the signal in the oscilloscope. Figure 9 shows the relatively clean spectrum from the signal. However, after turning the audio drive up too high, the audio amplifier begins to clip the signal. The spectrum in Figure 10 shows the story with a second peak at 3MHz (the spectrum in Figure 9 is a normal view; in Figure 10, I doubled the zoom to show the detail).

The Bottom Line

So how does the PCS64i stack up? It won't replace a traditional storage scope any time soon. However, with a price in line with a typical 20MHz scope, you might consider buying one instead of an inexpensive bench scope. True, the bandwidth isn't as high as a 20MHz unit, it is nearly as high and, in real life, you won't measure pure sinewaves anyway. For digital logic, a 20MHz scope is not too useful above 7MHz. The PCS64i will be serviceable to about 5MHz or so. However, with a 20MHz scope in this price range, you won't get digital storage, spectrum analysis, and the ability to put images easily into documents. You probably won't get on-screen measurements and true RMS voltage readings, either.

The PCS64i is certainly worth the asking price. It would be an even greater value if the scope bandwidth were higher and Velleman would provide a way for users to write their own software. If you don't have a scope, the Velleman provides a lot of bang for the buck. It makes an even better adjunct to an existing non-storage instrument. **NV**

Al Williams (WD5GNR) is an avid ham and divides his professional time between hardware and software designs. Al's company, AWC, is well-known for their products that augment microcontrollers, as well as for technical training. You can find out more about Al on his web site: http://www.al-williams.com/awce.

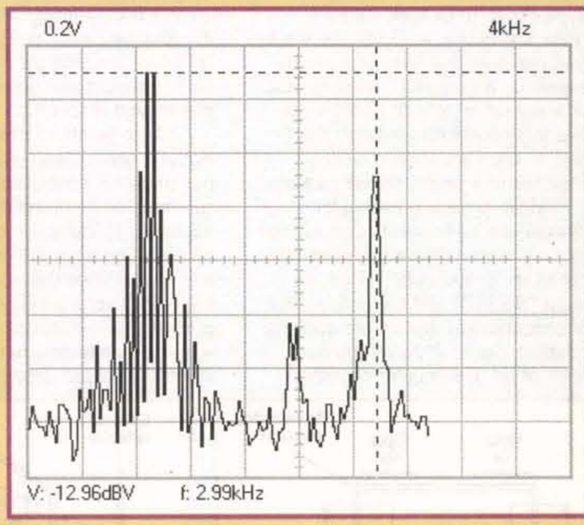

Figure 10. Spectrum of an Overdriven PSK31 Signal

OPTOCOUPLER CIRCUITS

by
Ray Marston

Ray Marston describes the operating principles and practical applications of a variety of optocoupler devices.

OPTOCOUPLER BASICS

An optocoupler device can be simply described as a sealed self-contained unit that houses independently-powered optical (light) Tx and Rx units that can be coupled together optically. *Figure 1* shows the basic form of such a device. Here, the Tx unit is a LED, but the Rx unit may take the form of a phototransistor, a photo-FET, an opto-triac, or some other type of photo-sensitive semiconductor element; the Tx and Rx units are housed closely together in a single, sealed package.

Most modern optocoupler devices use a phototransistor as their Rx unit; such a device is known simply as an 'optocoupler,' since the input (the LED) and the output (the phototransistor) devices are optically coupled. *Figure 2* shows the basic form of an optocoupler, together with a very simple application circuit. Here, when SW1 is open, no current flows in the LED, so no light falls on the face of Q1; Q1 passes virtually zero collector current under this condition, so zero voltage is developed across output resistor R2. Alternatively, when SW1 is closed, current flows through the LED via R1, and the resulting light falls on Q1's face, causing the phototransistor to conduct and generate an output voltage across R2.

Major points to note about the *Figure 2* optocoupler are that its output current is controlled by its input current, that a control circuit connected to its input can be electrically fully isolated from the output circuit, and that – since the input controls the output via a purely optical link – potential differences of hundreds of volts can safely exist between the input and output circuits. This 'isolating' characteristic is the main attraction of this type of optocoupler, which is generally known as an isolating optocoupler.

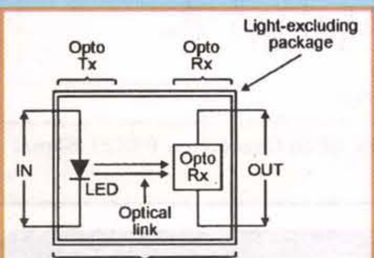

Figure 1. **Basic form of an optocoupler device.**

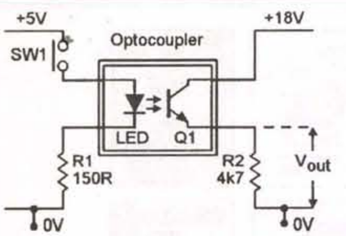

Figure 2. **Basic form and application circuit of a typical optocoupler.**

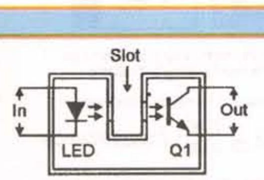

Figure 3. **Slotted optocoupler device.**

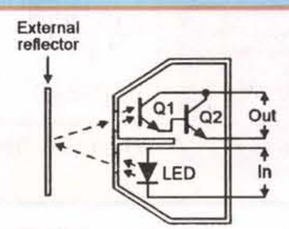

Figure 4. **Reflective optocoupler.**

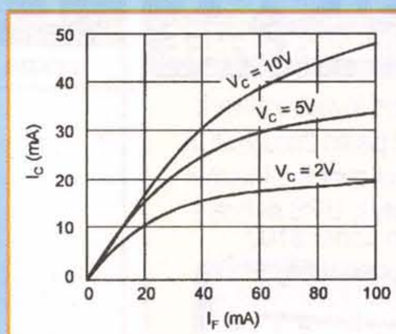

Figure 5. **Typical I_C/I_F characteristics of a simple optocoupler at various values of output-transistor collector voltage (V_C).**

The simple application circuit of *Figure 2* can be used with digital input/output signals only but, in practice, this basic circuit can easily be modified for use with analog input/output signals, as shown later in this article. Typical isolating optocoupler applications include low-voltage to high-voltage (or vice versa) signal coupling, interfacing of a computer's output signals to external electronic circuitry or electric motors, etc., and interfacing of ground-referenced low-voltage circuitry to floating high-voltage circuitry driven directly from the main's AC power lines, etc. Optocouplers can also be used to replace low-power relays and pulse transformers in many applications.

SPECIAL OPTOCOUPLERS

The *Figure 2* device is a simple isolating optocoupler. *Figures 3* and *4* show two other types of optocoupler. The device shown in *Figure 3* is known as a slotted optocoupler, and has a slot molded into the package between the LED light source and the phototransistor light sensor. Here, light can normally pass from the LED to Q1 without significant attenuation by the slot. The optocoupling can, however, be completely blocked by placing an opaque object in the slot. The slotted optocoupler can thus be used in a variety of 'presence'-detecting applications, including end-of-tape detection, limit switching, and liquid-level detection.

The device shown in *Figure 4* is known as a reflective optocoupler. Here, the LED and Q1 are optically screened from each other within the package, and both face outwards (towards a common point) from the package. The construction is such that an optocoupled link can be set up by a reflective object (such as metallic paint or tape, or even smoke particles) sited a short distance outside the package, in line with both the LED and Q1. The reflective optocoupler can thus be used in applications such as tape-position detection, engine-shaft revolution counting or speed measurement, or smoke or fog detection, etc.

OPTOCOUPLER TRANSFER RATIOS

One of the most important parameters of an optocoupler device is its optocoupling efficiency and, to maximize this parameter, the LED and the phototransistor (which usually operate in the infrared range) are always closely matched spectrally.

The most convenient way of specifying optocoupling efficiency is to quote the output-to-input current transfer ratio (CTR) of the device, i.e., the ratio of the output collector current (I_C) of the phototransistor, to the forward current (I_F) of the LED. Thus, CTR = I_C/I_F. In practice, CTR may be expressed as a simple figure such as 0.5, or (by multiplying this figure by 100) as a percentage figure such as 50%.

Simple isolating optocouplers with single-transistor output stages have typical CTR values on the range of 20% to 100%; the actual CTR value depends (among other things) on the input and output current values of the device and on the supply voltage value (V_C) of the phototransistor. *Figure 5* shows three typical sets of output/input currents obtained at different V_C values.

It should be noted that, because of variations in LED radiation efficiency and phototransistor current gains, the actual CTR values of individual optocouplers may vary significantly from the typical value. An optocoupler type with a typical CTR value of 60% may, for example, in fact have a true value in the range of 30% to 90% in an individual device.

OTHER PARAMETERS

Other important optocoupler parameters include the following.

ISOLATION VOLTAGE. This is the maximum permissible DC potential that can be allowed to exist between the input and output cir-

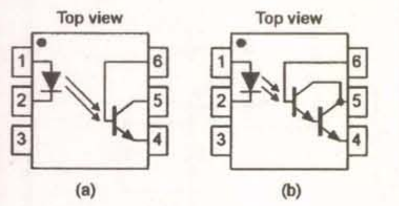

Figure 6. **Typical simple (a) and Darlington (b) isolating optocouplers.**

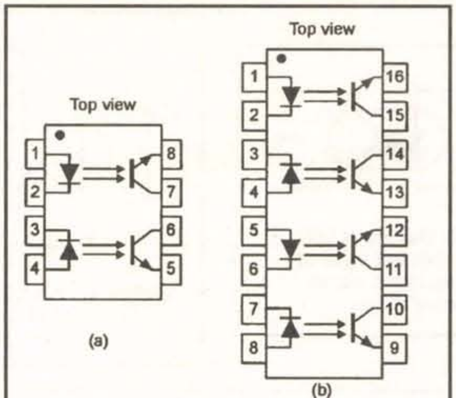

Figure 7. **Typical dual (a) and quad (b) isolating optocouplers.**

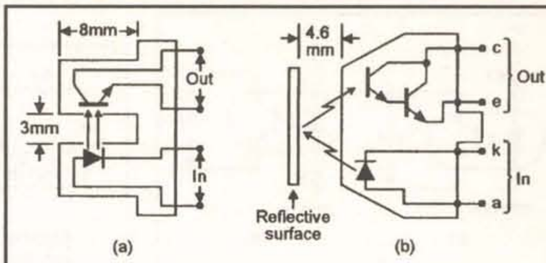

Figure 8. **Typical slotted (a) and reflective (b) optocouplers.**

cuits. Typical values vary from 500V to 4kV.

VCE(MAX). This is the maximum allowable DC voltage that can be applied across the output transistor. Typical values vary from 20V to 80V.

IF(MAX). This is the maximum permissible DC current that can be allowed to flow in the input LED. Typical values vary from 40mA to 100mA.

BANDWIDTH. This is the typical maximum signal frequency that can be usefully passed through the optocoupler when the device is operated in its normal mode. Typical values vary from 20kHz to 500kHz, depending on the type of device construction.

PRACTICAL OPTOCOUPLERS

Optocouplers are produced by several manufacturers and are available in a variety of forms and styles. Simple optocouplers are widely available in six basic forms, which are illustrated in *Figures 6* to *8*. Four of these (*Figures 6* and *7*) are isolating optocouplers, and the remaining two are the slotted optocoupler (*Figure 8(a)*) and the reflective optocoupler (*Figure 8(b)*). The table of *Figure 9* lists the typical parameter values of these six devices.

The simple isolating optocoupler (*Figure 6(a)*) uses a single phototransistor output stage and is usually housed in a six-pin package, with the base terminal of the phototransistor externally available. In normal use, the base is left open-circuit and, under this condition, the optocoupler has a minimum CTR value of 20% and a useful bandwidth of 300kHz. The phototransistor can, however, be converted to a photodiode by shorting the base (pin 6) and emitter (pin 4) terminals together; under this condition the CTR value falls to about 0.2%, but the bandwidth rises to about 30MHz.

The Darlington optocoupler (*Figure 6(b)*) is also housed in a six-pin package and has its phototransistor base externally available. Because of the high current gain of the Darlington, this coupler has a typical minimum CTR value of about 300%, but has a useful bandwidth of only 30kHz.

The dual and quad optocouplers of *Figure 7* use single-transistor output stages in which the base terminal is not externally available.

Note in all four isolating devices that the input pins are on one side of the package, and the output pins are on the other. This construction gives the maximum possible values of isolating voltage. Also note in the multichannel devices of *Figure 7* that, although these devices have isolating voltages of 1.5kV, potentials greater than 500V should not be allowed to exist between adjacent channels.

Isolating voltage values are not specified for the slotted and reflective optocoupler devices of *Figure 8*. The *Figure 8(a)* device has a typical slot width of about 3mm, and uses a single output transistor to give an open slot minimum CTR value of 10% and a bandwidth of 300kHz.

Finally, the reflective optocoupler of *Figure 8(b)* uses a Darlington output stage and has a useful bandwidth of only 20kHz. Even so, the device has a typical minimum CTR value of only 0.5% at a reflective range of 5mm from a surface with a reflective efficiency of 90%, when the input LED is operated at its maximum current of 40mA.

OPTOCOUPLER USAGE NOTES

Optocouplers are very easy devices to use, with the input side being used in the manner of a normal LED and the output used in the manner of a normal phototransistor. The following notes give a summary

Parameter	Isolating optocouplers				Slotted optocoupler	Reflective optocoupler
	Simple type	Darlington type	Dual type	Quad type		
Isolating voltage	±4kV	±4kV	±1.5kV	±1.5kV	N.A.	N.A.
V_{CE} (max)	30V	30V	30V	30V	30V	15V
I_F (max)	60mA	60mA	100mA	100mA	50mA	40mA
CTR (min)	20%	300%	12.5%	12.5%	10%	0.5%
Bandwidth	300kHz	30kHz	200kHz	200kHz	300kHz	20kHz
Outline	Fig 6(a)	Fig 6(b)	Fig 7(a)	Fig 7(b)	Fig 8(a)	Fig 8(b)

Figure 9. **Typical parameter values of the Figures 6 to 8 devices.**

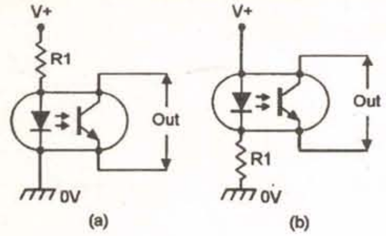

Figure 10. The LED current must be limited by a series resistor, which can be connected to either the anode (a) or the cathode (b).

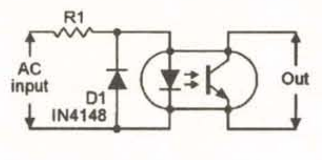

Figure 11. The input LED can be protected against reverse voltages via an external diode.

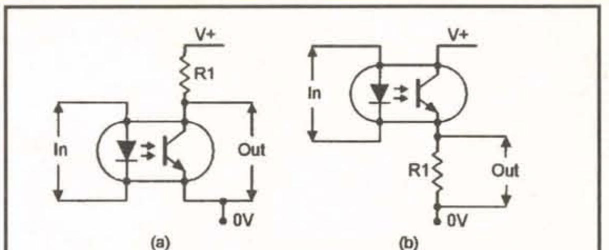

Figure 12. An external output resistor, wired in series with the phototransistor, can be connected to either the collector (a) or emitter (b).

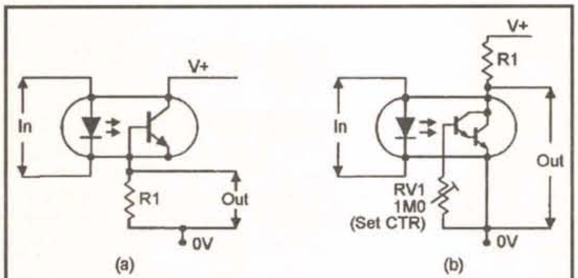

Figure 13. If its base is available, the phototransistor can be made to function as a photodiode (a), or its CTR values can be varied via RV1 (b).

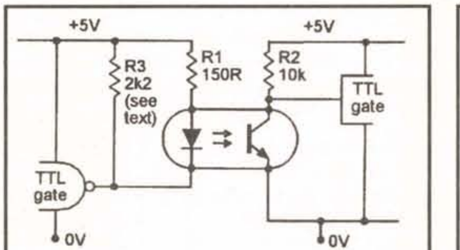

Figure 14. TTL interface.

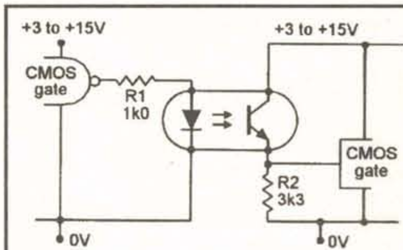

Figure 15. CMOS interface.

of the salient usage points.

The input current to the optocoupler LED must be limited via a series-connected external resistor which, as shown in *Figure 10*, can be connected on either the anode or the cathode side of the LED. If the LED is to be driven from an AC source, or there is a possibility of a reverse voltage being applied across the LED, the LED must be protected from reverse voltages via an external diode connected as shown in *Figure 11*.

The phototransistor's operating current can be converted into a voltage by wiring an external resistor in series with the collector of the device. This resistor can be connected to either the collector or the emitter of the phototransistor, as shown in *Figure 12*. The greater the value of this resistor, the greater is the sensitivity of the circuit, but the lower is its bandwidth.

In normal use, the phototransistor is used with its base terminal open-circuit. If desired, however, the phototransistor can be converted into a photodiode by using the base terminal as shown in *Figure 13(a)* and ignoring the emitter terminal (or shorting it to the base). This connection results in a greatly increased bandwidth (typically 30MHz), but a greatly reduced CTR value (typically 0.2%).

Alternatively, the base terminal can be used to vary the CTR value of the optocoupler by wiring an external resistor (RV1) between the base and emitter, as shown in the Darlington example of *Figure 13(b)*. With RV1 open-circuit, the CTR value is that of a normal Darlington optocoupler (typically 300% minimum); with RV1 short-circuit, the CTR value is that of a diode-connected phototransistor (typically about 0.2%).

DIGITAL INTERFACING

Optocoupler devices are ideally suited for use in digital interfacing applications in which the input and output circuits are driven by different power supplies. They can be used to interface digital ICs of the same family (TTL, CMOS, etc.) or digital ICs of different families, or to interface the digital outputs of home computers, etc., to motors, relays, and lamps, etc. This interfacing can be achieved using various special-purpose 'digital interfacing' optocoupler devices, or by using standard optocouplers; *Figures 14* to *16* show circuits of the latter type.

Figure 14 shows how to interface two TTL circuits, using an optocoupler circuit that provides a non-inverting action. Here, the optocoupler LED and current-limiting resistor R1 are connected between the 5V positive supply rail and the output-driving terminal of the TTL device (rather than between the TTL output and ground), because TTL outputs can usually sink a fairly high current (typically 16mA) but can source only a very low current (typically 400µA).

The open-circuit output voltage of a TTL IC falls to less than 0.4V when in the logic-0 state, but may rise to only 2.4V in the logic-1 state if the IC is not fitted with an internal pull-up resistor. In such a case, the optocoupler LED current will not fall to zero when the TTL output is at logic-1. This snag is overcome in the *Figure 14* circuit by fitting an external pull-up resistor (R3) as shown. The *Figure 14* circuit's optocoupler phototransistor is wired between the input and ground of the driven (right-hand) TTL IC because a TTL input needs to be pulled down to below 800mV at 1.6mA to ensure correct logic-0 operation.

CMOS IC outputs can source or sink currents (up to several mA) with equal ease. Consequently, these devices can be interfaced by using a sink configuration similar to that of *Figure 14*, or they can use the source configuration shown in *Figure 15*. In either case, the R2 value must be large enough to provide an output voltage swing that switches fully between the CMOS logic-0 and logic-1 states.

Figure 16 shows how the optocoupler can be used to interface a computer's output signal (5V, 5mA) to a 12V DC motor that draws an operating current of less than 1A. With the computer output high, the optocoupler LED and phototransistor are both off, so the motor is driven on via Q1 and Q2. When the computer output goes low, the LED and phototransistor are driven on, so Q1-Q2 and the motor are cut off. The reverse of this action can be obtained by wiring the optocoupler's output in series between R2 and Q1-base, so that Q1-Q2 and the motor turn on only when the computer output goes low.

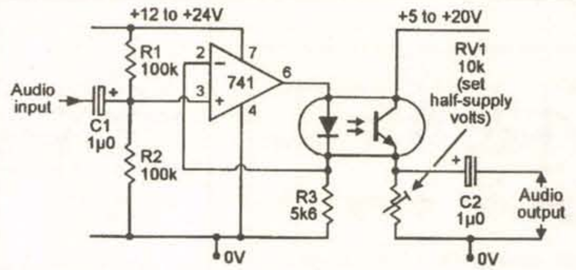

***Figure 17*. Audio-coupling circuit.**

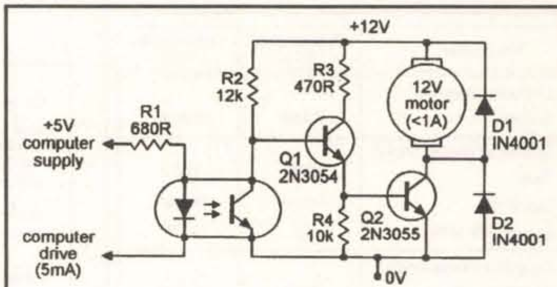

***Figure 16*. Computer-driven DC motor.**

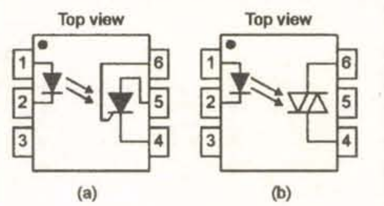

***Figure 19*. Typical optocoupled SCR (a) and triac (b).**

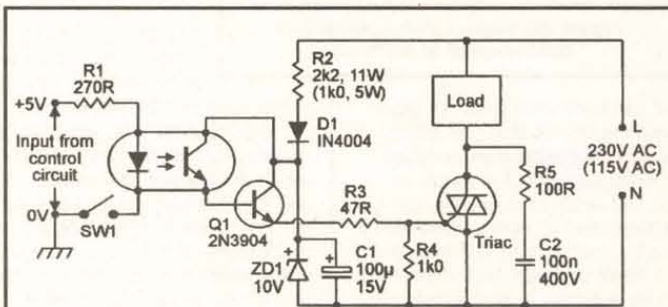

***Figure 18*. Simple non-synchronous triac power switch with optocoupled input.**

ANALOG INTERFACING

An optocoupler can be used to interface analog signals from one circuit to another by setting up a standing current through the LED and then modulating this current with the analog signal. *Figure 17* shows this technique used to make an audio-coupling circuit.

Here, the op-amp is connected in the unity-gain voltage follower mode, with the optocoupler LED wired into its negative feedback loop so that the voltage across R3 (and thus the current through the LED) precisely follows the voltage applied to the op-amp's pin 3 non-inverting input terminal. This terminal is DC-biased at half-supply volts via the R1-R2 potential divider, and can be AC-modulated by an audio signal applied via C1. The quiescent LED current is set at 1 to 2 mA via R3.

On the output side of the optocoupler, a quiescent current is set up (by the optocoupler action) in the phototransistor, and causes a quiescent voltage to be set up across RV1, which should have its value adjusted to give a quiescent output value of half-supply voltage. The audio output signal appears across RV1 and is DC-decoupled via C2.

TRIAC INTERFACING

An ideal application for the optocoupler is that of interfacing the output of a low-voltage control circuit (possible with one side of its power supply grounded) to the input of a triac power-control circuit that is driven from the AC power lines and which can be used to control the power feed to lamps, heaters, and motors. *Figure 18* shows an example of such a circuit; the figures in parenthesis show the component values that should be used if 115V AC (rather than 230V) supplies are used; the actual triac type must be chosen to suit individual load/supply requirements.

The *Figure 18* circuit gives a non-synchronous switching action in which the triac's initial switch-on point is not synchronized to the AC power line waveform. Here, R2-D1-ZD1 and C1 are used to develop an AC-derived 10V DC supply, which can be fed to the triac gate via Q1 and hence be used to turn the triac on and off. Thus, when SW1 is open, the optocoupler is off, so zero base drive is applied to Q1, and the triac and load are off. When SW1 is closed, the optocoupler drives Q1 on and connects the 10V DC supply to the triac gate via R3, thus applying full AC mains power to the load.

OPTOCOUPLED SCRs and TRIACS

SCRs (silicon controlled rectifiers)

Parameter	Optocoupled SCR	Optocoupled triac
LED characteristic		
I_F (max)	60mA	50mA
SCR/triac characteristic		
V_{MAX}	400V	400V
I_{MAX} (rms)	300mA	100mA
I_{SURGE} (see text)	5A	1.2A
Coupling characteristic		
Isolating voltage	±1.5kV	±1.5kV
Input trigger current	5mA typical (20mA max)	5mA typical (20mA max)

Figure 20. **Typical characteristics of optocoupled SCRs/triacs.**

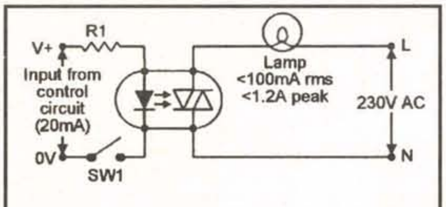

Figure 21. **Low-power lamp control.**

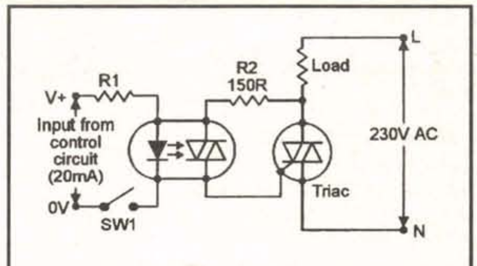

Figure 22. **High-power control via a triac slave.**

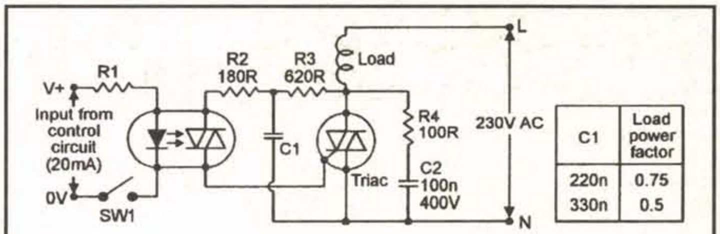

Figure 23. **Driving an inductive load.**

and triacs are semiconductor power-switching devices that (like transistors) are inherently photosensitive. An optocoupled SCR is simply an SCR and an LED mounted in a single package, and an optocoupled triac is simply a triac and an LED mounted in a single package. Such devices are readily available, in both simple and complex forms; some sophisticated triac types incorporate interference-suppressing, zero-crossing switching circuitry in the package.

Figure 19(a) and *19(b)* show the typical outlines of simple optocoupled SCRs and triacs (which are usually mounted in six-pin DIL packages); *Figure 20* lists the typical parameters of these two particular devices, which have rather limited rms output-current ratings, the values being (in the examples shown) 300mA for the SCR and 100mA for the triac. The SCR device's surge-current rating is 5A at a pulse width of 100µS and a duty cycle of less than 1%; the triac device's surge rating is 1.2A at a pulse width of 10µS and a duty cycle of 10% maximum.

Optocoupled SCRs and triacs are very easy to use; the input LED is driven in the manner of a normal LED, and the SCR/triac is used like a normal low-power SCR/triac. *Figures 21* to *23* show various ways of using an optocoupled triac; R1 should be chosen to pass an LED current of at least 20mA; all other component values are those used with a 230V AC supply.

In *Figure 21,* the triac is used to directly activate an AC line-powered filament lamp, which should have an rms rating of less than 100mA and a peak inrush current rating of less than 1.2A.

Figure 22 shows how the optocoupled triac can be used to activate a slave triac and, thereby, activate a load of any desired power rating. This circuit is suitable for use only with non-inductive loads such as lamps and heating elements, using a triac of suitable rating.

Finally, *Figure 23* shows how the above circuit can be modified for use with inductive loads such as electric motors. The R2-C1-R3 network provides a degree of phase-shift to the triac gate-drive network, to ensure correct triac triggering action, and R4-C2 form a snubber network, to suppress rate-of-rise (rate) effects.

OPTOCOUPLED SSRs

An optocoupled solid-state relay (SSR) is a device that can be used as a superior replacement for many types of low-power electromechanical relays. Like a normal relay, it provides complete electrical isolation between its input and output circuits, and its output acts like an electrical switch that has a near-infinite resistance when open and a very low resistance when closed and which – when closed – can pass AC or DC currents with equal ease, without suffering 'offset voltage' losses.

Siemens are the present market leaders in the optocoupled SSR field. Their basic design has an IR LED input stage and a dual n-channel MOSFET output stage that (unlike a dual bipolar transistor stage) does not produce significant offset voltage drops when biased on. The IR LED's output is coupled to the inputs of the MOSFETs via a bank of 25 photovoltaic diodes that – when illuminated – apply a 15V turn-on voltage to the MOSFET gates.

The simplest device in the Siemens range of optocoupled SSRs is the LH1540AT, which is housed in a six-pin package and has an output that acts as a normally-open (NO) single-pole switch. The device has an isolation voltage rating of 3.75kV and a maximum output load voltage rating of 350V. The LH1540AT has three output pins, which allow its two output IGFETs to be used in series for AC operation, or in parallel for DC operation.

When the input LED is passing a current of 5mA, the output can handle maximum load currents of 120mA and has a typical 'on' resistance of 25 ohms when used in the AC configuration, or 250mA and 5 ohms in the DC configuration. The device has typical on/off switching speeds of less than 1mS.

Other devices in the Siemens optocoupled SSRs range include ones that have outputs that act as single-pole or two-pole NC, NO, or change-over switches. **NV**

Newsbytes

HOME DIRECTOR PREVIEWS ITS EXPANDED LINE OF HOME NETWORKING SYSTEMS

Home Director, Inc., the recently launched spin-off from IBM, has previewed the first expansion to its line of breakthrough home networking products designed around the requirements of the digital age. The new product, to be known as the **Network Connection Center**, complements Home Director's existing line of products and offers customers a home networking alternative suitable for larger homes and home-based businesses.

Driving the company's focus on delivering Internet sharing, entertainment, education, and home office capabilities to consumers, the Home Director family of Connection Center products enables homes for the promise of broadband services. With a line of products that include features ranging from advanced telephony and video systems to fast 100MB Ethernet connectivity within the home, the forthcoming product adds to Home Director's leadership position in the home networking category.

"Since entering the home networking marketplace in 1998, Home Director has been dedicated to delivering the best available solutions to its customers," said Mary Walker, president and CEO of Home Director. "With the emergence of high speed Internet and broadband technologies, we needed to evolve our product line to better deliver their benefits to a broader range of homeowners and the new Network Connection Center promises to do just that."

The Network Connection Center takes the best features of Home Director's current line of products and expands them to meet the needs of more homeowners than ever before. Following extensive input from its network of Authorized Home Systems Integrators and new home builders, Home Director has designed the new Network Connection Center for more efficient cable management in a larger home.

The company also worked closely with service providers and technology companies, to better understand the emerging broadband and digital access devices that further enhance the capabilities of a home network. With the input that it received from these communities, Home Director developed a product that not only delivers on the power of today's technologies, but matches its existing Home Network Connection Center's flexibility for handling emerging technologies.

Addressing the needs of an expanded audience, Home Director created the Network Connection Center to deliver the best possible home networking solution to the previously untapped markets of larger homes and home-based businesses. Depending on the configuration, the Network Connection Center includes the capability of handling up to 16 incoming telephone lines going to 128 wall jacks.

To distribute data throughout a large home or small office, the Network Connection Center can be configured to include an eight port (expandable) Ethernet hub. For entertainment, the product matches the existing line of Home Network Connection Centers in distributing up to 16 incoming video signals from sources including cable TV, satellite, security cameras, and DVD or VCRs to any television in the home.

In addition to these features being available today, all of the Connection Centers have the ability to incorporate emerging technologies such as cable and DSL modems, as well as residential gateways and control systems when they are available. By delivering these systems today, Home Director is ensuring that new homes are ready for the future.

The Network Connection Center is the first new product to be demonstrated by Home Director since it separated from IBM.

As an independent company, Home Director is better able to react quickly to changes in market conditions and build the relationships necessary to deliver on the promise of a digital world. The flexible design of its product line, and the entrepreneurial nature of Home Director, provide a platform within which technology partners and service providers can develop and deliver integrated network components that meet consumers needs more efficiently than before.

Understanding the Marketplace

Since it first entered the market in the fall of 1998, Home Director has been determined to lead the home networking marketplace in delivering products that meet the needs of consumers, installers, and builders alike. As this market has evolved, and new technologies have emerged, Home Director has seen the need to evolve its products to meet market conditions.

Consumers

Today's consumers have grown

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PUBLISHER
Jack Lemieux *N6ZTD*

EDITOR
Larry Lemieux *KD6UWV*

MANAGING EDITOR
Robin Lemieux *KD6UWS*

ON-THE-ROAD EXHIBIT COORDINATOR
Audrey Lemieux *N6VXW*

SUBSCRIPTIONS
Abby Madain

CLASSIFIED ADS
Natalie Sigafus

DISPLAY ADS
Mary Gamar

up in the technology age and recognize that their homes need to be able to take advantage of the benefits that it delivers. Internet connectivity, digital satellite or cable television, multiple telephone lines into the home, and advanced home theater systems are just a few of the things that they are demanding. The key to meeting these needs is delivering a solution that addresses these technologies, but also delivers on the promise of emerging ones, such as DSL and cable modems and residential gateways, that will be available tomorrow. The Home Director solution is designed to meet these expectations.

Builders

As consumers become more technology savvy, they are demanding that their homes include a complete technology infrastructure. Over the past two years, builders have seen a dramatic increase in the demand for advanced wiring systems for telephones, video, and computer networking, as well as home entertainment, security, and automated lighting systems. Home Director has focused its efforts on the new home construction industry and has developed in-house expertise on the building process and an understanding of builders' needs both logistically and technically. In doing this, Home Director has become a partner to the industry.

Integrators

The key to Home Director's success in the new home construction industry was its development of the Authorized Home Systems Integrator program. These business partners are local experts, trained and authorized by Home Director to install, service, and support their home networking systems. By creating this standardized program, both consumers and builders have access to professionals they can count on.

The Home Networking Market

Cahners In-Stat Group, Scottsdale, AZ, projects that the home networking market will grow 60%, to $1.4 billion by 2003. Meanwhile, the Yankee Group, Boston, says that by 2003, there will be 10 million internally networked U.S. homes. In-Stat also reports that the home networking market grew sequentially by 18% in the third quarter of 1999, and is expected to reach $137 million in end user sales by the end of 1999.

The demand for web access, as well as the growth of high-speed connections to pipe the Internet into homes, are fueling home networking growth. For example, more than 27.3 million users worldwide are expected to use digital subscriber lines (DSL) by 2003, up from 70,000 in 1998, according to Framingham, MA-based International Data Corp.

Also driving growth are the large number of new housing starts, which now frequently offer so-called structured wiring — a combination of telephone, video, and computer wiring types that work in conjunction to deliver data throughout a home. By 2001, 20% of new single-family housing starts — or 222,000 homes — will feature this type of wiring, according to Dallas-based Parks Associates.

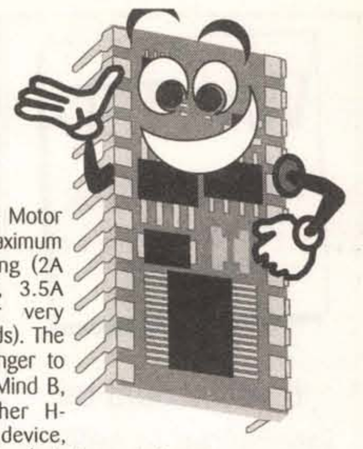
About Home Director

Based in Morrisville, NC, Home Director, Inc. was launched in January of 2000 as an independent, entrepreneurial spin-off of the former IBM Home Networking Solutions unit. As a market leader in the home networking industry, Home Director has built a successful business focusing on both leading edge technologies and strategic channel development.

Home Director products are available across the United States and Canada through a network of Authorized Home Systems Integrators (AHSIs). To locate an AHSI, visit the Home Director web site at www.ibm.com/homedirector or call toll free 1-800-426-7144.

STAMP APPLICATIONS

by Lon Glazner



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

Motor Control Made Easy

Back in August of '99, I wrote an article on the design of, and interface to, a high current H-bridge driver. The H-bridge is a configuration of transistors, which is often used for motor control applications. That design had a couple of drawbacks when used in conjunction with a BASIC Stamp. The most significant drawback was that the BASIC Stamp would have to devote all of its attention to controlling the H-bridge if varying motor speeds were desired.

Overview

A pulse-width-modulated (PWM) signal is typically used to control the amount of power provided by an H-bridge to its load (in this case, a motor). The amount of time that the H-bridge is "on" can be related to the "duty-cycle" of the PWM signal. A 50% duty-cycle correlates to the H-bridge providing half-power to the load (0% relates to no power at the load, and 100% is full power). By adjusting the duty cycle up or down, you can adjust the speed of a motor.

Using a BASIC Stamp to vary the speed of the motor directly doesn't allow your Stamp enough time to do anything else of much use, such as receive inputs from users to modify motor speed. For smaller motors (under 2A continuous), the Motor Mind B can fill in as both the H-bridge and the motor speed controller.

Prior to COMDEX in '98, I designed a BASIC Stamp-based motor control board as a demonstration of the Motor Mind B's capabilities. This system had one BASIC Stamp 2 (BS2) controlling three motor assemblies in conjunction with three Motor Mind B modules.

Defining the Design

When I started thinking of a demo for the Motor Mind B, I wanted to touch on as many of the common motor control requirements as I could. I ended up creating three separate motor control functions that displayed some very common motor control applications which could be implemented with the BASIC Stamp and the Motor Mind B.

The entire demonstration came to be affectionately called the "Gronkulator." For those of you interested in controlling motors with the BASIC Stamp, there may be some information of use to you in this article.

Figure 1 - Motor Mind B, 1" x 1" motor control module
Figure 2 - The Gronkulator in real life

Function 1: Geared 24VDC Motor

The largest motor on the Gronkulator is a 24VDC 1.5A heavily geared motor. Motors of this size, and especially those with gearing, can easily exceed the Motor Mind B's maximum current rating (2A continuous, 3.5A spikes for very short periods). The primary danger to the Motor Mind B, or any other H-bridge device, occurs during fast stops, starts, or during reversing. Geared motors with heavy loads such as the one discussed here can easily zap controlling electronics into silicon slag.

There are a few simple techniques that can be used to prevent damage from occurring to your Motor Mind B based system. For instance, by utilizing the /BRAKE pin on the Motor Mind B, or slowing responses to speed changes introduced by a user, the voltage/current spikes caused by geared motors can be reduced to levels which do not present a danger to the controlling electronics.

This motor control example provides a road map to controlling a heavily geared motor – with a substantial load – via simple joystick input. Motor speed and direction are easily controlled by user input.

Function 2: Self-Regulated Motor Speed

There are some instances where you would like to have your motor speed controlled by an outside stimulus. This can be accomplished with the SPDCON (speed control) command available in the Motor Mind B. In this example, the BS2 tells the Motor Mind B to adjust the motor speed based on a frequency at the Motor Mind B's TACH (tachometer

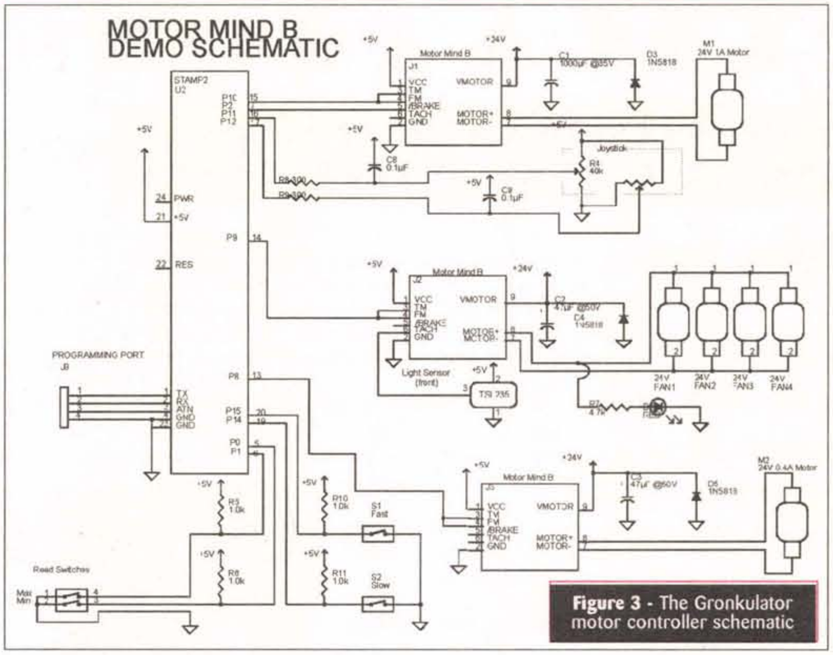


Figure 3 - The Gronkulator motor controller schematic

input). The BS2 sends a desired tachometer frequency to the Motor Mind B during program initialization. The Motor Mind B then adjusts the power to the motor up or down until the frequency input at the tachometer pin matches that of the desired frequency as set by the BS2.

This control method can be implemented with motors that have tachometer, or encoder, output signals. In this instance, however, a somewhat different concept has been implemented. This design has the Motor Mind B controlling four 24VDC fans wired in parallel. A light sensor that outputs a frequency feeds the tachometer input. Adjusting the amount of light reaching the sensor adjusts the speed of the fans. Blocking the light with your finger, or causing a shadow to cover the sensor, adjusts the fan speed. This simulates a temperature-to-frequency conversion circuit that might be used to control fans in an enclosure used by the BS2. Very little program space of the BS2 is required to implement this method of control.

Function 3: Reed Switches and Speed Control

The third motor control function displayed by the Gronkulator introduces position feedback and speed control through the BS2 to the Motor Mind B. This hardware and software combination was used to raise and lower a LCD display located at the top of the Gronkulator. The reed switches determine the upper and lower stop positions for the arm that the LCD display is attached to. A magnet mounted on a stationary portion of this motion system closes each reed switch when it comes into close proximity to the magnet. The switch closure is detected by the BS2 and the motor direction is reversed.

There are additionally two user-input signals that allow the user to speed up or slow down the movement of the arm carrying the LCD.

