NUTS & VOLTS MAGAZINE

OUR 19th YEAR

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VOL. 19 NO. 3
MARCH 1998

Exploring Electronics And Technology For The Hobbyist And Professional

THE COMPUTER CONTROLLED WORLD

RS-232 NETWORK CONTROL METHODS AND APPLICATIONS

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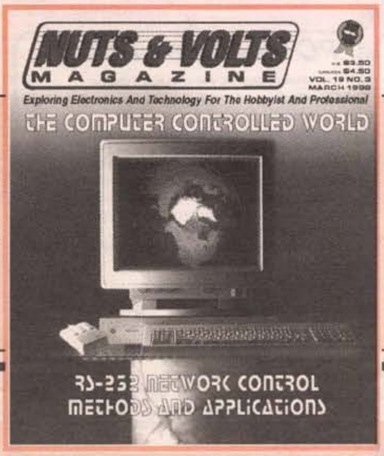

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reader FeedBack

Dear Nuts & Volts:

In the Jan. '98 issue, there is an article entitled "Power Supplies for Electronic Music."

This is a standard power supply configuration with a fancy name. That's okay. But to say we have a WHOPPING 0.75 amps at +15 volts is a stretch of the imagination. To me whopping refers to something large. Say a power supply with a 15 or 20 amp output. Especially when referring to line voltage operated equipment.

Enough of complaining.

I think *Nuts & Volts* is a great magazine and I look forward to receiving it.

Joe Lane
Canada

Dear Nuts & Volts:

Terry Weeder's article "Phone Line Transponder" could not have came at a better time. We had a need to 'Hard Reset' remote systems without calling someone out (usually on weekends or nights, usually me).

The only commercial product available from BlackBox that could be used did not have enough output ports and cost $795.00. Although Terry's design covered what most users would want, our requirements were a little different. I called Terry and told him what we needed. No problem, for a nominal fee he would modify the PIC's micro-code to do what we wanted.

I needed two units ASAP. No problem, the units were shipped the next day. I ordered two kits, got them later that week, then assembled them.

Several weeks ago, I installed the transponders at two remote dams. The System Engineer at Hoover Dam is delighted with the operation of Terry's transponders and I can now sleep at night. Thanks, Terry.

Dave Gunderson
via Internet

Dear Nuts & Volts:

In the Electronics Q & A in both the December and January issues, there is a schematic of a circuit that connects to the telephone line and uses current from the line.

The circuit uses current all the time, even when the phones are all hung up. And this current is enough to make Ma Bell think that there is leakage on the line. The problem is that they may send someone out to fix the leakage, and when they find that it is caused by the customer's equipment, they may bill the customer for the service call. This can get quite expensive. So users should be warned.

There are other circuits that run off two battery cells, and are connected to the line through several megohm resistors. These draw so little current that they are safe.

One other point: if this circuit is used on a line during a modem session, the flashing LED may cause the levels to change, and cause errors on the line. Or it could cause a clicking noise during regular voice use, since it is constantly switching on and off.

Under no circumstances should a device like this be connected to the phone line and be connected to any other circuit. The phone line should be isolated from any other circuit because lightning and other high voltage could come in on the phone line, and cause damage, both physically and bodily.

In the recorder circuit, the tape recorder is connected directly to the phone line, and that could be really bad if the recorder is not battery powered.

I hope this clarifies some problems with safety and telephone lines. Thanks for the good articles.

John Lundgren
via Internet

Dear Nuts & Volts:

I enjoyed the fun project in your Jan. '98 issue about the electronic mail box indicator system, however, I wish Kenton Chun would have gone one step further and designed a simple circuit that may be attached to the speaker wires of the wireless doorbell and could activate a small relay or FET to activate another device like a "MAIL'S HERE" sign or maybe a motorized waving flag. Just to make it even more fun. Any Ideas? Great magazine.

Kevin Stout
via Internet

Dear Nuts & Volts:

Regarding your article on the mailbox indicator — is there a way to boost the signal coming out of the speaker wires to drive a switch relay with a signal input voltage of 4V min.?

Tony
via Internet

Response:

Thank you for your questions and interest in the project. I intentionally omitted a visual indicator, in order to keep the project simple.

As a teacher for many years, I have become accustomed to offering the basic principles and hoping that improvements will be an exercise for the students!

If you wish to trigger an output with the doorbell output, you can use the speaker output to drive the base of a transistor switch. Any good-quality NPN transistor like a 2N2222 may be used.

Connect the collector of the transistor to the positive power supply rail and connect the emitter through a load like a relay coil to ground. Depending on the

Continued on page 98

OUR CLOSING DATE HAS CHANGED!!!!

The closing date for each issue of *Nuts & Volts* is now the 5th of the prior month, e.g., the closing date for the June issue is May 5th.

Please make a note of this for your records.

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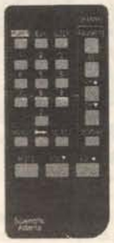

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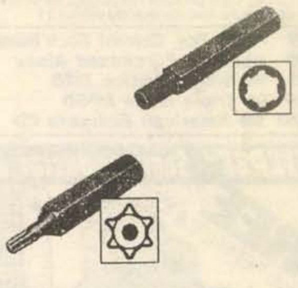

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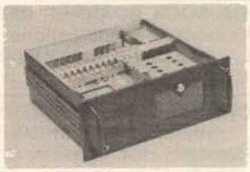

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COMPRESSOR AND OPTIONAL FUZZ FOR GUITAR

by Peter Lehmann

The project that I'm presenting here has three features that will be of interest to the electric guitarist.

First, when used with most electric guitars, it can be adjusted so that the amount of fuzz produced is controlled by the setting of the volume control on the body of the guitar.

Secondly, when used with a guitar with a pickup outputting at a very low level, it can alternatively be adjusted to provide the same level of compressed preamplification as produced when amplifying the outputting of a pickup of a higher level.

Thirdly, these adjustments are made by changing the setting of one potentiometer of the project which can be calibrated for each particular guitar that it is to be used with.

WHY COMPRESS?

Adding compression of the dynamic range inherent to a pickup causes single note lines or arpeggios to sound nearly as loud as a chord. Also, apparent sustain is improved, as the length of time before the decay of a note played passes below the threshold of hearing is increased.

WHY FUZZ?

Fuzz is the generation of harmonics by distorting the outputting of a pickup. The capability of adding varying degrees of fuzz gives the guitarist an increased range of tonal quality to experiment with.

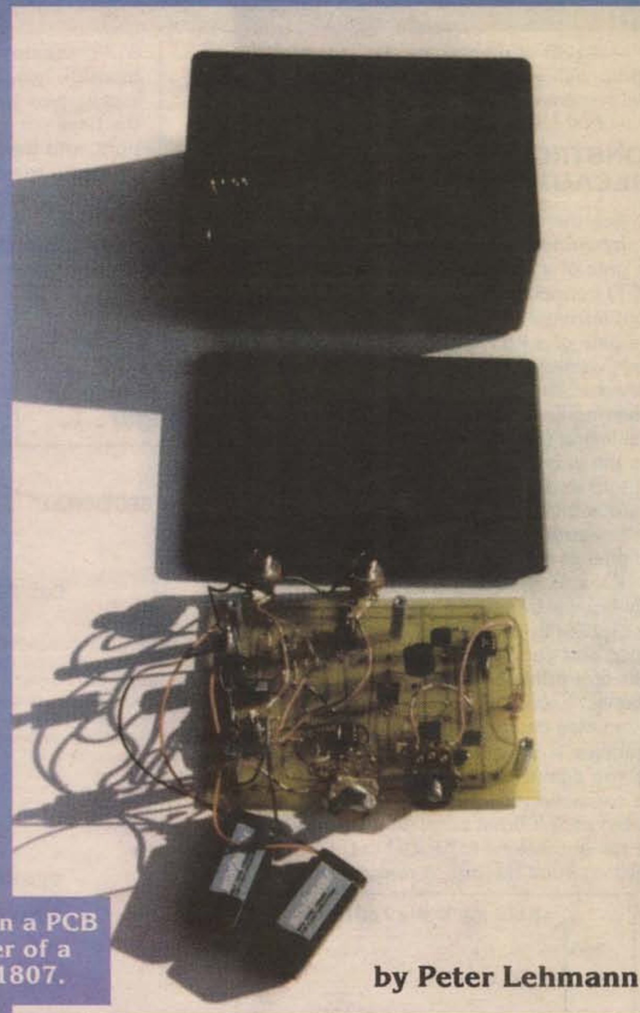
FEATURES

— Circuit components are widely available.

— Greater than 12 hours continuous operation when powered by two NiCd rectangular batteries.

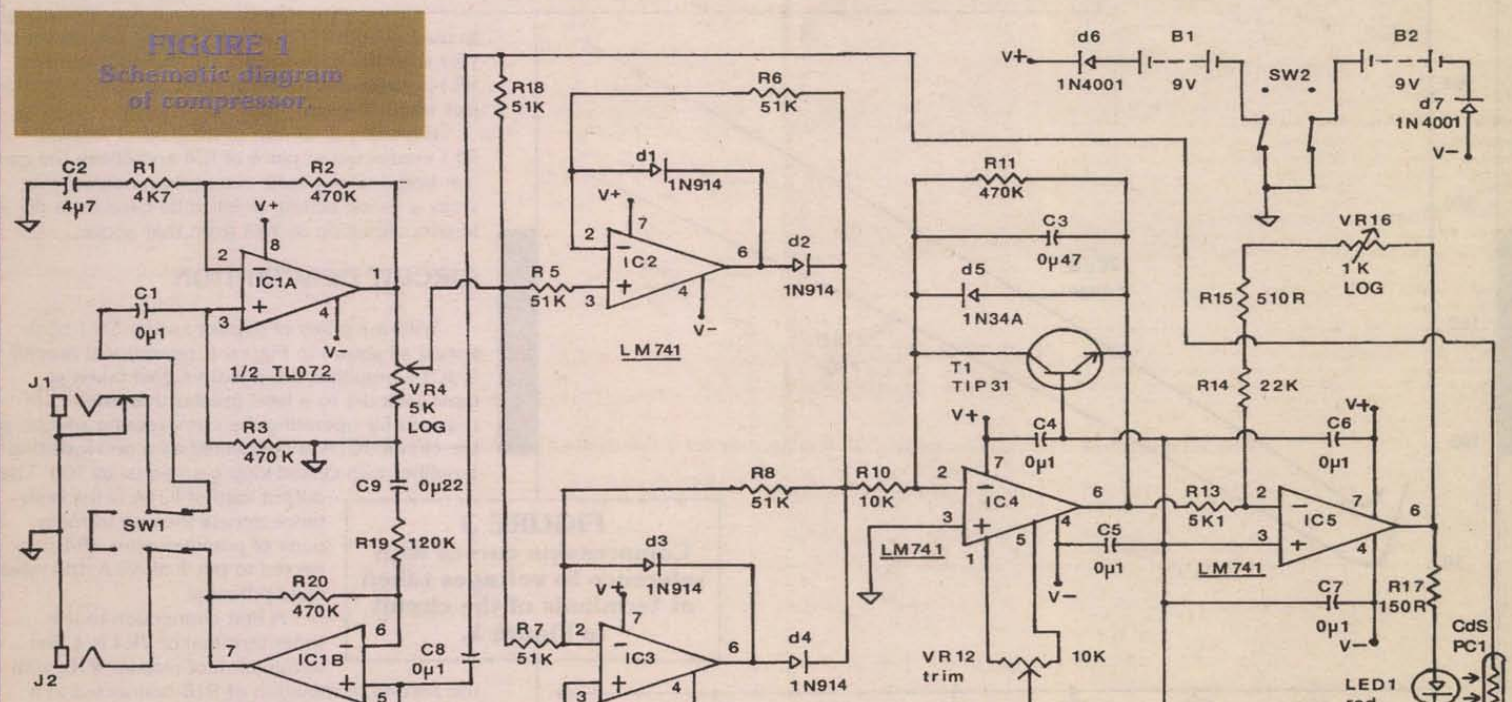
— Infinitely variable compression ratio, from 2 dB/20 dB range to 4 dB/31 dB range.

— Extent of fuzz variable while playing.



Compressor constructed on a PCB for attaching to the cover of a Radio Shack Box #270-1807.

FIGURE 1
Schematic diagram of compressor.



— 40 dB of preamplification for matching a pickup with very low-level outputting to input level requirements of a power amplifier.

— Flat frequency response.

CONSTRUCTION PRECAUTIONS AND AIDS

See the schematic diagram in Figure 1.

Integrated circuit IC1, type TL072, includes the gate of a Field Effect Transistor (FET) connected to each input terminal of the IC. The gate of a FET can be easily destroyed by a static electric charge. Soldering an eight pin, dual in-line (DIP-8) socket into the circuit to hold IC1, and inserting IC1 into its socket only when the circuit board is finished, is a deterrent against such destruction. Also, avoid touching the pins of the IC when installing.

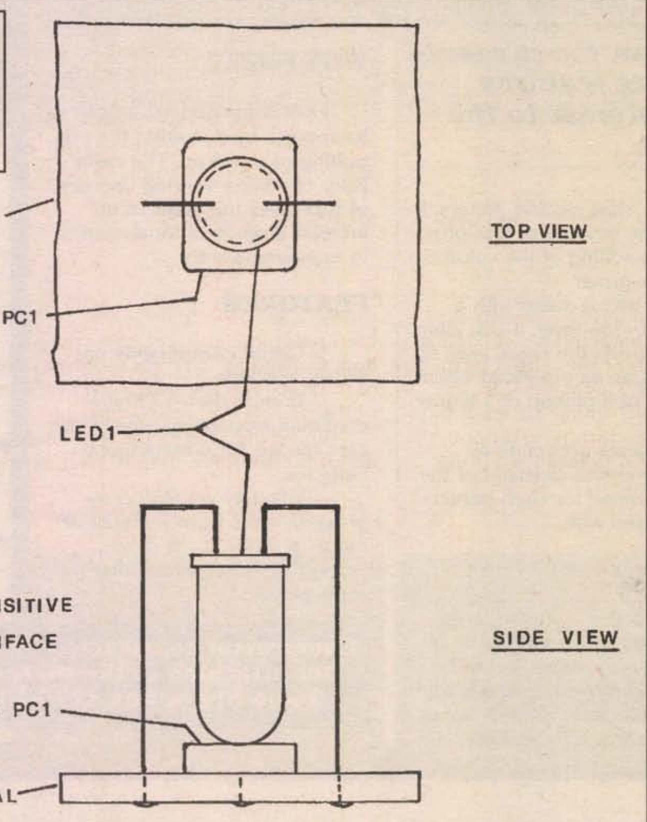
ICs 2, 3, 4, and 5, type LM741, use only bipolar transistors and so are not susceptible to destruction by static electricity, and can be soldered directly to the pads of a printed circuit board (PCB). However, excessive heat to the pins of an IC can also destroy any IC. The proper technique is to hold the tip of the soldering iron against the pad of each pin without contacting the pin. Solder is then heated until it flows completely around the pin and seems to "stick" to the pin, at which point the iron is removed.

Transistor T1, type TIP31, with its (metallic) heatsink lying down on the surface of your bench and its pins pointing towards you, is oriented with the base pin to your left, the emitter pin to your right, and the collector pin in the middle. When soldering to each pin of T1, be certain to heatsink that pin.

All wiring from the circuit board to jacks J-1 and J-2, switch SW1, and potentiometers VR4 and VR16 should be kept as short as possible as this wiring carries signals.

Photocell PC1 is susceptible to damage by heating the leads of the cell. Avoid overheating the soldered connection of the leads of PC1 to pads or terminals and make connections at least 1 cm distant from where the leads enter the cell. Cadmium sulphide (CdS) photocells are very sensitive to illumination by even very faint light. As a result, the compressing section of this project will not function according to design if your enclosure allows any ambient light to fall on its sensitive surface.

FIGURE 2
Light emitting diode/ photocell LED1/PC1 assembly, components of the circuit in Figure 1.



Before wiring potentiometer VR4 into the circuit, measure the resistance across the two outside terminals of VR4. Next, mount VR4 on a panel of your enclosure for this project and attach a pointer knob to the shaft of VR4. Mark the position of the knob's pointer corresponding to zero resistance between the wiper (center) terminal and the terminal to be connected to reference potential.

Advance the knob's pointer clockwise and mark its position corresponding to resistance between the wiper terminal and the terminal to be connected to reference potential equal to one-seventh (1/7) of the (actual) resistance of VR4 that was measured first. This calibration of VR4 is explained in the section on using this project which follows.

Exposing a section of the lead of resistor R13 connected to pin 6 of IC4 and above the circuit board to a greater extent than normal provides a circuit testing point to be used for a different calibration of VR4 from that above.

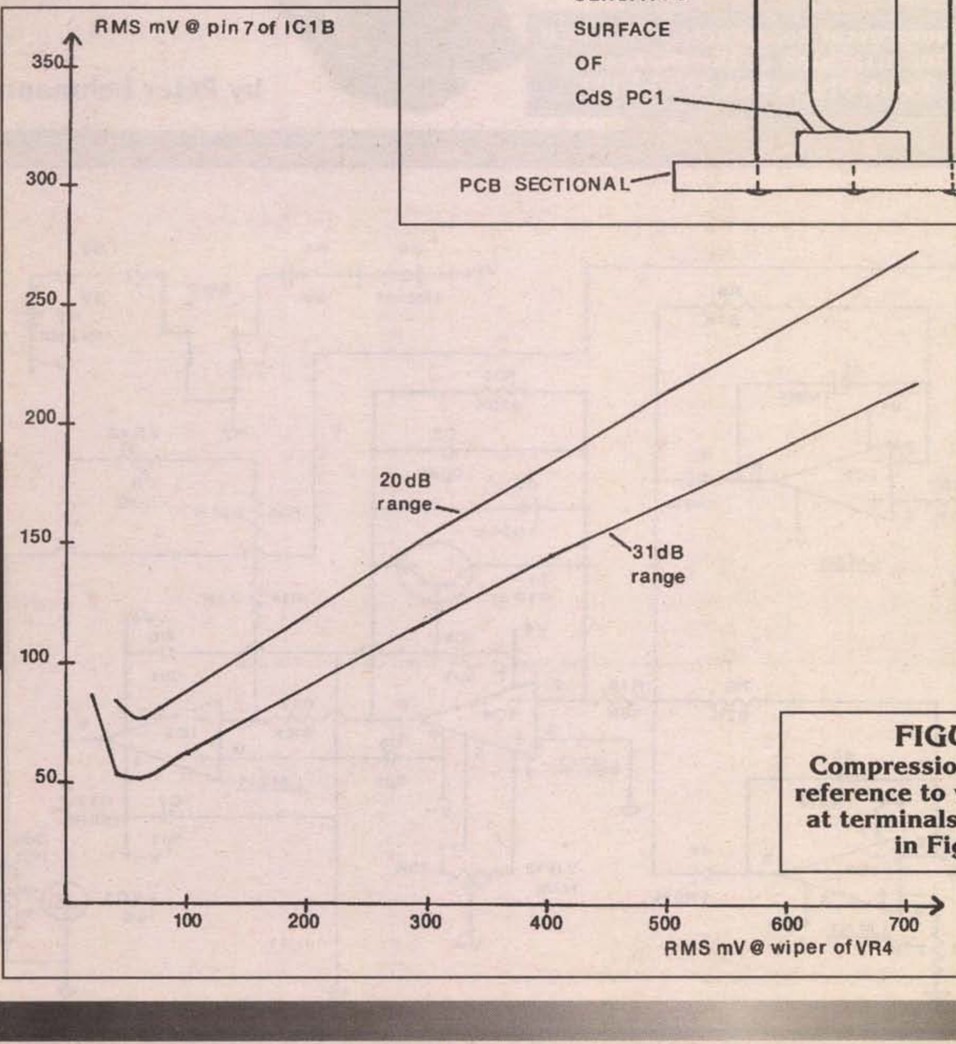


FIGURE 3
Compression curves with reference to voltages taken at terminals of the circuit in Figure 1.