Code Listing 1: MMBDemo.BS2

```
'MMBDemo.BS2
'
Input        0
Output       2
Input        11
Input        11
Input        12
Input        14
Input        15
'
MotorPin     VAR    Byte
SpeedMot1    VAR    Byte
SpeedMot3    VAR    Byte
Function     VAR    Byte
Speed        VAR    Byte
PotPin       VAR    Byte
Direction    VAR    Byte
Temp         VAR    Byte
PotResult    VAR    Word
'
StopMotor    CON    $00
ReverseMotor CON    $01
StatusCheck  CON    $05
Motor1       CON    10
Motor2       CON    9
Motor3       CON    8
BrakeMot1    CON    2
PotA         CON    12
PotB         CON    11
FastSW       CON    15
SlowSW       CON    14
MaxSW        CON    0
MinSW        CON    1
'*****************************************************************
Initialize:
        HIGH    BrakeMot1
        PAUSE   1000
        SpeedMot3 = $80
        LOW     Motor2
        PAUSE   500
        HIGH    Motor2
        PAUSE   100
        SEROUT Motor2,396,[$55,$04,$46,$50,$01]
        GOTO    MainProgram
'*****************************************************************
MotorSpeed:
        DEBUG   "Speed = ",ISHEX2 Speed,CR
        SEROUT MotorPin,396,[$55,$03,Speed]
        RETURN
'*****************************************************************
MotorFunction:
        SEROUT MotorPin,396,[$55,Function]
        RETURN
'*****************************************************************
MeasurePot:
        HIGH    PotPin
        PAUSE   1
        RCTIME  PotPin,1,PotResult
        RETURN
'*****************************************************************
MotorControl1:
        MotorPin = Motor1
        PotPin   = PotA
        GOSUB   MeasurePot
        debug   "potA ",ISHEX4 PotResult,cr
        If PotResult > $0850 then Forward
        If PotResult < $0750 then Backward
        LOW     BrakeMot1
        Function = StopMotor
        GOSUB   MotorFunction
        RETURN
Forward:
        HIGH    BrakeMot1
        SEROUT MotorPin,396,[$55,$05]
        SERIN   MotorPin,396,100,Forward,[Direction,Temp]
        If Direction <> 0 Then ReverseDirection
                PotResult = (PotResult - $0850)/3
                If PotResult > $FF then UpperLimit
                Speed = PotResult
                Gosub MotorSpeed
                RETURN
Backward:
        HIGH    BrakeMot1
        SEROUT MotorPin,396,[$55,$05]
        SERIN   MotorPin,396,100,Backward,[Direction,Temp]
        If Direction <> 1 Then ReverseDirection
                PotResult = ($750 - PotResult)/3
                If PotResult > $FF then UpperLimit
                Speed = PotResult
                Gosub MotorSpeed
```

The Hardware

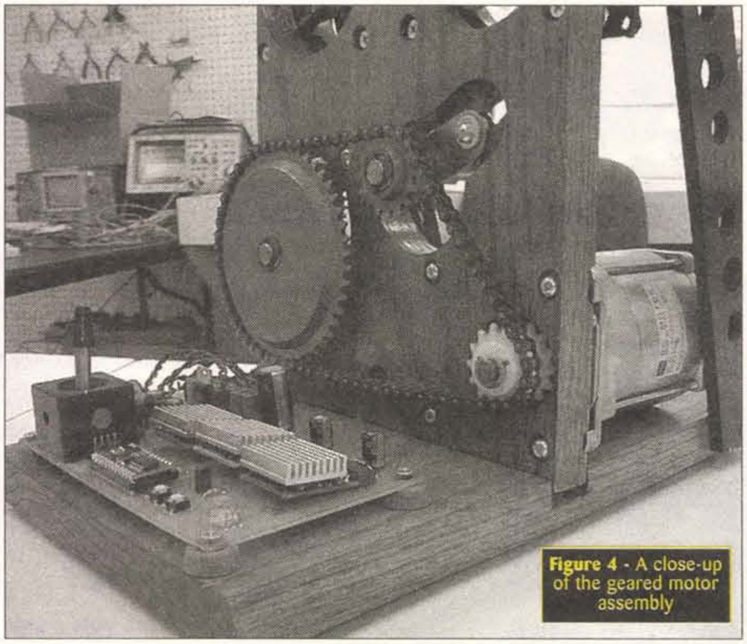


Figure 4 - A close-up of the geared motor assembly

There was quite a bit of customized hardware used in the Gronkulator. All of this hardware was ordered from the surplus company **C&H Sales (www.candhsales.com, 1-800-325-9465)**. I would recommend the C&H catalog to all Stamp hobbyists who are interested in interfacing to mechanical systems. They offer a wide variety of surplus motors, gears, and pulleys.

The schematic for the motion control aspect of the Gronkulator shows the simplicity that the Motor Mind B contributes to motor control.

Data sheets for the Motor Mind B can be downloaded at www.solutions-cubed.com. The Motor Mind B is ideal for simple proportional motor control applications. While it could be used for PID systems, the response time of the serial communication interface, the number of speed steps (255), and the slow PWM frequency, really limit it to motor systems which do not need fast response times. In other words, the Motor Mind B is inadequate for use as a DC motor position controller where a lot of resolution is required (precise positioning is not possible).

The Software

The software for the motor control applications that were used for this demonstration project is pretty simple. The only aspect of the software that requires much in the way of explanation is the MotorControl1 subroutine.

The hardware was designed to allow connections to both of the potentiometers available in the joystick that was purchased from C&H Sales. In the actual application, I only make use of one of these joysticks for speed and direction control of the geared motor (Motor 1). The RCTIME function was used to measure the position of the joystick. Any measurement greater than $0850 (decimal 2128) meant that the motor was supposed to be running in the forward direction. If the RCTIME joystick value is less than $0750 (decimal 1872), then the motor is supposed to be turning backwards. Any value in between $0750-$0850 implements a STOP command.

The motor speed is also calculated from the joystick values received from the RCTIME measurements. Prior to

RESOURCES

For more information on the BASIC Stamp, contact:

Solutions Cubed
Lon Glazner
3029 Esplanade Suite F
Chico, CA 95973
E-Mail:
lon@solutions-cubed.com
www.solutions-cubed.com
Phone: **530-891-8045**
Fax: **530-891-1643**

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Rocklin, CA 95765
phone **(916) 624-8333**
http://www.parallaxinc.com

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Sierra Vista, AZ 85635
phone **520-459-4802**
fax **520-459-0623**
www.seetron.com
info@seetron.com

```
          RETURN
UpperLimit:
     Speed = $FF
     GOSUB MotorSpeed
     RETURN
ReverseDirection:
     LOW    BrakeMot1
     Function = StopMotor
     GOSUB  MotorFunction
     PAUSE  100
     Function = ReverseMotor
     GOSUB MotorFunction
     PAUSE  100
     HIGH   BrakeMot1
     RETURN
'************************************************
MotorControl3:
     MotorPin = Motor3
     If IN0 = 0 then ChangeDirection0
     IF IN1 = 0 then ChangeDirection1
     IF IN14 = 0 then ReduceMot3
     IF IN15 = 0 then IncreaseMot3
     GOTO UpdateMot3
ReduceMot3:
     If SpeedMot3 < $0A then UpdateMot3
     SpeedMot3 = SpeedMot3 - 10
     GOTO UpdateMot3
IncreaseMot3:
     If SpeedMot3 > $F6 then UpdateMot3
     SpeedMot3 = SpeedMot3 + 10
UpdateMot3:
     Speed = SpeedMot3
     GOSUB  MotorSpeed
     RETURN
ChangeDirection0:
     Function = StopMotor
     GOSUB  MotorFunction
     PAUSE  50
     Function = ReverseMotor
     GOSUB  MotorFunction
     Speed = SpeedMot3
     GOSUB  MotorSpeed
WaitForHigh0:
     If IN0 = 0 then WaitForHigh0
     RETURN
ChangeDirection1:
     Function = StopMotor
     GOSUB  MotorFunction
     PAUSE  50
     Function = ReverseMotor
     GOSUB  MotorFunction
     Speed = SpeedMot3
     GOSUB  MotorSpeed
WaitForHigh1:
     If IN1 = 0 then WaitForHigh1
     RETURN
'************************************************
MainProgram:
     GOSUB  MotorControl1
     GOSUB  MotorControl3
     goto   MainProgram
```

sending the new speed to the Motor Mind B, the BS2 requests a STATUS update from the Motor Mind B. The STATUS command causes the Motor Mind B to return its current speed and direction to the Master device (BS2, in this case). The STATUS direction information is used to determine if the current speed and direction calculated from the joystick measurement is the opposite of that being implemented by the Motor Mind B. If this is the case, then instead of implementing the speed and direction from the joystick, the BS2 implements a direction reversal.

When reversing the motor, the BS2 first pulls the /BRAKE pin of the Motor Mind B low, which causes the H-bridge on the Motor Mind B to shut down. It is not necessary to use the /BRAKE when stopping or reversing all motors. But asserting the /BRAKE pin low is the safest way to stop a geared motor and prevent damage to the Motor Mind B or the BS2.

While the /BRAKE pin stops the H-bridge from driving the motor, it does not stop the Motor Mind B from generating a PWM signal to drive the H-bridge (the Motor Mind B, which is a module, consists of both a controller chip, and an H-bridge IC, on a PCB). For this reason, after asserting the /BRAKE pin, the BS2 sends a STOP command to the Motor Mind B which minimizes the duty-cycle generated by the on-board controller to drive the H-bridge IC. When the /BRAKE pin is driven high again, the motor will essentially be stopped.

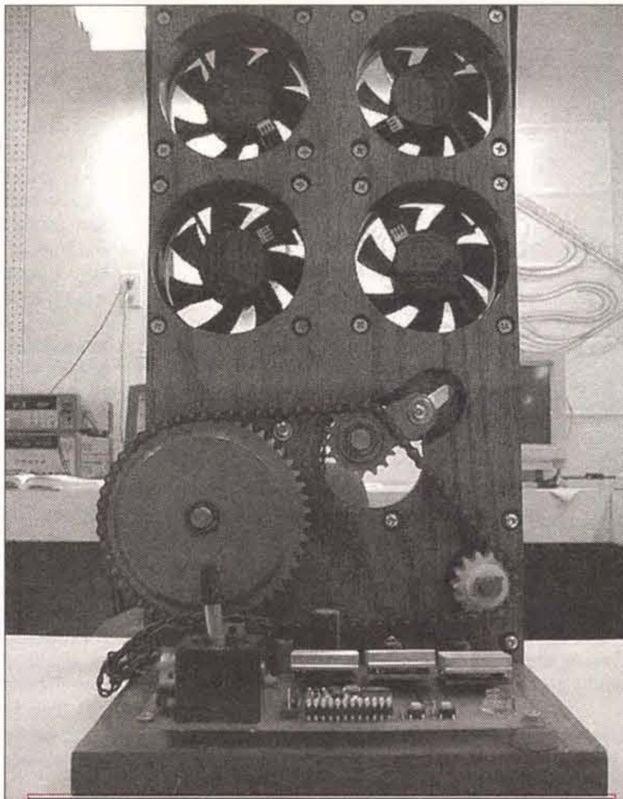
Figure 5 - The Gronkulator wind tunnel and gear system

In addition to the manipulation of the /BRAKE pin and sending the STOP command, the BS2 adds about 200ms of delay time to allow the geared motor to completely stop before the program drives the /BRAKE pin high, and then proceeds. This allows enough time for the mechanical motor to slow down and stop.

The second motor control module in this software occurs in the initialization portion of the program. This occurs when the BS2 sends a SPDCON command to a second Motor Mind B at the start of the program. The SPDCON command sets the desired frequency at the tachometer pin to 18,000Hz.

In addition to setting the desired frequency, the SPDCON command is used to set the "gate-time" of the tachometer function in the Motor Mind B. The gate-time allows the user to optimize the update rate of the speed control function versus the resolution of the tachometer. The slower the update rate of the speed control, the better the resolution of the tachometer. A more detailed account of this functionality can be found in the Motor Mind B data sheet.

Finally, the linear motion device that raises and lowers the LCD display is controlled by a third Motor Mind B via the BS2. The MotorControl3 subroutine tests the reed switch inputs (which close when they are in the proximity of a magnet) and two push button switches which can be used to increase or decrease the motor speed.

If a reed switch is closed, then the BS2 program stops the motor, reverses the motor, and sends the previous speed setting to the Motor Mind B. The program then waits until the reed switch has opened again before exiting the subroutine. Waiting for the reed switch to open prevents the BS2 from re-entering the subroutine and reversing the motor over-and-over again without ever allowing the reed switch to clear the magnet.

If the user-accessible speed control push buttons are pressed, the BS2 will increase or decrease the speed that will be sent to the Motor Mind B. This increases or decreases the rate at which a LCD is raised and lowered. Minimum and maximum speed values are also established to prevent the user from rolling over the byte-sized value that is used to control motor speed.

All things considered, the small amount of software used in this demonstration design adequately display the versatility in BS2 motion control when used in conjunction with a Motor Mind B.

In Closing

There were a few reasons I wanted to write this article on the Gronkulator. But first and foremost is the creativity required, and enjoyment received, in interfacing electronics to mechanical systems. I think that the enjoyment Stamp enthusiasts receive from "making stuff move" shows in the number of Stamp-based robotics projects available from Parallax, and other companies today (like Mondo-tronics; www.RobotStore.com).

Even though the Gronkulator is a couple of years old, I still like to power it up for visitors and allow them to control the various motors and fans, as well as use the talking clock (which wasn't discussed here). I still spend plenty of time thumbing through surplus catalogs searching out funky mechanical systems that beg for a BASIC Stamp controller.

Whether it's via the Motor Mind B or your average RC hobby servo, making mechanical systems has allowed me to explore a side of engineering that I don't typically get involved in. These excursions into mechanical systems have been real eye-openers and have provided me with the kind of fun that can be a catalyst for self-education. If you have the opportunity, find an old box of electro-mechanical junk and make something move. Your Stamp projects will never be the same afterwards. **NV**

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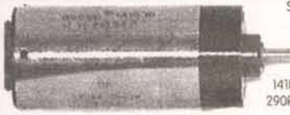
This brand new pump is powered by a three phase, 1HP, AC motor with built in thermal protection. The motor can operate on 200 / 230 or 460 VAC. Completely modular construction for easy maintenance. The unit weighs 78lbs. A super special item only one available. **LEYBOLD D16...............$1695**

NEW! NOW YOU HAVE COLOR (down to 60 ft.) UNDERWATER.

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustabe mount incl. Specs: 1/4" CCD, 350 Lines res., 0.5 Lux sensitivity, AGC, Auto Shutter. 12VDC @120mA, 4mm, 78° FOV lens. A real glass lens. NTSC video out. Superior construction. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area inspection camera. Great for weatherproof general outdoor use as well. **GM-400KW.......$219**

MINIATURE and, PRECISE, PORTESCAP, SWISS, GEARMOTOR.



State of the art "ironless" type, mini motor type M11-210-54-0 with approx: 40:1 gearbox. Size: 16mm d. x 43mm L Operating parameters: @6VDC input, 8mA, 141RPM No Load, @ 12VDC input, 12mA 290RPM No Load. Shown actual size

PORTESCAP, TYPE B: $15ea. 2 for $27, Special....10 for $125

ULTRA MINI and WEATHERPROOF, "LIPSTICK" CAM

Sleek black anodized, alum. housing, O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. <1ounce! IR SENSITIVE. 23mmdX50mm, 36" cable with BNC video & DC barrel jack.

GM-200K, PINHOLE Model. So tiny you can install it directly into a door. Only a 0.9" diameter hole! Specs as above. 90° FOV Pinhole lens. 1/2 once! Size only 23mm d x35mm long. Think of the places you could put this little jewel.

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

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

Like having your own R2D2. Intended for use in fortune 500 board rooms. The video performance is stunning. Superior to almost anything we have seen. Camera and lens is an integral assembly. Excellent Condition. Rugged black ABS enclosure. 8 pin mini-DIN & Std. SVHS jack. Size: 8"Dx6.5"H. Data on using the serial port is provided. The units self test on power up and the video is active. Reg price over $4K **SPECIAL PRICE....$249ea.**

MOTORIZED LINEAR SLIDE, offers 0.001" per step travel.

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

NEWPORT TRANSLATION STAGES.

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

DEL TRON LINEAR SLIDE with CLEVER LEVER

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

TEKTRONIX 2465-DM, 4 Chan., 300MHz, O'Scope, on screen waveform stats & DMM READOUT

One of the most popular & powerful scopes available at a reasonable cost. Features: 500ps/Div sweep, 2mV/Div. vertical sensitivity, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vert. & horiz. scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication.Plus complete DMM ! Complete with 2 probes, and manual. Excellent condition. 90 day warranty. **$2295.**

NEW! LCD COLOR, TFT, ACTIVE MATRIX DISPLAY offers 5.6" VIEWABLE AREA. Available Custom Case with BUILT-IN 12V GEL CELL, charger included. A Professional System.

You asked for it. Finally we found a unit with exceptional quality at an affordable price. Perfect as a portable, general purpose color monitor for standard NTSC color or B&W video systems. Fully compatible with all our cameras as well as Camcorder, VCR's etc. Perfect as a rear view system with any video camera by virtue of its built in, mirror image function. Completely enclosed unit has adjustments for color, contrast and brightness and a volume control for it's internal stereo speakers! Also has a std. 1/4 x 20 Tripod socket and a tilt down stand for table top viewing. Inputs include: audio (L&R) and video on std. 1/8" mini jacks. External 12VDC on std. barrel connector. Specifications: 5.6", TFT active matrix LCD with 76.8K Pixels, CCFL backlight with 270cd/m Luminance. 500mW audio output available on std. 1/8" jack. 12V@600mA powered, 50mV min. or std. line level audio input. Overall size: 6.4"W x 5.25"H x 2.2D" New first quality. An optional accessory kit is available which includes: A luggage quality, custom made, ballistic nylon, padded case with dual removable straps for shoulder and/or holding at waist level for portable, hands free viewing. Built into bottom of case is a 12V rechargeable battery. Also supplied is a complete set of A/V cables. AC power adapter, power switch and charger.

GM-TFT56, with AC power adapter.....$299ea.
GM-ACCYTFT..$35

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

That's right! COLOR! In the same size package too! Sleek aluminum housing fits like a glove! Removeable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "COLOR STEALTH CAM"

- 1/3" • 350 Lines
- 0 .7 Lux • AGC
- Auto Shutter
- Pwr. 6-12V @30mA
- 270k pixels
- Std. 7 mm, 56° FOV lens
- Focus:10mm to inf.
- NTSC video
- 1-ounce!
- Size: 31mm sq. x 28mm d.

GM-4000S-STD w/audio, SPECIAL...$89ea.

B & W "STEALTH CAM", MICRO SIZE, with AUDIO!

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

GM-2000S-STANDARD OR PINHOLE, SPECIAL...$69ea.

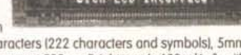
NOW YOU CAN SEE WHAT THE "FISHES ARE DOIN' (down 60 ft.) UNDERWATER B&W CAMERA with INTERNAL, INFRA-RED ILLUMINATOR!

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustabe mount incl. Specs: 1/3" CCD, 400 Lines res., 0.05 Lux sensitivity, AGC, Auto Shutter. 12VDC @225mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote areaa inspection camera. Great for general outdoor use as well. **GM-300KIR.......$179**

NEW, GM960 TIME LAPSE VIDEO RECORDER

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

FUTABA, 2X20 VACUUM FLUORESCENT DISPLAY MODULE



New or like new, model M202SD series. Can directly replace LCD displays. The module includes the VFD, microcomputer and driver. Connects directly to the system bus. Display up to 40 dot matrix, 5 x 7 characters (222 characters and symbols), 5mm H x 3.5mm W with cursor. Display color is green at 505nm. Brightness is 690 cd/m² with four level dimming function. Weight: 5 oz. Size: 6.7"L x 2.6"H x 1" thick. Power required is 5VDC @ 350mA. Serial or parallel interface selectable. Perfect for any high visibility display requirement. With data. ***SPECIAL FUTABA...........$15ea. 3 for $39***

DAYLIGHT/LOW LIGHT MINI CAM & A/I LENS, For dawn 'till dusk

applications. Rugged alum. housing, dual mtg. sockets. 1/3" CCD, 420 lines res., 0.1 Lux sens., AGC, 12VDC @120mA. Take full advantage of camera sensitivity with super, 4mm, f1.4, 78° FOV Auto Iris lens included. BNC video out. 50mm sq. X 65mmL. With pwr. adapt. **SPECIAL, GM-510A/I..$189 or 2/$349**

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

The model SD222-1000 is a NEW & very cool, self contained, alphanumeric, impact printer. Standard parallel port, internal Ni-Cad power supply. Can be powered via the 9VDC pwr. adapter supplied. Standard 2" paper (included) available everywhere. Has self test & diagnostic mode. Can emulate Epson and Citizen 560. It will print from the LPT port of your PC. Very rugged & well made. Perfect for remote printing or data logging application. Size: 8"L x 4.1"W x 3.5"H.
OUR PRICE.......$49ea. or 2 for $75

NEW, 9" SECURITY MONITORS, Hi-resolution,

700 Line, B&W units. 90 day warranty. BNC video in and loop through. Rugged steel case. Current production model. Limited qty. They will make your video look super!
SPECIAL...$119.00ea. 2 for $229.00

10V @ 2.5 AH SEALED, LEAD ACID, PACK.

Each pack has 5, 2 Volt cells. 'D'size cells are arrainged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Perfect for high drain applications. Make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D
SALE! 6-five packs for $20, 40 for $99

6V@12AH SEALED, RECHARGEABLE, BATTERY

New Panasonic, LCR6V12P1. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9"L x 3.7"H x 1.9"D
2 for $20, or 10 for $89

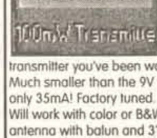
END FIELD of VIEW GUESSWORK! 3.5 to 8mm VARI-FOCAL LENS

Brand New, super f1.8 lens allows you to smoothly adjust from a 97 °FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris. **SPECIAL.....$79ea. or 2 for $149**

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

The GM-412 specs: B&W, size 1.5"sq. X 2.4"L, 250,000 Pixels, **380** Lines Resolution, Sensitivity **0.3** Lux, The GM410 specs: size only 1.5" SQ. x 1.6"L, >270,000 Pixels, **410** Lines Res., Sens. **0.05 LUX.**, Both cameras are 1/3" CCD with AGC & Electronic shutter. 12V @110mA power. NTSC out. IR SENSITIVE, BNC video out, Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform ***ANY*** camera in this magazine. Multi- lens options are available to exploit their superior performance. GM412 shown bottom. GM410 shown top. Prices are less c-mount lens.
GM412......$119, GM410.......$169

WORLDS SMALLEST ••• 100mW ••• VIDEO TRANSMITTER, ON SALE



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

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

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

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

SUPER SPECIAL OFFER, ACCESSORIES to COMPLETE YOUR CO2 SYSTEM!

CO2 Power Supplies: for 100Watt+ Tube.....$495ea.
for 60Watt Tube.........$449ea.
for 35Watt Tube.........$399ea.

Power supplies are removed from equipment, tested and guaranteed.
Note: power supplies are not available without laser tube purchase.
Articulated beam delivery arm with hand piece. Brand new. A fantastic item. with purchase of tube .....$895ea. Arm without laser tube.........$1295ea.

$5000 HI-TECH SURVEILLANCE SYSTEM, 83% OFF!

THIS SUPER SYSTEM INCLUDES:
- ***MOTORIZED, 6X ZOOM LENS***
- ***MOTORIZED, 360 ° PAN***
- ***MOTORIZED, TILT up to 90°***
- ***PHILIPS HIGH RES. 1/2" CCD CAM.***
- ***OPAQUE BLACK INNER DOME***
- ***CLEAR ACRYLIC OUTER DOME***
- ***ZOOM LENS CONTROLLER with A/I***
- ***PAN and TILT CONTROLLER***

Walk into any major department store and you will see these fully integrated systems. Manufactured by Sensormatic, the same company who supplied the Atlanta Olympics! These are late model, new in the box systems. Virtually ready to use. All you add is power and cable.A quality Philips, 1/2", B&W CCD camera provides 450 lines resolution and 0.5 Lux sensitivity! Anodized aluminum construction. Camera plus Pan & Tilt are powered by external 24VAC via the included Pan & Tilt controller. Super 6X, f1.2 motorized, Zoom, Focus and Iris lens provides the capability of "close up" inspections. Zoom lens controller with auto iris control included. Size of dome: 14"diam. Includes mounting kit for drop ceiling installation. Sensormatic price $5000ea. **COMPLETE SYSTEM SPECIAL....$849ea. or 2 for $1599**

Write in 166 on Reader Service Card.

Questions & Answers

TECH FORUM

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

QUESTIONS

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**

Is there a simple way I can add an analog S-meter to my portable AM/FM radio for AM reception only?

2001 **Marvin Rosen**
Baltimore, MD

I have a Techny MC200 microprocessor board (good board, lousy support). It has an RS232 COM port connection which does not have any means to talk to a PC.

Does anyone have or know of software or a flexible/configurable driver to get data from this microprocessor into a PC?

2002 **Jerome P. Johnson**
Salt Lake City, UT

I have an old Allied SX-190 shortwave radio which I need a schematic and possibly an operation manual for.

2003 **Gary**
Deltona, FL

I have a Zenith Data System laptop computer model ZFL 181-92 and cannot find any information about this computer. I need to know the processor speed and size of hard drive.

2004 **Kyle Burlington**
via Internet

Several years, ago several companies advertising in *Nuts & Volts* were offering radar detector testers. No vendors are currently advertising these units now. Does anyone know where I could purchase one?

2005 **Kurt Plowman**
Staunton, VA

I have a radar detector that is X, K, Ka, and laser. It also has "SWS" which looks like some type of local oscillator suppression so the detector does not transmit a readable signal that can be detected by police in states where use of these devices are not legal.

It also has "VG2" alert, occasionally it will alert, and the display will read out "VG@ Alert Radar may be in use." I have never seen any other message displayed, and it is always worded the same. My question is where does this signal come from?

Maybe the radar unit in police cruisers? What frequency, and coding scheme is used? Is the message I see a canned message that is triggered by sending a simple message number code, or is the complete message sent? Basically, what are the details of the VG2 alert messages and where do they come from?

2006 **Ed Pruitt**
via Internet

I want to be able to digitally create and output a musical tone or note directly to one or more speakers.

I am able to generate a frequency using an output port of a micro controller, but it sounds like a buzz rather than a tone.

What do I need to do to digitally create a tone that 'sounds' like music rather than a buzz?

My guess is that I need to layer several frequencies together, but that gets into which frequencies, and if they are digitally generated and output to a single speaker, wouldn't they add together and make a new, lower, frequency? I could easily output to three separate speakers if that is the solution.

2007 **Roger**
via Internet

I need a circuit to reproduce the tone of a chime tube. It needs to be a realistic sound, not something like a cheap doorbell, more like Big Ben.

At one time, the railroads used an artificial bell circuit, for warning purposes, on their switch engines. Something similar is what I'm looking for. Perhaps it's available on a chip by now. It needs to be operable one "Bong" at a time.

2008 **David Schoepf**
via Internet

I am seeking a C-language compiler for the PIC family of microcontrollers. I know that at least one firm makes it, but I've lost their contact information.

2009 **Thomas Ng**
San Jose, CA

I am interested in a circuit that will allow me to maintain the relative brightness of a remote lamp with that of outdoor ambient light levels.

20010 **N. Kuck**
Oak Ridge, TN

I have lost the power supply to my modem and need the voltage and current to get a replacement. The modem is a practical peripherals PM144MT II model #14400FX MT.

20011 **Rick Thompson**
Ramsey, MN

I recently purchased a Velleman PAL to RGB converter, Model K4600. It doesn't seem compatible with my USA video signal.

I can't do the first step of calibration, picture is B/W and RGB controls effect brightness of picture.

What are PAL, composite, and NTSC video and how can I get this box working?

20012 **Carl James**
Patchogue, NY

I have a robot that is controlled with the serial port on my computer. I would like to convert it to USB. Where can I find information on USB and can I access it using QuicBasic?

20013 **Dan Walsh**
Spalding, NE

I need information and/or a schematic on how to connect an HP external 8X CD-ROM drive to 600C. Cables from the HP are evidently not available, since they do not list 600C anymore.

20014 **Bill Ackley**
Cincinnati, OH

I recently had need to configure an antenna distribution system that was roof-mounted and piped both AM/FM signals over the same coax to be distributed to six outlets located 100 ft. from the antenna.

This remote antenna distribution system was built around a RadioShack auto antenna preamp. As a multicoupler, it worked quite well, but I was concerned with driving the length of cable with such a simple preamp.

The RadioShack preamp is about the only one made that amplifies both AM and FM signals and combines the two with simple capacitive coupling.

Is there a better way to drive the length of coax since the spec sheet reads that it is intended for auto coax lengths of about 46"?

I am really looking for a better way to combine amplified AM/FM signals so there is plenty of signal to work with at the other end.

20015 **Ralph Cameron**
via Internet

Is there a simple circuit that someone has designed to enable three keyboards to be physically tied to a PC?

A combination of transistors and an analog switch tied to the port's data line and clock should ensure that the computer "sees" only one

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.
- In most cases, only one answer per question will be printed.
- 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

TO BE CONSIDERED FOR PUBLICATION

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

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

INFORMATION/RESTRICTIONS

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

HELPFUL HINTS

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

keyboard at a time.

20016 **Tony Cervone**
Barrington, RI

I need a simple pulse train transmitter circuit that operates on a frequency of 230 MHz. The ability to vary the pulse is an added feature.

20017 **Antonio J. Anzevino**
Wappingers Falls, NY

What is the best way to build a 15- or 20-watt tube amp for a guitar?

20018 **Guy Beckford**
Aberdeen, MD

I noticed when I recorded on a chip that in play back, when I move the pentometer, the audio speeds up like a 45 RPM record running fast and slows down when I move the pentometer in the other direction passed the clock frequency.

Is this normal for all digital-to-audio chips? Is there audio output at the chip when I'm way beyond that clock frequency I recorded at?

What is the osc. frequency limits of the clock for voice communication?

20019 **William Moore**
Jacksonville, AL

My father recently acquired a Panasonic color video camera, model WV-3160 at an auction. He had thought it was complete with a recorder, but it only came with the camera portion. It has a din-type connector with somewhere between five and seven pins.

I have scoured the Internet with no success for information on this camera. Any information either on the pinout of the connector or a source for purchasing a compatible recorder would be appreciated.

20020 **Karl Bielefeldt**
via Internet

ANSWERS

ANSWER TO #10016 - JAN. 2000

Does someone know where I could get schematics for an Electohome EH580 sound system?

Try writing to: Canadian Electrohome, 809 Wellington St., Kitchener, Ontario, Canada N2G 4J6.

Tony
via Internet

ANSWERS TO #10014 - JAN. 2000

I want to build an AC voltage conditioner for a computer that would monitor the I/P voltage (household 120 VAC) and adjust the O/P to remain at 120 VAC if the I/P falls or rises.

An uninterruptible power source (UPS) may serve your needs. Many companies make them (e.g., APC and Tripplite), they are inexpensive, and they will keep your computer from crashing during a power fault.

Depending on your power quality, you may not need voltage conditioning — a simple UPS may be enough.

Modern switching supplies tolerate wide input voltage variations, so voltage conditioning is not as important. If you need the voltage conditioning, then look closely at the UPS specs because the copyrighters have muddled the issue.

A device that offers brownout protection may supply voltage conditioning — or it may just shutdown during a brownout.

An "online" UPS should work (they charge the battery and supply the load from the battery simultaneously), an "offline" UPS either charges the battery or supplies the load from the battery. An online UPS will cost more.

Gerald Roylance
Mountain View, CA

ANSWER TO #10013 - JAN. 2000

Need a schematic/service manual for a Zenith Model R476 AM/FM clock radio.

Michelle Troutman, 47 N. Main St., Brewer, ME 04412-2007 has the Zenith manual you need. E-Mail: **michelle@acadia.net** or order online at **www.acadia.net/michelle/**

Russell Kincaid
Milford, NH

ANSWER TO #10011 - JAN. 2000

I am looking for a schematic which will allow a laptop computer, through the COM1 or LPT1 port to communicate with HPIB equipped electronic test equipment.

Information on communicating with GPIB devices from a parallel port, with a cable schematic and software drivers developed by Chuck Guzis is available in a download file "PLOTGPIB.zip" available from many shareware distribution sites or contact: **Sydex**, P.O. Box 5700, Eugene, OR 97405; voice **503-683-6033**, Fax **503-683-1622**, data **503-683-1385**.

Chuck McGregor
Seattle, WA

ANSWER TO #10010 - JAN. 2000

I need a resistive heating element to use for igniting a hydrogen flame.

I have heard that nichrome wire

and platinum coatings are preferred as the platinum will act as a catalyst to sustain the burn at a much lower voltage. Where can I find information?

Platinum can indeed be used to ignite hydrogen flames at low temperature. It can also be used to cause catalytic combustion of hydrogen and air mixtures without any heat or electricity at all.

Issues #33, 34, and 35 of ***Home Power Magazine***, P.O. Box 520, Ashland, OR 97520 have articles that would be useful to anyone working with hydrogen systems and catalytic ignition.

Alfa Aesar Chemical Company, 1-800-343-0660 sells platinum and platinum-coated tungsten wires. You might also check your local jeweler, they often stock small quantities of platinum wire and can draw it to the

ANSWERS TO #10015 - JAN. 2000

I have a Collins Model TCZ-2 military transmitter Serial #36 dated 3/16/46. Where can I get a schematic or operating manual?

#1 The best source for military radio operating manuals is Fair Radio Sales out of Lima, OH. They cover manuals going back to WWII and, if they don't have the manual you need, they may be able to guide you to where one can be found. They regularly advertise is *Nuts & Volts.*

Chris
Bieber, CA

#2 The website: www.radioera .com/cds.htm advertises a CD covering Collins radios from 1946 to 1980. Also, contact Michelle Troutman, 47 N. Main St., Brewer, ME 04412-2007. Her website is www.acadia.net/michelle/

Russell Kincaid
Milford, NH

TECH FORUM

ANSWERS TO #1002 - JAN. 2000

I'm driving a stepper motor with a UCN5804B stepper motor driver chip. The motor is mostly idle, but still gets very hot. Is there a MOSFET or other way to turn off power to the motor when it isn't being directed to turn?

#1 Of course, you can use a MOSFET or any other kind of switch to power and depower your stepper motor driver or the set of outputs from the driver to the motor.

However, the reason your stepper motor driver continues to provide power to the stepper after it has arrived at position, is to provide "holding torque." If you depower the motor, it will be very easy for the load's position to drift, due to gravity, or what ever other forces are applied in your application.

In addition to whatever obvious problems that might cause, if your system uses the number of pulses sent to the motor as an estimate of the position of the load, allowing the load to drift will render that estimate inaccurate.

Tom Tillander
Bay Village, OH

#2 The stepper motor operates on pulses, each time it is pulsed on, the rotor moves one "cog" in the magnetic field. I don't have a schematic of the UCN5804B, but it has four drivers which implies that the motor is connected in an H-bridge.

This configuration is never off, so the motor gets hot. What you need is a single driver that pulses the motor on and off. Try disconnecting one side of the motor from the IC and connect it to ground. If it still gets hot, re-connect the other side to ground.

Russell Kincaid
Milford, NH

size you need for experimentation.

John G. Mills
Ben Lomand, CA

ANSWER TO #1008 - JAN. 2000

I have seen an interesting gadget (toy) called the Intel Play QX3 Computer Microscope.

If it works like I think it does, it would make a wonderful basis for experimenting with. Has anybody done anything with the Intel Play QX3?

You can find a review of the Intel Play QX3 microscope at: http://www.zdnet.com/products/stories/reviews/0,4161,2338361,00.html.

The review is generally positive, but points out some limitations. The $100.00 price is attractive, but you probably get a crummy image sensor and a crummy microscope. A reasonable microscope costs more than $500.00. I am leary of the magnification specifications.

A USB camera (without microscope) might serve your needs. Some USB cameras can be found for $50.00, but compare their pixel resolutions and light sensitivity. Most of these cameras are designed for low cost and are difficult to adapt to other uses.

If you want to capture images from a wide variety of optical instruments, your best option is to get a video camera with a C or a CS mount and the appropriate lenses and/or adapters.

Edmund Scientific's industrial optics catalog has some C mount adapters, but they are expensive.

For about $150.00, you can connect a microscope objective lens to a C mount camera — but it's bare bones without provision for focusing, illumination, or positioning.

For about $350.00, there are relay lens systems that convert a standard microscope eyepiece to a C mount — which isn't too expensive if you already have a good microscope and a C mount camera.

There should be similar adapters for telescope eyepieces, but I'm not familiar with any. Astronomical pictures are low light and may require a camera that can do long exposure times — something that inexpensive USB and video cameras may not offer.

Gerald Roylance
Mountain View, CA

ANSWER TO #1005 - JAN. 2000

I have a generator that works fine, the only problem is that it is 110-volts DC at 100 amps. I need a diagram to build a converter to 60-cycles AC, about 2,000 watts.

Waveform is not important because I know how to take care of that problem.

Unless your system was built in the 1940s or 50s, then it may already be an alternator and not a primitive generator system with brushes and commutators, etc.

On top of this, there is always the possibility that this generator is wound for too high a cycle such as 400 Hz or higher, and so, is not suitable for a modification. Thus you must first determine its frequency before attempting any modifications.

First, I suspect that you can go into the generator's bowels and disconnect the "diode bridge rectifier" system and achieve an AC current rather than build a complete inverter system.

If so, then your generator already produces AC, and you should address this at the point of AC, and modify it here to meet your required needs.

One hundred amps? This makes your generator a 12kW generator which is huge by today's standards. After you regulate the RPM to achieve 60 cycles, you should have plenty of wattage left over to run your 2,000 watt operating requirements.

However, if your generator (output frequency) runs at 100 Hz or higher as its standard level, then you may want to consider a new generator all together or use standard "inverter" circuitry to modify your DC to AC, but this circuitry can be rather expensive.

Chris
Bieber, CA

ANSWERS TO #1007 - JAN. 2000

On my computer (COMPAQ PRESARIO 5715) when I go to MSDOS I get WINDOWS and attempt to find the revision level of the DOS in the computer, I can only get the revision level of WINDOWS. How do I find out the revision level of the DOS? I have a book on DOS and if I knew the REV then I would know if the book pertains to the level that I have.

I am a newbie to the PC world.

Note — The remaining answers all pertain to the above question.

#1 Type "ver" at the DOS prompt. This tells you the DOS version number. The requester wasn't specific about which Windows he was running. If you're under Windows 95, it'll say "Windows 95" instead of "Dos X.X."

To go to DOS mode without entering Windows and all its associated overhead which runs in the background, hold down F8 on bootup. This brings up a startup menu which gives several selections. "Command Prompt" will get you the closest thing to pure DOS under Windows 95.

For Windows 3.1, the user should exit Windows as opposed to selecting the icon labled "MS-DOS Prompt."

There is a big difference between a DOS "window" within Windows and DOS itself without Windows hiding in the background.

John M. Carmack
via Internet

#2 For DOS up to Window 95, the command 'VER' did the job.

When one inputs 'VER' in Win95 and Win98 he gets Win95 and Win98 with brackets around the Windows version loaded.

One just must accept that Win95 has DOS 7 and Win98 has DOS 7.1, but one should also remember that the DOS has not changed much since 6.11 or 6.12 so that for the most part, the manual should be close.

Use the help command to get details for the command. Like 'COPY/? This will result in more than you really wanted to know about the command. This, along with the DOS manual you have, will get you through the worst.

Travis Brackeen
Savannah, GA

#3 Your question says "when I go to MSDOS I get WINDOWS." I assume you mean when you start an MSDOS prompt, you get a prompt that says "C:\WINDOWS>."

That is the default for a MSDOS prompt in the Windows environment.

The command for DOS version has always been "VER." In Windows 98, the VER command will report "Windows 98 [Version 4.xxxx]." Even if you boot to a "command prompt" (in effect, DOS), it will still report the Windows version.

Starting with Windows 95, Microsoft wanted to convey the image that Windows wasn't built on DOS. So they tried to eliminate references to DOS wherever possible. One effect is that the VER command returns "Windows xx .."

Another effect is that the DOS directory was changed from C:\DOS to C:\WINDOWS\COMMAND.

Windows 9X does, in fact, sup-

Continued on page 86

ANSWERS TO #1004 - JAN. 2000

I am considering a purchase of a miniature color video camera, but I noticed that they only have about 410 lines horizontal scan. I believe broadcast TV uses 525. Why the difference and what will I lose at the lower scan rate?

#1 A 410 line color camera can offer very respectable image quality and is actually higher resolution than what you will see during playback from your VHS recorder.

Although the color camera's imaging sensor has 410 lines, the actual video signal will be in the NTSC format and your TV will still operate on 525 lines.

The camera has 410 lines of resolution because of its imaging sensor array.

Nowadays, the sensor is an silicon chip based device and comes in several resolution formats. As you can imagine, the more resolution the more they cost. Many micro-sized CCD based color cameras are under 400 lines, so the product you are considering is better than most.

Besides line resolution, there are other issues that are just as important to good camera performance. The lux (light sensitivity) and automatic iris specs should be reviewed, too. But for general use, almost any modern 400+ line CCD color camera will give stunning video.

T. Black
Folsom,CA

#2 You are confusing the total number of horizontal scan lines (525 is correct for broadcast) with horizontal resolution, which is specified in number of lines.

This figure is actually the number of VERTICAL lines that can be resolved in any given horizontal scan line. The more, the better, but there are limits imposed by NTSC composite video standards, and the color subcarrier and associated filtering.

Normal broadcast doesn't go much over 350, and your typical VCR is doing great at 300.

If the camera you are considering will do 410 (these are probably "optimistic lines") it's doing quite well. It will work fine with any NTSC video device, TV, VCR, monitor, etc.

Jim Addie
LaGrange Park, IL

#3 I have seen a similar question answered a few years before in the Tech Forum, but incorrectly.

Nearly every video camera advertised has a standard RS-170 (B&W) or NTSC (color) video output, which has 525 lines of interlaced video, displayed at about a 60 Hz rate. This is the same signal used in North America by VCRs, TVs, and other video equipment.

The number of 'lines' advertised for a given camera refers to the horizontal resolution of the output video, which is a measure of picture quality.

Horizontal resolution is defined as the maximum number of black/white line pairs that can be reproduced by the camera. The same measurement also applies to TVs and video monitors, but a different measurement is used for printed images, where a black/white line pair is counted as two lines.

A horizontal video resolution test pattern looks like a series of vertical stripes on the screen, because what you are measuring is the ability for the video device to vary the signal level from black to white as fast as possible, while the electron beam scans across the screen horizontally.

Horizontal resolution is actually a measure of video bandwidth, with a bit over 80 lines per MHz of bandwidth. Thus, your 410 line camera's video circuitry has about 5.1 MHz bandwidth.

Notice that vertical resolution is fixed by the number of horizontal lines in the video format — in this case, 525. In reality, the actual resolution is a little bit less, because some of those lines are not visible, instead falling off the top and bottom of the screen. Also note that computer monitors do not lose resolution this way, because they 'underscan,' with the electron beam's path actually stopping before the edge of the picture tube.

The higher the horizontal resolution of a camera, the better the image it will produce, and the more expensive it likely will be.

Standard broadcast TV reception is limited to about 350 lines of resolution, because of the need to cut off the video signal near the 4.5 MHz sound IF carrier. So, your 410 line camera is actually a pretty good one, better than most VCRs could record.