CIRCUIT DESCRIPTION

With the poles of bypass switch SW1 positioned as shown in Figure 1, operational amplifier IC1A amplifies the pickup signal taken at input jack J-1 to a level greater than that required for operating the compressing section of the circuit. IC1A is connected as a non-inverting amplifier with closed-loop gain equal to 100. The output load of IC1A is the resistance across the end terminations of potentiometer VR4 connected to pin 1 of IC1A and reference potential.

A first connection to the wiper terminal of VR4 is a first termination of resistor R18, with the second termination of R18 connected to a first termination of PC1, connected by its second termination to the reference potential rail.

The connection of R18 to PC1 is connected to a first termination of capacitor C8. The second termination of C8 is connected to the non-inverting input terminal, pin 5, of operational amplifier IC1B. The closed-loop gain of IC1B, connected for non-inverting amplification, is equal to five (5). With the poles of SW1 positioned as shown in Figure 1, the output terminal of IC1B, pin 7, is connected to the tip-contacting terminal of output jack J2.

A second connection of the wiper terminal of VR4 is to connected first terminations of resistors R5 and R7, which is the input terminal of a fullwave rectifier, including operational amplifiers IC2 and IC3. Resistor R10 connects the output terminal of the fullwave rectifier to the inverting input terminal, pin 2, of operational amplifier IC4.

IC4 is connected as a logarithmic amplifier. Resistor R11, capacitor C3, diode d5, and transistor T1 are connected in parallel circuit forming a negative feedback loop from pin 6 to pin 2 of IC4. Transistor T1 produces the basic logarithmic input/output characteristic. Resistor R11 shapes the input/output characteristic of IC4 for the range of voltages taken at the output terminal of the full-wave rectifier. Capacitor C3 smooths the modulated DC voltage taken at pin 2 of IC4. Diode d5 stabilizes trimming output offset voltage at pin 6 of IC4 to less than 3 mV by adjustment of potentiometer VR12. Capacitors C4 and C5 bypass AC voltages from the power supply rails.

Resistor R13 connects output terminal pin 6 of IC4 to the inverting input terminal, pin 2, of operational amplifier IC5. IC5 is connected as an inverting amplifier with closed-loop gain variables between 4.4 and 4.6. Capacitors C6 and C7 provide power supply bypassing. Light emitting diode LED1, connected in series with current-limiting resistor R17 from pin 6 of IC5 to reference potential, illuminates the sensitive surface of PC1. See Figure 2.

At the top right-hand side of Figure 1, power switch SW2 thrown to the "on" position shown connects both the negative terminal of battery B1 and the positive terminal of battery B2 to the reference potential rail. Diodes d6 and d7 preclude inadvertent incorrect power supply voltages connected to the pins of the ICs.

HOW IT WORKS

If the input signal from the pickup of a guitar taken across the tip and barrel-contacting terminals of J1 is kept below about 50 mV RMS, then preamplifier IC1A isn't driven into saturation. Consequently, the waveform taken at pin 1 of IC1A follows the waveform of the outputting of the pickup minus any clipping.

Where the level of the input signal exceeds about 50 mV RMS, then IC1A is driven into saturation causing clipping, and fuzz is generated.

To simplify the following explanation, assume that IC1A isn't driven into saturation. The level of the output signal taken across the tip and barrel-contacting terminals of J2 is directly proportional to the product of the level of the input signal and the voltage division factor equal to the resistance of PC1, divided by the sum of the resistances of R18 and PC1. The intensity of illumination of PC1 by LED1 is logarithmically proportional to the level of the input signal. Therefore, the voltage division factor is inversely proportional to the level of the input signal.

With respect to the relevant response characteristics of LED1 and PC1, the resistance values of R11, R17, R18, and the feedback loop of IC5 control variation of the voltage division factor proportional to the level of the input signal. When the voltage division factor varies correctly, then the dynamic range of the output signal relative to that of the input signal is compressed.

Irregardless of the generation of fuzz, or the lack thereof, the wiper of input level control VR4 is set for 1V peak maximum taken across the wiper of VR4 and the reference potential rail.

With VR4 properly adjusted in this way, the compression curves of Figure 3 result. When the resistance of VR16 equals 1 Kohm, then compression occurs over the 31 dB range, resulting in the lower compression characteristic of Figure 3. With the resistance of VR16 reduced to 0 ohm, then compression occurs over the 20 dB range, resulting in the upper compression characteristic of Figure 3.

SPECIFICATIONS

Maximum current consumption: ± 10 mA
Frequency response: ±1 dB, 50 Hz to 20 KHz
Compression ratios: 31 dB range, 4:1; 20 dB range, 2:1
Compression characteristics: see Figure 3

PARTS LIST

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

R1	4.7K
R2	470K
R3	470K
VR4	5K ± 20% carbon, single turn, log taper potentiometer
R5	51K
R6	51K
R7	51K
R8	51K
R9	22K
R10	10K
R11	470K
VR12	10K 1/4W multiturn, vertical adjust, 0.1 inch pin spacing
R13	5.1K
R14	22K
R15	510
VR16	1K ± 20% carbon, single turn, log taper potentiometer
R17	150

Capacitors, polyester film, 50V, ± 10%, except where otherwise indicated

C1	0.1 microfarad
C2	4.7 microfarad, ± 20%, 50V radial bipolar electrolytic
C3	0.47 microfarad
C4	0.1 microfarad
C5	0.1 microfarad
C6	0.1 microfarad
C7	0.1 microfarad
C8	0.1 microfarad
C9	0.22 microfarad

Semiconductors

d1, d2, d3, d4	1N914 silicon switching diode
d5	1N34A germanium signal diode
d6, d7	1N4001 silicon rectifying diode
LED1	Diffused red T1 3/4-size, 10 MCD @ 20 mA typical
PC1	Cadmium sulphide photocell, Mouser Electronics Stock #338-76C59 or equivalent as follows: Light resistance at 10 LUX = 20K-50K Dark resistance, 10 sec. after removal of 10 LUX = 20M Peak response wavelength = 550 nanometer
T1	TIP31 NPN general-purpose transistor
IC1	TL072ACN DIP-8 dual JFET operational amplifier
IC2, IC3, IC4,IC5	LM741CN DIP-8 single operational amplifier

Mechanical Components

SW1, SW2	DPDT miniature toggle switch
J1	1/4 inch closed tip, two-conductor phone jack
J2	1/4 inch open tip, two-conductor phone jack

Miscellaneous

Printed circuit board or perfboard and push-in terminals (micro-flea clips), DIP-8 IC sockets, plastic enclosure, two pointer knobs, clips for two 9V rectangular batteries, circuit board mounting hardware, etc.

Sources of Supply

To order photocell PC1 from Mouser Electronics, call 1-800-346-6873 to receive a purchasing manual.

The printed circuit board shown in the photo and measuring 4" wide by 6" long, is available for $14.50 plus $1.50 for first class postage and handling (US Dollars), including a component layout schematic, from:

Betacircuit Designs
Suite J-11
8723 W. Chester Pike
Upper Darby, PA 19082

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USING THE COMPRESSOR (± FUZZ)

Set input level control VR4 for resistance across the wiper terminal of VR4 and the reference potential rail equal to one-seventh of the end-to-end resistance of VR4. Connect output jack J2 to the input jack of your power amplifier. Plug your guitar's output cable into input jack J1. While playing your guitar at the loudest level with the volume control on the body of your guitar set high, note whether or not fuzz is generated.

If fuzz is generated, then this first setting of VR4 is the correct one for your guitar. Fuzz is deselected and compression ratios in the range of 2:1 to 4:1 are retained by lowering the volume control on the body of your guitar to a setting slightly past the point where distortion is still audible. If fuzz isn't generated with the volume control on the body of your guitar fully advanced, then the project can be used for compressed preamplification with your guitar when the following second setting of VR4 is used.

Disconnect the plug to your power amplifier from input jack J2 of the project. Remove the circuit board of the project from its enclosure and connect negative and positive probes of a DC voltage meter to pin 6 of IC4 and the reference potential rail, respectively. With the volume control on the body of your guitar set high, while playing your guitar at the loudest level, turn up VR4 to the setting resulting in a maximum voltage reading at pin 6 of IC4 about equal to 0.5V. This second setting of VR4, with the volume control on the body of your guitar fully advanced, allows for selecting compression ratios in the range of 2:1 to 4:1.

IN CASE OF DIFFICULTY

In Figure 1, if the quiescent DC voltage taken across pin 6 of IC4 and the reference potential rail can't be reduced to less than 3 mV by adjusting VR12, check that the cathode and anode terminals of d5 are connected to pins 2 and 6 of IC4, respectively. Further, check that the shorting and tip-contacting terminals of J1 are connected.

If a buzzing noise from your power amplifier is heard when the power amplifier is connected to the project and your guitar's plug is removed from the input jack of the project, check that the shorting and tip-contacting terminals of J1 in Figure 1 are connected.

With the input level control turned up to maximum, and the sound output level is low, the cause might be that ambient light is leaking through the project's enclosure and illuminating photocell PC1 in Figure 1.