Don Rotolo
River Vale, NJ

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HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz $1,400.00
HP 70620B Preamplifier, $3,900.00
1.0-26.5 GHz, for 70000 series
HP 8559A/853A-001 Spectrum An., $3,750.00
0.01-21 GHz, 1 kHz res.,w/rackmount frame
HP 85640A Tracking Generator, $5,000.00
300 kHz-2.9 GHz, for HP 8560 series
HP 8568B Spectrum Analyzer, $8,500.00
100 Hz-1.5 GHz, 10 Hz min. res.
HP 8569B Spectrum Analyzer, $6,500.00
10 MHz-22 GHz, 100 Hz min.res.bw.
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 $275.00
HP 35676A Reflection $1,000.00
Transmission Test Kit, 5 Hz-200 MHz
HP 85027E Directional Bridge, $1,900.00
0.01-26.5 GHz, APC3.5(f) test port
HP 85054A Type N Calibration Kit, for HP 8510 series $1,800.00
HP 8757C-001 Scalar Network $5,500.00
Analyzer; fourth detector input option
HP R85026A WR28 Detector, $1,200.00
26.5-40 GHz, for HP 8757 series
WILTRON 560-98KF50 SWR Autotester, $1,800.00
10 MHz-40 GHz, for Wiltron 560 series

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., $1,900.00
0.1-1050 MHz, 10 Hz res., GPIB
FLUKE 6060B/AK Synthesized $1,900.00
Signal Gen., 0.1-1050 MHz, 10 Hz res.
FLUKE 6062A Signal Generator, $4,500.00
0.1-2100 MHz, 10 Hz res., GPIB
GIGATRONICS 1018 Synthesized $4,500.00
Signal Gen., 50 MHz-18 GHz, 1 MHz res.
GIGATRONICS 600/6-12 $2,500.00
Synthesized Source, 6-12 GHz, 1 kHz res., GPIB
GIGATRONICS 840-18 Freq. $2,750.00
Multiplier, 18-26 & 26-40 GHz outputs 0 dBm
GIGATRONICS 875/50 $2,500.00
Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm
GIGATRONICS 875/86 $3,750.00
Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs
GIGATRONICS 900/2-8 $2,500.00
Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB
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 85100V Frequency Mult., $3,750.00
10-15 GHz in / 50-75 GHz out >0 dBm
HP 8640B Signal Generator, $950.00
0.5-512 MHz, AM, FM, pulse modulation
HP 8656A-001 Signal Generator, $1,600.00
0.1-990 MHz, 100 Hz res., HPIB, OCXO
HP 8657A-002 Signal Generator, $3,250.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8660C/86602A/86632B Synth. $2,500.00
Sig. Gen., 1-1300 MHz, AM / FM
HP 8660C/86603A/86633B Synthesizer, $3,250.00
1-2600 MHz, 1 Hz res., AM / FM
HP 8672A Synthesized Signal $5,500.00
Generator, 2-18 GHz, +3 dBm output
HP 8673G-004,008 Synth. CW $12,500.00
Signal Generator, 2-26 GHz, >+8 dBm output
HP 8684B Signal Generator, $3,000.00
5.4-12.5 GHz, AM/ WBFM/ Pulse

SWEEP GENERATORS

HP 8340B Synthesized Sweep $20,000.00
Generator, 10 MHz-26.5 GHz, AM, FM
HP 8350A/83540A-002,004 $4,000.00
Sweep Oscillator, 2.0-8.4 GHz, 70 dB step attenuator
HP 8350A/83545A-002 Sweep $4,000.00
Oscillator, 5.9-12.4 GHz, 70 dB step attenuator
HP 8601A Generator/Sweeper, $400.00
0.1-110 MHz, +20 dBm levelled
HP 8620C Sweep Oscillator Frame $550.00
HP 86222A RF Plug-in, $1,200.00
10-2400 MHz, +13 dBm levelled
HP 86230B RF Plug-in, $375.00
1.8-4.2 GHz, +10 dBm unlevelled
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled $500.00
HP 86260A-H04 RF Plug-in, $500.00
10.0-15.0 GHz, +10 dBm unlevelled
HP 86290A-004 RF Plug-in, $1,750.00
2.0-18.0 GHz, +7 dBm levelled, rear output
WAVETEK 962 Sweep Generator, $1,250.00
1.0-4.0 GHz, markers, +12 dBm unlvld.
WILTRON 6647M Sweep Generator, $4,500.00
10 MHz-20 GHz, +10 dBm levelled

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, $2,500.00
75-110 GHz (WR10), -20 to +20 dBm
BOONTON 42B/41-4E Analog Power $450.00
Meter, with 1 MHz-18 GHz sensor
HP 435B/8481A Power Meter, $900.00
-30 to +20 dBm, 10 MHz-18 GHz
HP 435B/8481B Power Meter, $1,500.00
0 to +43 dBm, 10 MHz-18 GHz
HP 435B/8482H Power Meter, $900.00
-10 to +34 dBm, 100 kHz-4.2 GHz
HP 436A-022/8481A Power Meter, $1,400.00
-30 to +20 dBm, 10 MHz-18 GHz, HPIB
HP 436A-022/8484A Power Meter, $1,400.00
-70 to -20 dBm, 10 MHz-18 GHz, HPIB
HP 8477A Power Meter Calibrator, for HP 432 series $500.00
HP Q8486A Power Sensor, $1,500.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R8486A WR28 Power Sensor, $1,500.00
26.5-40 GHz, for HP 435/6/7/8

AMPLIFIERS, MISCELLANEOUS

HP 11729B-003 Carrier Noise Test $2,250.00
Set, 5 MHz-3.2 GHz
HP 415E SWR Meter $200.00
HP 8406A Comb Generator, $500.00
1/ 10/ 100 MHz increments, to 5 GHz
HP 8447A Amplifier, 20 dB, $375.00
0.1-400 MHz, 5 dB NF, +6 dBm output
HP 8447D-001 Dual Preamplifier, $900.00
26 dB, 0.1-1300 MHz, NF<8.5 dB
HP 8447E Amplifier, 22 dB, $750.00
0.1-1300 MHz, +13 dBm output
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $2,500.00
HP 8901B-1,2,3 Modulation An., $3,000.00
0.15-1300 MHz, rear input, OCXO, ext.LO
HP 8970A Noise Figure Meter $4,000.00
HUGHES 1177H10F000 TWT $2,500.00
Amplifier, >30 dB gain, 1.4-2.4 GHz, 20 Watts
HUGHES 8010H13F000 TWT $2,500.00
Amplifier, >30 dB gain, 3-8 GHz, 10 Watts
HUGHES 8020H01F000 TWT $4,250.00
Amplifier, >30 dB gain, 2-4 GHz, 20 Watts
RF POWER LABS ML50 $350.00
Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V
ROHDE & SCHWARTZ ESH2 Test $3,750.00
Receiver, 9 kHz-30 MHz

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 $95.00
Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
AVANTEK AMT-400X2 WR28 Active $450.00
Doubler, 13-20 GHz +10 dBm in, +10 dBm out
BAYTRON 3-28-300/10 WR28 Directional $300.00
Coupler, 10 dB, 26.5-40 GHz
BIRD 6735-300 1 kW Load, $650.00
25-1000 MHz, LC(f), with wattmeter
BIRD 8201 500 Watt Oil Cooled Load, DC-2.5 GHz, N(f) $350.00
BIRD 8251 1 kW Oil-Dielectric Load, DC-2.4 GHz, N(f) $500.00
CONTINENTAL MW. $225.00
RAE28-K-M WR28 x K(m) Endfire Adapter
FXR/MICROLAB S3-02N Triple Stub $125.00
Tuner, 200-1000 MHz, 100 Watts max., N(m/f)
FXR/MICROLAB SL-03N Stub Tuner, $75.00
0.3-6.0 GHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance $400.00
Trombone Line, 0-44 cm, DC-2 GHz
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) $300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33321K Programmable Step $475.00
Atten., 0-70 dB, DC-26.5 GHz, 3.5mm
HP 33327L-006 Programmable $1,000.00
Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm
HP 774D Dual Directional Coupler, 20 dB, 215-450 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, $450.00
100-2000 MHz, APC7 test port
HP 83017A Amplifier, $3,250.00
25 dB gain, 0.5-26.5 GHz, >+15 dBm
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) $150.00
HP 8472A Crystal Detector, $175.00
10 MHz-18 GHz, negative polarity, SMA
HP 8494G-002 Programmable Step $350.00
Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8495H-001 Programmable Step $400.00
Attenuator, 0-70 dB, DC-18 GHz, N
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA $375.00
HP 8497K-004 Programmable $750.00
Step Attenuator, 0-90 dB, DC-26.5 GHz
HP K422A WR42 Flat $350.00
Broadband Detector, 18.0-26.5 GHz
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R382A WR28 Direct $2,250.00
Reading Attenuator, 0-50 dB, 26.5-40 GHz
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz $500.00
HP R752C WR28 Directional Coupler, 10 dB, 26.5-40 GHz $450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $750.00
HP V752D WR15 Directional $650.00
Coupler, 20 dB, 50-75 GHz
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45712H-1000 WR22 $900.00
Frequency Meter, 33-50 GHz
HUGHES 45714H-1000 WR15 $900.00
Frequency Meter, 50-75 GHz
HUGHES 45716H-1000 WR10 $900.00
Frequency Meter, 75-110 GHz
HUGHES 45721H-2000 WR28 $1,000.00
Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz
HUGHES 45724H-1000 WR15 Direct $1,000.00
Reading Attenuator, 0-50 dB, 50-75 GHz
HUGHES 45732H-1200 WR22 Level $250.00
Set Attenuator, 0-25 dB, 33-50 GHz
HUGHES 45772H-1100 WR22 $400.00
Thermistor Mount, -20 to +10 dBm, 33-50 GHz
HUGHES 45773H-1100 WR19 $650.00
Thermistor Mount, -20 to +10 dBm, 40-60 GHz
HUGHES 45774H-1100 WR15 $750.00
Thermistor Mount, -20 to +10 dBm, 50-75 GHz
HUGHES 45775H-1100 WR12 $800.00
Thermistor Mount, -20 to +10 dBm, 60-90 GHz
HUGHES 45776H-1100 WR10 $850.00
Thermistor Mount, -20 to +10 dBm, 75-110 GHz
HUGHES 47316H-1111 WR10 $600.00
Tuneable Detector, 75-110 GHz, positive polarity
HUGHES 47741H-2310 WR28 $2,000.00
Phase Locked Gunn Osc., 32.000 GHz, +18 dBm
HUGHES 47742H-1210 WR22 $2,750.00
Phase Locked Gunn Osc., 42.000 GHz, +18 dBm
HUGHES 47974H-1000 WR15 SPST $375.00
PIN Switch, 250 MHz speed, 60-62 GHz response
KRYTAR 2616S Directional Detector, $200.00
1.7-26.5 GHz, K(f/m)/SMC
M/A-COM 3-19-300/10 WR19 $450.00
Directional Coupler, 10 dB, 40-60 GHz
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) $75.00
MIDWEST MICROWAVE 3537 DC $40.00
Block, 0.1-12.4 GHz, SMA(m/f) *NEW*
MINI-CIRCUITS ZFDC-20-4 $25.00
Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $375.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368BNM Coaxial High $500.00
Power Load, 500 Watts, 2.0-18 GHz, N(m)
NARDA 3752 Coaxial Phase Shifter, $1,000.00
0-180 deg./GHz, 1-5 GHz
NARDA 3753B Coaxial Phase Shifter, $1,000.00
0-55 deg./GHz, 3.5-12.4 GHz
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4226-10 Directional Coupler, $275.00
10 dB, 0.5-18.0 GHz, SMA(f)
NARDA 4227-16 Directional Coupler, $325.00
16 dB, 1.7-26.5 GHz, 3.5mm(f)
NARDA 4242-20 Directional Coupler, $100.00
20 dB, 0.5-2.0 GHz, SMA(f)
NARDA 4247-20 Directional Coupler, $200.00
20 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 4247B-10 Directional Coupler, $200.00
10 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) $65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $165.00
NARDA 768-10,-20 10 dB or 20 dB $120.00
Attenuator, 20 Watts, DC-11 GHz, N(m/f)
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 794FM Direct Reading $375.00
Variable Attenuator, 0-40 dB, 4-8 GHz
OMNI-SPECTRA 2085-6010-00 $50.00
Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)
PAMTECH KYG1014 WR42 $250.00
Junction Circulator, 18.0-26.5 GHz
SONOMA SCIENTIFIC 21A3 WR42 $75.00
Circulator, 20 dB, 20.6-24.8 GHz
TEKTRONIX 2701 Step Attenuator, 0-79 dB, $175.00
DC-1 GHz, AC or DC coupled
TRG B510 WR22 Direct Reading $1,000.00
Attenuator, 0-50 dB, 33-50 GHz
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
WAVELINE 100080 WR28 Terminated $200.00
Crossguide Coupler, 30 dB
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) $150.00
WEINSCHEL DS109LL Double $150.00
Stub Tuner, 0.2-2.0 GHz, N(m/f)

COMMUNICATIONS

HP 3780A-001 Pattern Generator / $1,000.00
Error Detector, 1 kb/s - 50 Mb/s
HP 59401A HPIB Bus Analyzer $375.00
MICRODYNE 1200MR 215-320 MHz $750.00
Telemetry Receiver, PSK demodulation
TEK 1410R NTSC Gen., w/SPG2 sync. $800.00
generator, TSG7 color bars
TEK 1411R PAL Gen.,w/SPG12 sync; $750.00
TSG11 color bars;TSG13 linearity
TEK 1411R PAL Test Gen., $1,000.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., $1,100.00
w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16
TEK 1411R-opt.04 PAL Test Gen.,w/
SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 $1,400.00
TEK 147A NTSC Test Signal $800.00
Generator, with noise test signal
TEK 148 PAL Insertion Test Signal Generator $700.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

FLUKE 2180A RTD Digital Thermometer $500.00
HP 7090A Measurement Plotting System $1,500.00
P.A.R. 5206-95,98 Two-Phase $1,500.00
Lock-in Amp., 2 Hz-100 kHz, GPIB
TEK TM5003 5000-series 3-slot $450.00
Programmable Power Module
TEK TM5006 5000-series 6-slot $600.00
Programmable Power Module
TEK TM504 500-series 4-slot Power Module $175.00
TEK TM506 500-series 6-slot Power Module $250.00
TEK TM515 500-series 5-slot Traveller Power Module $250.00

Write in 161 on Reader Service Card.

Events CALENDAR

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

Complimentary issues are available upon request for distribution to your attendees. A street addres 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.

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Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

FEBRUARY 2000

FEBRUARY 4-5

MS - JACKSON - State Convention. Jackson ARC, Ron Brown AB5WF, 601-982-0101 or 601-956-1448. E-Mail: ab5wf@arrl.net Web: http://www.jxnarc.org

FEBRUARY 5

KS - LA CYGNE - Hamfest. Mine Creek ARC, Mike Eyman W0XM, 913-898-4695. E-Mail: w0xm@arrl.net

MI - DEARBORN - Winter Swap. Armenian Community Center, 19319 Ford Rd. 8am-1pm. MI Antique RC, Don Colbert, 313-274-1948. E-Mail: DONSRADIO@AOL.COM

MI - NEGAUNEE - Hamfest. Township Hall, 42 M-35. 9am-3pm. Hiawatha ARA, Bill Beitel N8NRG, 906-226-2779. E-Mail: n8nrg@portup.com

SC - NORTH CHARLESTON - Hamfest. Stall High School. VE Exams. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: brycemyers@aol.com Web: http://www.qsl.net/wa4usn/index.html

FEBRUARY 5-6

FL - MIAMI - Southeastern Division Convention. Fair Expo Center, 10901 SW 24th St. (Coral Way). Sat: 9am-5pm, Sun: 9am-4pm. Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139. E-Mail: w4wyr@bellsouth.net Web: http://www.hamboree.org

FEBRUARY 6

OH - LORAIN - Hamfest. Gargus Hall, 1965 N. Ridge Rd. 8am-1pm. NOARS Winterfest, John Schaaf KC8AOX, 216-696-5709. E-Mail: noars@qsl.net

FEBRUARY 7

AZ - PHOENIX - Hamfest. St. Clement of Rome Catholic Church Social Hall, 15800 Del Webb Blvd., Sun City. Talk-in: 147.30+. West Valley ARC, Fred Jones KC5AC, 623-214-7054. E-Mail: kc5ac@arrl.net

FEBRUARY 11-12-13

FL - ORLANDO - State Convention. Orlando ARC, Ken Christenson KD4JQR, 407-291-2465. E-Mail: KD4JQR@Juno.Com Web: http://www.oarc.org/hamcat.html

FEBRUARY 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MI - TRAVERSE CITY - Hamfest. Cherryland ARC, Joe Novak W8TVT, 231-947-8555. E-Mail: w8tvt@arrl.net

NV - RENO - Hamfest. University of Nevada Radio Pack Club, Gary Grant K7VY, 775-784-6500 ext 276. E-Mail: k7vy@arrl.net

TX - AMARILLO - Hamfest. Potter/Randall County ARES/RACES, Ben Pollard WS5R, 806-342-9930. E-Mail: ws5r@arrl.net Web: http://www.qsl.net/w5wx

FEBRUARY 12-13

TN - MEMPHIS - State Convention. W. Ben Troughton KU4AW, 901-372-8031. E-Mail: bktrough@mem.net Web: http://www.dixiefest.org

FEBRUARY 13

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

FEBRUARY 19

AR - RUSSELLVILLE - Hamfest. AR River Valley AR Foundation, Jonathan Setcer KC5BRY, 501-968-2938. E-Mail: hamfest@setcer.com Web: http://www.cswnet.com/~arvarf/

CA - MONTEREY - Hamfest. Naval Postgraduate School ARC, Will Costello WC6DX, 831-375-8133. E-Mail: wc6dx@arrl.net Web: http://www.k6ly.org/radiofest

MA - MARLBOROUGH - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988

NY - HORSEHEADS - Hamfest. Elmira College Murray Athletic Center, The Domes, NYS Rt. 14. 8am-3pm. FCC Exams. Talk-in: 146.700-. The ARA of the Southern Tier, Gary Sekella N2OKU, 607-739-0134. E-Mail: arast@arast.org Web: http://www.arast.org

OR - RICKREALL - Hamfest. Polk County Fairgrounds, 520 S. Pacific Hwy. W. 9am-3pm. Talk-in:146.86-. Salem Repeater Association & The Oregon Coast Emergency Repeater, Inc., Evan Burroughs N7IFJ, 503-585-5924. E-Mail: n7ifj@teleport.com Web: http://members.xoom.com/kb7cw/sra/index.html

PA - OBERLIN - Hamfest. Citizens Fire Co. VE Testing. Talk-in: W3UU 146.16/76. Harrisburg RAC, Dick Bordner N3NJB, 717-939-4825. E-Mail: N3NJB@aol.com Web: http://hrac.tripod.com

TX - SMITHVILLE - Hamfest. Bastrop County ARC, John Creamer W5QXH, 512-321-1145 or 512-321-1074. E-Mail: jsc@smithsys.net Web: http://www.qsl.net/kb5yae

FEBRUARY 20

CO - BRIGHTON - Hamfest. Aurora Repeater Association, Wayne Heinen N0POH, 303-699-6335. E-Mail: n0ara@qsl.net Web: http://www.qsl.net/n0ara

MA - WESTFORD - Antique Radio Flea Market. Greater Boston Antique Radio Collectors, Tammy DeGray, 978-371-0512. E-Mail: arc@antiqueradio.com

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

NC - ELKIN - Hamfest. Briarpatch & Foot Hills ARCs, Glenn Diamond N4VL, 540-236-6514

NY - CHEEKTOWAGA - Greater Buffalo Winter Hamfest. Luke Calianno N2GDU, 716-634-4667 or 716-683-8880. E-Mail: lcalianno@freewwweb.com Web: http://hamgate1.sunyerie.edu/~larc

PA - CASTLE SHANNON - Hamfest. Volunteer Fire Dept. 8am-3pm. Wireless Association of South Hills ARC, Steve Lane W3SRL, 412-341-1043. E-Mail: w3srl@arrl.net Web: http://www.hky.com/~sanfordb/index.htm

FEBRUARY 26

IN - LA PORTE - Hamfest. Civic Auditorium, 1001 Ridge. 7am-1pm. Talk-in: 146.520 simplex, 146.610 (131.8 PL). Neil Straub WZ9N, 219-324-7525. E-Mail: nstraub@niia.net

GA - DALTON - Hamfest. Dalton ARC, Harold Jones N4BD, 706-673-2291

ND - BISMARCK - Hamfest. CDARC, Kurt Carufel KB0KDG, 701-222-0938. E-Mail: carufel@uswest.net

VT - MILTON - NVT Winter Hamfest. High School, Rt. 7. VE Exams. Talk-in: 145.15 repeat. The RAs of Northern VT, Mitch Stern W1SJ, 802-879-6589. E-Mail: w1sj@arrl.net Web: http://www.ranv.together.com

FEBRUARY 27

FL - ZEPHYRHILLS - Hamfest. Zephyrhills ARC, Ernie Vanselow KD4VRV, 813-783-8389 E-Mail: kd4vrv@gte.net

NY - HICKSVILLE - Hamfest. Levittown Hall, 201 Levittown Pkwy. 9am-2pm. Talk-in: W2VL, 146.85 repeater (136.5 PL). Long Island Moble ARC, Eddie Muro KC2AYC, 516-791-7630. E-Mail: hamfest@limarc.org Web: http://www.limarc.org

OH - CUYAHOGA FALLS - Hamfest. Emidio's Party Center, 48 E. Bath Rd., corner of St. Rd. 8am-2pm. Cuyahoga Falls ARC, Inc., Carl Hervol, 330-497-7047. E-Mail: carlh@pop.raex.com Web: http://www.cfarc.org

VA - ANNANDALE - Hamfest. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021. E-Mail: k3mt@erols.com Web: http://www.erols.com/k3mt/vws

MARCH 2000

MARCH 4

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

KY - CAVE CITY - Hamfest. Mammoth Cave ARC, Larry Brumett KN4IV, 270-651-2363. E-Mail: lbrumett@glasgow-ky.com Web: http://www.scrtc.blue.net/mcarc

NJ - PARSIPPANY - Hamfest. PAL Bldg., 33 Baldwin Rd. Splitrock ARA, Peter Glenn KC2KI, 888-511-SARA or 973-442-7379. E-Mail: KC2KI@qsl.net Web: http://www.ham.hsix.com/sara

TN - KNOXVILLE - Hamfest. Kerbela Temple, 315 Mimosa Ave. 8am-4pm. Talk-in: 144.83/145.43 or 146.52 simplex. Shriners of Kerbela ARS, Paul Baird K3PB, 865-986-9562

MARCH 4-5

FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rickie Brown KF4GXS, 727-863-1457. E-Mail: richar@gte.net. Don KK4VK, 727-848-8000. Web: http://home1.gte.net/koerner/gcarc.htm

MARCH 5

CANADA - BC - WESTMINSTER - Hamfest. Burnaby ARC, Jim McGill VE7IED, 604-946-9801

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

MARCH 10-11

NE - NORFOLK - State Convention. Elkhorn Valley ARC, Fred Wiebelhaus N0VLX, 402-379-1929. E-Mail: dfwiebel@sufia.net Web: http://www.qsl.net/evarc/

MARCH 11

AZ - SCOTTSDALE - Hamfest. Scottsdale ARC, Roger Cahoon KB7ZWI, 602-943-7651. E-Mail: wmgraceco@msn.com

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

CA - LINDA - Hamfest. Yuba-Sutter ARC, Ron Murdock W6KJ, 530-674-8533

CO - CASTLE ROCK - Hamfest. Denver Radio League, Chris Krengel KB0YRZ, 303-789-4736. E-Mail: kb0yrz@yahoo.com

FL - EAST ENGLEWOOD - Hamfest. Tringali Community Center. 8am-1pm. Talk-in: 146.700-. Englewood ARS, George Shreve KA4JKY, 941-697-3445. Web: www.flnet.com/~crosby/ears/index.html

MO - KANSAS CITY - Hamfest. Ararat Shrine, 5100 Ararat Dr. 8am-2pm. Talk-in: 145.13-. Ararat AR Shrine Club, Steve Dowdy WJ0I, 816-941-3392. E-Mail: sdowdy@qni.com Web: http://www.hambash.com

ND - WEST FARGO - Hamfest. Red River Valley Fairgrounds. 8am-3pm. AR license testing. Talk-in: 146.76-. Red River Radio Amateurs, Mark Kerkvliet KG0FR, 701-282-4716. Web: http://www.rrra.org

NH - LONDONDERRY - Hamfest. Lions Club. Talk-in: 146.850. Interstate Repeater Society, Paul Gifford K1LL, 603-883-3308. E-Mail: k1llx@juno.com

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

MARCH 11-12

LA - RAYNE - Hamfest. Rayne Civic Center. AARA. Al Oubre K5DPG, 318-367-3901. E-Mail: k5dpg@arrl.net Web: http://www.acadian.net/w5ddl/

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

MARCH 12

MA - WESTFIELD - Hamfest. Our Lady of the

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@megsinet.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.fivestarshows.com

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

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

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

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

MarketPro, Inc., 201-825-2229.
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.shownsale.com

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

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

Blessed Sacrament Parish Center, 127 Holyoke Rd. Talk-in: 146.94 (neg offset, no PL). Mt. Tom ARA, Cindy Loiero K1ISS, 413-568-1175. E-Mail: kissn1fi@javanet.com
PA - YORK - Hamfest. York County Area Vocational-Technical School. VE Testing. Talk-in: 146.97-. Keystone VHF Club, Dick Goodman WA3USG, 717-697-2490. E-Mail: yorkfest@aol.com Web: http://members.aol.com/yorkfest
WI - WAUKESHA - Hamfest. County Expo Center, N.1 W.24848 N. View Rd. 8am-2pm. Talk-in: 146.820 PL 127.3. SEWFARS ARC, John Breecher N9NWN, 414-835-7035

MARCH 18

CT - POMFRET - Hamfest. Eastern CT ARA, Paul Rollinson KE1LI, 860-928-2456. E-Mail: PaulRollinson@worldnet.att.net
FL - STUART - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841
GA - MARIETTA - Hamfest. Kennehoochee ARC, Charles Golsen N4TZM, 404-252-3303. E-Mail: cgolsen@atlanta.com Web: http://qsl.asti.com/hootch/KARC.html
MI - MARSHALL - Hamfest. Southern MI ARS & Marshall HS Photo Electronics Club, Wes Chaney N8BDM, 616-979-3433
NJ - CLINTON TWP - Hamfest. Cherryville Repeater Assn., Marty Grozinski W2CG, 908-788-2644 or 908-730-2771. E-Mail: w2cg@arrl.net Web: http://www.w2cra@qsl.net
WV - CHARLESTON - Hamfest. Jimmie Hewlett WD8MKS, 304-768-1142

MARCH 18-19

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

MARCH 19

IL - STERLING - Hamfest. Sterling High School Fieldhouse, 1608 4th Ave. Talk-in: 146.25/146.85 W9MEP. Sterling-Rock Falls ARS, Lloyd Sherman KB9APW, 815-336-2434. E-Mail: lsherman@essexl.com
MA - UXBRIDGE - Hamfest. Central MA Public Safety Assn., Mike Baril N1PSE, 508-278-3477 ext 1. E-Mail: info@cmpsa.org Web: http://www.cmpsa.org
OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+ or 442.85+. Toledo Mobile RA, Paul Hanslik, 419-385-5056. Web: www.tmrahamradio.org
WI - JEFFERSON - Hamfest. Tri-County ARC, Katherine Kutz KA9ODI, 920-563-8740. E-Mail: tricountyarc@globaldialog.com

MARCH 24-25

ME - LEWISTON - State Convention. Androscoggin ARC, Ivan Lazure N1OXA, 207-784-0350. E-Mail: ilazure@gwi.net Web: http://www.mainearrl.org/convent.htm
OK - TULSA - West Gulf Division Convention. Green Country Hamfest Assn., Merlin Griffin WB5OSM, 918-622-2277. E-Mail: megriffin@ionet.net Web: http://www.greencountryhamfest.org

MARCH 25

IN - COLUMBUS - Hamfest. Bartholomew County 4H Fairgrounds, Community Bldg., SR 11. 8am-2pm. Talk-in: 146.790/146.190. Columbus ARC, Marion Winterberg WD9HTN, 812-342-4670. E-Mail: carc_in@yahoo.com
IN - MICHIGAN CITY - Hamfest. High School, 8466 W. Pahs Rd. 8am-1pm. Michigan City ARC, Inc., Ron Stahoviak N9TPC, 219-325-9089
FL - PLANTATION - Cy Harris Memorial Free Flea. N.E. parking lot of Motorola, 8000 W. Sunrise Blvd. Talk-in: 146.79. Richard Block KG4CHW, kg4chw@arrl.net
OH - COALTON - Hamfest. Jackson County ARC, Edgar Dempsey KD8XL, 740-286-3239. E-Mail: kd8xl@juno.com
TN - TULLAHOMA - Hamfest. Middle TN ARS, Larry Marshall WB4NCW, 931-455-0070. E-Mail: lmarsh@edge.net
WV - BECKLEY - Hamfest. Plateau ARA & Black Diamond RC, James Martin KC8JSZ, 304-465-1428. E-Mail: w373@ientone.net Web: http://members.spree.com/sip1/plateau

MARCH 25-26

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

MARCH 26

IL - GRAYSLAKE - Hamfest. North Shore Radio Club, Jacob Fishman KF9ZF, 847-291-4160. E-Mail: kf9zf@lightwriters.com Web: http://www.ns9rc.org
OH - MADISON - Hamfest. Lake County ARA, Roxanne N8BC, 440-209-8953. E-Mail: tbrown@ncweb.com Web: http://www.gbhc.org

MARCH 31-APRIL 1

OK - MOORELAND - Hamfest. Tri-State AR Group, Jay Kruckenberg K5GUD, 580-994-2751. E-Mail: redcarpet@pldi.net

APRIL 2000

APRIL 1

CT - WATERFORD - Ham Radio Auction. Senior Center, Rt. 85. Talk-in: 146.730-. RASON, Tony Griggs AA1JN, 860-859-0162. Web: www.rason.org
CA - HANFORD - Swapmeet. Hanford Fraternal Hall, 10th Ave. @ Florinda. Talk-in: 145.11, 147.33, 224.44, 441.900 PL100. The Kings ARC, Rick 559-945-2266 8am-5pm. Doug 559-582-0949 8am-5pm
MO - LEBANON - Hamfest. Lebanon ARC, Micki Jensen KC0EEX, 417-588-2335. E-Mail: mjensen@llion.org
NJ - WEST ORANGE - Hamfest. High School, 600 Pleasant Valley Way. 8:30am-1pm. IRAC, Jim Howe N2TDI, 973-402-6066
TX - BRENHAM - Hamfest. Brenham ARC, Dan Lakenmacher N5UNU, 409-836-8739. E-Mail: lindan@phoenix.net

APRIL 2

CT - SOUTHINGTON - Hamfest. Southington ARC, Chet Bacon KA1ILH, 860-628-9346. E-Mail: chet@chetbacon.com Web: http://www.chetbacon.com/sara.html
NC - KINSTON - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724

APRIL 7-8

Events CALENDAR

WI - MILWAUKEE - Hamfest. Amateur Electronic Supply, Ray Grenier K9KHW, 414-358-4088.
E-Mail: rayk9khw@aol.com
Web: http://www.aes/jam.com

APRIL 8

AR - FORT SMITH - Hamfest. Fort Smith Area ARC, Kelsey Mikel KK5KU, 501-651-7003. E-Mail: kk5ku@amsat.org Web: http://www.qsl.net/fsaarc

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MN - ROCHESTER - Hamfest. Rochester ARC, John Scott N0HZN, 507-285-6522.
E-Mail: n0hzn@aol.com
Web: http://members.aol.com/rarchams

NH - TWIN MOUNTAIN - Hamfest. Town Hall. 8am-2pm. VE Exams. Talk-in: 147.345 (114.8 Hz). North County ARC and LARK, Richard Force WB1ASL, 603-788-4428.
E-Mail: bhabooks@together.net
Web: http://www.qsl.net/k1ncr

OK - LAWTON - Hamfest. Lawton Ft. Sill ARC, Bob Morford KA5YED, 580-353-8074 or 580-355-6120

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

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

APRIL 8-9

FL - SARASOTA - Sarasota Municipal Auditorium, 801 N. Tamiami Trl. Frank Cox Productions, 941-954-0202

APRIL 9

NC - RALEIGH - State Convention. Jim Graham Bldg., NCS Fairgrounds. 8am-4pm. Raleigh ARC, Chuck Littlewood K4HF, 919-992-5851.
E-Mail: k4hf@arrl.net Web: http://www.rars.org

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

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

APRIL 14-15

GA - ATLANTA - Southeastern VHF Conference. Dick Hanson K5AND, 770-844-7002.
E-Mail: k5and@ga.prestigue.net
Web: http://www.svhfs.org

APRIL 14-15-16

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

APRIL 15

AL - ALBERTVILLE - Hamfest. Marshall County ARC, Buddy Smith KC4URL, 256-593-2516.
E-Mail: kc4url@airnet.net

MN - BLAINE - Midwinter Madness. National Sports Center, 1700 105th Ave., N.E. Robbinsdale ARC, Harriet Johanson KB0UPG, 612-537-1722.
E-Mail: k0ltc@visi.com
Web: http://www.visi.com/~k0ltc

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

APRIL 16

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

MI - GROSSE POINTE - Hamfest. South Eastern MI ARA, Jerry Rosner N8FGK, 313-331-3336.
E-Mail: n8fgk@amsat.org
Web: http://members.home.net/semara

APRIL 21-22

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

APRIL 22

ID - IDAHO FALLS - Hamfest. Idaho Falls Elks Lodge, 640 East Elva. Talk-in: 443.00+, 147.15+. Eastern ID UHF Society, Jay Greenberg WA4VRV, 208-524-1388 or 208-526-7033.
E-Mail: wa4vrv@srv.net
Web: http://www.srv.net/~wa4vrv/hamfest.htm

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

APRIL 29

AL - MOULTON - Hamfest. Bankhead ARC, Rex Free KN4CI, 256-905-0822.
Web: http://www.homestead.com/n4idx

IA - DES MOINES - Hamfest. Des Moines RAA, Duane Bower WB0UCY, 515-287-6542.
E-Mail: duaneab@uswest.net

IL - STICKNEY - Hamfest. DuPage ARC, Ed Weinstein WD9ARY, 630-985-9256. E-Mail: DARCHamfest@aol.com
Web: http://www.w9dup.org

SC - SPARTANBURG - Hamfest. County Fairgrounds, 275 W. Bishop St. 8am-3pm. Blue Ridge ARS, Inc., Robert G. Watson W4RGW,
E-Mail: w4rgw@arrl.net

APRIL 30

DE - NEW CASTLE - State Convention. Nur Temple, Rt. 13. 8am-1pm. VE testing. Talk-in: 146.955- or 224.220/R. Penn-Del ARC, Hal Frantz KA3TWG, 302-793-1080.
E-Mail: hfrantz@snip.net
Web: http://www.magpage.com/penndel

IL - ARTHUR - Hamfest. Moultrie/Douglas County Fairgrounds. 8am-1pm. Talk-in: 146.055/146.655 & 449.275/444.275. Moultrie ARK, Ralph Zancha WC9V, 217-543-2178 days and 217-873-5287 eves.
E-Mail: rzancha@one-eleven.net

OH - ATHENS - Hamfest. Athens County ARA, John Cornwell NC8V, 740-593-6474.
E-Mail: jcornwell@eurekanet.com

MAY 2000

MAY 5-6

LA - BATON ROUGE - State Convention. Baton Rouge ARC, Herb Ramey W5LSU, 225-654-6087.
E-Mail: w5lsu@worldnet.att.net

MAY 6

AZ - SIERRA VISTA - Hamfest. Cochise ARA, Raymond Berger W1LYT, 520-378-4214

CO - MONUMENT - Hamfest. Pikes Peak RAA, Robert Ryals KI0GF, 719-265-9950.
E-Mail: rryals@pcisys.net
Web: http://www.qsl.net/ppraa/swapfest.htm

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

MAY 6-7

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

Events CALENDAR

MAY 7

MD - HAGERSTOWN - Hamfest. Antietam Radio Assn., Tina Jones KB8ZQM, 304-728-7769. E-Mail: kb8zqm@intrepid.net Web: http://www.qsl.net/w3cwc

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

PA - WRIGHTSTOWN - Hamfest. Warminster ARC, Roy Conners K3TEN, 215-947-9373. E-Mail: k3ten@arrl.net Web: http://www.voicenet.com/~k3dn

MAY 12-13

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

MAY 13

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MAY 13-14

CA - FERNDALE - Hamfest. Humboldt ARC, Marcy Campbell KE6IAU, 707-442-3866. E-Mail: marcidon@quik.com Web: http://www.humboldt.com

WA - YAKIMA - State Convention. Yakima ARC, Jack Wrenn N7KNO, 509-249-0897. E-Mail: n7kno@arrl.net Web: http://eagle.ykm.com/~w7aq/hamfest.html

MAY 19-20-21

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

MAY 20-21

IL - ELGIN - CoCoFEST. Elgin Plaza Hotel, 345 W. River Rd. Tony Podraza 847-428-3576. E-Mail: tonypodraza@juno.com

MAY 21

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

MAY 26-27

MS - PASCAGOULA - Hamfest. Civic Center, Jackson County Fairgrounds. Fri: 5-9pm, Sat: 8am-2pm. VE testing. Talk-in: W5WA 145.110-. Jackson County ARC, Charles F. Kimmerly N5XGI, 228-826-5811. E-Mail: montehat@datasync.com

MAY 27-28

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

JUNE 2000

JUNE 2-3-4

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

JUNE 3

ME - HERMON - Hamfest. Pine State ARC, Edward Richardson K1DTW, 207-825-4417. E-Mail: edandglo@earthlink.net

NJ - TEANECK - Hamfest. Bergen ARA, James Joyce K2ZO, 201-664-6725. E-Mail: @cybernex.net Web: http://www/bara.org

JUNE 3-4

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

JUNE 4

IL - PRINCETON - Hamfest. Starved Rock Radio Club, Alan Erbrederis N9PIB, 815-498-9675. E-Mail: w9mks@arrl.net Web: http://www.qsl.net/w9mks

PA - BUTLER - Hamfest. Breezeshooters ARC, H. Rey Whanger W3BIS, 412-826-8006. E-Mail: w3bis@breezeshooters.net Web: http://www.breezeshooters.net

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-335-9139. E-Mail: N4YIC@arrl.net or patnjack@erols.com Web: http://www.qsl.net/olevahams/

JUNE 9-10

TX - ARLINGTON - State Convention. HAM-COM, Maury Guzick W5BGP, 214-804-0680. E-Mail: chairman@hamcom.org Web: http://www.hamcom.org

JUNE 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MO - MACON - Hamfest. Macon County ARC, Dale Bagley K0KY, 660-385-3629. E-Mail: n0pr@arrl.net Web: http://www.cyberusa.com/~kfoster/hamfest.htm

NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm

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

JUNE 11

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

NY - BETHPAGE - Hamfest. Long Island Mobile ARC, Ed Muro KC2AYC, 516-520-9311. E-Mail: hamfest@limarc.org Web: http://www.limarc.org

OH - CANFIELD - Hamfest. Twenty Over Nine ARC, Don Stoddard N8LNE. E-Mail: n8lne@juno.com

OH - SUFFIELD - Hamfest. Goodyear ARC, Fred Mealy KC8BQX, 330-665-4563. E-Mail: fmealy@earthlink.net

TN - KNOXVILLE - Convention. RAC of Knoxville, David Bower K4PZT, 423-670-1503. E-Mail: rack@korrnet.org Web: http://www.kormet.org/rack

JUNE 17

MO - HOUSTON - Hamfest. Ozark Mountain Repeater Group, Blanche White N0FLR, 417-967-3000

NJ - DUNELLEN - Hamfest. Raritan Valley Radio Association, Fred Werner KB2HZO, 732-968-7789. E-Mail: wb2njh@aol.com Web: http://www.w2qw.org

JUNE 18

IN - CROWN POINT - Hamfest. Lake County ARC, Rick Terpstra WN9Z, 219-696-8324. E-Mail: terpstra@netnitco.net

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By George Trinkhaus

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Tesla Coil

96X004 $4.95 each

Secret of Tesla's Radio & Wireless Power

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RC3120D	5" x 16¾" x 13"	58.00
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AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

We've gone way past mere chaos here this month and are galloping headlong into full uproar. Y2K didn't get us, but we're the victims of a bug nonetheless, an ailment that strikes many Americans, though more usually in Spring or Autumn.

We're gathering together all the loose screws, gears, and baby 'bot wheels, packing them in boxes, and moving the whole caboodle down the Ohio river, to a small town clear in the next county.

That's right, folks, the Robot Ranch is shifting from its current rented digs to a permanent base. My wife and I have purchased a well-lighted basement workshop in small-town Ambridge, PA, a place where free-range robots buzzing around in the night won't irritate the neighbors. The workshop comes with other conveniences upstairs, too: a kitchen, a dining room, a living room, three bedrooms, a roof, etc., all designed to enhance workshop productivity.

But, the thing is, until I get those gears, wheels, and screws all safely unpacked in their new home, productivity here in the old Robot Ranch is going to plummet. Has plummeted. Which is a long way of saying that I don't have the I2C high-level master routines done yet — worked on 'em! — and I can't make any promises for next month, either. What I can do, though, is continue the motor driver tutorial and let y'all know what I've been reading lately (aside from mortgage contracts and real estate listings).

In other business ... last month, I published a comprehensive list of robotics clubs. I made a couple errors in the list (big surprise), which I get to correct this month (see sidebar).

I also mentioned something about a prize for another Lonely Gearhead drawing. This is the deal: If you live somewhere where there is not a robotics club, drop me a line with your contact info. You will not only be helping weave together far-flung threads of the amateur robotics community, you'll also be eligible for a drawing of Karl Lunt's new book, *Build Your Own Robot!*, just published by A K Peters. All entries must be received by March 1, 2000, and you can't be a personal friend or relative of mine. You know the drill. I will publish the names and any new club listings in the April issue of this magazine.

I am not selling your names, nor will you get spam on account of me. I have two motivations: First, I want there to be more robot clubs in general; second, I want there to be a robotics club here in southwest Pennsylvania.

Bipolar Transistor H-Bridge

Last time, I introduced some basic concepts of controlling motor speed and direction with pulse-width-modulation (PWM) and H-bridge circuits. I showed two unidirectional solid-state motor drivers, but both bidirectional motor drivers required relays to reverse the motor current. This time, I will show two simple H-bridges that are completely solid-state: one using bipolar transistors, the other using MOSFETs.

For both circuits, I used a 12V, 300 RPM Barber/Colman gearhead motor (#FYQF-63310-9) as the test motor with an RC snubber network with a resistance value of 47 ohms and capacitance of 0.0033µF.

Since a bipolar transistor conducts in only one direction when saturated ON, it must have an anti-parallel-connected "freewheeling" diode to conduct recirculating current in the opposite direction. Sometimes this anti-parallel diode is referred to as a "protection" diode because it prevents large negative or positive voltage spikes from forming across the transistor.

Remember, those spikes are a natural consequence of the motor's inertia and inductance attempting to keep current flowing through the motor's windings when the transistor supplying that current shuts OFF. The low-side diodes keep the negative spikes from going any lower than one diode drop below ground, while the high-side diodes keep positive spikes from rising any higher than one diode drop above B+.