Plug any holes in the enclosure and check that the enclosure assembles tightly. Another possible source of the difficulty could be a reversed connection of the emitter and collector pins of transistor T1. See Figure 1. **NV**

COMPUTER HARDWARE *cont.*

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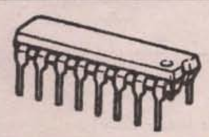

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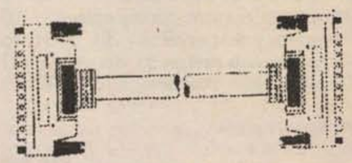

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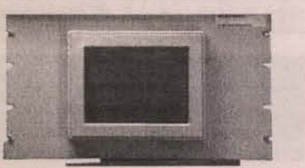

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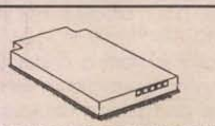

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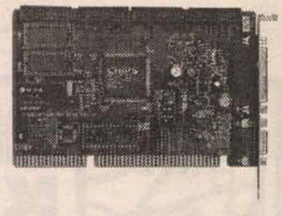

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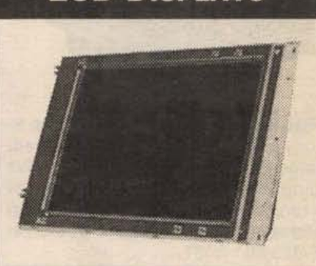

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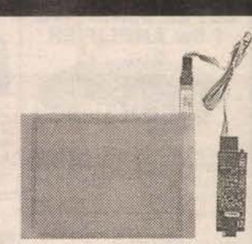

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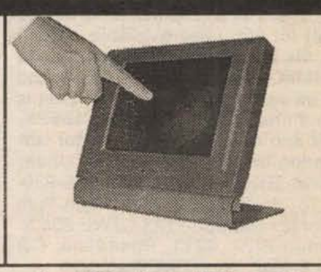

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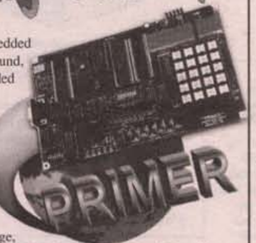

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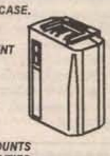

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Sensor Linearity Improvement

Open Channel

by Joseph J. Carr, CET
K4IPV

Sensors are devices that are used to measure a physical parameter. For example, thermistors and thermocouples measure temperature, while strain gauges can be used to measure vibration, pressure, and a host of other things. In past columns, I've discussed the Speake FGM-x series of flux gate magnetometer sensors. These devices produce an output proportional to the surrounding magnetic field.

On one level, a sensor or transducer (I used the terms interchangeably here) is "... a device that converts other forms of energy to electrical energy for the purposes of measurement or control." Figure 1 shows the relationship of the sensor in a measurement or control system. The physical parameter being measured impinges the sensor in some prescribed manner. The sensor then produces an electrical output. This output can be a change of resistance, a frequency, a current level or a voltage level. The signal is then conditioned in some manner, before being sent to a display or some device that either uses it or stores the data produced.

The description above is necessarily a little vague because there is a very wide variety of different types of sensors, the signal conditioning required, the type of display, or the actuator (or what have you) that is used.

Signal conditioning may consist of amplification, frequency response tailoring (filtering), logarithmic compression, analog-to-digital (A/D) conversion, frequency-to-voltage or frequency-to-binary conversion, and so forth. Today, with the large increase in the use of computers, the typical signal conditioning section will include an A/D converter, as well as a frequency response filter in order to reduce noise and prevent aliasing.

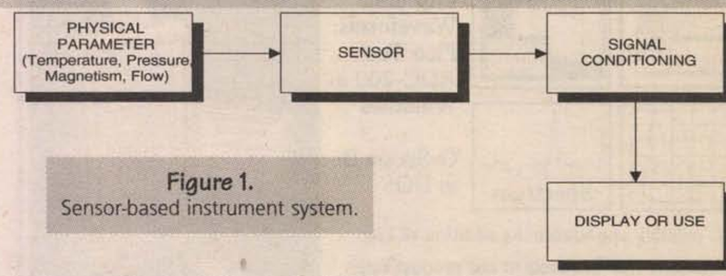

Figure 1.
Sensor-based instrument system.

Sensor Linearity

We humans like nice, orderly straight lines. We get uncomfortable if we see things that are not so orderly. Unfortunately, nature is not so orderly as we would like to see things. Figure 2A shows the ideal and actual curves produced by a hypothetical sensor. The dotted line is the ideal response. It is a straight line, so any given change in the input parameter will produce a proportional change in the electrical output signal. For example, a 10 percent change in ambient temperature ought to produce a 10 percent change in the output voltage of a PN semiconductor junction temperature sensor.

The actual curve shown in Figure 2A is (in this instance) S-shaped. It has a reasonably straight section (P1 to P2) that is linear (Figure 2B). The sensor can be used with relative ease when the input parameter remains within that region. The voltage V1 to V2 will change proportionally to ΔP. In some sensors, the linearity might not be perfect, but is considered close enough for some applications. The line might vary a little at one point or another, but remains within an acceptable error band.

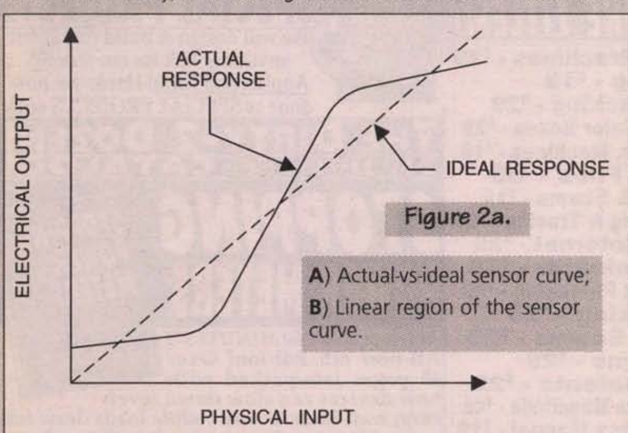

Figure 2a.

A) Actual-vs-ideal sensor curve; **B**) Linear region of the sensor curve.

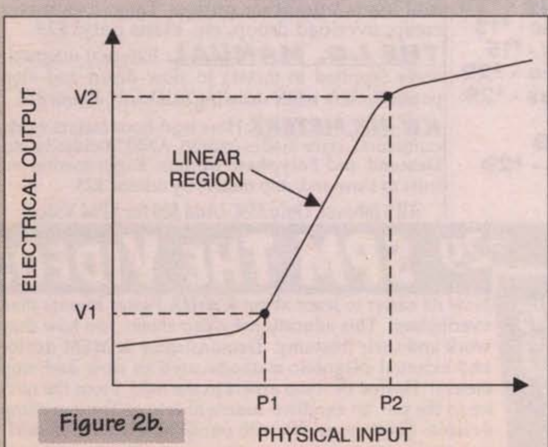

Figure 2b.

Regularizing and Linearizing Sensors

When the slope of the linear region is not correct, or the error is too great, then the sensor output signal can be conditioned to solve the problem. "Regularizing" is my term for making the sensor output meet some standard condition. For example, a pressure sensor may produce an output signal of 1.6 millivolts (mV) per Torr of pressure (Note: 1 T = 1 mmHg). Suppose we can display the pressure on a digital voltmeter. We could, of course, measure the voltage, and then do the multiplication in our head. The other method is to regularize the output signal.

Regularizing. Consider the example in Figure 3. Suppose we were to build a 0-200 Torr pressure meter. The selected pressure sensor has a sensitivity factor (S1 in Figure 3) of 1.6 mV/T. In order to make the display on the 0-1,999 mV digital voltmeter, we would want to make the sensitivity (S2 in Figure 3) 10 mV/T. The 180 Torr pressure would produce a voltage of 1,800 mV. If the decimal point on the DVM were set to the position shown (some digital panel meters allow positioning the decimal point), we would have a 0-199 Torr meter that has a 0.1 Torr resolution.

What gain is required of the amplifier in order to obtain S2 = 10 mV/Torr? The gain of an amplifier is the output divided by the input, or:

$$A_v = \frac{V_o}{V_{in}} = \frac{1800\,mV}{288\,mV} = 6.25 \qquad (1)$$

Alternatively, we could also (and more reasonably) divide the desired sensitivity by the actual sensitivity:

$$A_v = \frac{S2}{S1} = \frac{10\,mV/Torr}{1.6\,mV/Torr} = 6.25 \qquad (2)$$

By providing an amplifier with a gain of +6.25, we can convert the output of the pressure sensor from something that is difficult to read and use to something that is real easy to read.

Linearizing. By way of example, let's assume that we have a Generic Wonderful Sensor (GWS) that measures a physical parameter in P units. We know that the rated calibration factor of the sensor is 6

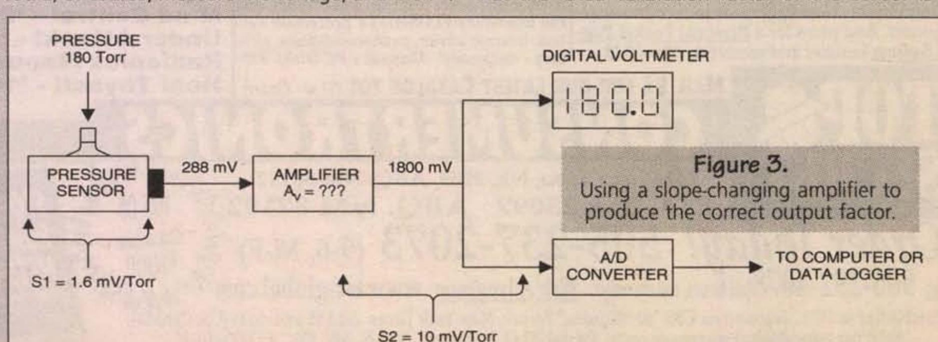

Figure 3.
Using a slope-changing amplifier to produce the correct output factor.

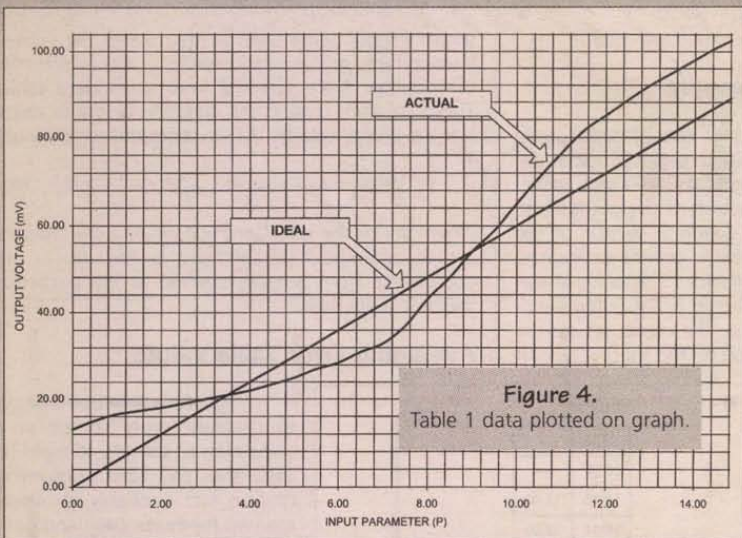

Figure 4.
Table 1 data plotted on graph.

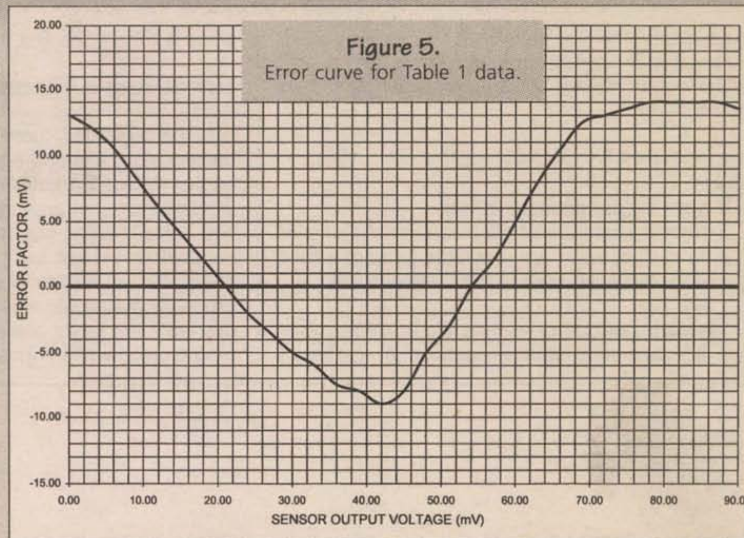

Figure 5.
Error curve for Table 1 data.

mV/P (see "Ideal" column in Table 1). When we test the actual sensor that we bought, we find that there is a variable error (see "Actual" column in Table 1) that is a function of the input value of P. Figure 4 shows the ideal and actual output curves. The ideal curve is a straight line with a slope of 6, i.e., the output voltage of the sensor (V_M) rises 6 mV for every change of 1 P unit.

If our application finds the overall error within acceptable limits, or if we can operate in a relatively linear portion of the curve (e.g., $1 \leq P \leq 5$), then we need not do anything. But if we wanted to correct the error, we would need to subtract out the error factor ("Error" column in Table 1). Figure 5 shows how the error varies with sensor output voltage. Notice that the error can be either positive or negative, and crosses the zero (no error) axis at two points.

There are a couple of different ways we could correct the problem, making the actual curve more linear. In the bad old days, we used "diode breakpoint generators" to smooth a curve. These circuits used a series of operational amplifiers that were each gated on by diodes when the input voltage reached a certain value. The gain of each operational amplifier was set to correct the curve over a small range of input values. The result was a "piece wise linear" approximation of the ideal curve. Such curves were linear over short ranges, resulting in an overall error that varied a whole lot less than the actual error. The problem, however, was that those circuits had their own errors, and some of the circuit errors were thermal-dependent (they used diodes, after all!).

A better way is to use either a look-up correction table in the computer that receives the data, or provide either a PIC microcontroller or BASIC Stamp circuit to correct the error. Figure 6 shows a generic scheme on how to correct the sensor voltage using a look-up table, either in the memory of a desktop computer or a local PIC/Stamp type of computer.

The parameter value 5.5 P units is applied to the sensor ("A" in Figure 6), which produces an output voltage that is converted to a binary number in an A/D converter ("B" in Figure 6). This value (call it V_M) is 27 mV (see "Measured Value" column in Figure 6). This value is compared with a look-up table and it is found that an error factor (V_E) of -6 mV is associated with a 27 mV input value ("C" at Figure 6). The measured value (V_M) and the error factor value (V_E) are then combined to form a corrected output value V_C ("E" in Figure 6) such that $V_C = V_M - V_E = (27\text{ mV}) - (-6\text{ mV}) = 27\text{ mV} + 6\text{ mV} = 33\text{ mV}$. The value 33 mV is consistent with the ideal curve value (see "Ideal" column in Table 1).

One approach to linearizing using a small processor is to store the look-up table in memory locations that can be calculated from the input data (Figure 7). In our example above, the value of P = 5.5 yields 27 mV. When this value is A/D converted, the result is a binary number 11011_2 (hexadecimal H1B – the "H" denotes the base-16 hexadecimal system). This number is added to a stored constant K of HF00 (binary 111100000000_2). The result is HF00 + H1B = HF1B (which is the same as binary 111100011011_2). The look-up table is stored in sequential locations in memory (see Figure 7), with the first value at location HF10 and the others following. The value we are looking for (-6 mV) is stored at HF1B.

The simplistic method discussed above assumes that the millivolt values are all integers. That might easily be true given the fact that A/D converters tend to output "integer" binary numbers, so the method can be used. In situations where the linearization is done in software in a personal computer, however, and where the A/D resolution is greater than that of the look-up table, some interpolation arithmetic can be provided to approximate values that are between the stored values.

Table 1.
Ideal and actual output values for a hypothetical sensor.

P Units	Ideal (mV)	Actual (mV)	Error (mV)
0.00	0.00	13.00	13.00
0.50	3.00	15.00	12.00
1.00	6.00	16.50	10.50
1.50	9.00	17.25	8.25
2.00	12.00	18.00	6.00
2.50	15.00	19.00	4.00
3.00	18.00	20.00	2.00
3.50	21.00	21.00	0.00
4.00	24.00	22.00	-2.00
4.50	27.00	23.50	-3.50
5.00	30.00	25.00	-5.00
5.50	33.00	27.00	-6.00
6.00	36.00	28.50	-7.50
6.50	39.00	31.00	-8.00
7.00	42.00	33.00	-9.00
7.50	45.00	37.00	-8.00
8.00	48.00	43.00	-5.00
8.50	51.00	48.00	-3.00
9.00	54.00	54.00	0.00
9.50	57.00	59.00	2.00
10.00	60.00	65.00	5.00
10.50	63.00	71.00	8.00
11.00	66.00	76.50	10.50
11.50	69.00	81.50	12.50
12.00	72.00	85.00	13.00
12.50	75.00	88.50	13.50
13.00	78.00	92.00	14.00
13.50	81.00	95.00	14.00
14.00	84.00	98.00	14.00
14.50	87.00	101.00	14.00
15.00	90.00	103.50	13.50

Table 2.
Errors of several sensors (K1-K5) and their average error.

P	K1	K2	K3	K4	K5	Average
0.00	13.00	13.23	12.91	13.09	13.14	13.08
0.50	12.00	12.09	12.33	11.54	11.61	11.91
1.00	10.50	10.07	10.12	10.36	10.54	10.32
1.50	8.25	8.54	8.00	8.37	7.94	8.22
2.00	6.00	5.66	6.31	6.47	6.18	6.12
2.50	4.00	3.55	4.29	4.03	3.98	3.97
3.00	2.00	2.42	2.17	1.62	2.40	2.12
3.50	0.00	0.22	0.31	-0.11	0.13	0.11
4.00	-2.00	-2.07	-2.36	-1.54	-1.58	-1.91
4.50	-3.50	-3.43	-3.42	-3.69	-3.33	-3.47
5.00	-5.00	-4.54	-4.85	-4.70	-4.58	-4.73
5.50	-6.00	-6.34	-6.34	-6.29	-6.26	-6.25
6.00	-7.50	-7.04	-7.10	-7.05	-7.09	-7.15
6.50	-8.00	-8.06	-8.48	-8.49	-7.56	-8.12
7.00	-9.00	-9.45	-9.40	-9.17	-8.73	-9.15
7.50	-8.00	-7.92	-7.69	-7.91	-7.57	-7.82
8.00	-5.00	-4.82	-5.46	-4.77	-5.09	-5.03
8.50	-3.00	-3.18	-2.60	-2.79	-2.99	-2.91
9.00	0.00	-0.46	0.19	0.47	-0.19	0.00
9.50	2.00	2.11	2.50	1.71	1.64	1.99
10.00	5.00	4.51	5.39	4.64	5.31	4.97
10.50	8.00	8.23	8.36	7.52	8.21	8.06
11.00	10.50	10.87	10.29	10.52	10.64	10.57
11.50	12.50	12.60	12.84	12.23	12.23	12.48
12.00	13.00	13.05	12.67	12.66	13.19	12.92
12.50	13.50	13.26	13.98	13.66	13.66	13.61
13.00	14.00	14.26	14.16	14.01	14.05	14.10
13.50	14.00	13.68	14.24	13.96	14.40	14.06
14.00	14.00	14.27	13.74	14.00	13.55	13.91
14.50	14.00	14.27	14.05	14.44	13.98	14.15
15.00	13.50	13.42	13.07	13.41	13.65	13.41

Another Approach

You can also use a polynomial math expression to linearize a sensor. The particular polynomial depends on the sensor, but let's look at the situation for thermocouple temperature sensors. The differential voltage between the two thermocouple junctions is proportional to the temperature difference, and is used as the output voltage. This potential is found from the equation:

$$V = a + bT + cT^2 + dT^3 + eT^4 + fT^5 \quad (3)$$

where:

V is the output potential in volts

T is the temperature of the measurement junction

a, b, c, d, e, and f are constants that are a function of the materials used in the thermocouple

In many practical cases, only the first three terms may be used (making the equation a quadratic), while in others, the first four terms are used.