This combination of four freewheeling diodes is used extensively

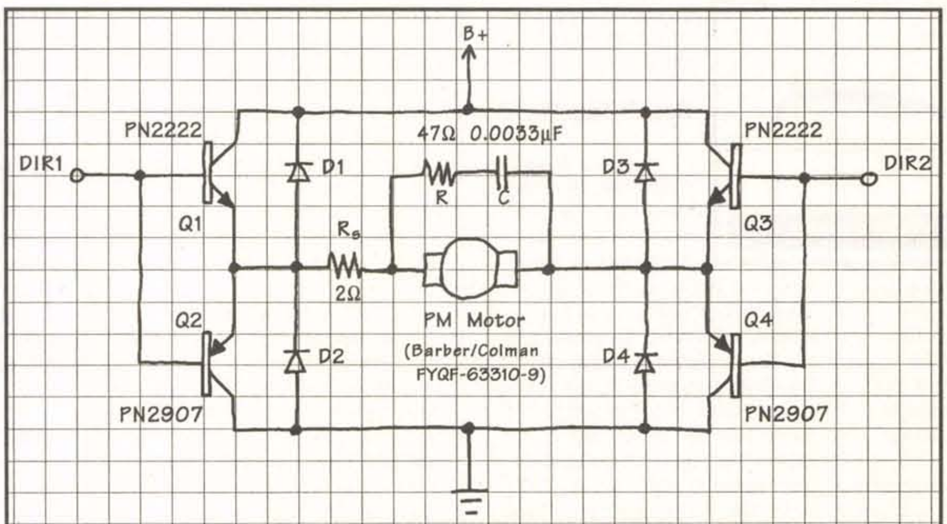

Figure 1: Bipolar Transistor or H-bridge

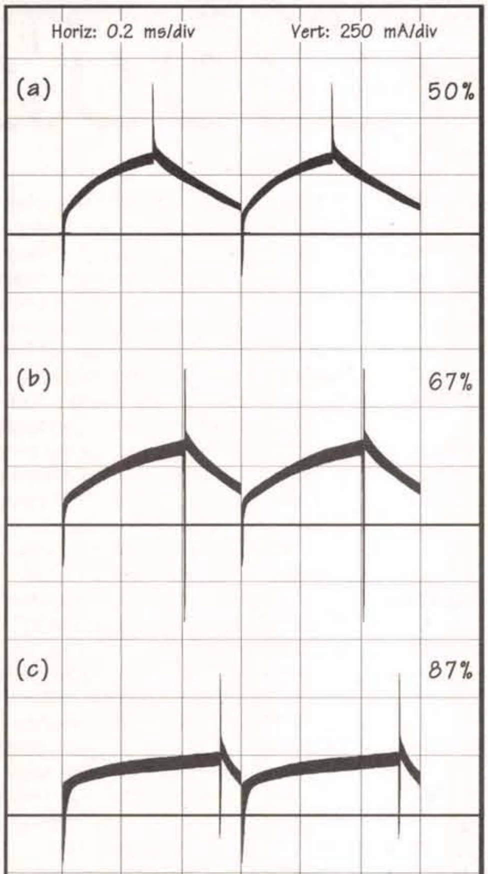

Figure 2: Bipolar PWM Current

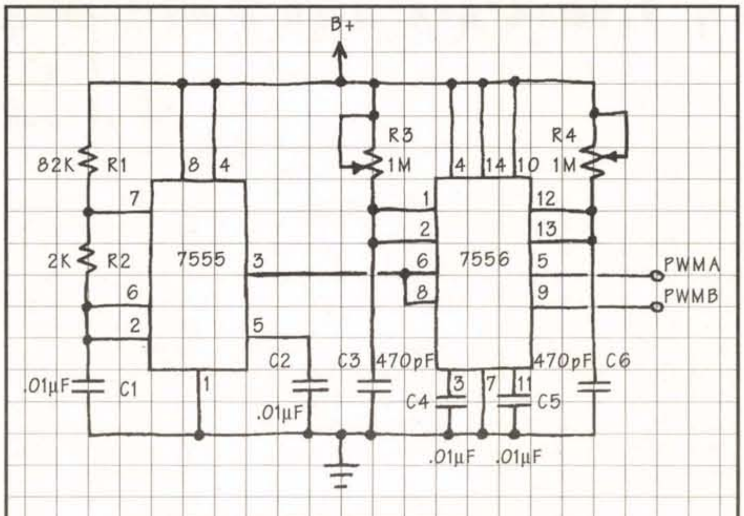

Figure 3: PWM Generator

elsewhere in electronics where it's known by a more familiar name: the full-wave rectifier bridge. In fact, diodes D1 through D4 in Figure 1 are actually part of a four-pin DIP package full-wave rectifier available from RadioShack (#276-1161).

The positive pin is connected to B+, the negative to ground, and the two AC "input" pins are connected to the positive and negative leads of the motor. A high-performance circuit would use individual high-efficiency, high-speed rectifier diodes, but the four-pin DIP package is particularly convenient to use because it requires half the connections of a circuit using individual diodes.

Bench-Top PWM

Figure 3 shows a simple two-channel PWM signal generator I used to drive the DIR1 input of the H-Bridge. Only one output channel is used, though you can use both PWMA and PWMB if you want to test two separate H-bridge circuits. The PWM frequency remains constant at a value determined by R1, R2, and C1 of Figure 2 (about 1.7 KHz in this case). A high level on DIR1 biases Q1 ON, and Q2 OFF. With DIR2 tied to ground, Q4 will always be ON and Q3 will always be OFF. The current follows the path through Q1, the motor, and Q4.

Both the high-side NPN and low-side PNP transistors are operated in Common Collector ("Emitter Follower") mode. So, as long as the PWM driving signal remains between B+ and ground, no base current limiting resistors are needed, which makes the circuit quite simple. Common-emitter mode would be more efficient (lower Vce saturation voltage, thus more voltage left over for the motor), but you can't just tie the high-side and low-side transistor bases together in a common-emitter circuit (but if you do, be sure to wear eye protection ...).

Common-emitter H-bridges require base resistors for each transistor and separate high-side and low-side drive circuits to prevent the base current of the high-side PNP transistor from turning on the low-side NPN transistor of the same branch. I opted for the simpler common collector circuit.

In order to show the behavior of both normal and recirculating currents, I inserted Rs, a two-ohm resistor, in the motor current path. By measuring the voltage across Rs with an oscilloscope and applying Ohm's Law (I=V/R), I determined the dynamic current flowing through the motor windings for various PWM duty cycles. The results are shown in Figure 2. If I were to do the measurements again, I'd use a smaller sense resistor (half an ohm, say) so its resistance would have less effect on the results.

Note that, for the sake of simplicity, I didn't include any circuitry to prevent shoot-through current spikes, which occur whenever both transistors of one leg of an H-bridge are conducting. Depending on how fast the DIR inputs change state, the conducting transistor may not have enough time to turn OFF before its complementary transistor turns ON, resulting, for an instant, in a very low impedance path between B+ and ground. A more robust design would include a method, hardware, or software, to ensure that there is a small dead-zone time delay between a high-side transistor turning OFF and the low-side transistor turning ON, and vice versa. Though I haven't checked, I suspect that shoot-through current may be the cause of the large positive and negative current spikes seen in Figure 2.

With a PWM 50% duty cycle on DIR1 (Figure 2a), the gearmotor barely moved and could easily be stalled. Whenever this happened, the overall voltage seen across Rs rose because the back EMF of the motor was no longer "fighting" the current, in effect decreasing the impedance of the motor. At a 67% duty cycle (Figure 2b), the motor ran only slightly faster, but much

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Email:	wbenson@ibm.net
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Address:	Castro Middle Scool 4600 Student Lane San Jose, CA 85130
Telephone:	(408) 874-3300
City & State:	**Atlanta, GA**
Group Name:	Atlanta Hobby Robot Club
Contact:	C. Barry Ward, president
Email:	cbward@abraxis.com, robotclub@idea-vision.com
URL:	www.botlanta.org
Meetings:	10:00 AM on the Last Saturday of each month
Address:	Radioshack.com 5600 Buford Hwy NE Doraville, GA 30340
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Group Name:	Central Illinois Robotics Club
Contact:	Jim Munro
Email:	jimmn@xnet.com
URL:	www.circ.mtco.com/
Meetings:	3rd Sunday of month (except Holidays) @ 1:00 PM
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Group Name:	Twin Cities Robotics Club
Contact:	Rand Whillock (whillock@htc.honeywell.com)
Email:	tcrobots-request@orbis.net
URL:	www.tcrobots.org/
Meetings:	3rd Thursday of each month, 7 to 10 PM Science Museum of Minnesota in St. Paul
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Group Name:	CMU Robotics Club
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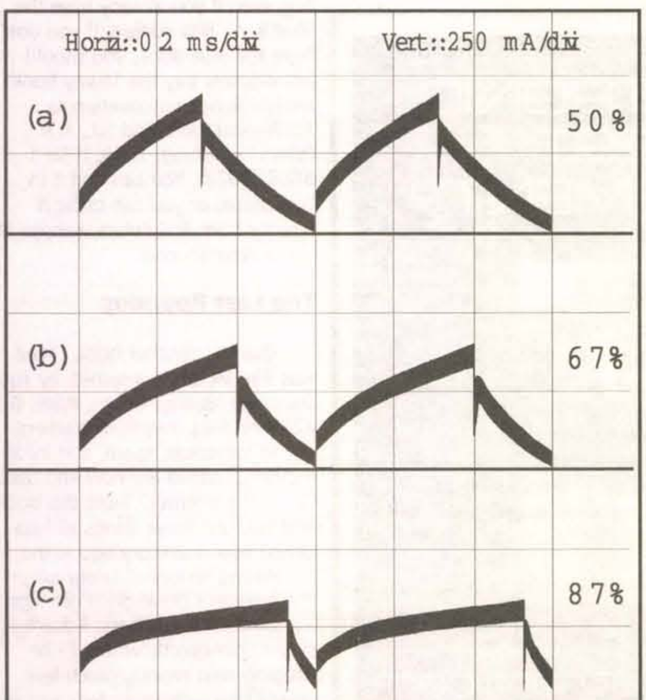

Figure 4: MOSFET PWM Current

more solidly and with less inclination to stall. At 87% (Figure 2c), the motor ran at nearly full speed.

The particular transistors I used for this test circuit weren't really suited to handle the currents demanded by the Barber/Colman gearhead. They ran very hot to the touch (I got a blister on one finger as proof), and I fried a half dozen of them in the course of my experiments. For lower current motors, such as the tape recorder-style motors, the circuit works fine.

Power MOSFET H-Bridge

Bipolar transistors are cheap and easy to apply for low-current circuits, but for higher currents, nothing can beat the ruggedness and simplicity of power MOSFETs. Figure 4 shows an H-bridge made from complementary P-channel and N-channel MOSFETs.

Here, both high- and low-side MOSFETs are connected to Common Source, the equivalent of Common Emitter in the bipolar world.

In the case of MOSFETs, though, common source topology does allow you to tie the high- and low-side gates together without fear for the high-side switch somehow turning the low-side switch ON.

Power MOSFETS have intrinsic anti-parallel diodes built in, so separate free-wheeling diodes aren't automatically needed. Finally, one of the more endearing characteristics of MOSFETs is that they conduct equally well in both directions when biased ON. This means that recirculating current can flow "backward" through a MOSFET with potentially lower voltage drop than if forced to flow through an anti-parallel diode.

I tested this circuit using the PWM generator of Figure 2 to drive DIR1 but, in this case, when DIR1 is high, the low-side MOSFET, Q2, turns ON and the high-side turns OFF. With DIR2 tied high, motor current goes through Q3, the motor, then Q2, opposite the case of the first circuit.

To keep my current measurements positive, I simply reversed my scope probes from the previous setup. The results are shown for 50%, 67%, and 87% duty cycles in Figure 5.

The motor ran noticeably faster at all three PWM duty cycles, which I attribute to the lower voltage drops across the MOSFETs as compared to the bipolars. Also, the motor could be run at duty cycles lower than 50%; the motor I tested operated satisfactorily as low as 33%.

Notice the waveforms are also relatively free from current spikes as compared with the bipolar waveforms. I noticed the "singing" of the gearmotor wasn't as loud, which may be a result of the cleaner waveform.

Yeah, but which one?

Which circuit would I choose? That would depend on the size and current required and cost constraints. The MOSFET circuit will outperform any comparable current-capacity bipolar circuit, but P-channel MOSFETs are more than twice the cost of their N-channel counterparts, so MOSFET H-bridges can be more expensive on the basis of the power transistor elements.

The MOSFET circuit presented here could be used for up to, say, 10 amps with suitable heatsinking. Scaling up the bipolar circuit to such levels quickly becomes a headache since a bipolar power transistor capable of handling 10 amps needs up to 1 amp just for base current, making base drive circuitry mandatory.

The MOSFET circuit can be driven directly by CMOS (as long as Vdd of the CMOS logic is powered from B+; if it's powered by +5V, you'll need some level-translation hardware). In the end, the costs tilt a little towards the MOSFET circuit. If P-channel MOSFETs were cheaper (something not likely to happen soon), it would be no contest.

Since N-channel MOSFETs are cheaper, how about just using N-channel MOSFETs for the whole H-bridge? Next time, I'll show some circuits that do just that.

The Tawny Book

"Inspiration to Implementation" was the subtitle to the 1993 breakthrough classic *Mobile Robotics* by Anita Flynn and Joseph Jones. Over the last seven years, the "Blue Book" introduced a whole generation of robot-builders to the marvels of microprocessor-based robotics. It was the first book to thoroughly cover all the issues today's robot builder encounters in the quest to build a mobile robot — everything from microcontroller electronics and prototyping, to batteries and subsumption programming. The book stood alone in its class, providing high-quality project plans and software for two simple robots — Tutebot and Rug Warrior — as well as invaluable general advice and hints for building any robot.

As testament to how good the book really was, *Mobile Robots* went through a dozen reprintings, and was translated into Japanese, French, and German (officially, at least; I'd be surprised if there aren't

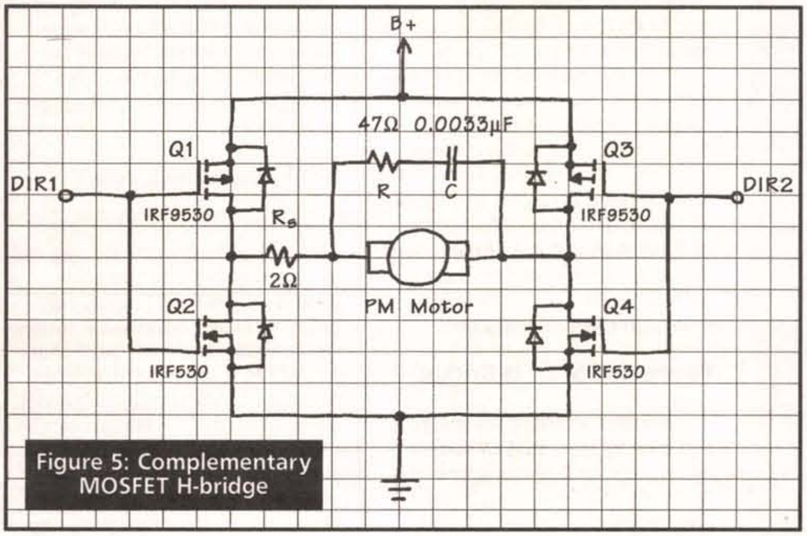

Figure 5: Complementary MOSFET H-bridge

a few unauthorized translations in other languages floating around).

For all the above, there were a few flaws in the Blue Book. I never much cared for the emphasis on LEGO components, which I always found expensive and hard to obtain in small quantities. I also would have liked to have seen more examples of robot software than Anita and Joe presented. Finally, the appendices listing suppliers and other information sources were written before the advent of the Web.

Well, all these problems – and more – have been addressed in the updated second edition of *Mobile Robotics*. It's no longer blue (at least the soft cover version isn't – more like brown and orange; I'd say it's tawny), but the best has gotten even better: the authors have expanded chapters, added more chapters, more appendices, and, well, more authors (Bruce Seiger, whose students beta-tested material from the first edition, is now listed as a co-author).

They've done away with the LEGO parts originally used for Tutebot in Chapter 2 and replaced them with Fischer-Technik components. I haven't worked with Fischer-Technik parts, but what I've seen looks quite interesting.

They've expanded Chapter 3 to include more microcontroller interfacing hints and examples, and Chapter 5 covers more sensors, as well as driver code to support them.

More Code, More Code!

The big win for people like me who wanted to see more robot software projects is they've added an entirely new chapter; Chapter 10 details some approaches to producing various interesting robot behaviors. They've given these behaviors intriguing names such as "Lewis and Clark" (a program which attempts to keep Rug Warrior moving and exploring new territory), "Moth" (a light-seeker), "Baryshnikov" (singing-and-dancing robot), "Mouse" (wall-following), "Magellan" (rudimentary navigation), "Apollo 13" (do a figure-eight around two light sources), and "Fire!" (a fire-fighting robot). Of these, only "Lewis and Clark" gives the whole program in IC; the rest of them are just roadmaps and hints as to how to go about programming them, what resources you'll need, and what kinds of problems you may encounter.

In Chapter 10, they also present ideas for multi-robot projects (an abiding interest of mine). There aren't any complete programs here, but enough code snippets (such as a beacon follower) and hardware ideas to get you going.

Chapter 11 and 12 are also completely new. Chapter 11 shows several commercial robots for doing tasks like scrubbing the floors of an institution, locating landmines, and patrolling warehouses. Chapter 12, though short, contains a wealth of salient observations about the mobile robot design process. My favorite is their statement that an effective robot can never be built in one iteration.

The usual systems engineering methodology supposes it should be possible to produce a working system in one iteration provided you follow good top-down engineering practice. My experience is just the opposite: an over-engineered robot is at least as likely to fail as something just thrown together.

Unlike bridge building, robotics is not a mature technology with a comprehensive set of mathematical models and design tools. Heck, that's why we're in this to begin with, to pioneer an unfolding art. Jones, Seiger, and Flynn have gone a long way toward making the art of mobile robotics a science.

The Tawny Book is worth getting even if you already have the Blue Book first edition. If you don't have the Blue Book, you should immediately buy the Tawny Book: *Mobile Robots: Inspiration to Implementation*, 2nd Ed., A K Peters Publishing, 1999, ISBN 1-56881-097-0. You can find it in bookstores or you can order it directly from A K Peters website at www.akpeters.com.

The Last Roundup

Quickly, another book I liked was *The Victorian Internet*, by Tom Standage (Berkley Books, ISBN: 0-425-17169-8). You think hackers, online romances, spam, and information overload are new and peculiar to the Internet? Read this book and find out these things all happened over a century ago in the fascinating history of telegraphy, the Internet's great-great grandpa.

Next time, aw heck, I don't even know exactly where I'll be sleeping next month, much less what I'll be writing, so let's just see how things, go, huh? For sure, I'll be back, though, talking robots. On that you can rely. **NV**

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

Robert Nansel
69 S. Fremont Ave. #2
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20 character x 8 line 7½L x 2½H *The built-in controller allows you to do text and graphics.*

Alphanumeric—parallel interface

16x1	$6.00	20x2	$8.00	32x2	$8.00
16x1 (lg. char.)	$8.00	20x4	$8.00	40x1	$8.00
16x2	$6.00	20x4 (lg. char.)	$10.00	40x2	2 for $20.00
16x2 (lg. char.)	$10.00	24x2	$8.00	40x4	$20.00
16x4	$12.00	32x4	$10.00	4x2	$5.00

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • ***Certain models are backlit, call for more info.***

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$20.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$15.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
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6" VGA LCD 640X480, Sanyo LMDK55-22 **$19⁰⁰**

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9" COLOR SVGA MONITOR $169.⁰⁰
Fully Enclosed – Tilt and swivel type.

MONITORS

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2 for $49⁰⁰

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NTSC COMPOSITE 4" LCD MONITOR $69⁰⁰

ROCKWELL™ "JUPITER" GPS RECEIVER $69.⁰⁰

Miniature (2.75" x 1.5" x .25") 12 channel receiver engine • Supports NMEA 0183 and binary protocols • Supports DGPS input in both protocols • Compatible with active and passive antennas • "Keep-Alive" reduced power capability • Standard 2mm 2x10 interface connector • Complete manual and interface documentation available • Compatible with most laptop software using NMEA interface • Suitable for wide range of GPS applications including: Handheld GPS, Automotive / Marine / Aviation Applications, Amateur APRS and Packet.

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1.8cm (0.7 inch) unit LCX009AKB 827H x 228V $29⁰⁰

CELL SITE TRANSCEIVER $29⁰⁰ 2 for $49⁰⁰

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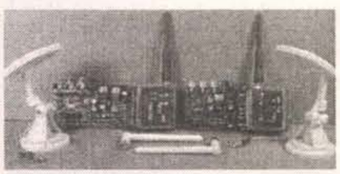

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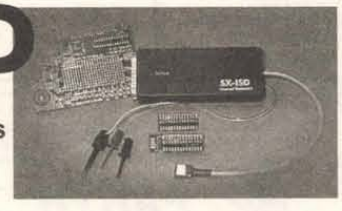

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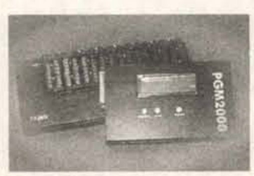

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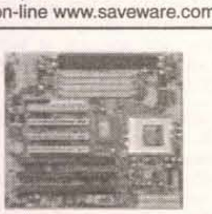

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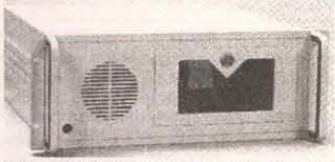

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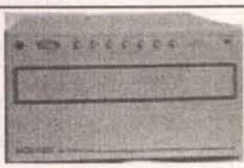

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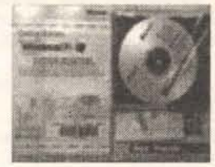

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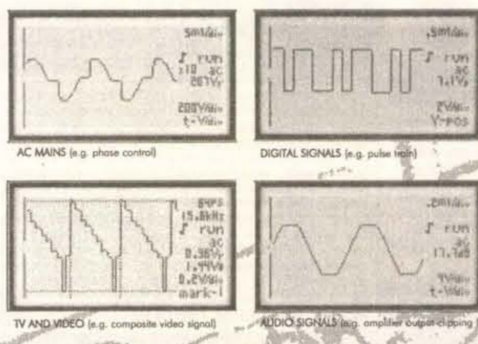

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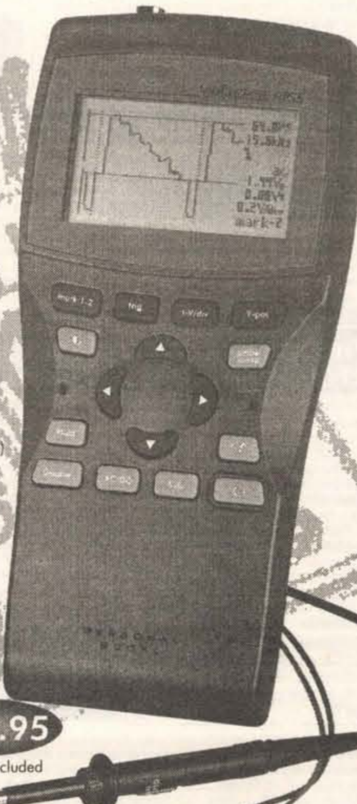

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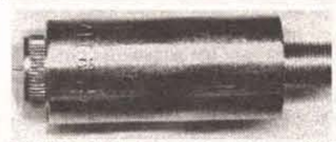

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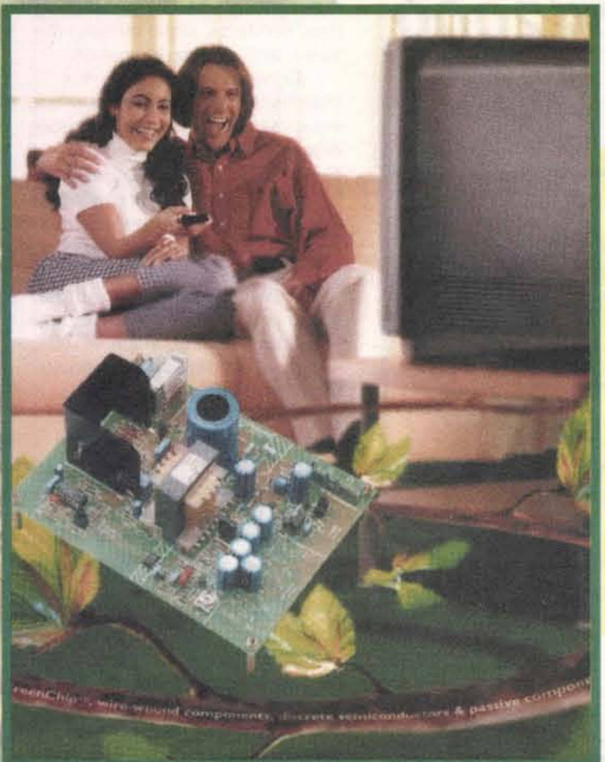
Continued on page 61

by Bill Siuru

PLUGGING ELECTRICITY LEAKS

Save Electricity, Money, and the Environment

Author James Thurber commented that his mother lived the latter years of her life suspecting electricity was dripping invisibly all over the house. Well, she was partly right.



GREENCHIPS™ CAN REDUCE POWER CONSUMPTION IN TVs AND VCRs.

According to researchers at the Department of Energy's Lawrence Berkeley National Laboratory, American consumers could save more than $1 billion annually by reducing electricity that "leaks" from TVs and VCRs, cable boxes, water bed heaters, aquariums, computers, microwave ovens, garage door openers, ceiling fans, hot tubs, answering machines, cordless phones, fax machines, video games, and even rechargeable electric toothbrushes.

Leakage includes standby losses of appliances that are switched off or are not performing their primary function. Leakage of electricity occurs even when users think their electronics or appliances are turned off, for instance, a TV that is using stand-by power for its "instant on" feature or battery rechargers that are not charging but still plugged in.

AC power adapters and rechargers alone cost US consumers an estimated $500 million a year in leakage. Measuring actual leakage in California and Florida homes, the Berkeley Laboratory researchers estimated that the average home leaks about 450 kW-hr per year, or about five percent of a home's electricity use.

Also, almost all growth in residential electricity consumption in the next two decades will come from often-neglected small appliances — the "miscellaneous" end uses. The Berkeley Lab scientists tallied past and projected electrical energy usage by nearly 100 of these electric products from 1976 to 2010.

Miscellaneous electricity use now accounts for about one-fifth of all electricity used in US homes and is growing quickly. The researchers project that without policies concerning miscellaneous energy use, it will increase between 1996 and 2010 by an additional 50 percent. This growth is equivalent to the output of about 15 1,000 MW power plants.

There are other reasons for plugging electrical energy leaks. Reducing electricity usage means less electrical power has to be generated which results in a direct reduction in air pollution from power plants and less carbon dioxide — considered a major contributor to global climate change.

Leaking electricity also generates heat, which increases the load on air conditioning systems. Items like computers, monitors, copy machines, and other pieces of office equipment are especially bad at adding to heat load when sitting idle in offices and homes.

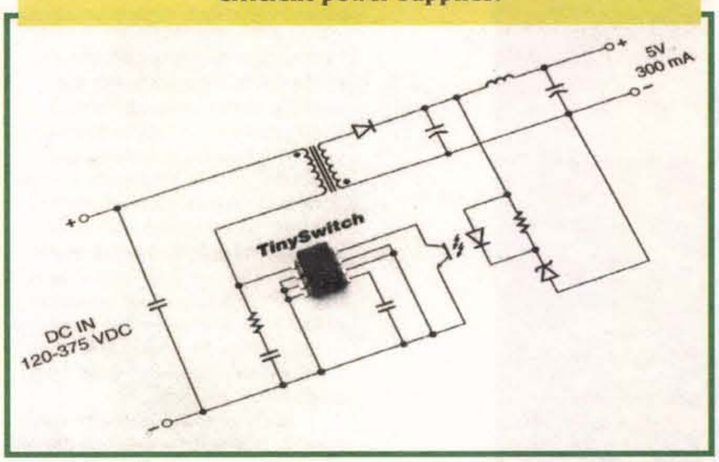
Finally, pulling the plug on electronics and appliances so they are truly off reduces the fire hazard and danger of electric shock.

There are many ways to reduce leaking energy losses. Appliances are now being designed to leak less electricity. Television sets, for example, currently draw about 40 watts to maintain remote control and

Inefficient low voltage power supplies leak electricity when they are not supplying power to the appliance.

Substantial savings are possible with Energy Star® Office Equipment. Look for the Energy Star® label when purchasing electronics or appliances. Other countries have equivalent programs.

TinySwitch that incorporates EcoSmart™ technology which will enable a new class of compact, energy-efficient power supplies.



instant-on features. New models on the drawing board and starting to appear in stores draw only five to 20 watts. The Energy Star® program created by the US Environmental Protection Agency (EPA) and the US Department of Energy (DOE) is aimed at helping consumers identify products that save money and protect the environment by saving energy. For example, virtually every TV and VCR manufacturer now offers products that wear the Energy Star label showing that they consume significantly less energy than standard products, while offering the same or better performance.

Computers, monitors, fax machines, and some other office equipment are also getting more efficient, thanks partly to the Energy Star program. Energy use by office equipment is one of the fastest-growing sources of electricity consumption in businesses and homes. It currently accounts for more than seven percent of total commercial sector electricity use.

Unfortunately, much of this energy is wasted because equipment sits idle for long periods throughout the day, as well as overnight and even weekends. Computers turned on for the entire business day are only in use for an average of four hours. Printers spend approximately 95% of their time sitting idle and copiers — which use more energy than any other type of office equipment — spend much of their time sitting idle. Fax machines are often left on continuously, but are actually used about one hour per day.

A typical office could save approximately 50% on its operating costs for office equipment by taking advantage of the power management features of Energy Star office equipment. These products save energy by powering down and "going to sleep," and sometimes automatically shut off completely when not in use. These energy efficient products have all the performance features of standard equipment, but they have an added ability to reduce wasted energy.

The low voltage power supplies and adapters — those familiar little black boxes that plug into wall outlets — are the culprit in some appliances. Cheaper models have high power losses (up to three watts) as long as they are plugged in. Higher quality, Underwriters Laboratory-certified power supplies are available that have a three-way on-ready-off switch. With this switch, the appliance is really turned off when the switch is in the off position.

Another energy saver is photovoltaic battery chargers for appliances like portable computers or cordless telephones. "Free" solar energy replaces the household outlet for keeping batteries charged. A simple circuit which manufacturers could incorporate into their appliances that draws power only when the battery needs power, has been proposed by the Berkeley research team. The rest of the time, the circuit switches itself off.

The researchers are also proposing a "Global One-Watt" plan to reduce standby losses of domestic electrical equipment throughout the world. The One-Watt plan includes a goal that 50% of all appliances manufactured in 2005 have standby losses reduced to less than one watt. This would be an international goal with each country selecting its own method for making it happen.

These could include voluntary labeling programs, mandatory government regulations, and national standards. There would also be international collaboration on definitions and test procedures.

This circuit could be installed in appliances so they draw power only when the battery needs power. The rest of the time, the circuit switches itself off.

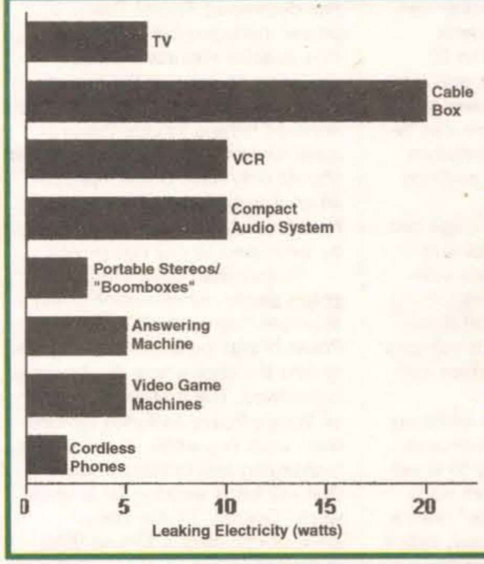
According to the proponents, the One-Watt plan is technically feasible for most appliances today and often already cost-effective. Indeed, the one-watt level for standby power is now routinely met by models offered by major manufacturers in most product categories, without affecting the services delivered to consumers. The One-Watt Plan could eliminate about 70% of the standby losses that now account for about 5% of domestic electricity usage.

Several commercial products are now available to help reduce energy leakage from consumer electronics. Power Integrations, Inc., recently introduced its TinySwitch™ family of energy-efficient ICs (integrated circuits) for use in power supplies.

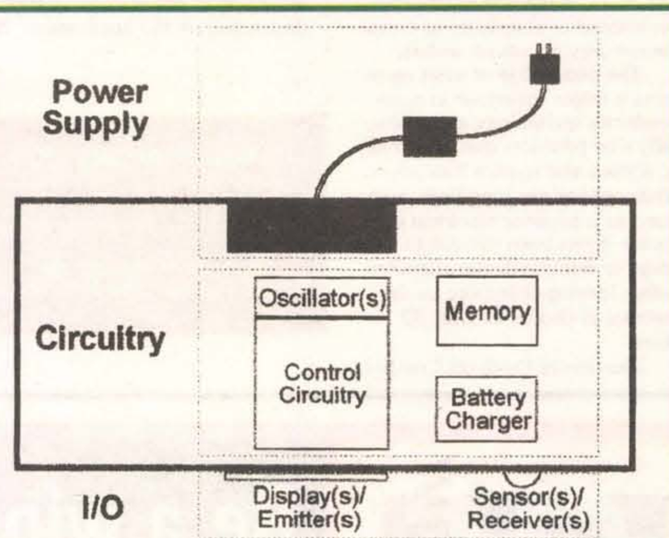
Incorporating EcoSmart™ technology, manufacturers can cut energy leaks in a wide range of electronic products such as cordless and cell phone chargers by essentially "pulling the plug" when the phone is not attached.

The technology reduces no-load power consumption to less than 100 milliwatts, about 10 to 20 times less compared to a typical AC adapter. EcoSmart technology which uses extremely low-current circuit techniques and a new "Efficiency Mode" control method, is very low cost — unit prices range in 10,000-piece quantities from $0.75 to $0.81.

Europe's largest semiconductor company, Philips Semiconductor, has available its GreenChip™ which can reduce electricity wasted by TVs and VCRs by up to 99%. Using a single



Standby power consumption for various household appliances.



Advanced Charger Technology's ACTivator uses patented Dynamic Electrochemical Waveform technology to analyze the battery being charged to determine its state of charge. The ACTivator's intelligent software then continuously adjusts the charging current to obtain the optimum charge for the battery. Alexander's Optimizer 2000 Series offers many features to determine a battery's full charging point. The unit can be used to charge Ni-Cd, Ni-MH, Lead Acid, and Lithium-Ion (one-five cell) battery packs.

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Texas Instrument's SMP430 ultra-low-power microcontrollers consume only about 4 microwatts (1.3 microAmps) in standby mode. MoBLTM SRAMs from Cypress Semiconductor use up to 90% less power than standard low-power SRAMs. KEC's Switch On Demand (SOD) devices stop leaking electricity at the source, yet allow appliances to respond to remote control or telephone signals.

Texas Instruments
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NEW PRODUCT

GreenChip, the typical power consumption in standby mode is reduced from between 5 to 10 watts to just 1 to 2 watts, and is still able to supply full power in less than one second. This can be reduced even further to between 0.1 and 0.5 watts by the addition of a second GreenChip.

Normally, computer chips can only operate at a few volts and would be destroyed if main voltages were applied to them. GreenChips have a special structure that reduces the high voltages down to a level that the chips can handle.

IBM has developed a semiconductor manufacturing process to shrink electronic circuitry to smaller dimensions and fit more computer logic or "intelligence" onto a single chip. This technology, called CMOS 7S, is the first to use copper instead of aluminum to create the circuitry on silicon wafers.

The bottomline of what represents a major milestone in semiconductor technology are potentially new products that are smaller, lighter, and require less power. While copper has long been recognized as a superior electrical conductor, it has been difficult to adapt to semiconductor manufacturing, leaving aluminum as the material of choice for over 30 years.

Electronics Products Company has developed Trickle Power, a power management technology that enables electronic circuit designers to achieve the lowest power consumption possible. The concept behind Trickle Power is quite simple — an electronic circuit should only have power applied when it is performing a useful function. Idle circuitry should not be permitted to use any power.

Rather than controlling a chip's power consumption using a separate chip-controller, Trickle Power brings power-control circuitry into the chip where the power is consumed. The first applications of Trickle Power included laptops that work two whole days without recharging and cellular phones that will keep working for a whole week! Overall, Trickle Power devices can offer a 75% to 95% reduction in power consumption depending on the application. **NV**

FOR MORE INFORMATION:

Leaking Energy Home Page
http://EETD.LBL.gov/leaking

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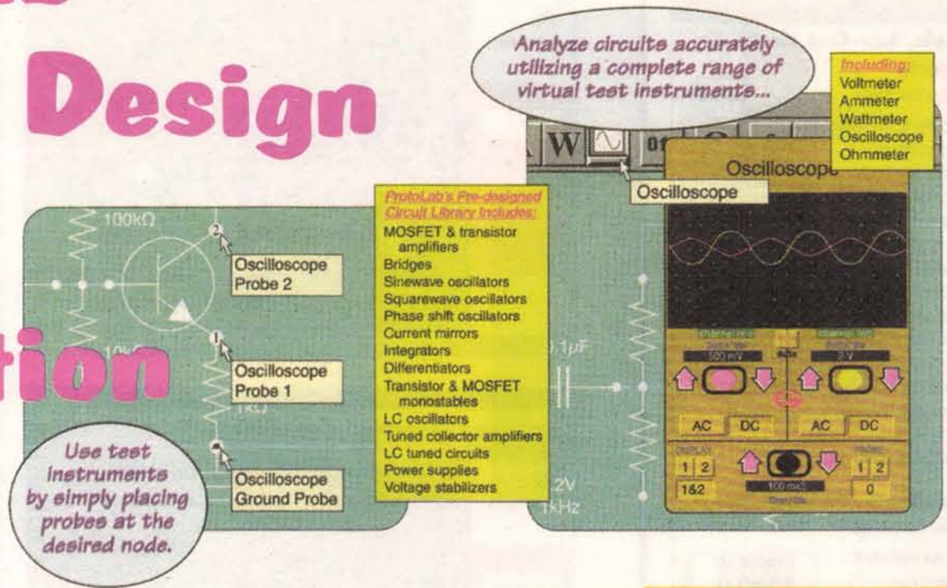
ProtoLab Circuit Design and Simulation



by
Fred Blechman

There's an old expression among fighter pilots that flying simulated air combat is "the most fun you can have with your clothes on!" Well, for the avid electronics hobbyist and experimenter, the same might be said for simulating and analyzing circuits with ProtoLab!

The Good, the Bad, and the Beautiful

Let me say right up front that ProtoLab 4.0 — as this is being written — is good, but lacks some features that will be included in the upcoming ProtoLab 5.0 (see sidebar). As a matter of fact, by the time you read this, ProtoLab 5.0 will probably be available, for the same $49.95 price, or a considerably lower price ($9.95?) as an upgrade to those who already have ProtoLab 4.0.

At the risk of sounding like a salesman, I'd recommend — if you have any interest at all in electronic circuit design or analysis — you get ProtoLab right away, even if only 4.0 is available, and "play" with it. You'll love it! And it will get you ready for big-brother 5.0. One caveat, however. ProtoLab 4.0 runs in Windows 3.1 or Windows 95. ProtoLab 5.0 will be limited to Windows 95 and 98. This review will describe the operation of ProtoLab 4.0.

ProtoLab 4.0

System requirements are very modest; any IBM-PC compatible with an 80386 processor or better, SVGA graphics, 4MB of RAM, and less than one megabyte of hard drive space. You will need to be running Windows 3.1 or 95 with a mouse or trackball that has a left and right button. As a "worst case," I ran ProtoLab 4.0 in Windows 3.1 with no problems.

Installation is a snap and takes less than two minutes. The program is supplied on a 1.44MB 3.5-inch floppy disk with a Setup file. All files are placed in a single directory during set-up. Simple and straightforward.

Running the program is also simple. As a matter of fact, the program I received for review did not contain any documentation, and there was none on the disk! Yet, by just "playing around" I found myself — after very little head-scratching — able to perform most of the functions available in this version of ProtoLab by just referring to pop-up notes for each element of the toolbar, and to a Help line at the bottom of each screen. Operation was as close to "intuitive" as any program I've ever run.

Documentation

Documentation is provided (mine had been inadvertently omitted) in the form of a very handy 4.5- by 5.5-inch 20-page illustrated "Operations Manual." After receiving mine, I discovered some additional features of the program.

The manual, however, is abbreviated in some explanations. This report will amplify some areas of the manual for the dual purpose of acquainting you with ProtoLab 4.0 in case you might want to purchase it, and to help you use it if you do purchase it.

ProtoLab is a $49.95, easy-to-use analog (AC/DC) circuit design and simulation tool. It allows you to create and edit analog circuits instantly on an IBM-compatible personal computer while choosing from active and passive components, including transistors, diodes, resistors, capacitors, and inductors. Eighteen pre-designed circuits are also included. You can then analyze your circuit with five virtual instruments, including a dual-trace oscilloscope. Amazing!

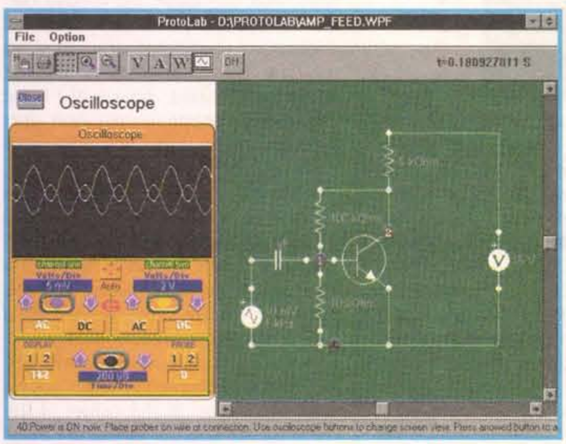


FIGURE 1. ProtoLab 4.0 screen with virtual dual-trace scope showing probe traces at "1" and "2" in the circuit. Note placement of the ground symbol

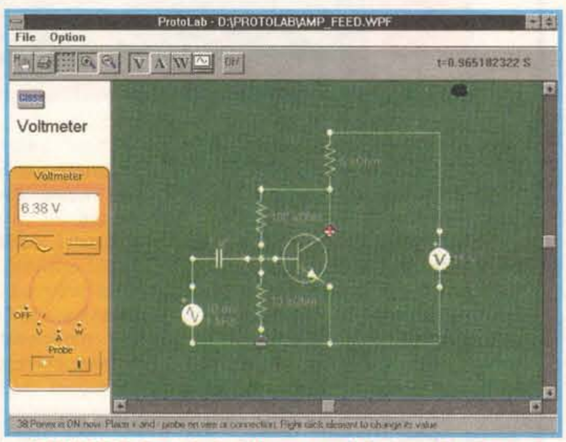


FIGURE 2. ProtoLab 4.0 screen with virtual voltmeter reading. Positive probe is at "+" and ground probe at "-".

The ProtoLab 4.0 Screen

When you start the program, you'll see a large green space with dots marking a design grid, vertical and horizontal scroll bars, and an open space on the left for the use of the virtual test instruments.

The grid defaults to its center area, but can be scrolled to a huge total area that I calculate could allow 17,000 passive components (resistors, capacitors, and inductors) to be shown — but I'm told that the program bogs down with more than about 30 active components (transistors, MOSFETS, or power sources.) That can still be a large circuit!

Along the top of the screen is a menu bar with only two choices: File and Option. File allows you to choose a New screen, Load one of the 18 pre-designed circuits, Save a circuit with its current name, Save As with a new name or directory loca-

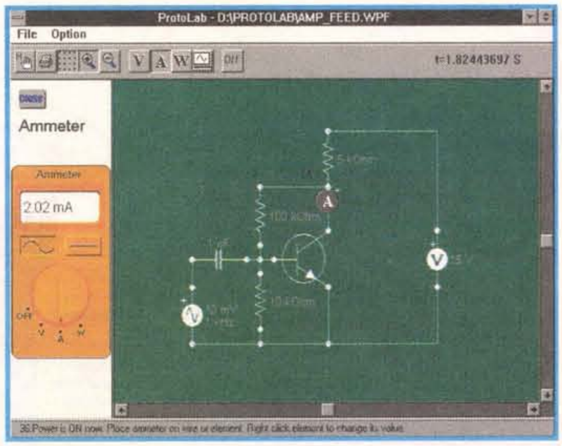


FIGURE 3. ProtoLab 4.0 screen with virtual ammeter inserted in the circuit at "A."

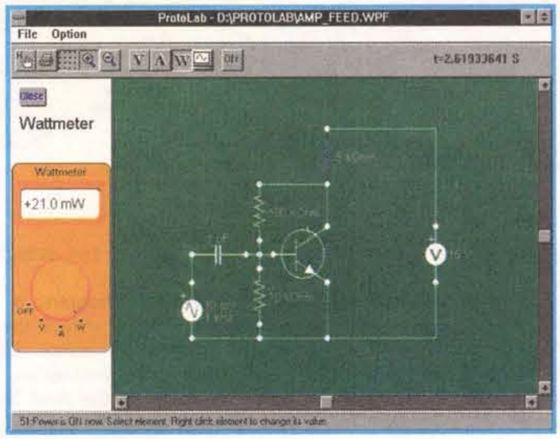


FIGURE 4. ProtoLab 4.0 screen with virtual wattmeter reading at the 5K resistor.

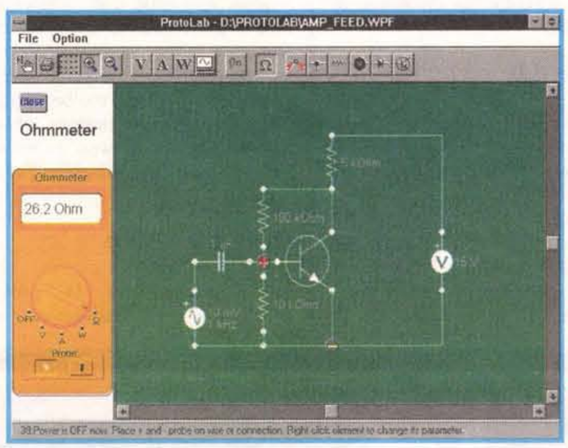


FIGURE 5. ProtoLab 4.0 screen with virtual ohmmeter reading between "+" and "-" in the circuit.

tion, Print the circuit shown, Find Circuit if you have scrolled the screen beyond the circuit, or Exit the program.

The Option pull-down allows you to delete the screen grid marks (which appear unnecessary, since the grid marks do not appear in printouts), to Zoom out to double the design area (and the circuit half size), and to select Precision settings. The Precision feature allows you to adjust timing intervals, voltage, and current steps for precise analysis – preset to optimum operating levels for circuits of moderate size.

Below the menu bar is a 19-element toolbar that lets you perform all the available functions, although there are shortcuts for some of the functions. Little pop-up notes appear under each tool as you place the mouse cursor on it.

You can move the entire schematic around the screen; print the circuit; zoom large or small; choose a voltmeter, ammeter, wattmeter, oscilloscope, or ohmmeter for analysis (turning them on or off as required); delete components; insert lines and junctions; insert passive components; insert voltage and current sources; insert diodes; insert transistors and MOSFETS; rotate components; or mirror components. The meanings of these functions will be clarified as we proceed.

Analysis with ProtoLab 4.0

(NOTE: Unless otherwise specified, "click" refers to the left mouse button. The right button is used only as specified.)

We'll start by doing some analysis on one of the 18 pre-designed circuits, using the various "virtual instruments." Let the fun begin!

By clicking the mouse button on File, and selecting Load, you can select a pre-designed circuit. Double-click on one and it appears immediately in the green area. The right portion of Figure 1 shows the circuit for a single transistor AC-coupled amplifier with DC feedback.

Note that ProtoLab's .wpf graphic format is not a common format, and not easily converted to other formats. However, ProtoLab 5.0 will allow circuit Copy and Paste to other applications.

Now, by clicking the oscilloscope button on the toolbar, a virtual dual-trace oscilloscope appears on the right portion of the screen. See Figure 1. The scope screen is marked with tiny red grid dots.

A red "1," a yellow "2," and a black ground symbol appear at points on the circuit. These represent the scope probe locations. Also, numbers appear in the "Volts/Div" windows under "Channel One" and "Channel Two," as well as in the "Time/Div" window. These are intelligently pre-set for the pre-existing designs.

But only a straight yellow line appears on the scope screen. You have to turn on the instrument by clicking the "ON" button on the toolbar! Now you see a red sinewave (Probe 1) and a yellow sinewave (Probe 2).

If you are at all familiar with an oscilloscope, you can now move the probes (click on "1," "2," or "0" under "Probe," and you can show either or both probe curves under "Display"), you can change the grid volt and time divisions (click on up/down arrows), and you can specify AC or DC for each curve by clicking on the desired mode.

If this isn't enough to keep you busy, you can move the mouse cursor to the scope screen and the "Volts/Div" readings change to show you the exact coordinates on the scope screen grid. Amazing! Figure 1 shows the scope in operation after moving Probe 1 to the transistor base.

But that isn't all. You can also change the value of any component by placing the cursor on it and using the right mouse button to bring up a fill-in box to make a change and see the effect on the scope screen. This is true electronic breadboarding.

If you get all messed up with the volt and time division scales, click on the Auto button at the center of the oscilloscope and the values are magically optimized to give you readable traces.

Without going into excruciating detail, the other virtual instruments work in a similar fashion. See Figures 2, 3, 4, and 5. Remember that the power to the circuit must be turned "on" to have the instrument read (except for the ohmmeter, which is used with power "off").

When using the ammeter, it is not necessary to break open the circuit to insert the meter probes. Just click on a circuit line and the ammeter is automatically inserted at that point.

Also, note that the voltmeter and ammeter have an AC (sinewave symbol) or DC (straight line symbol) selection bar. When using the voltmeter and ohmmeter, you must select probe and ground points. For the wattmeter, you merely click on a circuit component.

While no separate Help file is provided, context-sensitive help is provided at the bottom line of each screen.

Circuit Design with ProtoLab 4.0

While it is easy to use or change some of the pre-existing circuits for your needs, you certainly will want to check out some of your own designs. This is done quickly and easily with ProtoLab 4.0 — though with a number of limitations that will be eliminated in ProtoLab 5.0.

What limitations? This is strictly for analog work, and no integrated circuits are provided (although you can use squarewaves as an input source). Designing your own circuit is easy and fun if it is within the limitations of components available. You cannot create your own components.

Only non-polarized capacitors are shown, although electrolytic values can be specified. Transistor choice is limited to the 2N2222 or "ideal," or an NPN MOSFET. The only diodes available are a 1N4148 silicon signal diode, or zener diodes in the .5-watt 5% 1N52XX series from 3.2 to 33 volts. No LEDs are provided. This is being corrected in ProtoLab 5.0, where over 100 components are being added to the existing selection.

Laying out your circuit is just a matter of selecting components from the toolbar and placing them on the circuit grid. If there are choices for that component (like resistor, capacitor, or inductor for passive components), you will find those on the left side of the screen. Click, drag the symbol around the circuit screen grid until it is exactly where you want it, and left click to place it. Right click and a pop-up box allows you to establish values for that component. It couldn't be easier.

If you need to rotate the symbol (vertically or horizontally) before placing it, the "R" key on the keyboard, or the Rotate symbol on the toolbar, does the job. If it needs to face in the opposite direction (such as a transistor), use "M" on the keyboard or the Mirror symbol on the toolbar. As my grandchildren

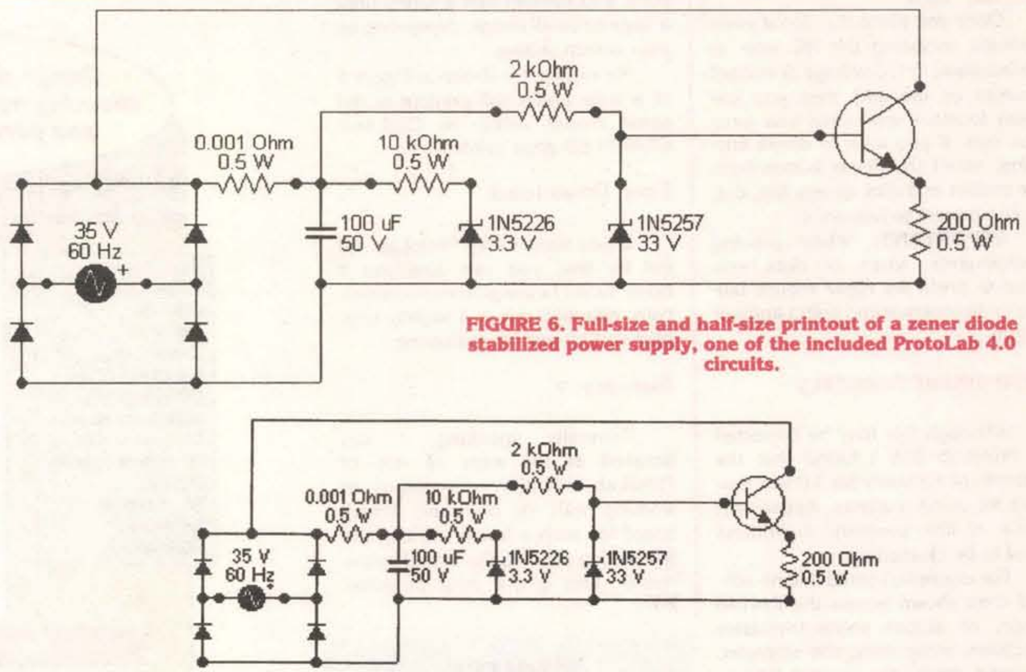


FIGURE 6. Full-size and half-size printout of a zener diode stabilized power supply, one of the included ProtoLab 4.0 circuits.

ProtoLab 4.0 Pre-Designed Circuits

- Single transistor AC-coupled amplifier
- Single transistor AC-coupled amplifier with DC feedback
- Full-wave bridge circuit widely used in a power supply
- Wheatstone Bridge
- Transistor Colpitts oscillator, sinewave for AF or RF
- MOSFET phase shift oscillator, inductorless, for AF
- Current mirror circuit
- Collection of passive integrators and differentiators
- MOSFET multivibrator — squarewave oscillator
- Transistor multivibrator
- Transistor monostable or one-shot
- Single MOSFET amplifier
- Two-transistor LC oscillator
- RF tuned collector transistor amplifier
- Passive series and parallel LC tuned circuits
- Zener diode stabilized power supply
- Current stabilizer
- Schmitt Trigger

ProtoLab 5.0 Features

Two major limitations of Version 4.0 are that the schematics are in a non-transportable format, and there are limited types and numbers of components.

Version 5.0 will allow Copy and Paste of a schematic to any other Windows application, and will add many integrated circuits.

The following components are being added: electrolytic capacitors; five more MOSFETS; a thyristor; a fast-recovery diode; two Schottky diodes; three relays; a digital-to-analog converter; an analog-to-digital converter; four voltage regulators; 24 op-amps and comparators, 14 74HC-family logic chips; transformers; and switches.

exclaim, "Cool!"

Once you place the circuit components, including the AC sine- or squarewave, or DC voltage or current sources on the grid, then you join them together with wires and junction dots. If you want to delete anything, select the delete button from the toolbar and click on any line, dot, or component to remove it.

IMPORTANT: When placing components, wires, or dots, you need to press the ***right*** mouse button to discontinue and select another action.

Instrument Accuracy

Although this may be corrected in ProtoLab 5.0, I found that the instrument accuracy for 4.0 was suspect for some readings. Apparently, some of the program algorithms need to be cleaned up.

For example, I could find no voltage drop shown across the IN4148 diode, or across some transistor junctions. When using the ammeter, in some cases, the current flowing into and out of a circuit node did not add up. On DC voltage readings, the results showed as negative voltage in many places with only a single positive voltage source.

Printing the Circuit

I was especially pleased with the dark and sharp printout of the circuits, and the fact that it would print a large or small image, depending on your screen setting.

An example is shown in Figure 6 of a large and small printout of the same circuit using an OkiLaser OL400 LED page printer.

Free Download

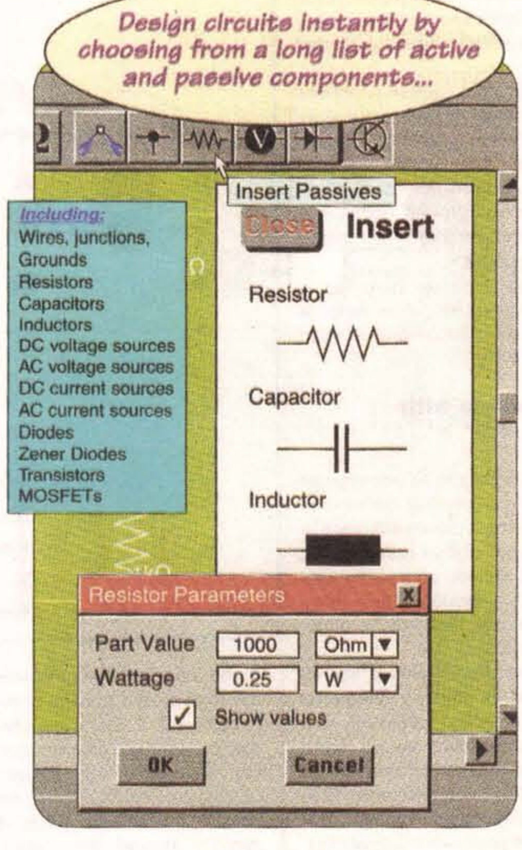
If you want to try ProtoLab 4.0 out for free, you can download it from http://www.globalspecialties.com, although this is a slightly crippled version just for evaluation.

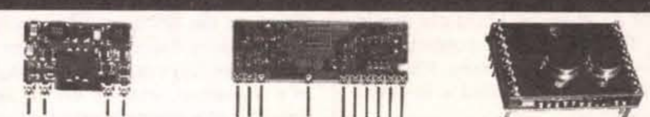
Summary

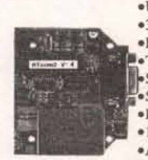
Generally speaking, I was amazed at the ease of use of ProtoLab 4.0, the convenience of working with an electronic breadboard for such a low price, and the fascination of using the virtual instruments. This is one neat program! **NV**

Source

Global Specialties
Highland Industrial Center
1486 Highland Avenue
Cheshire, CT 06410
Suggested price: $49.95
Only available from stocking distributors.
Call **1-800-572-1028** or check http://www.globalspecialties.com for a distributor near you.







by Russ Knapp

Digital Voltage Supply from your PC

A power supply — completely controlled by your PC — may be one of the most useful additions to your hobby area or test shop.

This project should find many uses in the general area of circuit building and testing.

INTRODUCTION

Not only can you control the output voltage with a high degree of accuracy, but you can also select which polarity this output voltage will be. Further, you can avail yourself of the many features in a computer-controlled power supply. Such features as sweep, allow the user to program a specific sequence of voltages, with both the actual voltage and the time delay between increments fully programmable.

The usefulness of this product is greatly enhanced by the feature that allows the user to manually program a text file that represents an arbitrary output sequence from the supply, allowing an almost unlimited sequence of voltages and time delays to occur. All input files are easily edited with any text editor.

The circuit uses the PC parallel port (printer port) to control the programmable power supply thus keeping the design quite simple both in terms of circuit design and fabrication.

The maximum voltage on the output is 10.0 volts for a positive polarity output or -10.00 volts, if the polarity is negative.

The system uses a 10-bit, D-to-A to set the voltages. Thus, the resolution is limited to about 26 mV.

The power op-amp — OPA 547 — provides over 100 mA sink and source with voltage swings of ±10 volts.

This programmable supply requires an external supply to provide the ±12 volts for operation. This external supply is typical of readily-available, low-power switching supplies commonly found in PC and notebook personal computers. Or alternatively, the external supply can be a portable-type commonly found in many electronics catalogs. (The end of this article includes a supplier list from whom external supplies may be obtained.) In any event, what is required is an external supply that provides ±12 volts with at least 100 mA capability. The -5 and +5 volt supplies (on the

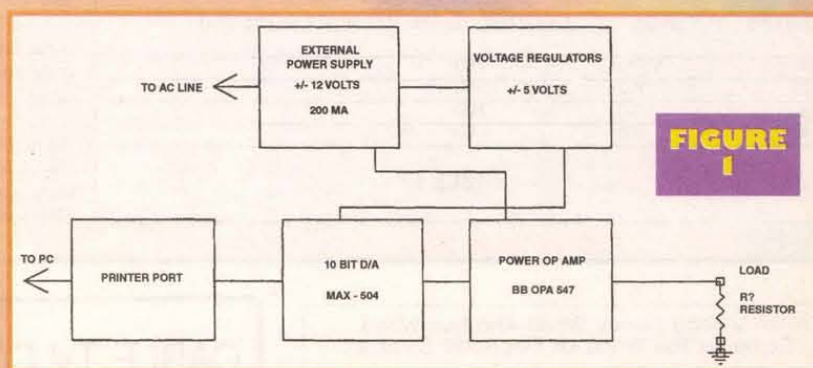


FIGURE 1

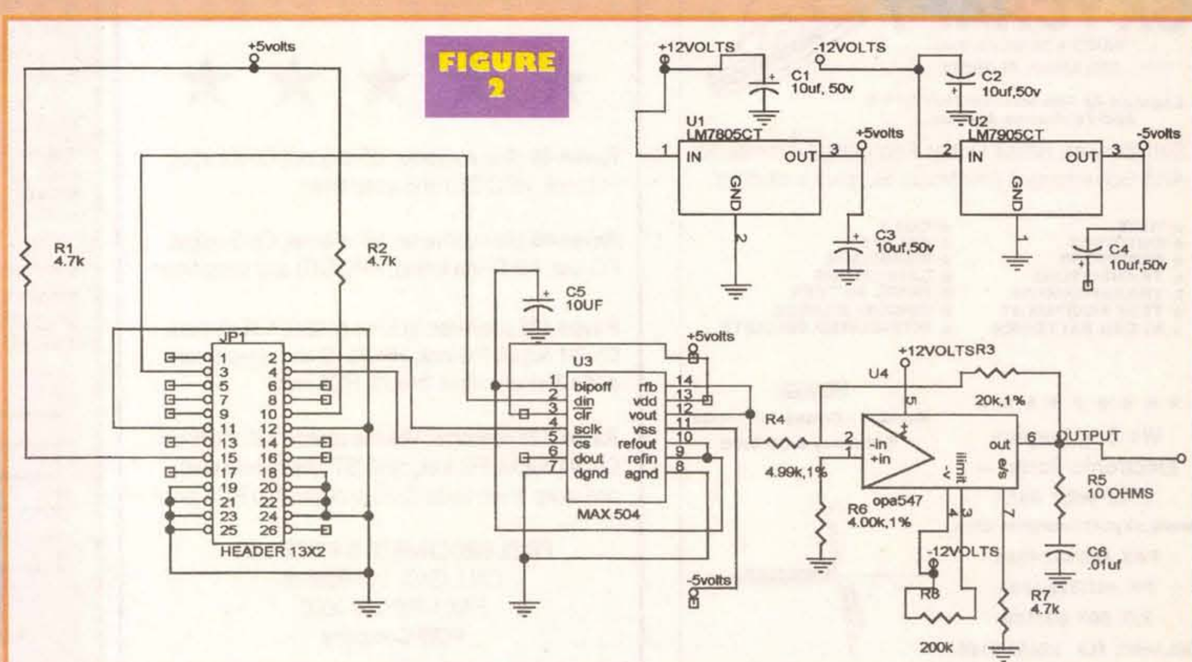
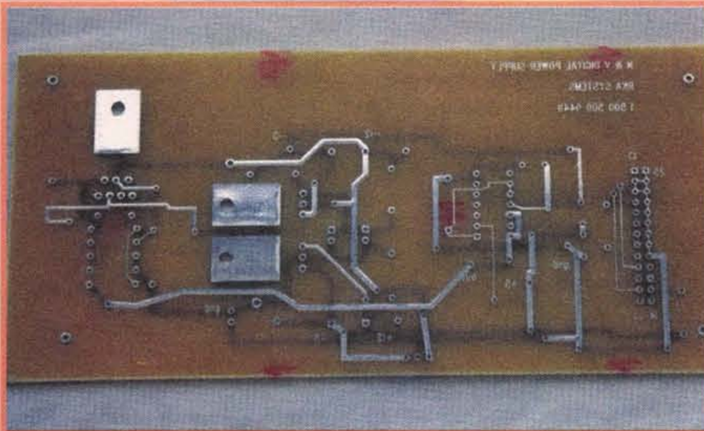


FIGURE 2



LINE#	VOLTAGE	DELAY(Note: this line is not in the file)
1	0.0	100
2	8.0	100
3	0.0	100
4	8.0	100

TABLE I

board) are derived from the -12 and +12 outputs, with the use of regulators, LM7805 and LM7905.

For the programmable supply, the voltage and current limits are shown in the following:

Voltage: 10 Volts
Current: 100 mA
Polarity: Plus or Minus

A time delay control between programmable voltages is also available ranging from about 50 milliseconds to seconds, however, is dependent on the user's PC internal clock and, therefore, programmed delays are only approximate.

TECHNICAL

For this design (see Figure 1), a very simple concept is used: The accurate output of a D-to-A converter is simply amplified with feedback to provide a proper voltage level and this, along with sufficient current drive from the output power op-amp, provides the proper programmed user voltage output. D-to-A converters, when given a proper binary word input, will give an output that is precisely proportional to the level implied by this binary word.

All D-to-A converters have some finite errors associated with their outputs since only quantized "steps" of voltage are allowed. These steps for the current system are about 26 mV. Thus, the output is always formed by the addition of some quantity (selected by the input binary word) of 26 mV "steps." The PS-1 uses the Maxim MAX504 for the DA function.

With selection of reference voltages used in this design, the output of the D-to-A is -2.5 to +2.5 volts. For general applications of a power supply, we desire that the output be bipolar. The second stage of the PS-1 uses a power op-amp (Burr Brown OPA547) with complementary output transistors to form a power operational amplifier. This configuration not only provides a gain of 4-to-1, but also allows the required bipolar output current sink and source function.

The entire output swing — -10.0 to +10.0 volts — is represented by a 10-bit word. Thus, the output can be resolved with an accuracy no better than 0.026 volts, which implies better than 0.1% accuracy and resolution. This is usually sufficient for most construction and test projects.

The main schematic (Figure 2) indicates the use of a Maxim504 for the D-to-A converter. This device is a serial in, 10-bit D-to-A that gets its data input as a 16-bit serial word from the printer port.

The software provided with this kit sets up this chip first by providing a chip select, which is asserted with a low logic level. Following this, the data (representing the desired output voltage) is provided on the data input line and this, after some delay, is clocked with a positive transition on the clock line.

Data bits are sent along this serial line as a serial word of 16 bits. The first four bits are "dummy" bits and can be either 1s or 0s. The next 10 bits represent the output voltage. The last two bits are "filler" bits. Thus, the input serial 10-bit word representing the desired output is placed into the D-to-A.

CONSTRUCTION

Assembly of the board is quite straightforward. Simply follow the pictorial in Figure 3 and the component location explicit in the mask pattern of the board.

After checking all wiring, plug the board in and monitor the output line with a good DC voltmeter.

START UP

Fire up the PC and go to the directory in which you have put the software (usually 'rkasys'). The operating software is in a file called 'PS.EXE.' Both ps.exe and seq.dat

1	Single Voltage
2	Voltage Sweep
3	Continued Voltage Sweep
4	Sequence File
5	Continued Sequence File
6	Quit

Figure 4 — Software Display

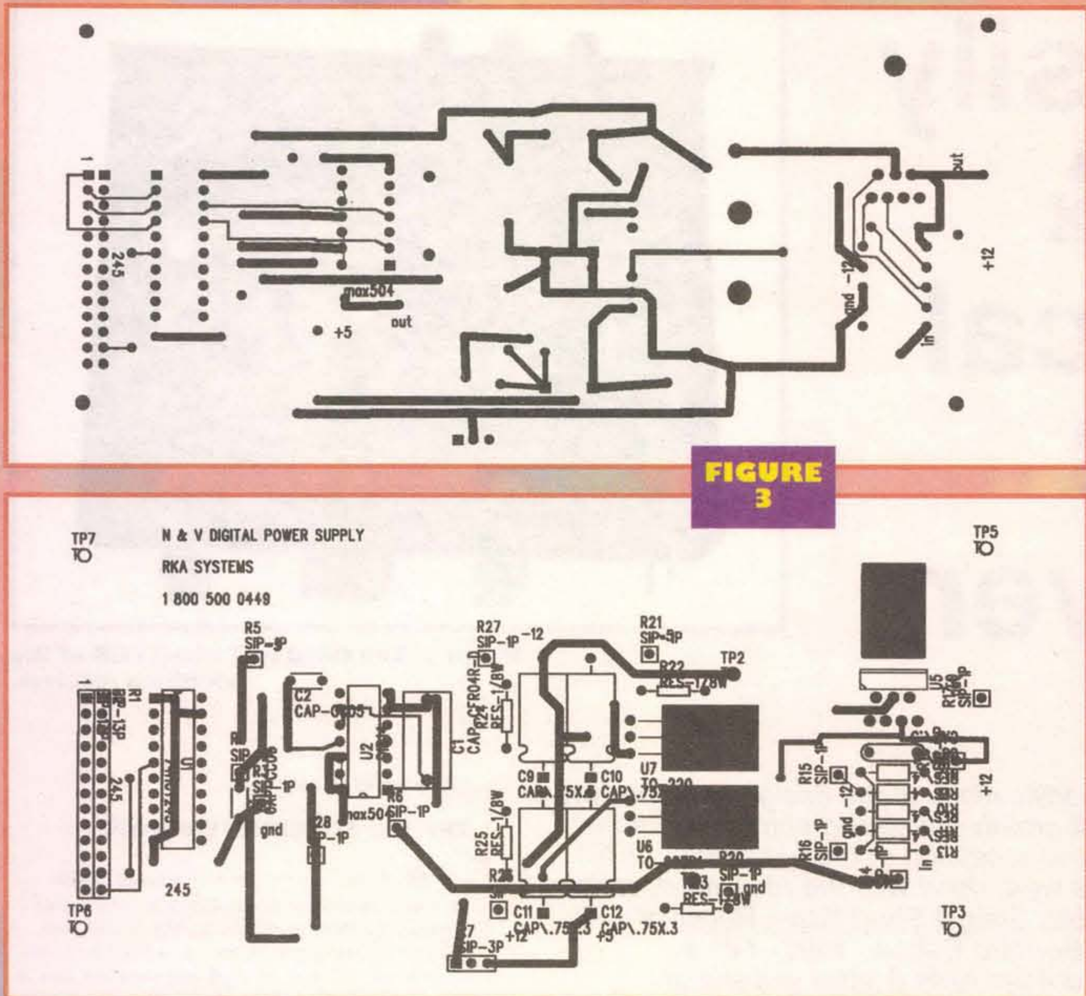


FIGURE 3

should be in the same directory. Typing "ps" and return will start the program and the main menu should show up on the screen as shown in Figure 4.

Choose "1." Single Voltage. Enter "0" when requested to enter a voltage. After hitting "return," the output of the supply should now be zero volts (approximately). Now, try the Sweep and Sequence File options, being careful not to exceed the maximum voltage limits (+10.0 to -10.0 volts).

SOFTWARE CONSIDERATIONS

The software for this project was written in Borland Pascal 6.0 and is available in both source and executable on the disk that came with the kit.

From Figure 4, we see that there are six options implied from the main menu. The first and simplest is the output of a single voltage. The user simply selects (1) Single Voltage i.e., press key "1." Inputting a voltage between -10.0 and +10.0 volts will cause the output to go to the nearest possible voltage. Remember the output can only get as close as possible as the delta limit of 0.026 volts allows.

Voltage Sweep allows the user to sweep from a low to a high voltage with control of how many steps are required to do this, as well as programming a fixed delay at each step. The user does this by selecting a low voltage, how many steps in the sweep, and the delay (in milliseconds) that would be inserted at each step. Another option ("3") allows the user to have the programmed sweep continue to operate until the user hits the return key.

A powerful function included in the software package is the ability of the user to use an easily-edited text file ("SEQ.DAT") to drive the output of the power supply. Using this technique, virtually any bipolar voltage sequence can be derived. The user simply programs the supply by editing the text file SEQ.DAT.

The user can edit this file to any sequence of voltages that he desires. Note that the delay column is intended as approximate units of one millisec, but will depend directly on the clock rate of the CPU in the user's PC.

Finally, the sequence file can be asked to run on a continuous basis. Note that the output resets to zero at the end of each file sequence. An example of the file SEQ.DAT is shown in Table 1.

This waveform happens to produce eight-volt pulses with approximately 100 mS duration and 100 mS between pulses. However, any sequence could be manually edited as long as one stays within the voltage (-10.0 to +10.0) and delta time (50 to 10,000 mS) limits of the device.

The above represents what is typical in the file SEQ.DAT. It indicates for each line, the Line #, the desired voltage, and the approximate delay in milliseconds to the next sample. **NV**

For questions and comments:

E-MAIL:
info@rkasys.com
WEB SITE:
http://www.rkasys.com

RKA Systems
17595 Vierra Cyn. Rd., Unit 279
Salinas, CA 93907
1-800-500-0449

External Supply Suppliers:

Anchor Electronics 408-727-3693
Skynet Electronics 408-495-6355

A complete kit of parts is available from RKA Systems for $120.00 (fully assembled and tested $140.00). This includes the required supply, PC board, parts, and floppy with DOS software. Additional software in the form of simple drivers in Basic and Pascal are also provided on the disk for users who wish to develop their own programs.

BILL OF MATERIALS

Item	Quantity	Reference	Part
1	1	C1	10uF, 50V
2	3	C2,C3,C4	10uF, 50V
3	1	C5	10uF
4	1	C6	.01uF
5	1	JP1	Header 13x2
6	3	R1,R2,R7	4.7K
7	1	R3	20K, 1%
8	1	R4	4.99K, 1%
9	1	R5	10 ohms
10	1	R6	4.00K, 1%
11	1	R8	200K
12	1	U1	LM7805CT
13	1	U2	LM7905CT
14	1	U3	MAX 504
15	1	U4	opa547

An Easily Built & Practical SWBB Receiver

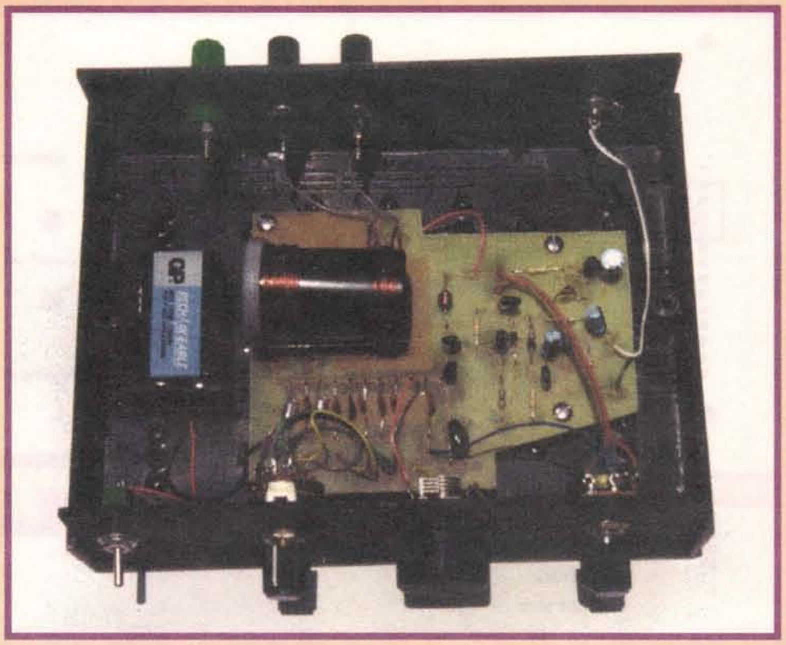


Photo 1: The filled and wired PCB of the modified receiver.

by Peter Lehmann

Detailed in this article are modifications to the design of a shortwave (SW) receiver that — without greatly increasing complexity of the design — substantially improve reception of broadcast band (BB) stations. These modifications were done with the receiver described on pp. 53 to 63 of R.A. Penfold, Simple Short Wave Receiver Construction (Great Britain: Bernard Babani, 1990). For a copy of these pages, check out the Nuts & Volts website at www.nutsvolts.com. See Figure 1 of this article for the schematic diagram of the original design.

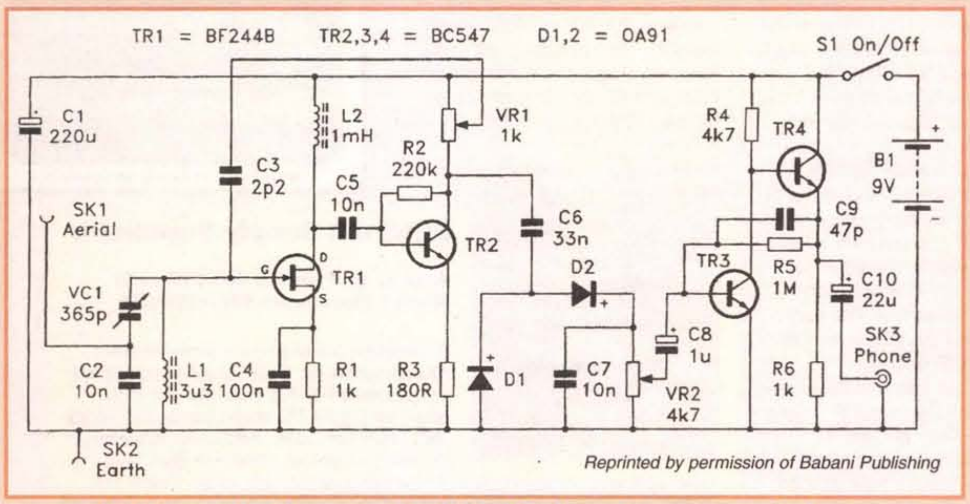


Figure 1: Schematic diagram of original TRF receiver connected to a long wire antenna.

My modifications to Mr. Penfold's design, shown in Figure 2, include the following: **(1)** The receiver is connected to a dipole in place of a long-wire antenna. **(2)** The coupling of the antenna to the radio frequency (RF) tuning section is inductive as opposed to capacitive. **(3)** Positive band selecting and fine tuning replace a single tuning capacitor. **(4)** The modified receiver is designed for coupling the single stage of AF amplification of the receiver to a powered speaker. This reduces the rate of current drain of the rectangular nine-volt battery powering the receiver. **(5)** Transistor TR4, arranged as an emitter-follower, functions as a buffering stage instead of for the original purpose of impedance matching to an earphone.

TRF VS. SUPERHETERODYNE

All of the currently manufactured SWBB receivers operate with superheterodyne signal processing. Prior to detection, the signal processing for reception occurs at a fixed frequency between RF and AF frequency ranges and at the radio frequency of tuning where reception is, respectively, according to superheterodyne and tuned radio frequency (TRF) methods. As a result, the least complex circuitry with sensitivity eliminating the need for a large antenna, and selectivity eliminating interference between station broadcasts, is designed according to the superheterodyne method.

Amplitude modulation of an RF carrier by an AF signal generates first and second sidebands each with frequency content equal to, respectively, the sum and difference of the modulating and carrier frequencies. Where the modulated carrier is to convey the AF range up to 10 KHz for adequate transmission of music, the bandwidth of modulation of the carrier is equal to 20 KHz.

The allocated transmitting frequencies of the SW broadcast stations are closely spaced together. In response to this, the band width of the band-pass filtering intermediate frequency (IF) section of at least the economical and currently available commercial SW receiver is about equal to 5 KHz. Therefore, this type of receiver severely limits demodulation of any AF information of a frequency greater than about 2.5 KHz.

Modifying Mr. Penfold's simple TRF receiver to include a dipole antenna and inductive coupling of the antenna to the tuning section of the receiver improves selectivity. However, the selec-

The selectivity of the modified receiver can be viewed as a double-edged sword.

tivity of the modified TRF receiver is still substantially less than that of the typical SW superheterodyne receiver. The selectivity of the modified receiver can be viewed as a double-edged sword. A desired reception with relatively little interference from the transmissions of other stations and demodulation within the full AF range is possible with this receiver. On the other hand, simultaneous reception of separate transmissions — or breakthrough — must be contended with to a much greater extent when operating the modified TRF receiver of this article than is the case with superheterodyne receivers.

Another appeal of the modified TRF receiver is that, despite the sheer simplicity of the circuitry shown in Figure 2 relative to that of even a rudimentary superheterodyne receiver, long distance reception of a good quality is possible on a regular basis with this receiver.

DESCRIPTION OF FIGURE 2 AND FIGURE 3

Starting at the dipole antenna, the antenna is constructed by making a break at the middle of a straight wire that is 5.5 meters in length. Thereby, efficiency of conversion of electromagnetic radiation to current flowing through the antenna is at a peak, or the antenna is resonant, when the frequency of that radiation is equal to the speed of light (c) divided by the wavelength of 11 meters (two times 5.5 meters).

The leads at one end of 300 ohm twin-lead connect across the break in the dipole antenna and the leads at the opposite end of the feed line connect across single layer antenna coil L1. Tuning coil L2 is a single layer coil wound on the same form that coil L1 is wound on and is the inductor of the parallel resonant or tank circuit of the tuning section of the receiver. The lead to the first turn of coil L2 facing coil L1 is connected to the gate terminal of junction field effect transistor (JFET) TR1. The lead to the final turn of coil L2 is connected to the negative (-) terminal of the power supply — battery B1 — or the common rail. The inductance of coil L2 is equal to 3.3 microHenries based on the original design of the TRF receiver of Mr. Penfold.

The physical dimensions of the L1/L2 coil assembly, in inches, are given in Figure 3. The ratio of the diameter of the cylindrical form that coils L1 and L2 are wound on divided by the winding length of coils L1 and L2 approaches the optimum value of between two and three. The number of turns of antenna coil L1 is equal to five based on the recommendation of an optimum number of turns of an antenna coil of between three and five. The number of turns of tuning coil L2 to yield the desired value of inductance was calculated according to a first adaptation of Wheeler's formula relating inductance to dimensions of an air core single layer coil with no gaps between the turns of the coil,

@h p=(4.000,9.735) l=1.600
@h p=(4.150,6.775) l=0.790
@h p=(2.380,6.784) l=1.360
@h p=(2.450,4.853) l=0.750
@h p=(2.640,2.735) l=0.850

$$L = \frac{r^2 \times N^2}{9r + 10l}$$

where L equals inductance in microHenries, r equals the outside radius of the coil in inches, l equals the axial length of the coil in inches, and N equals the number of turns of the coil.

[Refer to B.B. Babani, *Coil Design And Construction Manual* (Great Britain: Bernard Babani Limited, 1960), pp.16, 19 & 14.]

Transposing the axial length l of Wheeler's formula to the left side of the formula,

$$l = \frac{r^2 \times N^2}{10L} - 0.9r$$

The axial length of the coil l must also be equal to the product of the number of turns of the coil and the inverse of turns per linear inch corresponding to the gauge of the wire forming the coil. Turns per linear inch of 18 AWG enameled wire is equal to 23.6. Substituting for axial length l in the above transposed formula,

$$N \times \frac{1 \text{ inch linear}}{x \text{ turns}} \overset{?}{=} \frac{r^2 \times N^2}{10L} - 0.9r$$

where the correct value of N is chosen, then left and right sides of this last expression of Wheeler's formula are equal.

The pole of band-selecting switch SW1 is connected to the common rail. Setting the pole of switch SW1 to one of five positions separately connects varying quantities of capacitance from the gate terminal of transistor TR1 to the common rail, and in parallel circuit with the inductance of coil L2.

The tuned frequency of the receiver is equal to the resonant frequency of the total capacitance con-

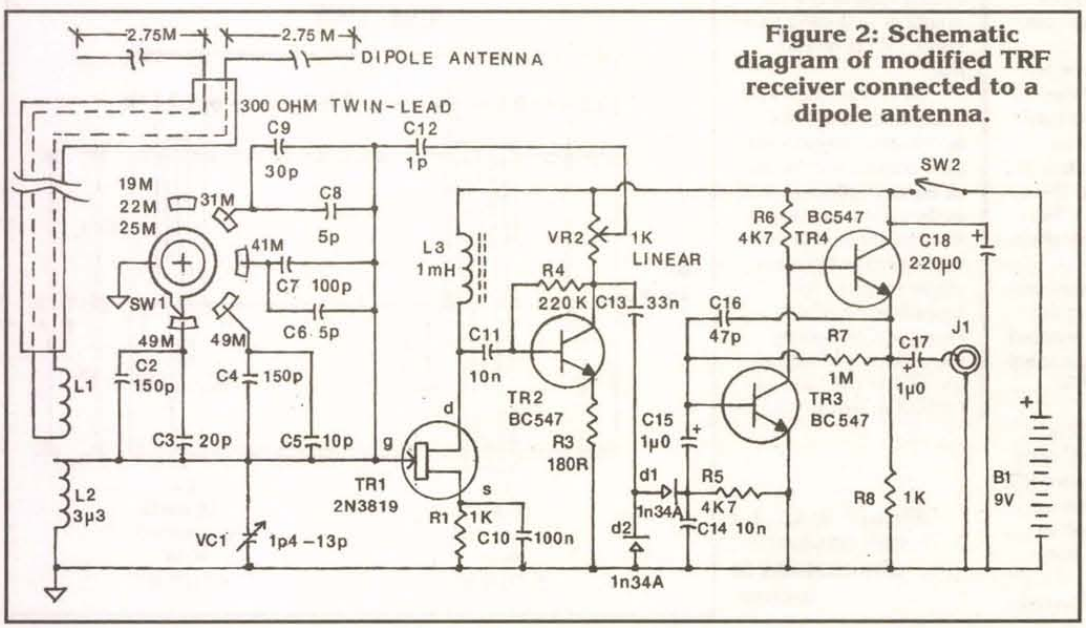


Figure 2: Schematic diagram of modified TRF receiver connected to a dipole antenna.

nected in parallel circuit with coil L2 according to the equation,

$$f_O = \frac{1}{6.28\,(L2 \times C_T)1/2}$$

where fo is equal to the resonant frequency in Hertz and CT is equal to total capacitance in Farads. The required capacitance to be switched into parallel circuit with coil L2 for tuning to a band covered by the receiver, where fo is equal to the upper frequency limit of the band, is equal to capacitance CT minus the summation of the average capacitance of the gate to source junction of transistor TR1, 40 picoFarads, plus the minimum capacitance of bandspread tuning variable capacitor VC1, 1.4 picoFarads.

N-channel JFET TR1 is connected as a first stage of RF amplification. The gate and source terminals of JFET TR1 are ohmic contacts to a p-type region adjacent to the N-channel and the N-channel, respectively. For linear amplification, this junction is reverse-biased by the positive DC voltage taken at the source terminal of JFET TR1 resulting from the connection of the source terminal to the common rail with resistor R1. With respect to direct current, the gate terminal of JFET TR1 is at the potential of the common rail as a result of the connection of coil L2 from the gate of JFET TR1 to the common rail.

With respect to RF voltage, the source terminal of JFET TR1 is at the potential of the common rail as a result of capacitor C10 connected in parallel with resistor R1. Negative feedback, which would excessively decrease RF gain of JFET TR1, is thereby eliminated. The connection of the drain terminal of JFET TR1 to load inductor L3 is the output terminal of the first stage of RF amplification.

The terminations of capacitor C11 connected to the drain terminal of JFET TR1 and the base terminal of NPN transistor TR2, connected as a common emitter (CE) RF amplifier, capacitively couples first and second stages of RF amplification of the receiver.

The voltage gain of CE amplifier TR2 is equal to the resistance of the output load, resistor VR2, divided by the resistance of resistor R3. Voltage gain greater than about 5.6 of this second stage of RF amplification would result in instability as a result of the presence of stray feedback.

Resistor Vr2 is the output load of CE amplifier TR2. Therefore, connection of the terminations of capacitor C12 to the wiper terminal of resistor VR2 and the gate terminal of JFET TR1 is a variable positive regenerative feedback circuit over both first and second stages of RF amplification. The value of capacitance of C12, 1.0 picoFarad, is less than that of the corresponding capacitor of the receiver of Mr. Penfold's design as the inductive coupling of the modified receiver is a "looser" coupling than the capacitive coupling of the original design.

Capacitor C13, connected from the collector of transistor TR2 to the connection of the anode and cathode of, respectively, diodes d1 and d2, affects AC coupling of the output voltage of the second stage of RF amplification to detection. The voltage drop across resistor R6 connected from the cathode of diode d1 to the common rail is the output voltage of detection.

The input terminal of a first stage of AF amplification, made up of NPN transistor TR3 connected to its related components in the CE configuration, is connected to the output terminal of detection by the connection of the positive and negative terminals of electrolytic capacitor C15 to the base of transistor TR3 and the cathode of diode d1, respectively. The voltage gain (Av) of this first stage is about equal to 160. or 44 dB. The output load of the CE amplifier including transistor TR3 is resistor R6.