Linearizing a Thermocouple

The equation governing the thermocouple demonstrates a strong non-linear dependence of the output voltage on temperature. As explained above, in some cases, an approximation of the output voltage is made using just the quadratic version of the equation (cubic and higher terms deleted or approximated with an additional constant). This practice was especially reasonable when better linearization methods were not easily available. The computer can be programmed with information on the specific type of thermocouple being used so that either the correct look-up table or the correct values of the coefficients of Equation 3 are selected from a standard table. These are then used in the equation below to calculate the proper voltage V(T) to represent temperature T:

$$V(T) = a_0 + A_1V + a_2V^2 + a_3V^3 + \ldots + a_nV_n \quad (4)$$

where V(T) is the calculated voltage, V is the thermocouple differential voltage, and a_0 through a_n are coefficients from a table specific to the particular thermocouple used.

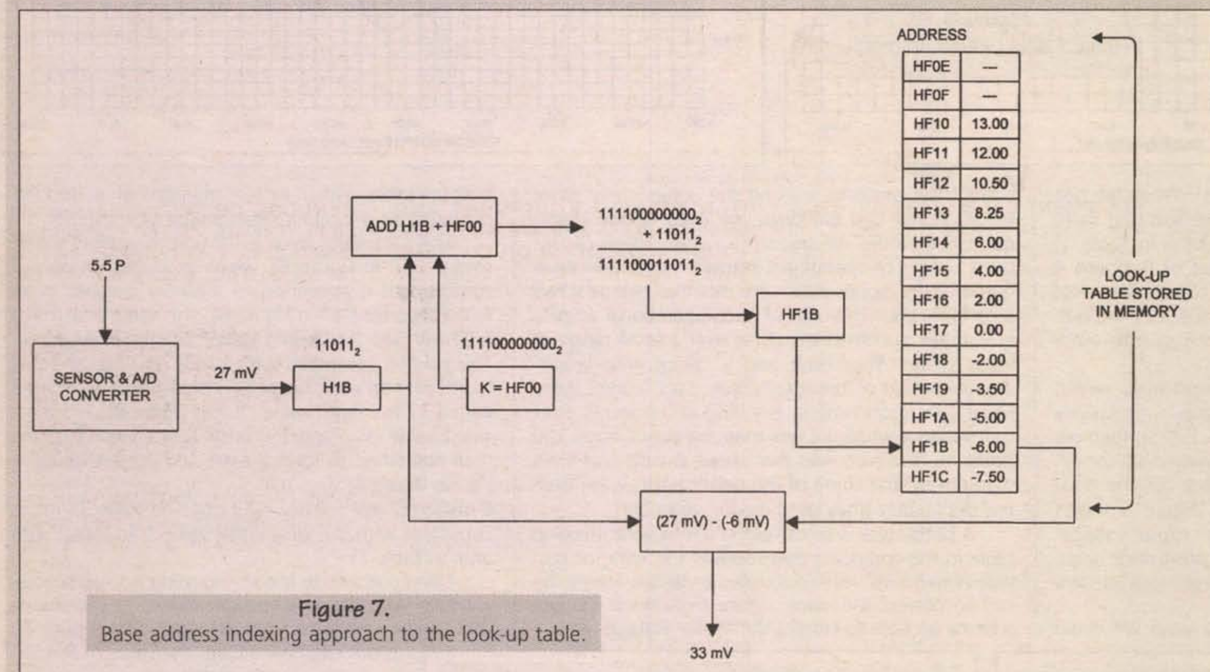

Figure 7. Base address indexing approach to the look-up table.

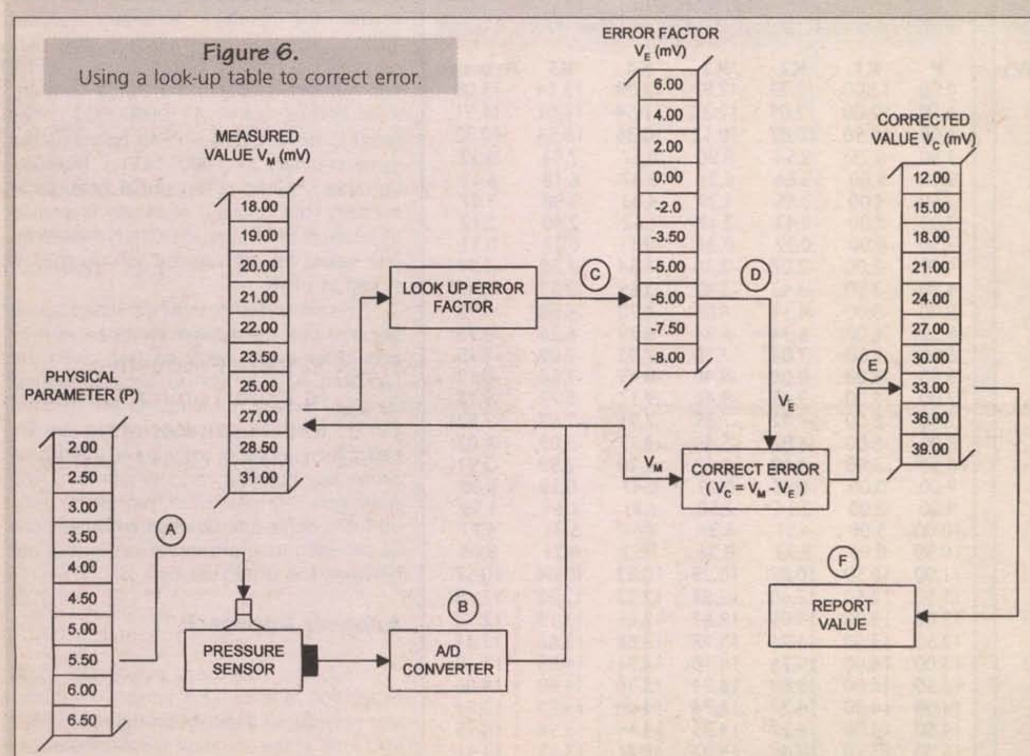

Figure 6. Using a look-up table to correct error.

Averaging Error Table Values

It might be a little bothersome to calibrate every sensor in a given class of sensors. It might be expensive and time consuming (and in fact, probably is). There are two methods used, and both involve averaging. If you measure a number of sensors and find the error value for each P value (Table 2), and they are relatively close together, then you can create a single average value that is not too far from any of them.

The other method involving averaging is found when the standard deviation of errors is wider. In that case, the values can be grouped into, say five to seven, different categories, and the average for that particular group is found. That average then serves for sensors in that category. Each new sensor is then characterized at the factory as to which band it falls into. I've seen blood pressure sensors that contained a method of identifying the particular class a sensor falls into. For example, a resistor can be used, e.g., 10k, 20k, 30k, 40k, and 50k, for five different classes. The instrument where the sensor is used reads the value of the resistor and selects a stored error or calibration table accordingly.

More on the FGM-x Magnetic Sensors

In past issues of this column, I've discussed the Speake FGM-x series of magnetic sensors. The FGM-x series of magnetic sensors are available from Fat **Quarters Software and Electronics** [24774 Shoshonee Drive, Murrieta, CA 92562; **909-698-7950** (voice) and **909-698-7913** (FAX); http://www.dconn.com/FatQuartersSoftware (web page)]. I was, therefore, quite interested when I found out about a worldwide web site that contained the results of a scientist's examination of a set of three FGM-3 devices. If you are interested, then the URL for that web site is:

http://www.tuc.nrao.edu/~demerson/magnet/magnet.html

Some of the techniques discussed in this month's column can be used with the FGM-x series of sensors. **NV**

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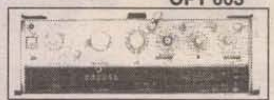

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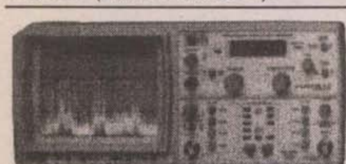

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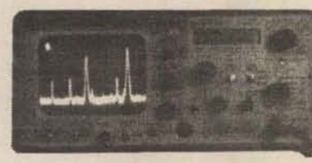

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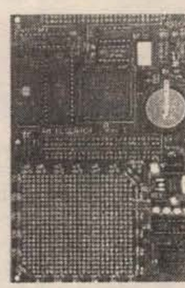

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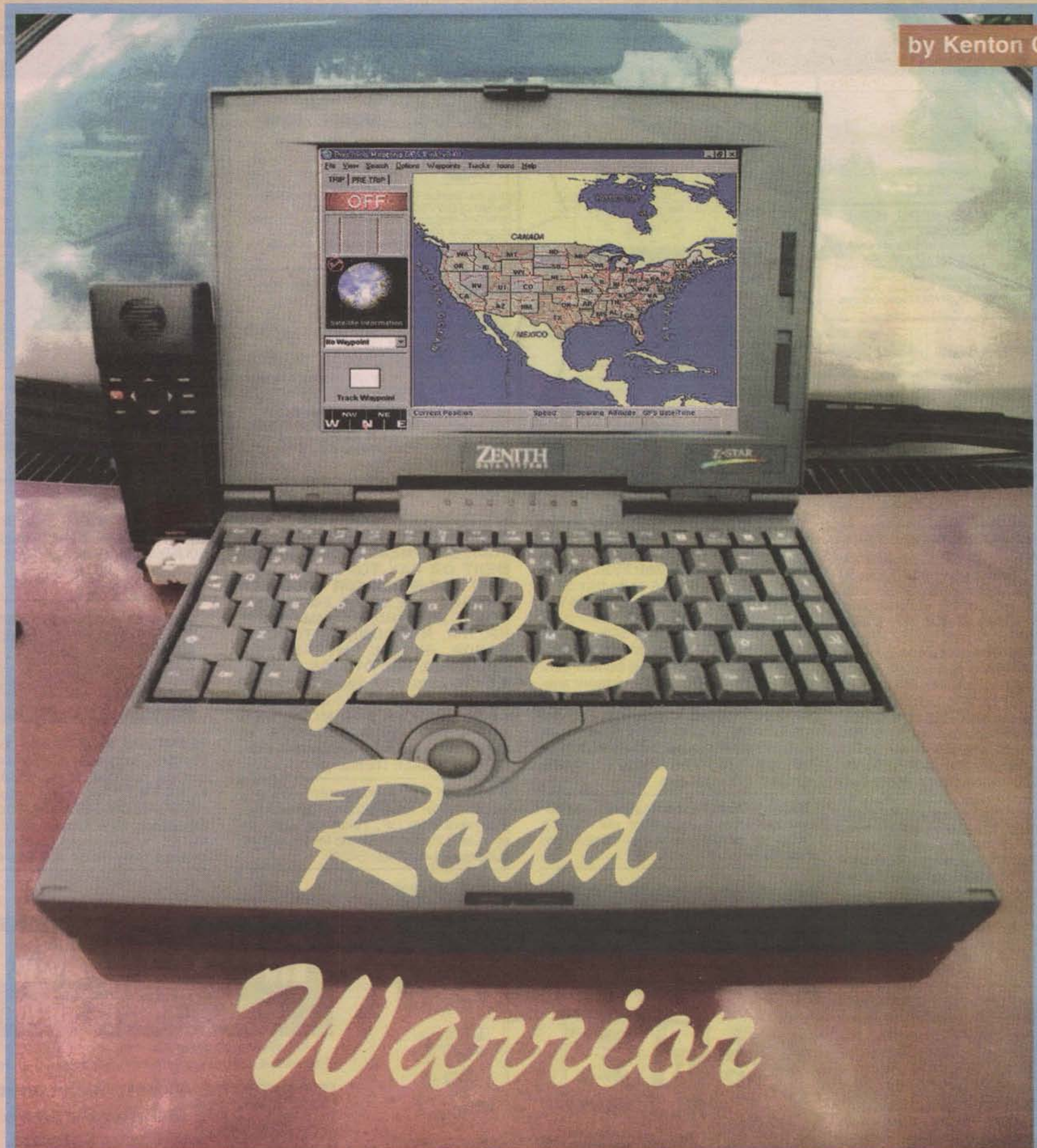


by Kenton Chun

GPS Road Warrior

Any hardware hacker worth his or her salt has probably dabbled with GPS. Any hardware hacker who likes to fish definitely has.

Some of us have already heard the story about the character who had his handheld GPS thrown overboard by the charter boat captain who thought the guy was trying to steal the coordinates of his favorite fishing holes!

In spite of the slight fix inaccuracies introduced by the government's so-called "Selective Availability," GPS has grown to become the number one preferred navigational instrument by the American public.

To date, the handheld GPS unit has been very useful to those willing to manually translate Latitude and Longitude (Lat/Lon) readings to map coordinates — a difficult feat considering that most maps do not include Lat/Lon measurements.

The task actually became more difficult when GPS manufacturers decided that, in order to achieve better resolution, they would display the Lat/Lon in degrees, minutes, tenths, and hundredths of a minute. Map readers were forced to interpolate the tenths and hundredths of a minute into the more conventional seconds of polar coordinate notation.

Higher-priced GPS units feature map databases and moving map displays, but they can more than double the cost of the unit, and ultimately they are disappointing because of the practical size and resolution limitations of a "handheld" GPS.

Moving map systems also come at the cost of a higher power consumption, something a handheld unit should not have. Their databases also depend on relatively small Read Only Memories which must be periodically updated at a horrendous cost.

Most of these combination GPS-Database Systems also contain data of a very specific nature, such as airport approach vectors, or shoreline data which is of little use to road warriors.

The alternative to purchasing a non-land GPS and trying to adapt it for use on city streets is to keep the handheld unit just that — a handheld unit — and using the data output from it to update a laptop computer running a map display program. Quite a few of these are now available at a surprisingly low cost, under $100.00.

The laptop has a much better display resolution, and a street mapping application running off a CD-ROM will supply far more detailed data on land features than any specialized GPS unit can.

This month's project will be to put together the computer, GPS, and software for a real-time map display of our travels on the road.

NMEA 0183

NMEA 0183 is a standard protocol, used by GPS receivers to transmit data serially. NMEA output is EIA-422A compatible but, for most purposes, you can consider it RS-232 compatible. NMEA talks at 1200-9600 bps, eight data bits, no parity, and one stop bit (8N1). NMEA 0183 "sentences" are all ASCII.

Each sentence begins with a dollar sign ($) and ends with a carriage return linefeed (<CR><LF>). Data is comma delimited.

All commas are included as they act as data place markers because some GPS' do not send all of the fields. A checksum is optionally added (in a few cases, it is mandatory).

Following the dollar sign is the address field "aabbb." "aa" is the device ID and generally "GP" is used to identify GPS data. Transmission of the device ID is usually optional. "bbb" is the sentence formatter, otherwise known as the sentence name.

NMEA 0183 version 1.5 uses approved data sentences RMB, RMC, and WPL. More recently, version 2.0 added approved data sentences GGA, GSA, GSV, and RTE, in addition to those in the previous version. Table 1 shows a sample of the data returned by a few

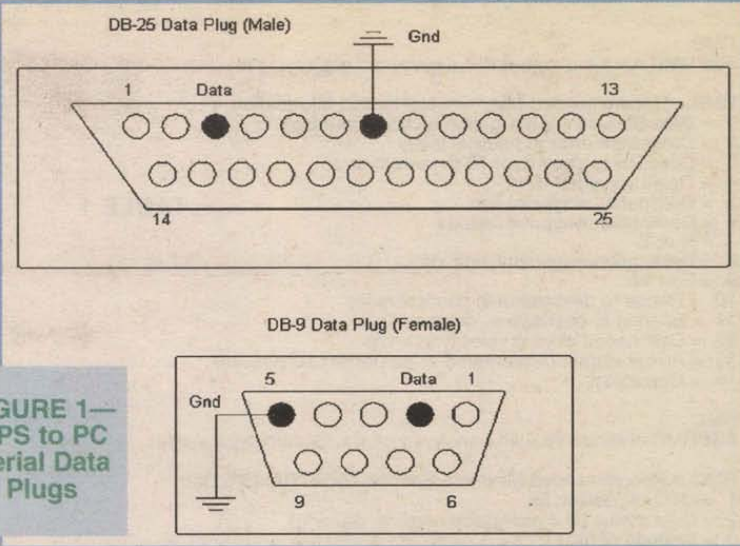


FIGURE 1— GPS to PC Serial Data Plugs

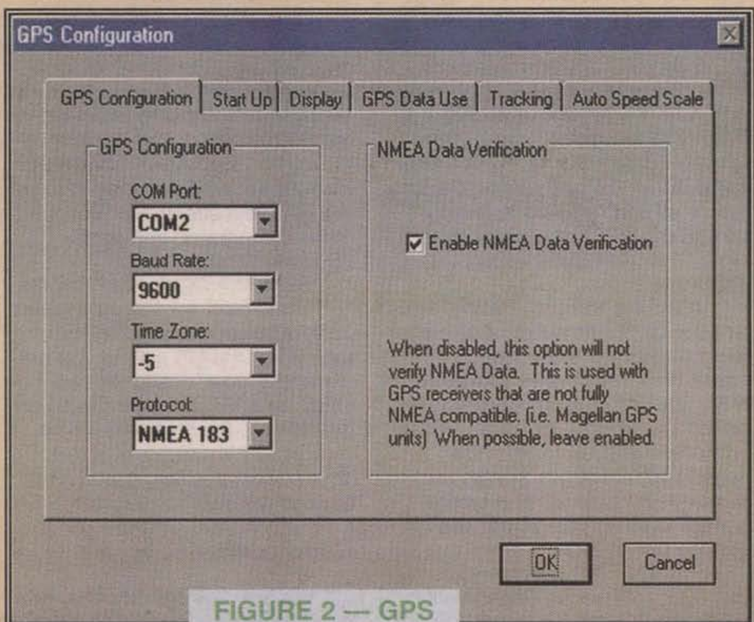
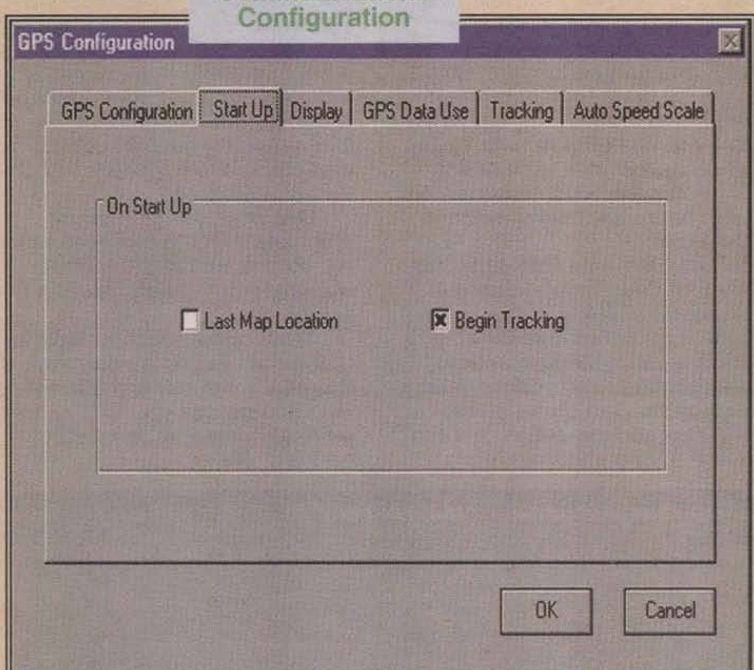