NPN transistor TR4 is connected with its accessory components as a common collector or emitter follower, and buffers the input amplification stage of a powered speaker from the single stage of AF amplification of the receiver. Connecting the collector of transistor TR3 to the base of transistor TR4 is the output to input connection between the amplifying and buffering stages. High frequency roll-off over both amplifying and buffering stages, for stability of amplification, is accomplished by the connection of capacitor C16 from the emitter to the base of, respectively, transistors TR4 and TR3. Resistor R8, connected from the emitter of transistor TR4 to the common rail is the output load of the buffering stage.

The positive and negative terminals of electrolytic capacitor C17 connected to, respectively, the emitter of transistor TR4 and the shaft contact of phono jack J-1 connects the output terminal of the buffering stage to the input terminal of the phono plug of a powered speaker connected to the receiver.

RECEIVING — HOW IT WORKS IN FIGURE 2

To achieve maximum improvement of the selectivity of the original TRF receiver, ideally the resonant frequency of the dipole antenna of the modified TRF receiver would be equal to the average of the frequencies covered by the modified TRF receiver. However, if that is the case, then transistor TR4 is overloaded and positive regenerative feedback has no effect on signal strength. Where each leg of the dipole antenna

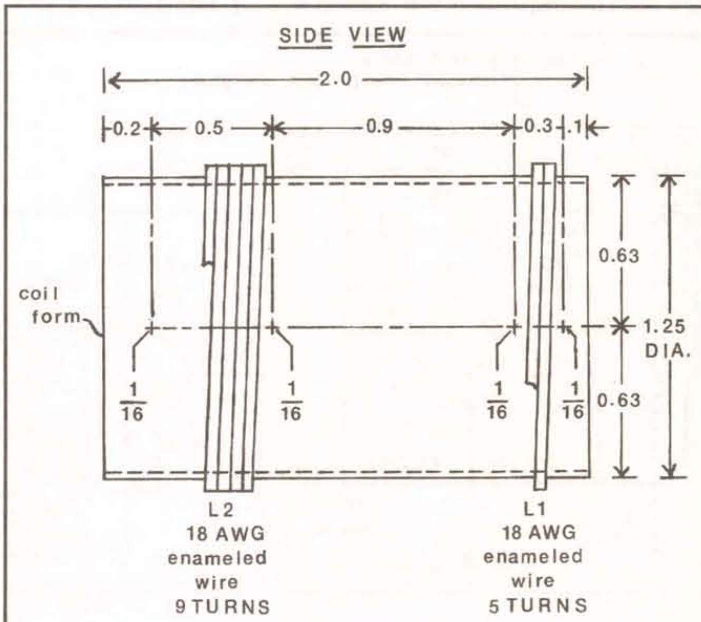


Figure 3: L1/L2 coil assembly, dimensions in inches.

of Figure 2 is cut to the length shown (equal to nine feet), then a fair amount of selectivity of reception at the antenna is achieved without overloading the receiver. That is, the dipole antenna of Figure 2 is resonant for electromagnetic radiation of a wavelength equal to 11 meters.

A voltage is generated at the break in the antenna of Figure 2 causing current to flow through the feed line and also through the antenna towards the ends of the antenna. Current travelling from the break to the end of a leg of the antenna is reflected back to the break with a 180-degree phase reversal as a result of the reflection at the end of the leg. Where the length of each leg is equal to 1/4 of the wavelength of the radiation acting on the antenna, then a time interval equal to 1/2 the period of the voltage induced by that radiation has elapsed when the reflected current arrives at the break.

In that time interval, the voltage induced at the break has shifted phase by 180 degrees, and the reflected current is in phase with current flowing through the feed line and reinforces it.

Resonance of the tank circuit occurs when the values of reactance of the total capacitance placed in parallel circuit with coil L2 and that of coil L2 are equal. Where the pole of switch SW1 is set in the position of not connecting any of the band selecting capacitors to the common rail, then the gate to source junction of JFET TR1 and VC2 are the only sources of capacitance in parallel circuit with the inductance of coil L2.

This gate to source capacitance individually varies with each given transistor in the range of 30 pF to 50 pF. Therefore, this setting of SW1 produces a band selection within the bounds of the 19 meter, 22 meter, and 25 meter bands dependent on the particular value of gate to source capacitance of the installed JFET.

When the inductive and capacitive reactances of the tank circuit are equal, the counter voltages of the reactances mutually cancel and oscillatory discharge occurs. Selectivity of the tank circuit is at a maximum when the voltage taken at the gate of transistor TR1, with respect to the common rail, is predominantly a function of this oscillatory discharge.

Therefore, selectivity of the tank circuit corresponds directly to the extent with which the antenna circuit is loosely coupled to the tank circuit. The inductive coupling of the antenna circuit to the tank circuit of Figure 2 is a very loose type of floating coupling as both terminations of coil L1 are connected to the antenna rather than an arrangement where one termination of coil L1 is connected to the common rail.

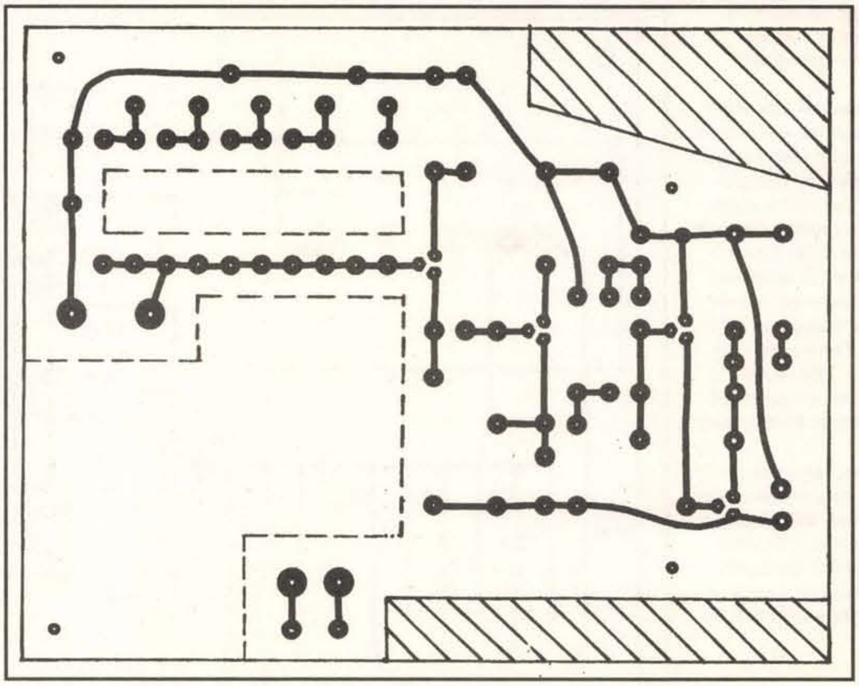


Figure 4: Positive 1:1 foil-side view of PCB.

Positive regenerative feedback over both stages of RF amplification occurs because the difference of the phase of the output and input voltages of each stage of RF amplification is equal to 180 degrees. Therefore, the difference of the phases of an output voltage taken at the collector of transistor TR2 and of the corresponding input voltage taken at the gate of JFET TR1 is equal to 360 degrees which is equivalent to 0 degrees.

With respect to the common rail, if the voltage taken at the gate of JFET TR1 is positive going, then the reverse-bias on the gate to source junction of JFET TR1 is decreasing and the resistance of the channel of JFET TR1 is also decreasing. Therefore, the voltage drop across inductor L3 is increasing and the output voltage taken at the drain terminal of JFET TR1, with respect to the common rail, is negative going.

Referring to transistor TR2, if the voltage taken at the base of transistor TR2 is positive going relative to the common potential, then collector-to-emitter current increases in response to the increase of forward-bias on the base-to-emitter junction. The increase of collector-to-emitter current produces a greater increase of voltage drop across resistor VR2 than that of resistor R3 directly proportional to

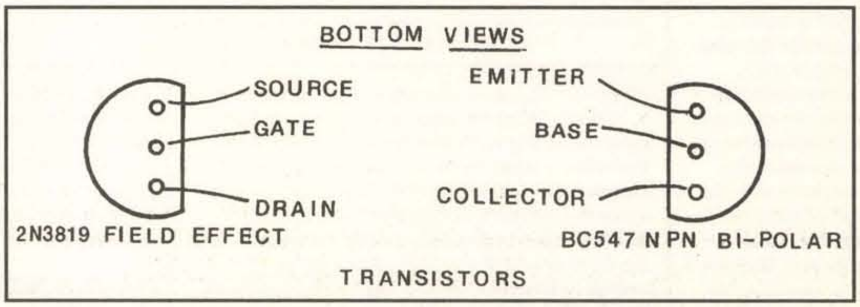


Figure 5: Pin-out identification of transistors.

the ratio of the resistance values of resistors VR2 and R3. Therefore, the output voltage taken at the collector is negative going with respect to the common rail.

High frequency roll-off of the AF amplification section — transistor TR3 and its associated components — is derived from increased negative feedback of the upper frequency components of the output voltage of the buffer stage, transistor TR4 configured as an emitter follower, taken at the emitter of transistor TR4. Since transistor TR3 is configured as a CE amplifier, the output and input voltages taken at, respectively, the collector and base of transistor TR3 are 180 degrees out of phase. The emitter follower configuration of transistor TR4 results in equal phase of the voltages taken at the input (base) and output (emitter) terminals of transistor TR4.

Capacitive reactance is inversely proportional to frequency. Therefore, as a result of the connection of capacitor C16 from the emitter to the base of, respectively, transistors TR4 and TR3, the voltage drop of a negative feedback component taken across the base and emitter of transistor TR3 increases directly with the frequency of that component.

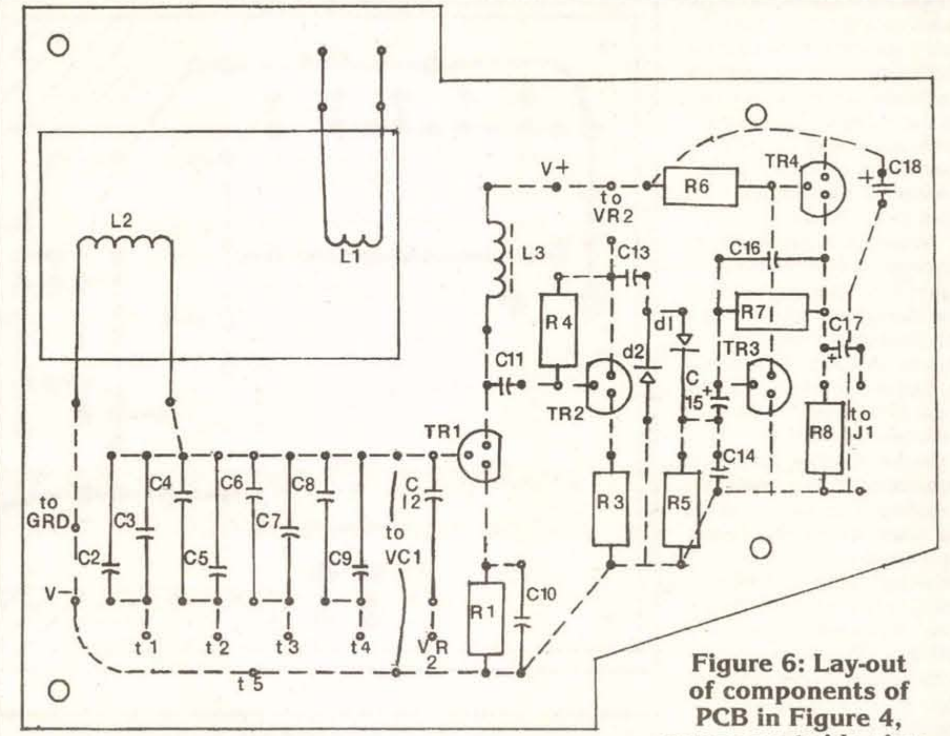


Figure 6: Lay-out of components of PCB in Figure 4, component-side view.

CONSTRUCTION

Figure 3 shows the L1/L2 coil assembly. The coil form of this assembly can be the plastic canister that 35mm film is sold in. Drill 1/16 inch diameter holes coincident and perpendicular with the center axis of the canister that pass through facing and opposite sides of the canister. The coils must be wound in the identical direction around the canister with the turns as closely spaced together as possible, ideally with no air gaps between the turns. With the coils positioned towards you as shown in Figure 3, both leads of coils L1 and L2 exit, respectively, from the back and facing sides of the canister.

Shown from the foil side, the positive 1:1 trace/ pad pattern for producing the printed circuit board (PCB) of the modified receiver is shown in Figure 4. The locations of the 1/16 inch (outside diameter) pads indicate the centers of mounting holes. The rectangular areas enclosed by dashed lines should be covered with tape to prevent etching of those enclosed surface areas. Areas of the board that include cross hatches are cut away from the board prior to etching. Reducing the amount of foil to be etched decreases the possibility of underetching of the circuit traces and conserves etchant.

When filling the etched and drilled board, referring to Figure 6 indicates the position of the components of the circuit viewed from the component side of the PCB. The parts list indicates the values and types of the components. The transistors have been correctly soldered to the PCB when the flat face of transistor TR1 is on the righthand side and the flat faces of transistors TR2, TR3, and TR4 are on the lefthand side. Figure 5 shows the pin identification of the transistors.

Upon completion of filling the PCB, the PCB is ready for mounting in a project enclosure and connecting the PCB to components of the receiver that are mounted on the front and rear panels of the enclosure.

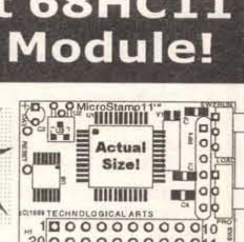
Looking at Photo 1, the components of the receiver mounted on the front panel identified from left to right are SPST power switch SW1, rotary band-selecting switch SW2, variable capacitor VC2, and regenerative feedback controlling potentiometer VR2. Mounted on the rear panel are three binding posts, one for an optional connection to ground and the other two for connecting to the antenna, and a phono (RCA) output jack. Connecting the controls and connectors to the PCB with sections of multicolored ribbon cable lends a neat appearance to the project.

ADJUSTMENT AND OPERATION

Refer to Figure 2. Some adjustment to the values of band-selecting capacitors C2-C9 might be required for reasonably accurate band selection due to three causes.

Firstly, the change of capacitance of the tank circuit corresponding to tuning from the high to the low frequency limits of a given band or band section covered by the receiver is only equal to about 9 picoFarads.

Secondly, the values of capacitors C2-C9 are calculated based on the average value of capacitance of the gate to source junction of JFET TR1, the actual value of which could dif-



fer from the average by as much as 10 picoFarads. Thirdly, the tolerance of the ceramic disc and polystyrene-type of capacitors C3-C9 is equal to 5%.

If you own or have access to an RF frequency generator/counter, then adjustment of the values of capacitance to be switched in for selecting bands is fairly easy. Otherwise, the extent to which band selecting capacitance is off can be roughly gauged by listening to the receiver and noting whether or not the reception of stations drops off drastically when bandspread tuning variable capacitor VC2 of Figure 2 is near the end of rotation to the left or to the right.

Tuning for a station is best accomplished according to the following procedure. After selecting a band, the bandspread tuning knob (on the shaft of VC2 of Figure 2) is rotated to midpoint of the full rotation for the control.

The knob of the regenerative feedback control (on the shaft of VR2 of Figure 2) is then advanced until the receiver is driven into oscillation. The knob controlling feedback is then backed off slightly until oscillation of the receiver ceases. Next, bandspread tuning is adjusted until the desired station becomes audible. To improve reception re-adjust the feedback control, then fine tune with the bandspread tuning control. **NV**

PARTS LIST

Resistors, Ohms, 1/4W carbon film, 5%, except where otherwise noted

R1	1.0K
VR2	1.0K, 20%, single turn linear taper potentiometer
R3	180.0
R4	220.0K
R5	4.7K
R6	4.7K
R7	1.0M
R8	1.0K

Capacitors

VC1	1.4 pF to 13.0 pF air variable trimmer, EF Johnson # 193-4, Ocean State Electronics part # TC-1934
C2	150.0 pF, 50V, 5% axial polystyrene
C3	20.0 pF, 50V, 5% ceramic disc
C4	150.0 pF, 50V, 5% axial polystyrene
C5	10.0 pF, 50V, 5% ceramic disc
C6	5.0 pF, 50V, 5% ceramic disc
C7	100.0 pF, 50V, 5% axial polystyrene
C8	5.0 pF, 50V, 5% ceramic disc
C9	30.0 pF, 50V, 5% ceramic disc
C10	0.1 microFarad, 50V, 10% polyester film
C11	0.01 microFarad, 50V, 10% polyester film
C12	1.0 pF, 50V, 5% ceramic disc
C13	0.033 microFarad, 50V, 10% polyester film
C14	0.01 microFarad, 50V, 10% polyester film
C15	1.0 microFarad, 50V, 20% radial mini polarized electrolytic
C16	47.0 pF, 50V, 5% ceramic disc
C17	1.0 microFarad, 50V, 20% radial mini polarized electrolytic
C18	220.0 microFarad, 25V, 10%, radial polarized electrolytic

Inductors

L1	5 turns of AWG 18 enameled wire
L2	3.3 mH, 9 turns of AWG 18 enameled wire
L3	1.0 mH ferrite core RF choke

Semiconductors

d1	1N34A germanium signal diode
d2	1N34A germanium signal diode
TR1	2N3819 N-channel JFET
TR2, TR3, TR4	BC547 NPN small signal bipolar transistor

Mechanical Components

SW1	single pole, 5 position, panel mounting rotary switch
SW2	SPST miniature power switch
J1	chassis mounting phono (RCA) jack
BP's	three of binding posts, banana jacks, or other type of feed-through for connecting to antenna and ground

Miscellaneous

4 inch x 6 inch single sided PCB stock; multi-colored ribbon cable; one rectangular 9V battery and clip or holder; 18 AWG enameled wire; a film canister for 35mm film; a project enclosure; three control knobs; 300 ohm twin-lead and antenna wire; antenna insulators; etc.

Sources

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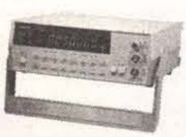

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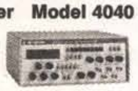

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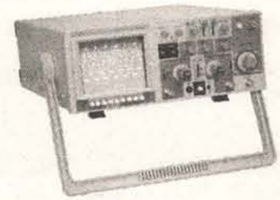

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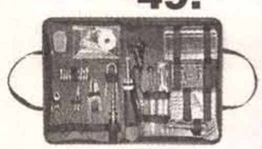

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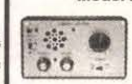

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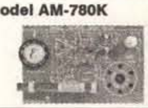

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Continued from page 42

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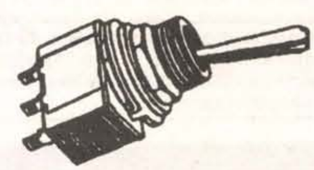

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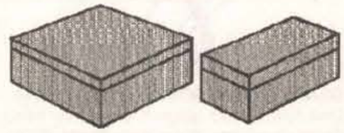

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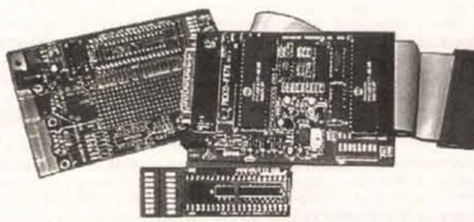

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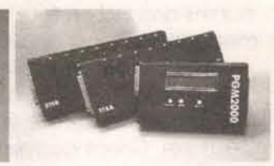

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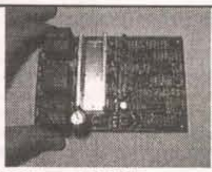

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Signal Generators — Part 2

Last month, I introduced the topic of signal generators. This month, we will look at the frequency synthesizer. A synthesizer architecture is shown in Figure 1. This type of signal generator is more modern than the old-fashioned type, and is capable of producing very accurate, high-quality signals.

There are three main sections to this signal source: Reference Section, Frequency Synthesizer, and Output Section. In Figure 1, each section is broken down into further components for sake of easy analysis.

Reference Section

The Reference Section is at the very core of the signal generation process. It is an accurate, stable, fixed-frequency source such as a crystal oscillator. The frequency of the reference section must be precisely adjustable over a small range so that it can be compared to a higher order standard, such as a Cesium-beam oscillator or WWVB comparator receiver, for purposes of calibration.

Because it controls the frequency synthesizer, the stability of the reference section determines the overall stability of the signal generator. The stability of ordinary crystal oscillators is reasonably good for many purposes, but not for use in the reference section of a signal source. For that purpose, either Temperature Compensated Crystal Oscillators (TCXO) or Oven Controlled Crystal Oscillators (OCXO) are used for the reference section. The TCXO will typically exhibit crystal aging of better then ±2 ppm/year, and a temperature aging of ±1 ppm/year. The OCXO is capable of 0.1 ppm/year for aging and 0.01 ppm/year for temperature.

The crystal oscillator is usually operated at a frequency such as 5 MHz, but lower frequencies are often needed. To generate these lower frequencies, a divide-by-N digital counter is provided. This circuit will divide the output frequency by some integer — N — to produce a much lower reference frequency.

Many signal generators provide REF. OUT and EXT. REF. IN capability (these connections are often located on the rear panel of signal generators, so may be overlooked). The REF. OUT connector provides the reference signal to other instruments, or can be used for calibration purposes. The EXT. REF. IN allows the use of an external reference source in place of the internal reference section. This is done sometimes to lock up two signal generators that must work together, or to substitute a much more accurate reference such as a Cesium-beam clock.

Frequency Synthesizer

The actual signal is produced in the frequency synthesizer section. It is generated by a voltage-controlled oscillator (VCO) whose output is compared to the reference signal. Voltage variable capacitance diodes ("varactors") can be used for the VCO, as can surface acoustical wave (SAW) oscillators (which are used at higher frequencies and in the microwave bands).

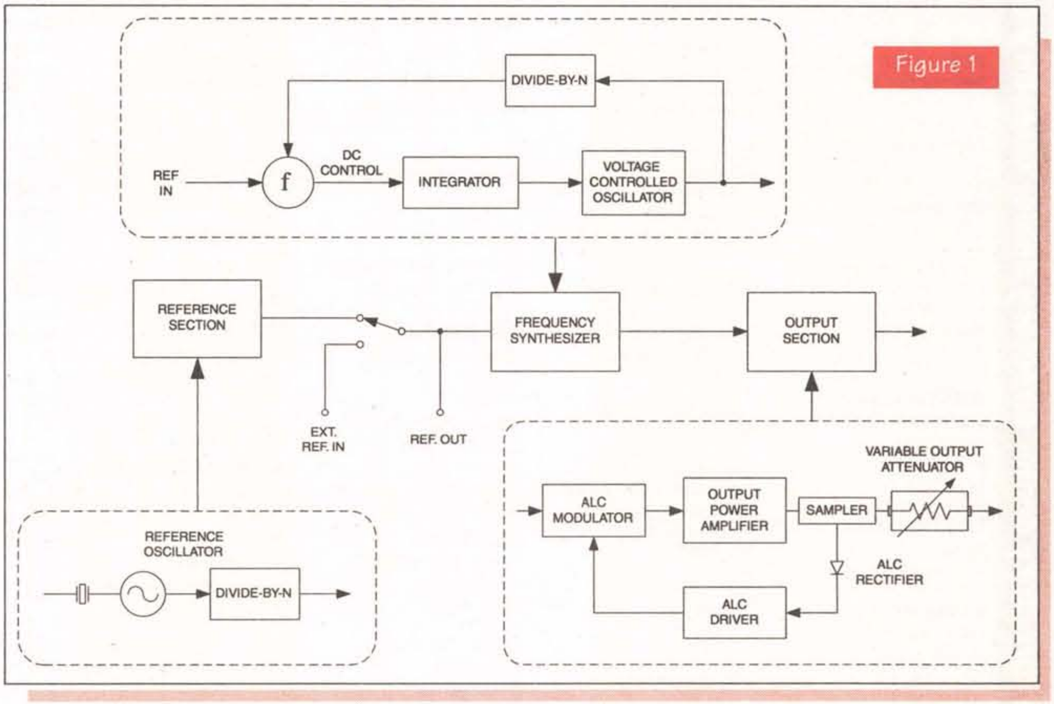


Figure 1

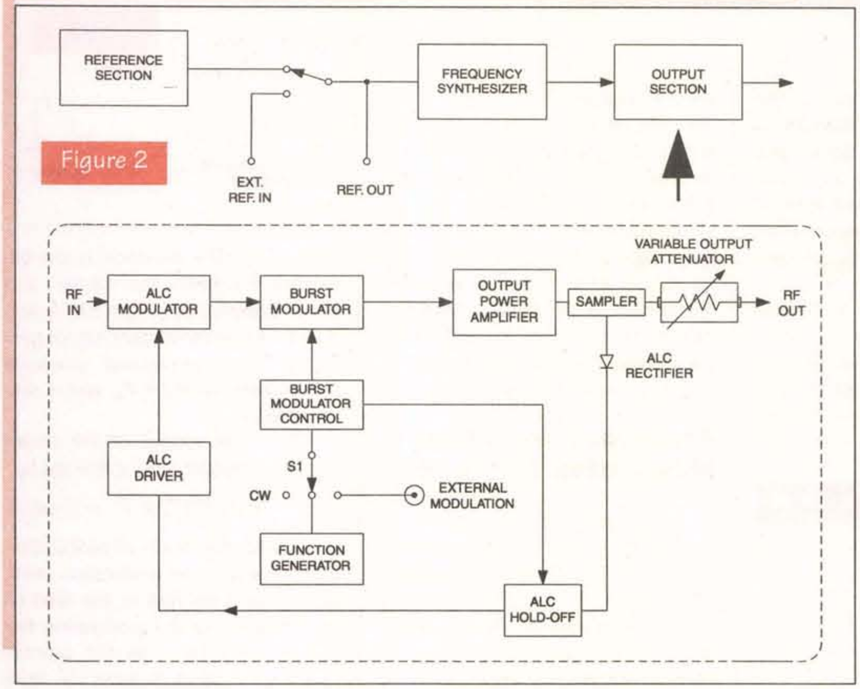


Figure 2

The frequency of the VCO is set by a DC control voltage applied to its tuning input line. This control voltage is generated by integrating the output of a phase detector or phase comparator that receives the reference frequency and a divide-by-N version of the VCO frequency as inputs. When the two frequencies are equal, then the output of the phase detector is zero, so the VCO tuning voltage is at some quiescent value.

But, if the frequency of the VCO drifts, the phase detector output becomes non-zero. The integrator output ramps up in the direction that will cancel the frequency drift of the VCO. The VCO frequency is continuously held in check by corrections from the integrated output of the phase detector. This type of circuit is called a phase-locked loop (PLL).

Suppose, for example, a signal source has a reference of 5 MHz, and it is divided by 20 to produce a 250 KHz reference. If the frequency synthesizer divide-by-N stage is set for, say, N = 511, then the VCO output frequency will be 0.25 MHz x 511 = 127.75 MHz. Band switching, operating frequency, and frequency resolution are controlled by manipulating the reference frequency divide-by-N and VCO divide-by-N settings. In some cases, the frequency is entered by keypad, and this tells the signal generator how to set these values. Alternatively, "tunable" signal generators may have a digital encoder shaft connected to a front panel control.

Noise Floor

The noise component of the output signal is composed of thermal noise and phase noise. Of these two, the phase noise tends to dominate the performance of the signal source. Both the Reference Oscillator and VCO phase noise contributes to the overall output phase noise. There is a 20 LOG(N) degradation of the phase noise performance of the signal source because of the divide-by-N nature of the PLL. Fortunately, the bandwidth of the PLL tends to limit the contribution of the VCO phase noise to the overall phase noise performance.

Output Section

The output section performs three basic functions: It boosts power output to a specified maximum level; it provides precision control over the actual output level; and keeps the output level constant as frequency is changed.

The power amplifier is a wideband amplifier that produces an output level of some value in excess of the required maximum output level (e.g., +13 dBm). A calibrated precision attenuator can then be used to set the actual output level to any lower value required (e.g., -136 dBm to +13 dBm).

The accuracy of the output power setting is dependent on keeping the RF power applied to the attenuator input constant, despite the fact that oscillators (including VCOs) tend to exhibit output signal amplitude changes as frequency is changed. In older manual signal sources, there was a zero center RF voltmeter at the input of the attenuator, and the output coarse attenuator level could be manually set to the zero line, making the calibration of the fine attenuator meaningful. Modern signal sources, however, use an automatic level control (ALC) circuit to accomplish this job.

Automatic Level Control (ALC)

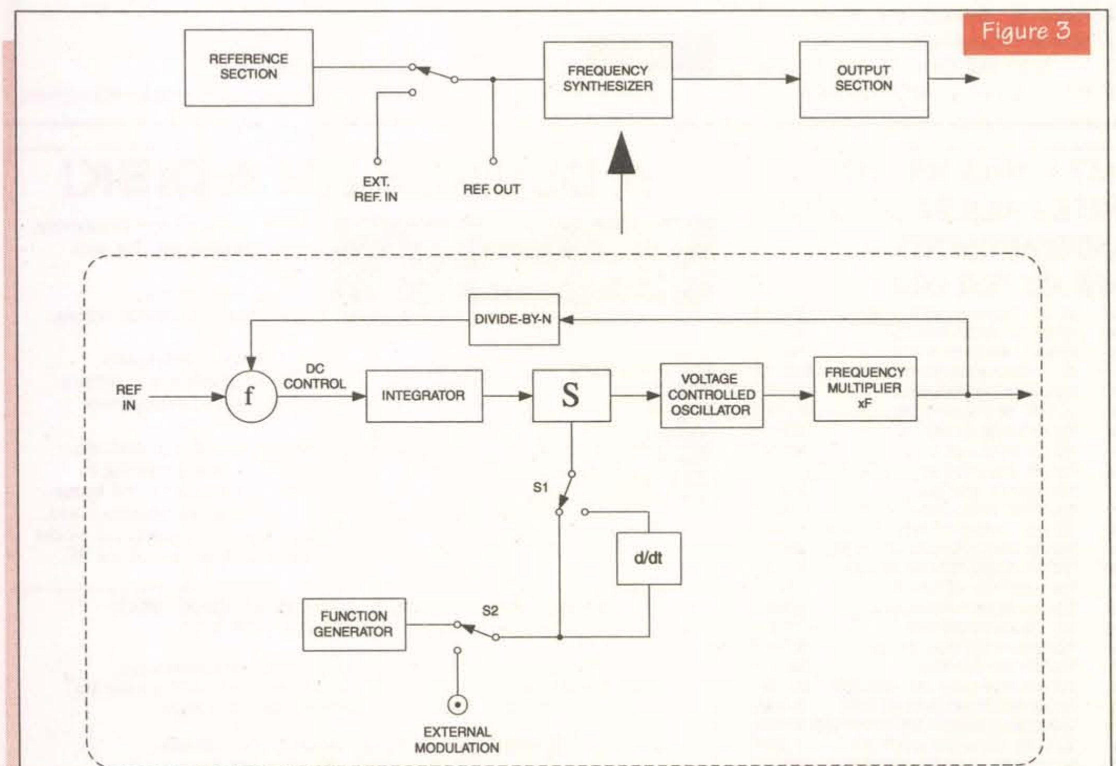
The ALC modulator is essentially an amplitude modulator that is controlled by a DC voltage developed by rectifying and filtering a sample of the RF output level. The ALC driver compares the actual output level with a preset value, and adjusts the control signal to the ALC modulator in a direction that cancels the error.

Modulators

A signal generator is said to differ from a signal source in that it will provide modulation of the CW signal. Although I believe that is a distinction without a practical difference, it is nonetheless a commonly held usage.

Amplitude Modulation (AM)

Amplitude modulation conveys intelligence over a radio carrier by means of varying the amplitude in accordance with the applied audio. The sinewave RF carrier is described by $a(t) = A_c \sin(2 \pi f_c\, t)$, where a(t) is the instantaneous amplitude, A_c is the peak amplifier, f_c is the carrier frequency and t is time. When another signal is used to vary the amplitude of the carrier, amplitude modulation (AM) results:

Figure 3


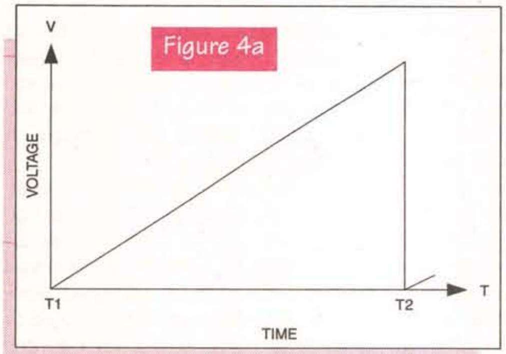


Figure 4a

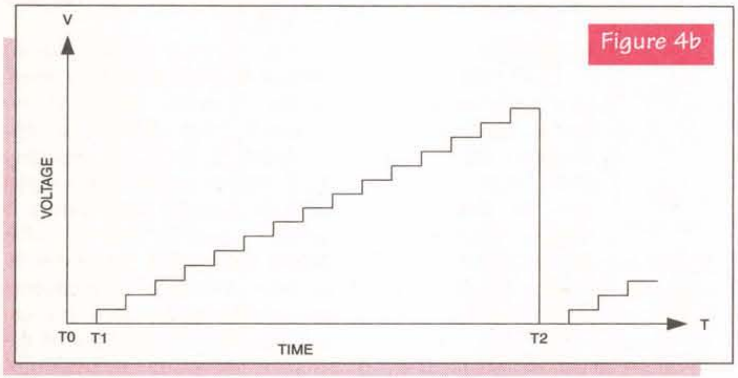


Figure 4b

$$s(t) = A_c \, Sin(2\pi f_c t) \times [1 + \mu \, Sin(2\pi f_m t)]$$

where

μ is the depth of modulation
f_m is the modulating frequency
(all other terms previously defined)

You will see the terms linear AM and logarithmic AM. The former is used when the depth of modulation is expressed as a percentage, and the latter when it is expressed in decibels (dB). Figure 2 shows the block diagram of the output section of a signal generator that offers amplitude modulation. The depth of modulation for most signal generators is adjustable over at least 0 to 30 percent, while some offer 100 percent AM.

The amplitude modulator is called a burst modulator in some signal generators, and is placed between the ALC modulator and the output power amplifier stage. The input signal used to modulate the RF carrier can be derived from an external source, or provided by an internal function generator that produces at least sinewaves. The function generator might also produce square waves, sawtooth waves, triangle waves, or pulses, depending on the nature of the signal generator. When the CW mode is desired, the modulating source is turned off.

Note that there are two modulators in Figure 2: ALC modulator and burst modulator. The ALC modulator is designed to keep the output RF level constant, while the burst modulator wants to vary the output RF level in accordance with the applied audio signal. These two circuits are, therefore, in conflict with each other. The ALC Hold-Off circuit is used to moderate this conflict.

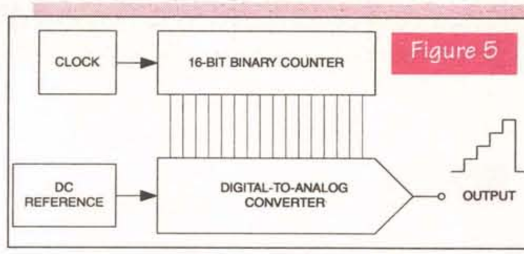


Figure 5

Frequency and Phase Modulation (FM & PM)

There are two basic forms of angular modulation: frequency modulation (FM) and phase modulation (PM). In FM, the carrier frequency is varied in accordance with the modulating frequency, while in PM, the carrier frequency remains constant, but its phase is varied. Both FM and PM are considered essentially the same. Consider the case of FM. When there is no modulation present, the RF carrier (f_c) will remain constant. But as a sinewave audio signal is applied, the carrier frequency will deviate from f_c to a lower frequency (F1) on one peak of the modulating frequency (f_m), and to a higher frequency (F2) on the alternate peak of f_m. The deviation is the difference between the carrier and either extreme, i.e., $+F_d = F2 - f_c$ and $-F_d = f_c - F1$. In most cases, signal generators use symmetrical sinewave modulation, so $+F_d = -F_d$, and is simply called F_d.

The peak voltage of the carrier remains constant, and is defined by:

$$V = V(t) \, Sin[2\pi f_c + \beta \, m(t)]$$

In FM, the depth of modulation is expressed as the modulation index (β), which is defined as the ratio of the deviation to the modulating frequency, or F_d/f_m. The FM process produces a large number of sidebands and, at certain values of β, the carrier will go to zero. The sidebands are described by mathematical entities called Bessell functions. In phase modulation, the modulation index (β) is related to the variation in the phase, i.e., $\beta = \Delta\phi_{peak}$.

Straight frequency modulation is created by varying the frequency of the oscillator in the frequency synthesizer (see Figure 3). Phase modu-

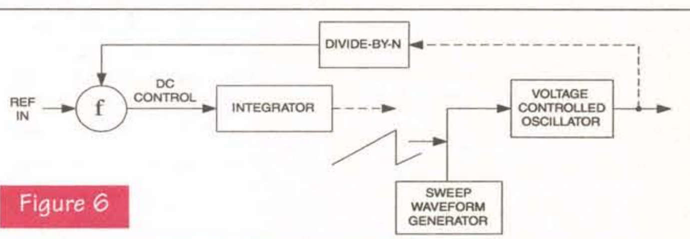
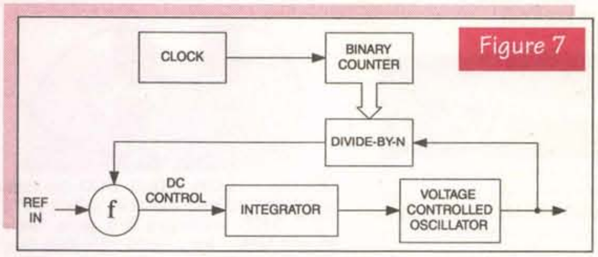


Figure 6



lation, on the other hand, is sometimes generated by using a reactance modulator to vary the phase of the oscillator signal.

Sweep Generators

Sweep generators ("sweepers") are used to produce a signal that changes frequency over a specified range. Although the sweeper nominally resembles an FM generator, there are differences. For one thing, the sweep range is usually quite a bit larger than the deviation of an FM signal generator. Another thing is that the sweeper tends to change frequency from one limit to the other, and then snaps back to the first limit.

There are three basic forms of sweep: linear (or "ramp") sweep, stepped sweep, and list sweep. All of these forms use a voltage-controlled oscillator frequency synthesizer, but the difference is in the waveform used for sweeping the output signal. Figure 4A shows linear sawtooth waveform sweep. At time T1, the ramp applied to the VCO is at zero and begins ramping up. The frequency begins to move upwards from the zero-volts value in a linear manner until time T2, at which point it snaps back to the zero-volts value.

Stepped sweep (Figure 4B) uses a series of discrete voltage steps to change the frequency of the VCO. This method does not produce an output on every frequency in the output voltage range from T1 to T2, but rather only at specific values determined by the steps. The steps are produced in a circuit such as shown in Figure 5. A digital-to-analog converter (DAC) produces an output voltage that is proportional to the binary number applied to its inputs. The maximum output voltage is set by an internal or external DC reference voltage, and the applied binary number. In this case, the DAC input is driven by a binary counter which, in turn, is incremented by a digital clock (square wave generator).

The maximum number of steps that can be accommodated using any given binary counter is 2^N, where N is the bit length of the counter. For the 16-bit counter shown in Figure 5, therefore, a total of $2^{16} = 65,536$ different levels (including zero) can be created. The maximum output voltage is less than the reference voltage by the 1-LSB (least significant bit) voltage, or $1/2^N$. If a 16-bit counter is connected to a DAC with a 10.00 volt reference source, then the 1-LSB step is 0.00015 volts and the maximum output voltage is 10.00 - 0.00015 volts = 9.99985 volts.

Output Reverse Power Protection

Many signal generators are used to test radio communications transceivers. These devices contain both transmitter and receiver, which share a common output connector to the antenna. If the signal generator is connected to the antenna connector to test the receiver, and someone accidentally keys the transmitter, then serious damage can result to the signal generator. High quality instruments provide architectures with output reverse power protection. This circuitry will prevent damage to the signal source if a high RF power level is applied to its output connector.

Digital sweepers also have a DAC to control the VCO, but will drive it with a series of values stored in a digital memory similar to those used in computers. This permits arbitrary waveforms to be created.

Figure 6 shows one way sweepers are built: open loop. The frequency synthesizer loop is broken, and a linear sawtooth, stepped waveform, or list generated waveform is applied to its DC control voltage input. Another approach is shown in Figure 7. This is a closed loop approach. The frequency synthesizer loop is not opened, but rather a binary counter or list memory is used to drive the divide-by-N counter in the synthesizer PLL feedback loop. **NV**

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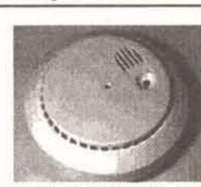

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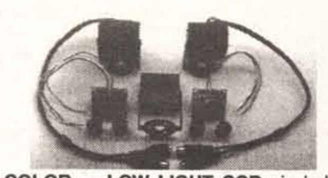

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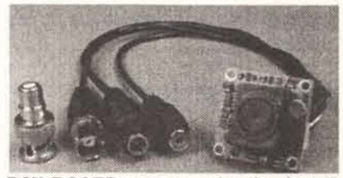

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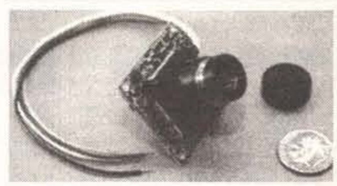

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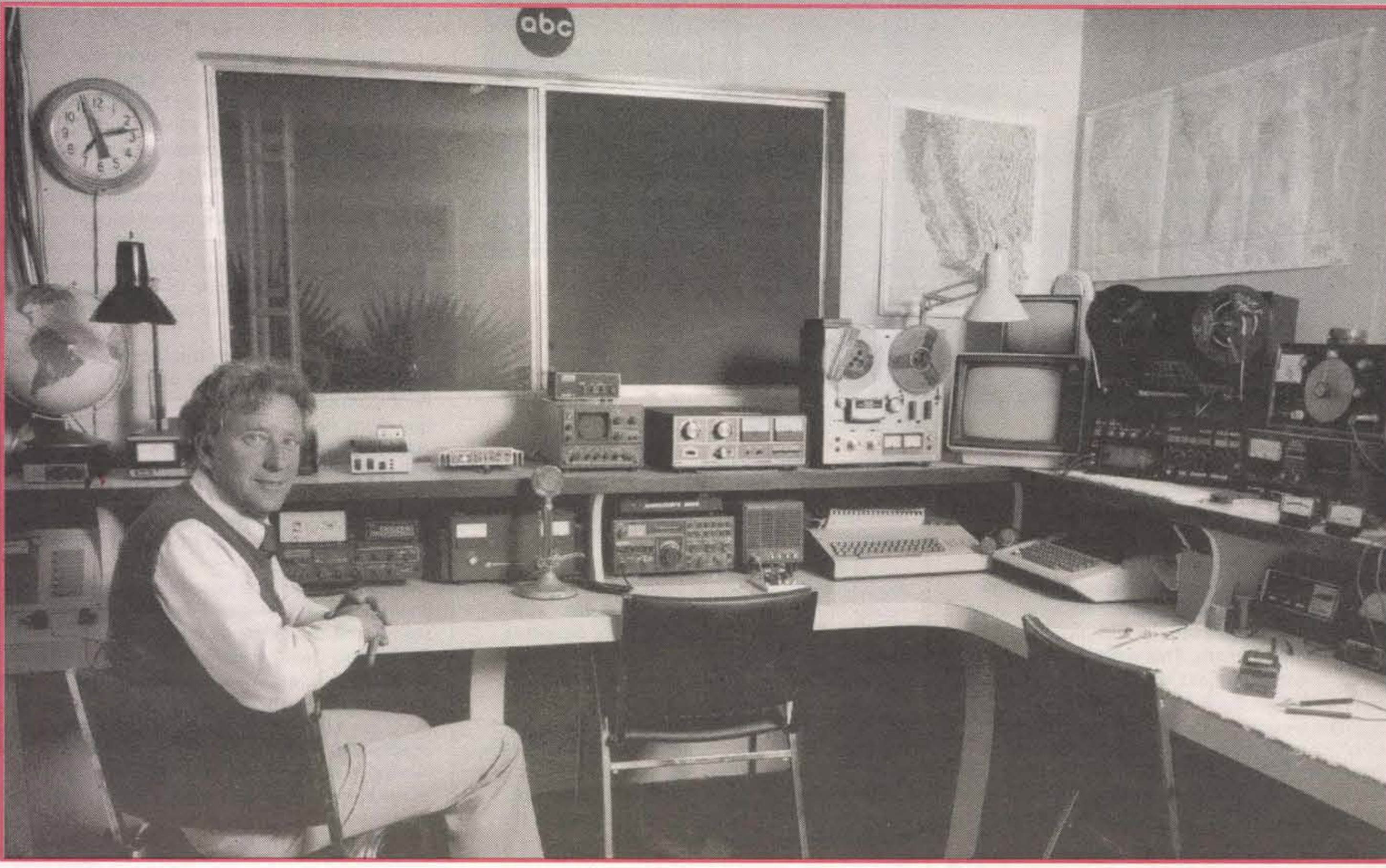
Continued on page 76

FEDERAL COMMUNICATIONS COMMISSION SIMPLIFIES HAM TESTS AND LOWERS CODE SPEEDS



On April 15, 2000, the new Federal Communications Commission (FCC) amateur radio service license restructuring becomes law. The present six ham radio classifications will be reduced to three. The three present Morse Code test speeds will be reduced to one at only 5 wpm. There will also be a reduction of the number of written examination elements from five to three.

"The new rules that simplify the amateur radio service operator license structure will streamline the number of examination elements and reduce the emphasis on telegraphy," comments the FCC. "We believe that these changes will also contribute more to the advancement of the radio art, reduce administrative costs that we incur in regulating the amateur service, and ultimately streamline our license processing even more," adds an FCC spokesman. "The dropping of the code speed to only 5 wpm will eliminate unnecessary requirements that could discourage or limit individuals from becoming trained operators, technicians, and electronic experts," adds the FCC.

When the rules officially go into effect on April 15, 2000, the amateur radio service examination elements will be the following:

Element 1	5 wpm code test for General and Extra
Element 2	Entry-level No-Code Technician theory, 35 Q & A
Element 3	General class theory, 35 Q & A
Element 4	Extra class theory, 50 Q & A

Ask any Boy Scout how easy 5 wpm Morse Code is.

Present amateur operators holding any class of license will not lose any privileges. These licenses may continue to be renewed indefinitely with their present operating privileges and sub-bands.

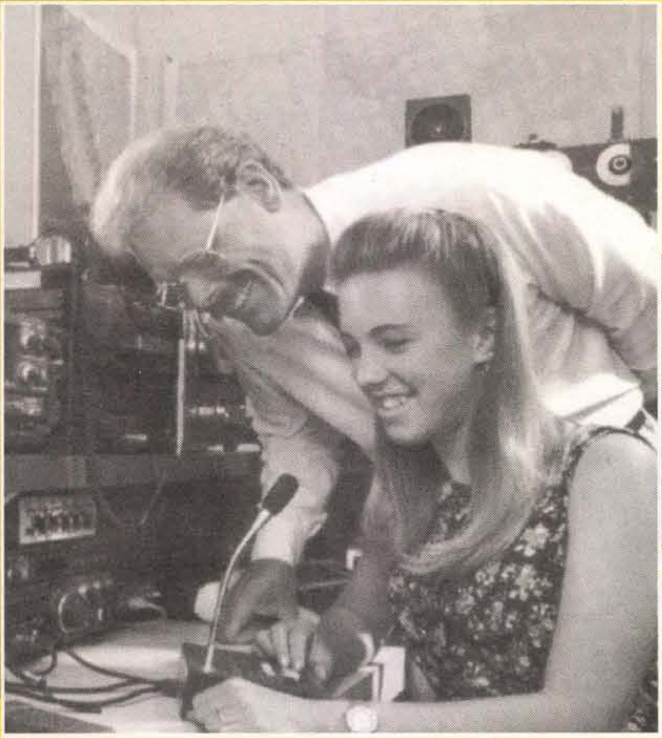
The entry-level, No-Code Technician class license will simply be called "Technician Class," and will consist of only a single 35-question, multiple-choice exam. The Novice written examination will become extinct.

The worldwide General class license is the big one that everyone with "just" the Tech or Tech-Plus has been longing for — a straightforward, 35-question, General written examination and, for the first time in USA amateur radio history, a simple 5 wpm code test. Five words per minute is so easy that applicants with a handicap could easily jot down dots or dashes on their paper, and then spend time converting them over to plain language letters and numbers to pass the test. Applicants with severe handicaps could even substitute a sending test instead of a receiving test. Most everyone can easily memorize the Morse Code in a couple of days, and learn to recognize the sounds at 5 wpm in a couple of weeks. Ask any Boy Scout how easy 5 wpm Morse Code is.

EXTRA CLASS

No further 5 wpm code test. Once you have passed the code at 5 wpm, it will also serve as the Extra class 5 wpm requirement, too. The Extra class theory test will be 50 multiple-choice questions and answers.

Technician class operators will have VHF and UHF privileges only — no worldwide band privileges below 30 MHz. Existing Technician-Plus operators may continue to enjoy their limited CW and 10-meter voice privileges on some



The new rules place emphasis on radio operating skills and not necessarily on Morse Code speed skills.

of the worldwide bands, but when they next renew, their license will only be labeled as "Technician" and they will need to carry around proof that, back in the old days, they were originally Tech-Plus.

The new Technician class license will be far easier to obtain than before because applicants are no longer required to pass the Novice written exam. This means the new No-Code Technician class license will be twice as easy as before April 15.

The General class written examination won't change much — in fact, the Question Pool Committee will simply delete some of the rules and regs questions dealing with old code test speeds, and develop some new rules and

The new No-Code Technician class license will be twice as easy as before April 15.

regs dealing with the new General 5 wpm simple code requirement.

But the Extra class written exam may really become a brain-buster. They will take questions from the old Advanced class tough question pool, and merge them into new digital and spread spectrum questions of Extra class, and come up with a 50-question written exam that should be quite a challenge to pass. But since this is the top license, and there is no longer any additional Morse Code requirement, the truly technical ham should have no problem in meeting the challenge.

THE RUSH IS ON

In the FCC 75-page Report and Order, they made mention that any current examination credits accrued before April 15 could be used to upgrade to the General class or Extra class if all of the requirements were met. For General class, this means 5 wpm code and passing the General class PRESENT written exam. For Extra class, it means that the applicant, before April 15, could take all of the written elements and no additional code test beyond 5 wpm and then turn into an Extra class operator after April 15.

The stampede is on by General class operators who are presently licensed as Generals to scoop up Advanced class books and Extra class books, and take both theory elements before April 15.

For No-Code Technician class operators, they are immediately learning the code at 5 wpm and the General theory, and taking both the code and theory tests before April 15. This turns them into a Technician-Plus operator with General credit. After April 15, the applicant goes back to the examiners and turns in the General written credit and now becomes a full-fledged new General class operator. And the big deal about General class is it opens up all of the worldwide General class sub-bands for worldwide communications. It's the biggie!

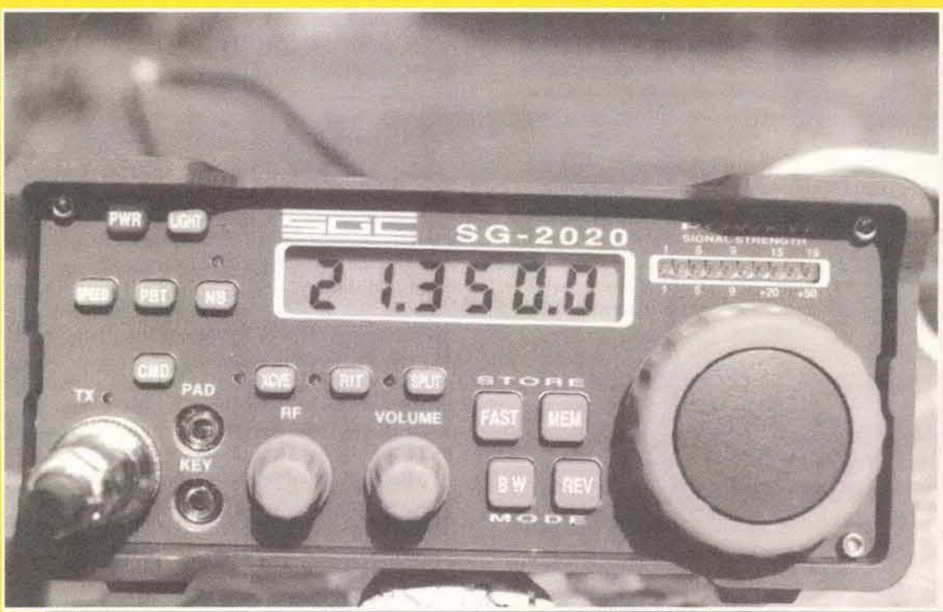
Non-hams are waiting to take all of the tests AFTER April 15 because they can avoid having to take the Novice written exam. Newcomers to ham radio could take the 5 wpm code test, Tech written, and General written, and instantly become a General class operator — well, not quite instantly, but as soon as the examiners turn in the exam session electronically with their volunteer exam coordinator, and the next day the FCC puts the license on the database.

More than half of today's ham radio operators are Technician class — mostly with the no-code license. The new rules have caused these no-code Techs to have a second thought about learning the code, and getting to the simple 5 wpm level. And it's working — Morse Code learning has never been as popular as it is right now. For those long-time hams who feel Morse Code is indeed an important part of the examination system, take heart — more hams are now learning the code in such numbers that we have never in the history of ham radio seen such CW interest.

And for those hams that feel the written exams are getting watered down, the Question Pool Committee is seeking input on what new questions need to be added to Technician class, General class, and Extra class. Since I'm a member of the Question Pool Committee, I encourage all readers to send me appropriate questions and multiple-choice answers that you would like to see worked into the three new test question pools.

And for kids, the new Technician no-code license requires only half as many questions to study, so it will be much easier to teach Technician class to extremely young would-be hams. In the past, we had to teach both Novice and Technician theory elements to obtain the No-Code Tech — now the Novice element gets deep-sixed. And, by the way, any present Novice class licensees may still continue to renew their license and enjoy Novice sub-band frequencies.

While most hams — especially No-Code Technicians — are elated about the prospects



New slow code rules will popularize worldwide radio sales!

of a simple code test for the worldwide bands, some hams are shocked by how easy it is to now obtain the ham radio ticket. And they are quite vocal on the airwaves and on the Internet. This writer has been licensed for almost 50 years, and to me, it's never been easier than now.

So, did the FCC dream up these new rules based on comments from only those who sell ham radio equipment and want to see more sales in the future? Not at all — in fact, in the 75-page FCC Report and Order, every page is loaded with specific references to individual comments by specific individuals representing personal or corporate views of the amateur radio service. In fact, the FCC truly did a marvelous job of detailing the Report and Order on important comments that were both for, as well as against, the overall rule changes. And the FCC goes into great detail on how they considered each comment in the overall plan to improve our service and bring it into line with the new millennium.

WHAT PLAN FOR YOU?

If you're not licensed yet as an amateur operator, wait until after April 15 and go from zero to General class by learning the code and learning Element 2 Technician class question pool and Element 3 General class question pool. You can expect the new books NOT to be available until about May for the new pools, but if you study only the Technician class questions in the present No-Code Technician book, and study the present General class questions in the General class book offered right now, you should be well-prepared for any test after April 15.

For those long-time hams who feel Morse Code is indeed an important part of the examination system, take heart — more hams are now learning the code in such numbers that we have never in the history of ham radio seen such CW interest.

If you are already licensed as a Technician class ham, get the General class written and the 5 wpm code test out of the way before April 15. Keep in mind, you'll need to go back again to the examination group and process your passing paperwork a second time in order to receive the new General class ticket.

If you're a General class operator now, try to locate someone's old Advanced class books, and get these two exams out of the way that will qualify you for the new Extra class license after April 15. If you decide to take the Extra AFTER April 15, hold out until the Question Pool Committee comes up with all of those crusher questions and a new textbook I'm presently working on.

All ham radio stores carry license manuals, but I'm told Advanced and Extra class books are just about sold out. General class books are in great shape. If you have a RadioShack nearby, you can pick up my Technician and General class books there.

Above all, learn the code at 5 wpm and pass the code test NOW. While I don't believe the code test can be made any "harder" after April 15, I see a single code test as one that may get more complex because, as the only code test, it means a lot to pass. Better do it now when the examiners are still working under the old rules with their usual code examination at 5 wpm.

For late-breaking news, you can call my class line information number at 714-434-0666 and hear my voice as I cheerfully tell you about what's happening with the exciting amateur radio service and the changing exam elements. If ever you wanted to get your ham ticket, there's no better time than right now to do it, and to quickly upgrade to at least General class. NV

Continued from page 72

ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.
Feel free to participate with your questions, as well as comments and suggestions.
You can reach me at:
TJBYERS@aol.com
TJBYERS@juno.com
or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

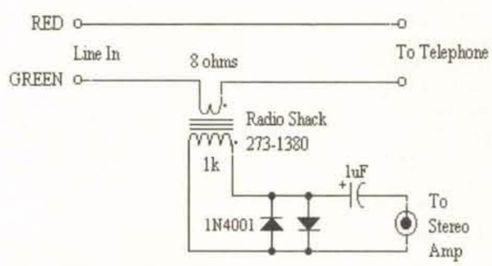
Hard of hearing or wanna play spy? Here's how to **tap a phone** on the cheap. **New tricks for the ICL7106**, and **secrets of the 555. Packet radio** for both the experimenter and the serious, and a rare glimpse of a **popular transmitter tube from the past**. More fun with **Lissajous** (even though he's dead) and last, but not least, **what the ATX means to you**.

Say What?

Q - I have an elderly uncle with severely-impaired hearing. He's unable to communicate on a telephone because he can't hear it. I purchased an amplified phone and a battery-operated in-line phone amplifier, but neither were effective. I noticed that when he uses headphones on a stereo he can adjust the volume to a level that allows him to listen to the radio just fine. My question: How can I take a standard telephone line and port it to a stereo amplifier so that he can listen to the caller through headphones and adjust the volume to his needs? I prefer to buy something, but will build, if necessary.

P. Medich
via Internet

A - Actually, there's a lot of support out there for the hearing impaired. TTY communications — which is free via your local phone company — pops to mind. I've had to use it before, when I was working with an hearing-impaired editor, and wouldn't have been able to complete the project without it. But it's not the only solution. If your uncle can still hear to some extent, and wants to be independent of keyboard technology, phone amplifiers are a viable alternative. Most instruments magnify sound by only 3X, which obviously it isn't enough for your uncle. However, I did find one from **Ameriphone (800-894-9549; http://www.seniorshops.com/seniorshops/inhanam.html)**, that promises gains of up to 100X, but it doesn't work with phones that have the keypad in the handset. If you don't mind doing it yourself, here's how.



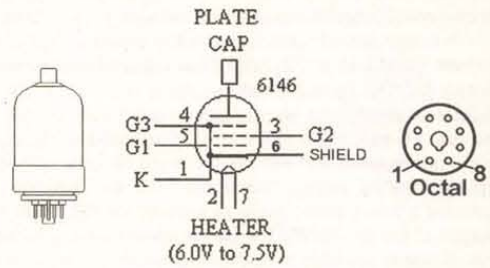
Simply break one of the phone leads (red or green) and insert an audio output transformer. Notice that the 8-ohm secondary winding is in series with the phone line and the high-impedance winding goes to your stereo amplifier. That's it. The back-to-back diodes limit the stereo input voltage to 0.7 volts and the 1uF capacitor prevents the diodes from dragging down the input impedance of the amp.

Reports Of My Death Are Premature

Q - I'm currently restoring an old Lafayette two-meter 6146 tube amp. It's in pristine condition, minus a plate transformer and a few unknown connections, specifically pins 3, 5, and 6 on both tube sockets. Do you have any knowledge of these pins and what their function might be? I also need to know what the plate voltage for both of these tubes should be.

Tim Terrorisi
via Internet

A - The 6146 is a small, lightweight beam-power pentode designed for service as a very high-frequency amplifier. Its high power output, low driving power requirements, and sturdy construction make it ideal for mobile and compact equipment. Here are the specifications you're looking for.



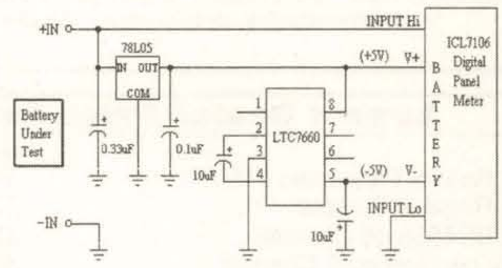
Shielding and effective RF grounding are facilitated by the cathode (pin 1), grid 3 (pin 4), and an internal shield (pin 6), all of which are connected inside the tube. Isolation of the output from the input is further enhanced by a top-cap plate connection. The maximum plate voltage is +750 volts, but +500 volts is considered optimum. The voltage on grid 2 (pin 3) should be half the plate voltage or +250 volts, whichever is smaller.

ICL7106 Power of Separation and Input

Q - This is sort of a blast from the past for you. In the Jul. '97 issue, you provided a schematic for isolating the input and power supply to an ICL7106-based voltmeter. I saw it when it came out but just got around to trying it out. It did not work. Did you ever go back and troubleshoot this circuit to come up with a way to use the input voltage for both power and monitoring?

Bill Kline
Dow AgroSciences
Vegetation and Crops Management R&D
wnkline@dowagro.com

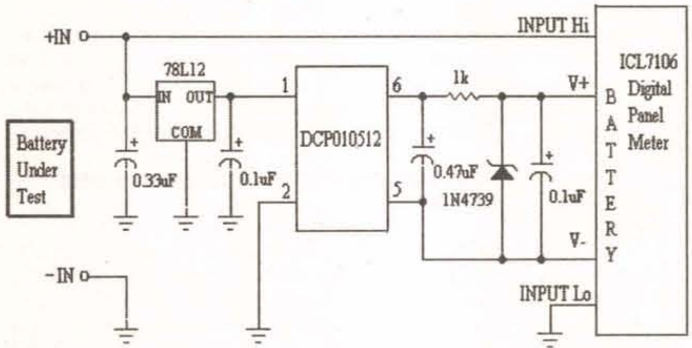
A - Sure have, and came up with a few more solutions — none of which are as simple as the one I showed in that first answer (in that design, the COMMON and INPUT Lo weren't hard wired together — but that's another story). In a standard configuration, the INPUT Lo and COMMON pins are shorted, causing INPUT Lo to rest 2.8 volts below V+ and hover 6.2 volts above V-. Herein lies the problem. While there are ways to separate the COMMON line from the differential inputs, it requires external components and compromises the CMRR (common-mode rejection ratio) of the voltmeter. Moreover, it's unlikely you can make these modifications to your existing meter, which brings us back to square one: Isolating the battery power from the voltage inputs. Here are my top picks.



The first uses a switched-capacitor inverter (I chose the LTC7660 for this design because it's available from many sources under names like ICL7660 and TC7660) that places the Reference line below ground — but not exactly. In fact, the power is split evenly between V+ and V-. Well, inside the ICL7106, that's not the way it is, so that even though this is a working solution, it's not a perfect one. You need to trim the reference voltage, which is accessible via pins 35 and 36. If you're lucky, you'll find a potentiometer that lets you do this, but in the cheap panel meters it's a fixed 1k resistor. Feedback from readers tell me that placing a 910-

ohm resistor across the 1k produces the best results, but that may change from meter to meter. Like I said, this is a longer story than I have space for here; for more info on this topic, surf to **Intersil Corp. (407-724-7000; http://www.intersil.com)** and download the ICL7106 data sheet.

A better solution, albeit overkill, is to use a DCP010512 from **Burr-Brown (800-548-6132; http://www.burr-brown.com)**. This is a complete flyback DC/DC converter encapsulated in a 14-pin DIP package. This chip is capable of supplying 1 watt of power at 12 volts (about 80mA); its siblings include 5V, ±5V, ±12V, 15V, and ±15V versions of the same. However, its output is unregulated, and will reach almost 15 volts unloaded, which is pushing the absolute Vss voltage limit of the ICL7106. To be on the safe side, I've included a 9-volt zener diode to protect the ICL7106. While it's overkill, the output of the DCP010512 is barely loaded, which means there's almost 80 mA of power available for other instruments that need isolation — perhaps a current meter or insolation monitor, which can make the $8.00 it costs for this chip be a real bargain. And here it is.



555 Shows Its Ugly Side

Q. I stumbled across a neat timer circuit that uses a 555 chip, which I decided to build. It works, but only somewhat. It works for a cycle or two, then becomes erratic, or mostly, locks up. If I disconnect the battery and let the circuit sit for a few minutes, it will work for a few cycles and screw up again. I even bought a new 555 from RadioShack, and it does the same thing. How come it works sometimes and not others?

Sal Marino
via Internet

A. You've discovered one of the best kept secrets of the 555. That is, they aren't all the same. In fact, I know which one you have. It's the NE555 from Texas Instrument (silver top, right?), because that's what RadioShack stocks even though the catalog says LM555. The difference is that the LM555 is a bipolar chip and the NE555 is a CMOS chip. And I bet that pin 2 of this circuit is waving in the air — picking up static electricity. When the first CMOS 555s showed up on my workbench, I had the same problem until somebody told me they were CMOS, then the light went on. When working with CMOS technology, every pin has to go somewhere, used or not. What you need to do is tie pin 2 high through a 10k resistor, that's pretty close to its bipolar equivalent, and the circuit will work. Here's an excellent tutorial web site on the 555 that's a must for any serious experimenter.

http://www.uoguelph.ca/~antoon/gadgets/555.htm

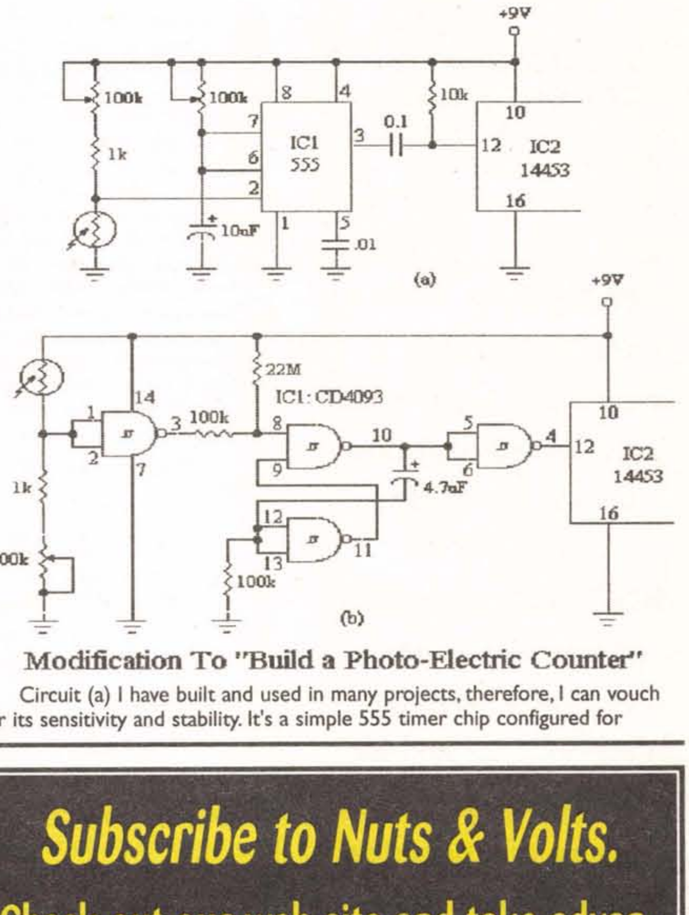
Slow It Down!

Q. I recently purchased an Epson Digital camera. The real-time counter reflects the approximate number of pictures remaining in the camera, but it doesn't reflect the number (jpeg file) of the picture actually taken. I realized the potential of using the flash to trigger a counter of some type. The Sept. '99 issue featured a photo-electric counter reviewed by Fred Blechman. I purchased the kit from Centerpointe Electronics and assembled the counter. It works great, except the counter advances more than one digit per flash. That's because the camera flash operates on multiple/variable pulsed flashes that are fractions of a second in duration, which the photo-electric counter reacts to.

The recovery of the camera flash is about one second. I'm looking for a modification to this counter to accept the first flash pulse but ignore the next flash(s) under one second. My goal is to take all photos under the flash mode and use the photo-electric counter to log the picture file count in ascending order.

Gene Miller
via Internet

A. What you need is a one-shot multivibrator timer ahead of the counter chip. What a one-shot timer does is trigger on the first input pulse then ignore any other input until the timer expires, after which it's ready to receive the next input. One-shot multivibrators are used in many applications, including switch debouncers, PC watchdog circuits, darkroom timers, and alarm systems. For this product I recommend either of the two following circuits.



Modification To "Build a Photo-Electric Counter"

Circuit (a) I have built and used in many projects, therefore, I can vouch for its sensitivity and stability. It's a simple 555 timer chip configured for monostable operation. Notice that in this design I've reversed the position of the photocell (P1). I find this to be more sensitive than the other way around when using this chip. The other thing you can do is to create a monostable timer from the spare gates on the CD4093 NAND logic chip (b). I've never tested the circuit using this particular chip, but it works with 4011 chips so I don't see a problem. Moreover, the circuit board can be easily modified to accept this circuit using the pin numbers listed, which means you don't have to add a daughterboard to the project. But to be on the safe side, I'd buy an extra chip and test it on a breadboard before cutting circuit board traces.

ATX Power Supply Pinout ... Really

Q. You had a question that began "My ATX computer doesn't turn on ..." In the answer, I believe you described an AT power supply interface, not an ATX interface. Doesn't an ATX interface have a single 20-pin connector and ±3.3V, in addition to ±5 and ±12? I would like to replace my AT motherboard with an ATX motherboard. I have a full tower AT case with a nice 300W AT-style power supply. Is it practical to modify the AT power supply?

Charles Morgan
via Internet

A. I received three similar questions that week, one asking for an AT pinout and the other two an ATX pinout. I obviously got the charts mixed up when I submitted the column (read the following question and you'll see where the confusion happened). Here's the pinout of an ATX power supply ... really.

ATX Power Supply Pinout

Pin Number	Function	Color	Comment
1	+3.3V	Orange	
2	+3.3V	Orange	
3	COM	Black	
4	+5V	Red	
5	COM	Black	
6	+5V	Red	
7	COM	Black	
8	PWR_OK	Gray	high when +3.3V and +5V are in tolerence
9	+5VSB	Violet	+5V out when AC is present
10	+12V	Yellow	
11	+3.3V	Orange	
11	+3.3V sense	Brown	kelvin voltage sense input to reduce error
12	-12V	Blue	
13	COM	Black	
14	PS_ON	Green	goes low to turn on power supply
15	COM	Black	
16	COM	Black	
17	COM	Black	
18	-5V	White	
19	+5V	Red	
20	+5V	Red	

The output wattage of the ATX power supply depends on the system configuration and the number of peripherals it supports. This handy table can be used to determine your power supply needs.

ATX Power Supply Sizing

Wattage		160W	200W	250W	300W	
Output	Min. Current	Max. Current	Max. Current	Max. Current	Max. Current	Comment
+12V	0.0	10.0	10.0	10.0	10.0	
+5V	1.0	6.0	21.0	25.0	30.0	+3.3V and +5V combined
+3.3V	0.3	18.0	14.0	16.0	28.0	current is 2/3 wattage max.
-5V	0.0	0.3	0.3	0.3	0.3	
-12V	0.0	0.8	0.8	0.8	0.8	
+5VSB	0.0	0.72	0.72	0.72	0.72	+5V when AC is present
ISA slots		1	1	1	1	includes one shared slot
PCI slots		3	3	4	5	
Bays		6	6	6	6	external and internal total

Unlike the AT power supply, there is no on/off switch. AC power is always present inside the power supply, as indicated by the presence of a DC voltage on +5VSB (pin 9). Instead, the power supply is controlled by the motherboard. When the power switch is turned on, the motherboard first searches for the presence of a +5VSB signal. If it's there, the motherboard pulls the PS_ON input (pin 14) low, which starts the power supply. PS_ON has no effect on +5VSB, which is always enabled when AC power is present. This arrangement lets the motherboard do soft starts, and lets the PC slip in and out of the standby and sleep modes.

During operation, the system constantly monitors PWR_OK (pin 8). Should the +5V or +3.3V outputs fall below an acceptable level, this output goes low and the system initiates a shutdown procedure, thereby assuring data integrity.

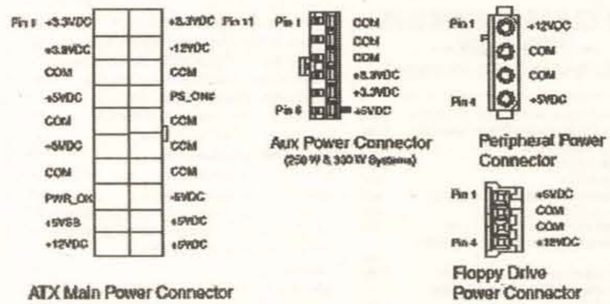
So, can you modify your AT power supply to meet ATX specs.? I doubt it. Pentium motherboards require a lot of +3.3V current, as you can see by the table above. So where do you get this 3.3 volts from? You could try tapping the +5v source, but that brings up a problem of voltage regulation. Or you can add a 3.3V winding to the flyback. It's a better solution, but the 3.3V regulation has to be tighter than the +5V, which means you'll have to move the voltage sense line from one winding to the other and change resistor values to get the proper range. Finally, don't forget the PWR_OK, PS_ON, and +5VSB functions that the AT supply lacks — features you'd have to add. The conversion isn't worth it, especially when you consider that **Jameco (800-831-4242; http://www.jameco.com)** and others sell new 300W ATX power supplies for about $50.00

ATX to AT Power Supply Adapter

Q. I would like to connect an ATX power supply to an AT motherboard, but cannot find the pinout conversion. Can you help? Also which is the ATX pin #1?

George Gray

A. The last part of the question is easy, just look below.



Caption: ATX Connectors

The first part is harder, as you can see by reading the question above. Unlike going from AT power to ATX, though, the ATX power supply has all the voltages needed for an AT motherboard. The hard part is fooling the interlock devices while providing protection for the AT motherboard. At the risk of raising the wrath of my editor, here is the AT power supply pinouts again so that we can compare them to the ATX pinout chart above.

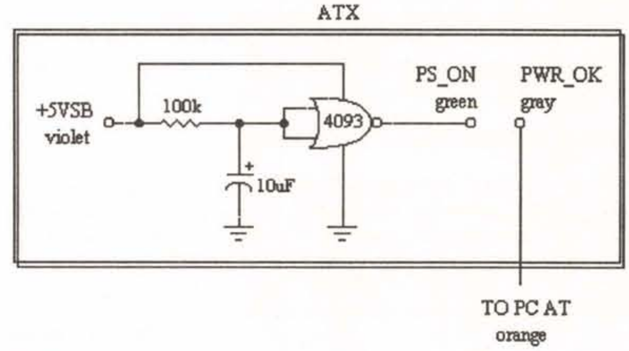
AT Power Supply Pinout

PS Plug	Pin	Name	Color	Description
	1	PG	Orange	Power Good; +5V when all voltages are ready
	2	+5V	Red	+5 volts (optional)
P8	3	+12V	Yellow	+12 volts
	4	-12V	Blue	-12 volts
	5	GND	Black	Ground
	6	GND	Black	Ground
PS Plug	**Pin**	**Name**	**Color**	**Description**
	1	GND	Black	Ground
	2	GND	Black	Ground
P9	3	-5V	White	-5 volts
	4	+5V	Red	+5 volts
	5	+5V	Red	+5 volts
	6	+5V	Red	+5 volts

As you can see, there's no problem matching up the voltage outputs from one connector to the other. Simply match them color for color. The lone exception is the orange wire, which changes from a power source in the ATX to a signal source in the AT. Back in the days when the AT was T.Rex, the presence of a voltage on PG (pin 1, P8) told the motherboard it was safe to boot. In the ATX, that line is PWR_OK (gray). But before PWR_OK goes high, PS_ON (green) must go low. Herein lies the challenge because we don't want to apply power before it's time. Still, I'm going to take a stab at it.

What I want to do first is insert a switch in line with the ATX AC input cord because I don't want the power supply on all the time. Remember, we're going to defeat the protective shutdown circuits. However, I will use the +5VSB (violet) signal to start the sequence. According to ATX specs, the +3.3V and +5V outputs must be stable within 500 mS of pulling PS_ON low. If not, power up is aborted.

So what I'm gonna do is insert a slight delay between the appearance of +5VSB and PS_ON. This will give the ATX power supply time to stabilize before we hit it. This can be done with a simple logic gate and a capacitor, as shown below.



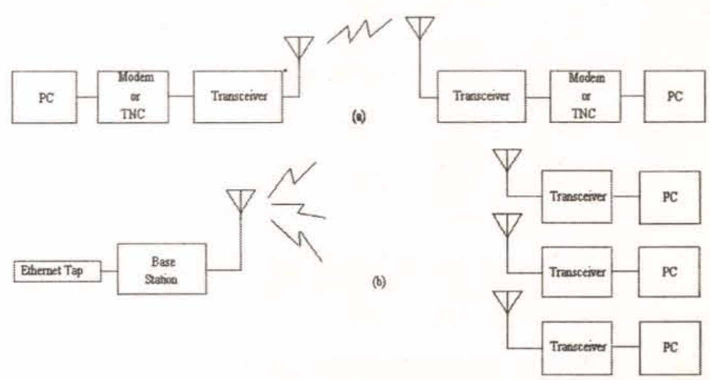
The time constant is set for about 1 second, which should give the ATX power supply time to settle down. At that point, the gate will trigger and pull PS_ON low. While any logic gate will work, I purposely chose a Schmitt Trigger to prevent bounce as the gate toggles from high to low. Finally, the PWR_OK output tells the AT motherboard it's safe to boot.

Digital Radio and Wireless Ethernet

Q. This may sound funny (or weird!), but what does it take to digitally modulate a radio transmitter with a signal from an Ethernet network? By the same token, what would it take to demodulate that same signal and interface it to another network? The data rate would be somewhere between 64 to 128 Kbps. Basically, it would amount to a wireless LAN. If you could steer me to documentation or other information, I would be most grateful.

Dave Frechette
via Internet

A. This is an extremely tough question to answer because of the technologies involved. Don't get me wrong, the concept is simple enough, but implementing it is harder than it looks.



The PC-to-PC wireless network (a) is the simplest to implement because it doesn't have to operate at Ethernet speeds, which typically range from 3 Mbps to 10 Mbps, or with Ethernet protocol. This is what ham radio operators call "packet radio." The transmission rate is 9600 baud, and the protocol is AX.25 — a "language" the radio community has adopted so that any AX.25-equipped ham operator can exchange data with anybody else in the ether who has a ham rig and an AX.25-compatible PC. You can build an AX.25 modem for about $300.00; the distance you can "chat" between stations is limited only by your radio equipment.

AX.25 Radio Packet Protocol

Flag	Address	Control	Protocol ID	Data	FrameCheck	Flag
1 byte	14 to 70 bytes	1 byte	1 byte	up to 256 bytes	2 bytes	1 byte

If you're interested in this approach to wireless PC networks, and don't mind working with Linux, the site below has everything you need — including the software — to get you up and running using your existing modem.

Linux hands-on for AX.25 a la BPQ
http://www.combtx.com/linux/ldp/HOWTO/AX25-HOWTO.html

Related web sites include:

AX.25 protocol history
http://minnie.cs.adfa.edu.au/Dual/section3_4.html

Getting Started, A Packet Radio Primer
http://www.highfiber.com/~rhackett/primer.html

Your Complete Guide to Networking, and Using, Packet Radio
http://www.packetradio.com/

Wireless LAN/MAN Modem Product Directory
http://hydra.carleton.ca/info/wlan.html

Book: Basic Packet Radio
by Joseph E. Kasser
http://www.amazon.com

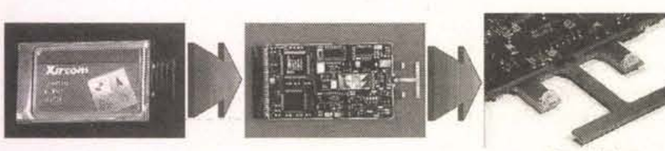
Book: NOSintro - TCP/IP over Packet Radio
by Ian Wade, G3NRW
http://www.netro.co.uk/nosintro.html

The drawback is that AX.25 won't work with your Ethernet cable — only between ham radios. To connect a PC to your Ethernet via radio, you need the setup shown in (b), where a special modem base station plugs into an Ethernet wall outlet — just like a desktop PC. This effectively adds the remote PC to your family of network users. To them, the remote PC is just another node; the RF link is transparent. However, this solution isn't cheap. The Ethernet modem runs around $1,100.00, and the receivers are $300.00 apiece. Fortunately, only one base station is needed per network, which can now serve as many remote PCs as you wish — at least up to the number of nodes your network can support, counting both in-house and remote (typically 100 nodes). So if you have a lot of people roaming the floors with notebooks that need access to the Ethernet, this could be a cost-effective solution to a spider web of hard wiring. The frequency is 2.4 GHz and distances are 500 feet or less, depending on the make, model, and line-of-site obstructions. Installing multiple base stations in strategic locations can extend the coverage because the receiver will automatically switch from one transmitter to another in the same way pagers and cell phones do.

Netwave, originally licensed by Prismark, is the most popular wireless Ethernet system. It is made by **Intersil (888-468-3774; http://www.intersil.com)** and **Xircom (805-376-9300; http://www.xircom.com)**. Their prices compare favorably, and both build the receiver in a credit-card-sized PC Card (PCMCIA) case — a real plus when schlepping around a PC notebook for eight hours.

However, neither are as fast as a true coaxial installation — but there is one out there who claims 11 Mbps, and they are only slightly more expensive. For $499.00 per receiver and $999.00 for the base station, **RadioLAN (408-616-6300; http://www.radiolan.com)** promises to deliver true Ethernet performance, not the 6 Mbps or less that other vendors admit is more realistic. Of course, the more you approach true Ethernet over the airwaves, the more it's going to cost. The next step up is a steep one.

Before you ask, no you can't build your own. Look at the receiver itself, with its integrated microstrip antenna and surface mount devices



Even if you had access to the soldering equipment and PCB layout software, you won't have the tools to program and debug the receiver. You can imagine what takes place inside the base station!

MAILBAG

Dear TJ:

For those unfortunates who have no oscilloscope, an easy way of demonstrating Lissajous figures is with a graphing calculator, like a TI-81 or better, using the parametric equation function. For MODE select NORM, FLOAT, RAD, PARAM, CONNECTED, SEQUENCE, GRID OFF (or ON), RECT. For RANGE select Tmin=0, Tmax=6.3 [which is equal to 2pi], Tstep=.1, Xmin=-1, Xmax=1, Xscale=1, Ymin=-3. Press the Y= button and enter (for starters) the equations for the simplest Lissajous figure — the circle, X1t=.7sin T and Y1t=3cos T. Press GRAPH and watch a circle appear on the screen. Then work your way up to X1t=.7sin2T and y1t=3cos3t. Have more fun varying the coefficients of T in the parametric equations. By the way, the coefficients .7 and 3 are to compensate for the unequal lengths (aspect ratio) of the X and Y axes on the TI screen.

Norman Fine
via Internet

Response:

For those readers who didn't quite understand what you did to get these patterns, here's the basic Lissajous equation

Cartesian equation: $x = a \sin(nt+c)$, $y = b \sin(t)$

Jules Antoine Lissajous (1822-1880) was very interested in the interaction of waves. In 1850, he was awarded a doctorate for a thesis on vibrating bars using Chladni's sand pattern method to determine nodal positions, and in 1855 developed an optical expression of his equation using tuning forks attached to mirrors — the earliest laser show, I'm sure.

TJ Byers
Q & A Editor

Editors Note

For a demonstration of what Lissajous patterns look like, try the web page listed below. You must use a java enabled browser to view the demonstration.
http://members.aol.com/edhobbs/applets/lissajous/index.html

Dear TJ:

The fact that an ATX power supply is never REALLY disconnected from the AC mains is the major reason why ATX systems suffer power supply failures during line surges (lightning) even though they are "OFF."

Hope this helps someone.

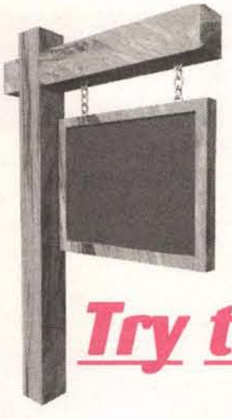
Don Pomeroy
via Internet

Send all questions, as well as comments and suggestions for this column to:

TJBYERS@aol.com
TJBYERS@juno.com

or by snail mail to

Nuts & Volts Magazine
Q & A Editor
430 Princeland Ct.
Corona, CA 92879



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port the DOS API and function calls. Doing so allows the greatest compatibility with old programs, and required some very clever techniques.

The specific call for "DOS version" is interrupt 21, function 30. If you write a little program, you can read the DOS version from the DOS API. Here's an example in Pascal (quicker to write than assembler):

```
program dosver;
 uses dos;
 var dos_ver: word;
 begin
  dos_ver := DOSversion;
   writeln('The DOS Version is
',hi(dos_ver),'.',low(dos_ver));
 end.
```

This program returns 10.0 on both Windows 95 OSR2 and Windows 98. So you could say that the DOS version behind these versions of Windows is version 10.0.

You won't find a book on DOS version 10, of course. The last version of DOS that was marketed was version 6.2. A book on DOS 6.2 will be the closest match, but many of the commands and utilities are no longer included or supported with Windows.

Some of the old programs can be found on the Windows 95 CD, and others are obsolete and/or incompatible with Windows.

Since you say you are a newbie, I recommend that you avoid experimenting with the old DOS utilities under Windows 9X.

Tim Godfrey
via Internet

#3 Starting with Windows 95, DOS is "no longer supported." Thus, when you issue the DOS command VER you get "Windows 95 [Version 4.00.1111] or something close to it (the version I gave is for OSR2). Unofficially, DOS in Windows 9X is DOS 7. It is a stripped-down version of DOS 6.22.

You'll be hard pressed to find a book on DOS that is shipped with Windows 9X.

Here is a link that can ID all versions of Windows starting with 95:

http://www.walbeehm.com/mrcode.html#Win9xNTVer

Here is a page that describes DOS 7 commands:

http://www3.sympatico.ca/rhwatson/dos7/index.html

Austin C. Phelps
Orlando, FL

#4 You didn't say if it was Windows 3.1, 95, 98, or NT, but generally this is how it goes.

Windows 3.1 went on top of DOS, and really was an add on. If you have 3.1, then under the program manager click file and close. You will get a DOS prompt. Type VER, it had better be something less than version 7, as that is where Windows 95 started.

The others really did not boot DOS first, but the DOS emulater is really part of Windows.

If you press F8 when you first boot up and see Windows 9N starting, you will get a menu. Select command prompt only and type VER at the DOS prompt.

Probably 7.0, 7.1, etc. You could also let Windows boot and under Start/shutdown restart in DOS mode, then type VER at the DOS prompt. NT generally requires you to go to Start/Programs/Command prompt, if you have privileges.

You should get the version of NT. I love DOS, but if you are a newbie, why do you want to get involved with the messiness of DOS?

Joe Heck
Wrentham, MA

ANSWERS TO #1003 - JAN. 2000

How can I tell the difference between a regulated and an unregulated 12-volt DC power supply? Can I power a VHF radio with a 12-volt automotive battery and simultaneously charge the battery with a 10 amp, 12-volt battery charger?

#1 A regulated supply uses circuitry to maintain the output at the specified voltage. So a 12V regulated supply should provide very close to 12V.

Actually, some supplies — in an attempt to simulate an automotive voltage — will provide 13.8V. That voltage is often found in vehicles while the engine is running and the battery is charging.

An unregulated supply will have a higher output voltage when no load is connected. For a 12V nominal supply, the unregulated no load output voltage will likely be in the 16- to 20-volt range.

The best way to tell the difference is to use a voltmeter and measure the output with no load.

A properly designed, modern VHF radio will have no problems operating off a lead-acid storage battery that is being charged. With older radios, the ripple voltage put on the battery by the charger might cause some hum in your audio. If the battery is defective (with high internal impedance), the terminal voltage during charging might become high enough to damage a radio. Again, check it with a voltmeter.

Tim Godfrey
via Internet

#2 The difference between unregulated and regulated voltages are their values with and without a load applied.

A regulated 12VDC supply will typically measure 12VDC ±0.5VDC (11.5VDC-12.5VDC) regardless of the load applied, up to the supply's current rating.

Automotive DC power, however, typically varies between 11VDC and 14VDC, depending on whether the car is running, the load applied to the battery (engine off) or alternator (engine running), and the RPM of the running engine. This is what's called "unregulated" power and is the main challenge for "automotive" electronics.

Inherent in their design, "12-volt" automotive devices actually operate between the above voltage values.

Typically, automotive electronic devices have built-in power regulators so their circuitry isn't affected too much by the voltage swings present in automotive electrical systems.

Can you power automotive electronics and charge a car battery using a car battery charger? Yes, only if the device you're operating does not draw more current than the charger can output. Furthermore, the time it takes the car battery to charge will increase depending on the "load" you apply to the charger — the more current your device(s) draw, the less will be available to charge the battery.

Your 10A charger should be able to handle "the strain" only if your VHF radio does not draw more than 10A while transmitting. If it does, even for an "instant," then you'll need a "beefier" charger (i.e., a 20A charger).

Finally, be very careful to not let the charger run "open circuit" (lose connection to the battery) the voltage could reach 15VDC which can damage your radio. Also, never, ever connect or disconnect the charger while the radio is operating — the resulting "power surge" could also damage the radio!

Also, ensure there's plenty of ventilation (air flow) around the charger while you're operating in this mode or it might "burn up" due to overheating.

For the record: I do not recommend operating your charger this way. If you really want/need to operate your automotive electronics using "outside" power, your local RadioShack sells AC-operated supplies specifically designed for these purposes.

Ken Simmons
Auburn, WA

#3 The label should tell if it is regulated or not, but if there is no label, look inside. If there are transistors and ICs, it is most likely regulated. If there is just a transformer, rectifier diodes, and filter capacitor, it could still be regulated against line voltage changes by use of a ferro-resonant transformer.The only way I can think of to check that is to find a variable voltage source, like a Variac transformer, measure the output voltage while varying the input from 90 volts to 130 volts. If the output varies from 10 volts to 13 volts, it is not regulated.

Yes, you can operate your radio with a battery and charger. The battery makes a very good filter capacitor as long as there is not a lot of ripple coming out of the charger. Make sure the charging current is not 10 amps while the radio is using two amps because the excess current will deplete the water in the battery and produce an explosive mixture of hydrogen and oxygen. A regulated supply of 13.8 volts will keep the battery charged and not deplete the water.

Russell Kincaid
Milford, NH

#4 The easiest way to tell if a 12-volt power supply is regulated is to monitor the output voltage with a voltmeter, a digital voltmeter (DVM) is preferred, with no load, and then put a load on it.

For example, if the power supply is capable of several amps, connect the DVM to the output without a load. Connect a load to the power supply and if the voltage drops more than about 0.1 volts, the power supply is probably not regulated.

To power a VHF radio with 12-volt automotive battery and simultaneous charge, the battery is possible, however, if the charger is of the pulse type you may have pulse noise on the signal when you transmit and pulse noise in the speaker when receiving.

Another concern is the full charge voltage of the charger. Some chargers have a float charge voltage near 15-volts. Check the manufacturer's specifications on the VHF radio to ensure the charging voltage will not exceed the ratings of the radio.

The DVM in the first part of the answer can be used to check the float charge voltage of the charger when the battery is fully charged.

Ned Stevens
Murray, UT

#5 The best way to determine if a power supply is regulated is to watch the output voltage as you vary the load.

Ideally, one would do that with an oscilloscope, however, you might get by with a voltmeter connected between the output leads. If the voltage drops considerably when you increase the load, then the supply is unregulated.

An unregulated supply will probably also have a considerable amount of ripple on it. The amount of ripple will most likely increase as you increase the load.

It is that ripple that may make your VHF application problematic. The ripple will find its way into your transmitted signal causing annoying (and probably illegal) interference.

An unregulated supply may also have an output voltage quite a bit higher than the rated voltage. That high voltage could damage your radio.

If the charger voltage isn't too high for your radio, you might consider adding a switching circuit that disconnects the charger when you're transmitting, and reconnects it when you're only receiving.

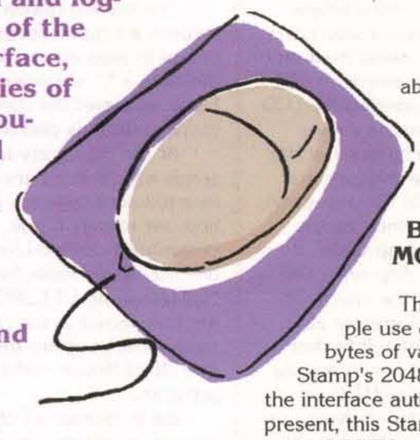
Tom Tillander
Bay Village, OH

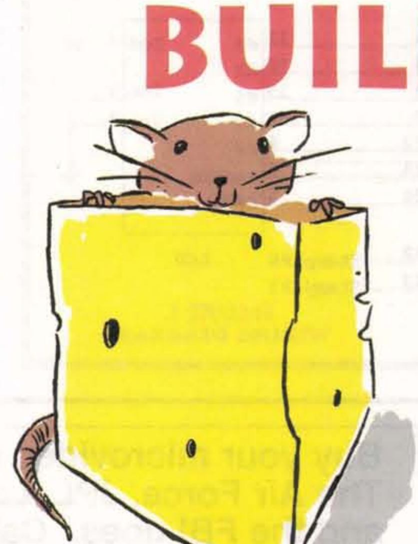
BUILDING A BETTER MOUSE TRAP — PART 2

A Mouse for Your BASIC Stamp

by Steve Parkis

Last month's issue detailed the physical and logical aspects of the PS/2 mouse interface, and offered a series of low-level driver routines as potential building blocks for a mouse-driven system. In this issue, a mouse, BASIC Stamp II, LCD, and a Scenix SX28-based interface are integrated to provide complete mouse functions for a BASIC Stamp. The interface's program and two BASIC Stamp programs are presented. MINMOUSE.BS2 shows a very simple use of the mouse interface, while MOUSMENU.BS2 illustrates a sophisticated implementation using an LCD for typical "point and click" and "drag and drop" operations. Both Stamp programs use a mere two Stamp I/O pins.





System Architecture

The BASIC Stamp communicates with the mouse and the LCD via the SX28 interface program. The interface is designed to speak only when spoken to by the Stamp. The mouse and LCD are similarly responsive to the SX28's interface program. This approach gives the Stamp top-level control and coordination of all interface, mouse, and LCD functions. To support this configuration, the mouse is used in an unusual fashion: the remote mode.

In this mode, the mouse accumulates and buffers its own movement data until prompted to forward operating status information. As a result, the Stamp program can receive, analyze, and act upon summarized data of mouse movements that occurred while the Stamp was otherwise occupied.

Synchronous serial protocol — akin to the mouse protocol described last month — is used between the Stamp and the mouse interface, allowing simple SHIFTIN and SHIFTOUT Stamp instructions to accomplish all interface functions with only two Stamp I/O pins.

Hardware Configuration

A BASIC Stamp II and two wires are the only new components needed beyond last month's demonstration setup. Connect Stamp pins 13 (P6) and 14 (P7), the SX28 mouse interface, a mouse, and LCD as shown in Figure 1. The LCD is optional; the mouse interface works fine without it, but the absence of visual feedback leaves a lot to be desired in most applications. A 4x20 LCD is needed to use MOUSMENU.BS2 as written.

BASIC Stamp MINMOUSE.BS2 Program

This program shows a very simple use of the interface. It uses six bytes of variable space and ~320 of the Stamp's 2048 EEPROM locations. Although the interface automatically initializes an LCD if present, this Stamp program directs all output to the DEBUG screen and uses none of the LCD functions.

Let's look first at this Stamp program from an overall, functional perspective. When the interface's program is ready to accept commands, the Stamp instructs it to set the mouse in remote mode. The Stamp then commands the interface to retrieve mouse movement and button status information and send that information back to the Stamp. The Stamp analyzes the mouse data, generates DEBUG messages describing any mouse activity, loops back to obtain a fresh set of movement-button data, and so on. We'll next examine each of these steps in greater detail.

The Stamp program synchronizes with the interface by waiting for the SHIFTIN/SHIFTOUT clock pin to be driven low. The interface program normally drives this line low to temporarily suppress communication with the Stamp. At start-up, the Stamp uses this first "not ready" assertion to conclude that the interface's initialization has progressed sufficiently for coordinated communication to proceed.

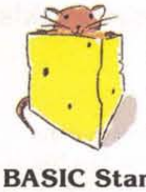
The Stamp then loads command code $07 (hexadecimal 07) into variable to_SX for subsequent transmission to the interface by the putSX subroutine. After determining that the interface has released the clock line to a high logic level, putSX shifts the command out. Upon receiving this command code, the interface suspends Stamp communications while setting the mouse to remote mode and then re-enables Stamp communications. Next, the Stamp sends command code $08 to the interface. The interface reponds by again putting the Stamp "on hold" while it solicits movement and button information from the mouse. After the interface has retrieved this information and released the Stamp communications hold, the getSX subroutine shifts each data byte into the Stamp.

The Stamp examines the second and third bytes for any X-axis (left or right) and Y-axis (forward or backward) displacements. Bits in the first byte indicate button closure status and whether second and third byte displacement values are positive (right/forward) or negative (left/backward). After issuing DEBUG statements, the Stamp program loops back to command the interface to get three more data bytes, and the process is repeated.

Using a mouse with your Stamp can be this simple. The three mouse-generated bytes showing displacement and button status tell the complete story of what actions a mouse user has taken. You can use the mouse as a convenient pair of de-bounced switches or a simple movement detector by incorporating these routines into your own Stamp application program.

You may be wondering at this point why you can't just hook the mouse up to your Stamp directly and communicate with it via SHIFTIN and SHIFTOUT instructions. The reason is that the mouse generates the clock signal for its synchronous serial communications, and the Stamp generates the clock signal for SHIFTIN and SHIFTOUT instructions. As a result, an intermediary is required to catch,

Part 3 will show how programming modifications alone provide a PS/2 keyboard interface for use with a BASIC Stamp.



hold, and forward communications in both directions. That's the crux of the interface program. Next, we'll look at a more elegant implementation of the interface.

BASIC Stamp MOUSMENU.BS2 Program

MINMOUS.BS2 offers a means to tap into a mouse, but little in the way of user-friendliness. MOUSMENU.BS2 uses the same getSX and putSX subroutines for Stamp-interface-mouse communications, but adds some punch to show the real capabilities of the interface program. A quick overview of the program follows to give some context to the more technical, follow-on descriptions.

The Stamp first establishes communications with the interface and mouse, then displays a menu on the LCD. The user "points and clicks" (mouse movements cause the LCD cursor to move around the LCD screen; mouse button presses are analyzed to determine where the cursor is upon switch closure) to select one of two menu options. The main menu itself and both main menu options involve extensive LCD input and output operations to position the LCD cursor, display characters, determine cursor position, and/or determine the character at the current cursor position. These techniques are laid out in the code and available for inspection, but further discussion here will center on the mouse-related aspects of the Stamp code.

The first option, "I/O pins," displays a second LCD screen which presents the input/output status (DIRS) and logic level present at each of the Stamp's I/O pins (INS). It further supports "drag and drop" operations to modify any pin's output latch logic level (OUTS) or input/output status. This offers an on-the-fly pin status determination and modification capability for testing or debugging. For additional information on using this option, see the Stamp I/O Pins section below.

The second option, "Mouse droppings," invokes a simpler routine that moves the LCD cursor in response to mouse movements, and deposits a "." wherever the cursor travels, or a blank wherever the cursor travels while the left mouse button is pressed.

At the nitty-gritty level, MOUSMENU.BS2 sends a local loopback echo check to the interface followed by reset, get mouse ID, set resolution, set remote mode, and get mouse status commands destined for the mouse (see subroutine configureMouse for command sequences). Null-terminated, EEPROM-resident text strings are transferred to the LCD to form the main menu. The program then loops through subroutine checkMouse — the real workhorse of this program.

Each iteration of checkMouse begins with a get remote mode data command for the mouse. The direction and magnitude of any mouse movement reflected in the resulting data packet is used to determine if the LCD cursor should be moved. To make LCD cursor movements as smooth and consistent as possible, displacement data in successive packets are summed and the cursor is moved only if the accumulated sum in either axis exceeds a programmable threshold. If the cursor should be moved, the subroutine calculates a new (and often far from obvious or intuitive) LCD screen address and sends the cursor there.

Each remote data packet is also checked for button closure (or click, in mouse lingo). If a click occurred, the character at the LCD's cursor is retrieved: if '1,' the modifyPins routine is invoked; if '2,' the mouseDroppings routine receives control; if neither, the click is ignored

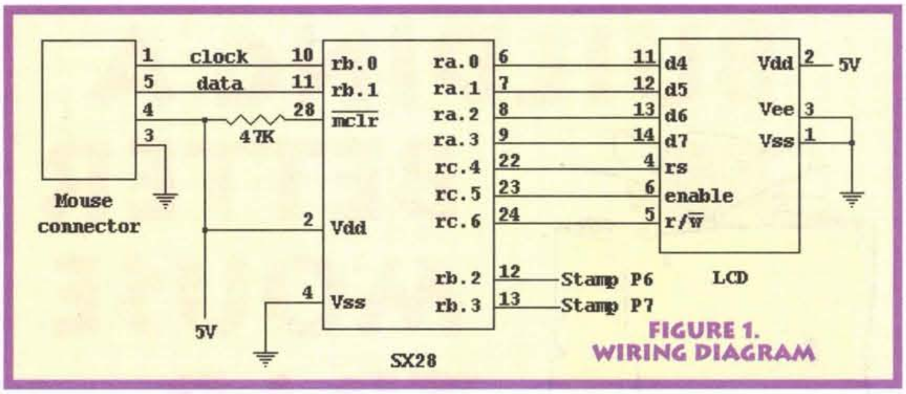


FIGURE 1. WIRING DIAGRAM

```
P15                   P0
      I O  H L
OIIIIIII   IIIIIIIO
HHHHHHHH   HHHLLLHH
```

FIGURE 2. I/O PINS LCD DISPLAY (EXAMPLE)

and checkMouse is called again.

The modifyPins and mouseDroppings routines are variations on the main menu's theme. Both use the checkMouse subroutine extensively to determine if the mouse moved or if one of its buttons was pressed/released. Both translate that information into area select, point and click, or drag and drop actions. Finally, both return to the main menu if the right button is clicked.

SX28 Mouse Interface Program

This program will look familiar to those who studied last month's article. A synchronous serial interface to the Stamp has been added, the mouse routines have been converted from straight-line code to subroutines, and a command code-based branch table has been added. Further, a new set of macros converts management of the SX28's port b pins to use shadow direction and output registers — a useful technique to avoid hair-pulling read-modify-write effects. New LCD subroutines provide the capability to read the LCD's cursor location and the data stored and displayed at that location.

Stamp I/O Pins

The I/O Pins option from the main menu offers immediate Stamp pin modification and visual feedback capabilities under mouse control. The LCD display is shown in Figure 2.

The bottom row shows all of INS, i.e., each pin's IN value, 'H' for high or 'L' for low. You can drag and drop an 'H' or 'L' onto any column in this row, but keep in mind you're setting the pin's OUT value by doing so, not its IN value. One row up, each pin's DIR setting is shown as 'I' (input) or 'O' (output), which also can be changed by drag and dropping an 'I' or 'O' from the master characters in the third row up.

The DIRS and INS values are completely refreshed upon modification of any value. The top row is simply an indication of the pin display order; P15 values at the far left through P0 on the right. (Avoid modifying P6 and P7, since they're used for Stamp-to-mouse interface communication.)

Using the mouse and display to change pin settings is useful to demonstrate how Stamp I/O pins work. If a Stamp pin is an output, its OUT (output latch) value is reflected by its IN value: drag and drop an 'H' onto an 'L,' for instance, and the output pin's IN becomes 'H' when the display is refreshed.

On the other hand, if the pin is an input, it is disconnected from its output latch and changing its OUT value has no effect on its IN value unless the pin's DIR is also changed to 'O.' If the pin is an input and not connected to external logic, it is "floating" and its IN value can change without apparent reason. Floating inputs and the interplay between DIRS, OUTS, and INS are a common source of confusion for Stamp users — causing and seeing these effects can make these principles easier to grasp and remember.

Component Sources

B G Micro's 4x20 LCD1002 ($5.95, www.bgmicro.com/) is an economical and effective LCD choice. Parallax, Inc. (www.parallaxinc.com/) sells the BASIC Stamp II and the SX28AC/DP microprocessor. Parallax also sells hardware programmers for the SX series, and offers an excellent, free SXKey28L assembler, which can be downloaded from the Parallax web site.

Next

In the third and final part of this series, see how slight changes to the SX28's interface program provide a PS/2 keyboard capability for a BASIC Stamp program. **NV**

BASIC Stamp is a registered trademark of Parallax, Inc.

Author Steve Parkis is an electronics enthusiast with decades of experience in a variety of programming languages. He specializes in creating custom microprocessor tools for system analysis and development. His e-mail address is parkiss@earthlink.net.

BASIC STAMP "MOUSE" PROGRAMS

MINMOUS.BS2

This program implements a PS/2 mouse interface for use with a Parallax BASIC Stamp II. It supports all standard, two-button PS/2 commands. It also provides a simple LCD interface. All communications with the Stamp are synchronous-serial and compatible with the Stamp's SHIFTIN and SHIFTOUT commands. The interface program in conjunction with a mouse, LCD, and Stamp can implement typical mouse display and control functions for BASIC Stamp programs using only two Stamp pins. The interface program is implemented in a Scenix SX28 and uses the SX28's internal oscillator.

MOUSMENU.BS2

This program demonstrates advanced use of the mouse interface. It uses menus, point and click, and drag and drop functions. It offers two choices from the main menu. The "I/O Pins" choice allows the user to view and modify the DIRS and OUTS variables by mouse actions. The "Mouse droppings" option leaves "." at all the LCD locations visited by the cursor, or erases them if the mouse right button is pressed. Exit either option and return to the main menu by pressing the right mouse button.

You can download these programs from our website at www.nutsvolts.com

```
' MINMOUSE.BS2
' Demonstration program showing minimal mouse use.  All output
' is to DEBUG screen.

x           VAR   BYTE     ' utility byte variable
to_SX       VAR   BYTE     ' data to SX mouse interface
from_SX     VAR   BYTE     ' data from SX mouse interface
mouse_bits  VAR   BYTE     ' mouse operating data byte 1
x_disp      VAR   BYTE     ' mouse operating data byte 2
y_disp      VAR   BYTE     ' mouse operating data byte 3

awaitSX:
' Wait for SX interface to assert low on clock line as part of its
' initialization.  At that point it's safe to attempt command
' transmissions.
FOR x = 0 TO 255:IF in6 = 1 THEN awaitSX: NEXT
to_SX = 7: GOSUB putSX          ' set mouse to remote mode

mainLoop:
to_SX = 8: GOSUB putSX          ' get remote mode data
GOSUB getSX: mouse_bits = from_SX  ' store byte1 in mouse_bits
GOSUB getSX: x_disp = from_SX   ' get X axis displacement value
GOSUB getSX: y_disp = from_SX   ' get Y axis displacement value
IF x_disp l y_disp = 0 THEN checkButtons
DEBUG CR,"mouse moved "
IF x_disp = 0 THEN checkY
IF mouse_bits.BIT4 THEN movedLeft
DEBUG "right ": GOTO xDone
movedLeft:
DEBUG "left "
xDone:
IF y_disp = 0 THEN checkButtons
DEBUG "and "

checkY:
IF y_disp = 0 THEN checkButtons
IF mouse_bits.BIT5 THEN movedDown
DEBUG "up": GOTO checkButtons
movedDown:
DEBUG "down"

checkButtons:
IF mouse_bits.BIT0 = 0 THEN checkRightButton
DEBUG CR,"left button pressed"
checkRightButton:
IF mouse_bits.BIT1 = 0 THEN mainLoop
DEBUG CR,"right button pressed"
GOTO mainLoop

putSX:
' send byte to SX interface
IF IN6=0 THEN putSX            ' wait for SX to release clock line
SHIFTOUT 7,6,0,[to_SX]         ' shift to_SX byte out
INPUT 6                        ' restore clock line to input
INPUT 7                        ' restore data line to input
RETURN

getSX:
' accept byte from SX interface
IF IN6 = 0 THEN getSX          ' wait for SX to release clock line
SHIFTIN 7,6,lsbpost,[from_SX]  ' shift from_SX byte in
INPUT 6                        ' restore clock line to input
RETURN
```

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

The SCAM Chip

by Ryan Sheldon, National Control Devices • (417) 646-5644 • www.controlanything.com

Control the pan and tilt of 256 different cameras from your desktop PC.

Wouldn't it be cool to watch several video cameras simultaneously on your desktop PC? Way back in May '99, I wrote an article called "Video for Windows" that showed you how to do it. If you missed the article, you can download it from my web site at www.controleverything.com. It shows you all you need to know to attach 16 cameras to your PC and watch all of them at once in a Windows 98 window.

Wouldn't it be even cooler to control the position of each camera from your desktop PC? You know, pan and tilt each camera under software control so you can remotely control what you are looking at.

If you have seen the movie "Sliver," then you can imagine what kind of trouble you can expect yourself to get into. Well, I thought it would be an interesting application, so this month, I designed a new chip that would allow you to do just that — the SCAM chip.

The SCAM Chip

The SCAM (Servo CAM) chip allows you to software-control pan and tilt of 256 different cameras using your favorite programming language. The SCAM chip is very easy to use. It only has eight pins and only requires a five-volt DC power supply and four external parts. Using two wires from the RS-232 port of your

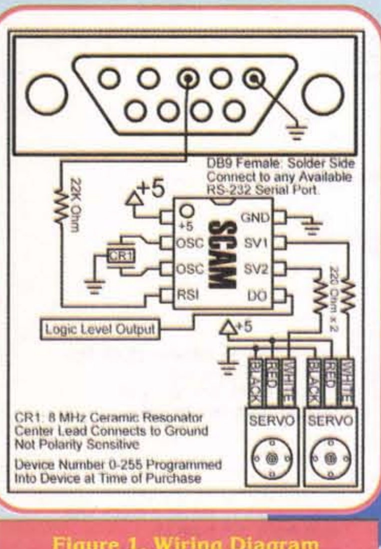


Figure 1. Wiring Diagram

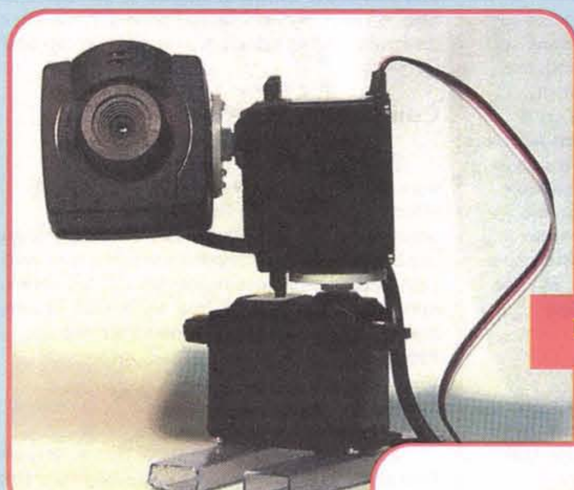


Figure 2A

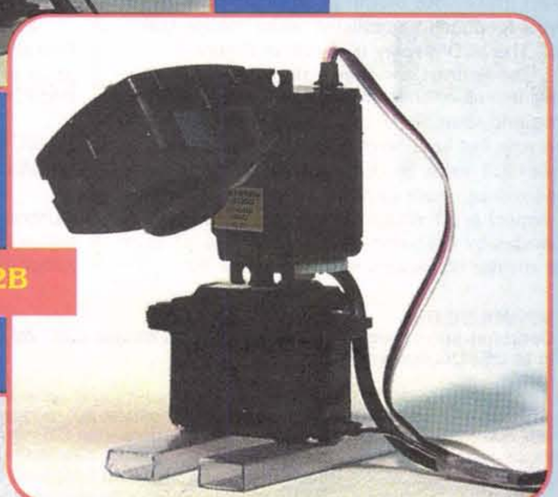


Figure 2B

Figure 2C

Glue the motors together as shown in these pictures.

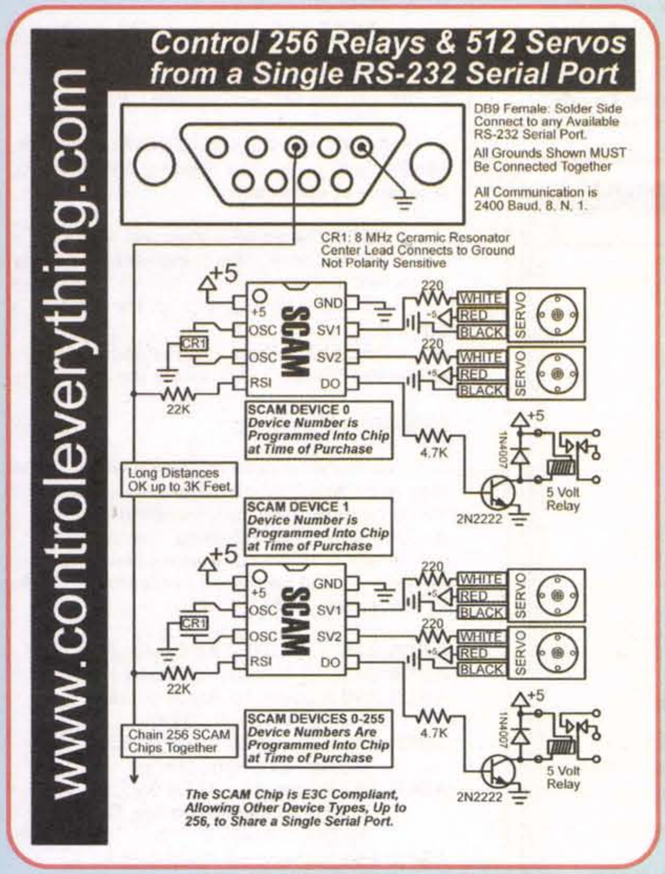


Figure 3

Figure 4

computer, you can pan and tilt 256 cameras over a distance exceeding 2,000 feet. The SCAM chip supports 180 degrees of software-controlled pan and tilt.

The SCAM Chip is E3C compliant, allowing 256 different device types to co-exist on a single RS-232 serial port. The SCAM chip receives its commands from any RS-232 data source and is ideally suited for use with the BASIC Stamp, as well as desktop computer systems.

The Project

Positioning a camera can be done one of two ways. You can spend a lot of money ($200-$300) and have a really good (and perhaps bulky) set of camera motors. Or, you can spend $40-$50 and move the camera with a couple servos and the SCAM chip. Servos are not the best choice for heavy cameras, but they are perfect for those tiny board cameras you see advertised everywhere.

It is important to keep our application as affordable as possible. You can easily build this project for less than $200.00 including a color CCD board camera, or you can build it for around $100.00 with a black and white CCD board camera.

We used Part #P9506-ND Color CCD w/Audio.

You will also need some hot glue and a hot glue gun.

Building the Circuit

It is important to build the circuit BEFORE gluing the motors together. The circuit will be used to center the motors PRIOR to gluing, making initial positioning more predictable. Follow the schematics shown in Figure 1 for connecting the components together. **DO NOT USE A BREADBOARD. YOU MUST USE A SOLDER-BASED PROTOTYPING BOARD.** Using a breadboard will add too much capacitance to the 8-MHz ceramic resonator causing unreliable operation, and in most cases, device failure.

Use hot glue to attach the hobby servos together as shown in Figure 2. **MAKE SURE THE MOTORS ARE CENTERED BY ATTACHING THEM TO THE SCAM CHIP PRIOR TO GLUING.**

Networking SCAM Chips

It is possible to connect up to 256 SCAM chips to a single RS-232 serial port and control each one individually or all simultaneously. Figure 3 shows a simple wiring diagram for connecting multiple SCAM chips to your computer. Note that SCAM chips are individually programmed with a device number at the time of purchase. You MUST order SCAM chips with different device numbers for this to work.

User Interface

Figure 4 shows a simple user interface written under Visual Basic 6 Professional for controlling up to 256 SCAM chips from a single serial port. The user interface is very easy to use. Simply move the camera select slider (bottom slider) to select a camera to control.

Once the camera is selected, you can use the vertical and horizontal positioning sliders to position the camera anywhere you want. A check box is provided for turning the digital output on or off on each chip.

Note that only one-way communication is supported by the hardware and it is NOT possible to ask the chip what the current status is of the digital output or the current position of the cameras.

SCAM Commands

The SCAM Chip has several commands built-in that make it very easy for anyone to use. Commands are sent to the SCAM chip from just about anything capable of sending RS-232 data at 2400 baud. The SCAM chip can be programmed from QBasic, C++, Visual Basic, the BASIC Stamp, or just about anything capable of sending ASCII character codes. The examples shown in Figure 5 were written under Visual Basic 6 and illustrate many of the commands supported by the SCAM chip.

E3C Compliance

E3C Compliance (Enabled 3-Wire Communication) allows up to 256 different devices to share a single serial port. Any device that is E3C compliant can be accessed using simple ASCII character code. Commands for an E3C compliant device always begin by sending ASCII character code 254. This places the device in command mode.

For example, the CHECK_CLICK subroutine sends ASCII character code 254 to enter command mode, and 3 to turn on the digital output pin. To turn off the digital output pin, 254 followed by 4 is sent to the device.

Positioning servos is very easy using this command-based system. Here's a quick example:

- ASCII 254 enters command mode.
- ASCII 0 sends the command for setting the position of both servos.
- ASCII 0-174 is sent to set the position of servo 1.
- ASCII 0-174 is then sent to set the position of servo 2.
- ASCII 85 is then sent to conclude the

NEW CONTACT INFO:
Ryan Sheldon
National Control Devices
P.O. Box 455
Osceola, MO 64776
Phone: (417) 646-5644
FAX: (417) 646-8302
ncdryan@aol.com
www.controlanything.com

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

ASEL Video Switcher, R85 Relay Controller, VF Display/Controller
National Control Devices
P.O. Box 455
Osceola, MO 64776
Phone: (417) 646-5644
FAX: (417) 646-8302
www.controleverything.com
ncdryan@aol.com

command "packet" and update the servos.

The SCAM chip also supports commands for positioning each servo independently. For example, if you want to set the position of Servo 1 only, you can send the following sequence of commands:

- ASCII 254 enters command mode.
- ASCII 1 sends the command for setting the position of servo 1.
- ASCII 0-174 is sent to set the position of servo 1.
- ASCII 85 is then sent to conclude the command "packet" and update the servo.

Similarly, servo 2 can be positioned independently of servo 1 by sending the following sequence of commands:

- ASCII 254 enters command mode.
- ASCII 2 sends the command for setting the position of servo 2.
- ASCII 0-174 is sent to set the position of servo 2.
- ASCII 85 is then sent to conclude the command "packet" and update the servo.

Multiple Devices

Communicating to multiple devices is also very easy. Any E3C compliant device supports six commands used for controlling which device responds to incoming commands. Before any of these commands can be issued, the device must be placed in command mode by first sending ASCII 254.

ASCII 248 Enable All Devices
ASCII 249 Disable All Devices
ASCII 250 followed by ASCII 0-255, Enable a Specific Device
ASCII 251 followed by ASCII 0-255, Disable a Specific Device
ASCII 252 followed by ASCII 0-255, Enable a Specific Device, Disable All Other Devices
ASCII 253 followed by ASCII 0-255, Disable a Specific Device, Enable All Other Devices

In our Visual Basic 6 example program, only one E3C command is used. This command allows you to speak to an individual device without affecting any of the other devices. When the bottom slider is moved (shown in Figure 4), the following commands are sent:

- ASCII 254 puts the SCAM chip in command mode.
- ASCII 252 is used to Enable a Specific Device and Disable all Others.
- ASCII 0-255 is then used to control which device receives commands.

As the slider is moved, the device that is suppose to respond to commands is changed, allowing you to easily communicate to a device of your choice.

Sending the command to enable all devices (248 shown above) will allow you to position all cameras simultaneously. Sending command 250 will allow you to communicate to multiple devices of your choosing.

Availability

Note that the SCAM chip is still in development at the time of writing and some functions are subject to change. The SCAM chip is available for $10.00/each or 10 for $90.00. You must supply a device number of 0 to 255 when ordering.

The SCAM chip is scheduled for immediate release to *Nuts & Volts* subscribers with a valid subscription number. Please visit www.controleverything.com for additional ordering information. **NV**

Figure 5

Project1 - Form1 (Code)

(General) | SetServos

```
Private Sub Check1_Click()
    If Check1.Value = 0 Then                        'If Check is Turned Off
        MSComm1.Output = Chr$(254)                  'Enter Command Mode
        MSComm1.Output = Chr$(4)                    'Turn Off Output
    Else                                            'Otherwise
        MSComm1.Output = Chr$(254)                  'Enter Command Mode
        MSComm1.Output = Chr$(3)                    'Turn On Output
    End If
End Sub
Private Sub Form_Load()
    MSComm1.PortOpen = True                         'Open Serial Port
End Sub
Private Sub HScroll1_Change()
    HScroll1.ZOrder 0                               'Bring H-Slider to Front
    SetServos                                       'Update Servo Positions
End Sub
Private Sub HScroll1_Scroll()
    HScroll1.ZOrder 0                               'Bring H-Slider to Front
    SetServos                                       'Update Servo Positions
End Sub
Private Sub HScroll2_Change()
    Label2.Caption = HScroll2.Value                 'Update Interface Caption
    MSComm1.Output = Chr$(254)                      'Enter Command Mode
    MSComm1.Output = Chr$(252)                      'Command to Select a Device
    MSComm1.Output = Chr$(HScroll2.Value)           'Set Device Number to Control
End Sub
Private Sub HScroll2_Scroll()
    Label2.Caption = HScroll2.Value                 'Update Interface Caption
    MSComm1.Output = Chr$(254)                      'Enter Command Mode
    MSComm1.Output = Chr$(252)                      'Command to Select a Device
    MSComm1.Output = Chr$(HScroll2.Value)           'Set Device Number to Control
End Sub
Private Sub VScroll1_Change()
    VScroll1.ZOrder 0                               'Bring V-Slider to Front
    SetServos                                       'Update Servo Positions
End Sub
Private Sub VScroll1_Scroll()
    VScroll1.ZOrder 0                               'Bring V-Slider to Front
    SetServos                                       'Update Servo Positions
End Sub
Public Sub SetServo1()
    MSComm1.Output = Chr$(254)                      'Enter Command Mode
    MSComm1.Output = Chr$(1)                        'Set Servo 1 Position
    MSComm1.Output = Chr$(HScroll1.Value)           'Set Position
    MSComm1.Output = Chr$(85)                       'End Packet
End Sub
Public Sub SetServo2()
    MSComm1.Output = Chr$(254)                      'Enter Command Mode
    MSComm1.Output = Chr$(2)                        'Set Servo 2 Position
    MSComm1.Output = Chr$(HScroll2.Value)           'Set Position
    MSComm1.Output = Chr$(85)                       'End Packet
End Sub
Public Sub SetServos()
    MSComm1.Output = Chr$(254)                      'Enter Command Mode
    MSComm1.Output = Chr$(0)                        'Set Both Servo Positions
    MSComm1.Output = Chr$(HScroll1.Value)           'S1 Position
    MSComm1.Output = Chr$(VScroll1.Value)           'S2 Position
    MSComm1.Output = Chr$(85)                       'End Packet
End Sub
```

Part:	Source:	Price:
Hobby Servos	www.towerhobies.com	<$15/each
SCAM Chip	www.controleverything.com	$12/each
Includes 8 MHz Resonator		
220 Ohm Resistors	www.digikey.com	<$1.00
22K Resistor	www.digikey.com	<$1.00
Small CCD Camera	www.digikey.com	$50-$150

TABLE 1

New Product News

DIGITAL POWER SUPPLY

The new DP225 from Technology Systems is one of the finest digital control power supplies on the market today. This new supply features a digital control output from 2 to 25 volts.

The DP225 has many advantages over analog models. There is no potentiometer drift due to vibration, temperature, or humidity. The unit supplies 500 mA of current across the entire voltage range in 100 millivolt steps, and is equipped with auto sense that automatically switches the pre-regulator high or low to conserve energy and avoid thermal overloading.

All you have to do is set the voltage you want by adjusting the three thumb wheel switches, the internal circuitry takes care of the rest by keeping the voltage constant up to 500 mA under full load, with a load regulation of .1% and a temperature stability of 1%.

For more information, contact:

TECHNOLOGY SYSTEMS
4 PROSPECT PL., DEPT. NV
TORRINGTON, CT 06790
860-496-9823

CCD COLOR VIDEO CAMERA

Alltronics CCD color video camera is enclosed in an attractive white molded plastic case. The dimensions are approximately 4.5"L x 2.5"W x 1.5"D.

The camera has NTSC standard output, runs on 5VDC @ 100mA, and works with CCTV or VCR.

A cable is included as a keyboard plug power adapter for use with PCs and video capture card.

Alltronics part 99V006 sells for $79.95.

For more information, contact:

ALLTRONICS
2300-D ZANKER RD., DEPT. NV
SAN JOSE, CA 95131-1114
408-943-9773 FAX: 408-943-9776
E-MAIL: ejohnson@alltronics.com
WEB: http://www.alltronics.com

Showcase your New Products here! Send all press releases or information/photos to:

Nuts & Volts Magazine
New Product News
430 Princeland Court,
Corona, CA 92879
or E-Mail to
newproducts@nutsvolts.com

RACK MOUNT LINEARIZERS

Linearizer Technology announces the availability of a compact rack mount linearizer for satellite ground stations and teleports.

The WAFL series rack mountable linearizers operate over a full S, L, C, X, Ku, K, and Ka satellite bands.

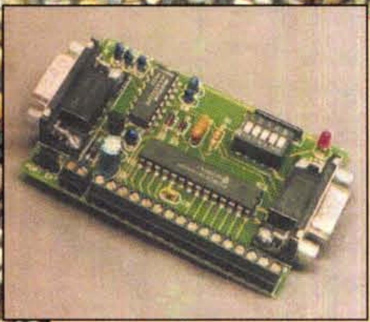
These units are designed for use with SSPA, TWTA, and Klystron high power amplifiers, and typically provide a four-fold increase in output power for a 30 dB carrier-to-intermodulation ratio. For multi-carrier traffic, a greater than 10 dB reduction in distortion products is achievable.

These rack mount linearizers are totally self-contained, and designed to be inserted between the up converter and high power amplifier without any additional hardware. Installation and alignment can be completed in less than 30 minutes.

The WAFL models measure 19" x 3.5" x 12", and are competitively priced.

For more information, contact:

LINEARIZER TECHNOLOGY, INC.
3 NAMI LN., UNIT C-9, DEPT. NV
HAMILTON, NJ 08619
609-584-8424 FAX: 609-631-0177
E-MAIL: eklepner@lintech.com
WEB: http://www.lintech.com



DIGITAL I/O MODULE

The WTDIO-M is a member of the new stackable RS-232 data modules available from Weeder Technologies.

Fourteen I/O pins can be individually configured for input or output. Outputs can sink or source 25 mA and can change logic state upon command, or simulate a one-shot (high or low) pulse output with software programmable lengths of 10 to 655,350 uS.

Inputs can either be polled, or set up to report a logic transition such as that produced by a switch or button wired to ground. Automatic debounce will mask multiple transitions produced by contact bounce, typematic repeat is simulated if a button is held down. Read or write data to eight I/O pins as a parallel port with a single command. Also supports 4 x 4 matrix keypad decoding.

All modules in this series can be plugged end-to-end on a common RS-232 cable attached to the serial port of a host PC. An on-board 32-position DIP switch sets the address of each module, which is used for identifying data transmitted from it, as well as directing data transmitted by the host. The data bus supports full anti-collision discipline between connected modules and will allow up to 32 modules to share the same communications line.

Power is supplied by an external 8 to 25 VDC source (not included) to the first module in the chain and is carried down the RS-232 cable to successive modules.

The WTDIO-M sells for $49.00. Data book is available upon request.

For more information, contact:

WEEDER TECHNOLOGIES
P.O. BOX 2426, DEPT. NV
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VOICE/FAX 850-863-5723
WEB: www.weedtech.com

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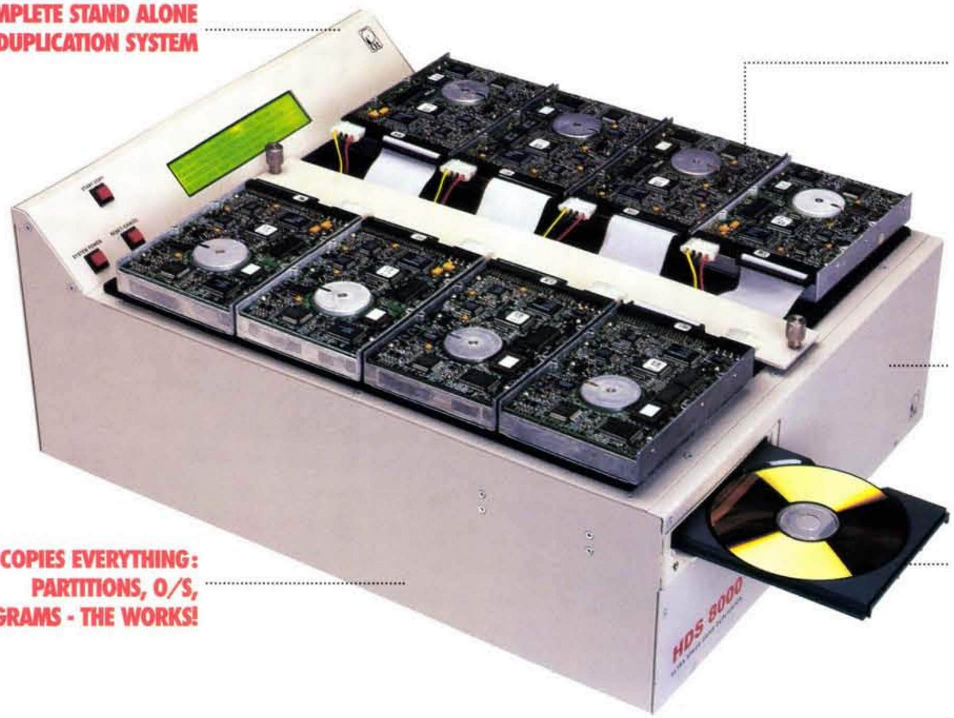

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