FIGURE 2 — GPS Communications Configuration



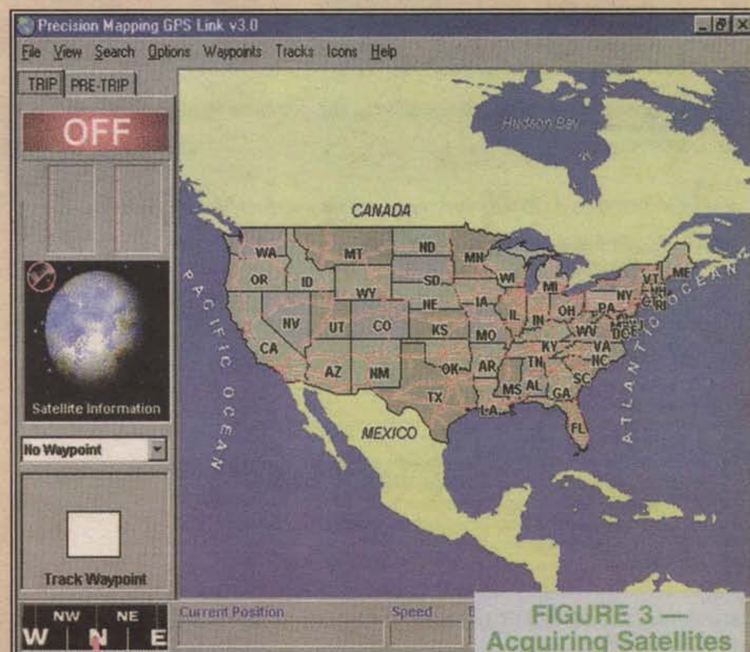


FIGURE 3 — Acquiring Satellites

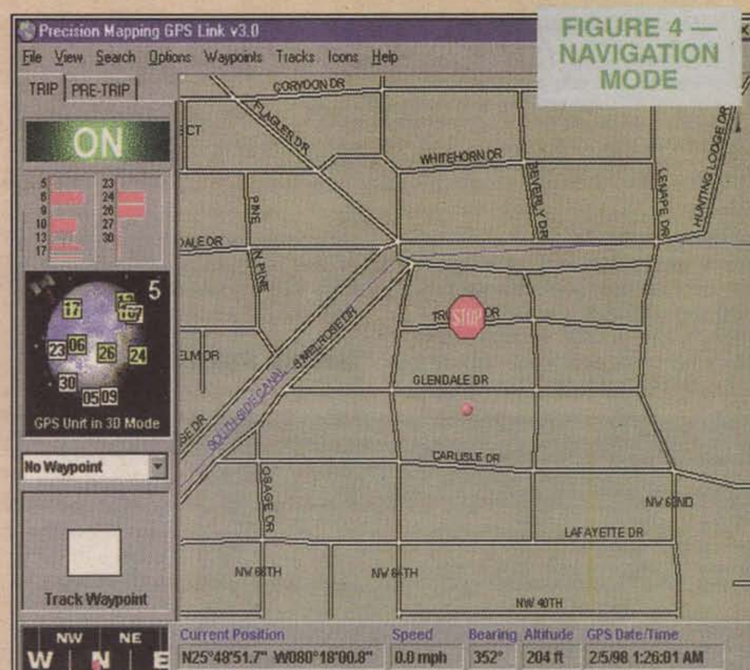


FIGURE 4 — NAVIGATION MODE

TABLE 1

RMB
$GPRMB,A,x.x,a,c--c,d--d,llll.ll,e,yyyyy.yy,f,g.g,h.h,i.i,j*kk

RMB = Recommended Minimum Navigation Information
1 = Data Status (V = navigation receiver warning)
2 = Crosstrack error in nautical miles
3 = Direction to steer (L or R) to correct error
4 = Origin waypoint ID#
5 = Destination waypoint ID#
6 = Destination waypoint latitude
7 = N or S
8 = Destination waypoint longitude
9 = E or W
10 = Range to destination in nautical miles
11 = Bearing to destination, degrees True
12 = Destination closing velocity in knots
13 = Arrival status; (A = entered or perpendicular passed)
14 = Checksum

RMC
$GPRMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,ddmmyy,x.x,a*hh

RMC = Recommended Minimum Specific GPS/TRANSIT Data
1 = UTC of position fix
2 = Data status (V = navigation receiver warning)
3 = Latitude of fix
4 = N or S
5 = Longitude of fix
6 = E or W
7 = Speed over ground in knots
8 = Track made good in degrees True
9 = UT date
10 = Magnetic variation degrees (Easterly var. subtracts from true course)
11 = E or W
12 = Checksum

GGA
$GPGGA,hhmmss.ss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh

GGA = Global Positioning System Fix Data
1 = UTC of Position
2 = Latitude
3 = N or S
4 = Longitude
5 = E or W
6 = GPS quality indicator (0 = invalid; 1 = GPS fix; 2 = Diff. GPS fix)
7 = Number of satellites in use [not those in view]
8 = Horizontal dilution of position
9 = Antenna altitude above/below mean sea level (geoid)
10 = Meters (Antenna height unit)
11 = Geoidal separation (Diff. between WGS-84 earth ellipsoid and mean sea level. = geoid is below WGS-84 ellipsoid)
12 = Meters (Units of geoidal separation)
13 = Age in seconds since last update from diff. reference station
14 = Diff. reference station ID#
15 = Checksum

GSV
$GPGSV,4,1,13,02,02,213,,03,-3,000,,11,00,121,,14,13,172,05*67

GSV = Number of SVs in view, PRN numbers, elevation, azimuth & SNR values.
1 = Total number of messages of this type in this cycle
2 = Message number
3 = Total number of SVs in view
4 = SV PRN number
5 = Elevation in degrees, 90 maximum
6 = Azimuth, degrees from true north, 000 to 359
7 = SNR, 00-99 dB (null when not tracking)
8-11 = Information about second SV, same as field 4-7
12-15 = Information about third SV, same as field 4-7
16-19 = Information about fourth SV, same as field 4-7

sentence protocols.

There are several other data protocols in use, some standard and some proprietary. Different manufacturers have various proprietary sentence protocols, usually to drive GPS accessories (autopilots, differential receiver systems, etc.) All that is necessary is to have a GPS that outputs data in approved NMEA 0183 sentence syntax.

Getting Started

We could go ahead and write interfacing routines and communications software to bring our laptop and GPS receiver together, but why go through the trouble when it has already been done? We decided to use Chicago Map's Precision Mapping Streets V3.0.

On one CD, you get a street-level mapping program of the entire continental United States. It also contains a serial port driver for collecting NMEA 0183 data from our GPS receiver (www.chicagomap.com). What they are not able to sell you is the cable.

Serial data at 1200-9600 bps can be sent reliably over two wires. Of the two, one is a ground. It doesn't get much simpler than that! Our Garmin 12XL GPS receiver cable uses a brown wire to transmit data. Magellan units use an orange wire.

There is no data flow control. The black power wire is also the data ground. It is suggested that you go ahead and purchase the appropriate external power cable for your particular handheld unit. It will have both power leads for a cigarette lighter power plug and the data lead in one cable.

If your PC or laptop uses DB-9 (nine pin) connectors for the serial port, wire the connector so that the GPS data line goes to pin 2. The ground is pin 5. If your PC or laptop uses DB-25 (25 pin) connectors for the serial port, wire the connector so that the GPS data line goes to pin 3. The ground will be pin 7 (Figure 1).

Install the Mapping Software and the GPS Link option. The entire program will not require much space on the hard drive (about 10 MB). The vast majority of data is left on the CD where it belongs. Unless you intend to fly at supersonic speeds 10 feet above the ground, even a fairly slow CD and processor will keep up with you on the moving map display.

Start the GPS Link program and click on the File, Configuration, Gps configuration toolbar. Set the COM port and the baud rate. The COM port must be available on your computer and not shared with any other devices (modem, mouse, etc). The baud rate can be anything from 1200 to 9600. You may have to check your GPS receiver set-up screen at this point to determine which data speeds it supports; 4800 baud appears to be a common default.

The time zone should be -5 for the East Coast and the protocol should be NEMA 183. Your time zone is calculated from ZULU, or the Greenwich Meridian as zero, west negative, east positive. Next, click on the Start Up tab and tick the "start tracking" option. You can set up other preferences at this point, but this is all you need to get started (Figure 2).

Next, get into the menu option of your GPS receiver that deals with interfacing. On the Garmin 12XL, it is under the Setup menu heading, "interface." Set the interface selection to NMEA/NMEA, and the version to the latest available, 1.5 or 2.0. Finally, set the baud rate to match whatever you selected on the GPS link software.

Start Tracking

Plug your connector into the serial port of your PC. Turn on your GPS and put it into navigation mode. You can start up the computer and the GPS link application at anytime, but you will not see any kind of activity until the GPS has acquired the necessary satellites to get an initial location fix.

Once the GPS receiver has gone into at least 2D mode, the program will begin tracking. You can tell the program is responding to the receiver before this by watching the satellite display on the left side of the screen. Satellites acquired by the receiver will be displayed in yellow with field strength indications on the accompanying bar graph (Figures 3 and 4).

When the location is fixed, the "OFF" indicator will turn to a green "ON," and your location will be marked on the US map. If you are stationary, your location will be indicated by a "STOP" sign. Once you get moving, the stop sign will be replaced by a directional arrow. Your current position, speed, and bearing will also be indicated.

Conclusion

We are having a lot of fun with our GPS navigation system. With PC prices so low, we are considering the possibility of putting together a cheap system to install permanently in our vehicle, for use as an additional navigational aid. Think about it — you too can have the GPS accessory normally considered only a luxury car item, in your workday beater car!

Best of all, you can still use your handheld GPS receiver for hiking, boating, and all of the other uses that you originally bought it for as well.

That's all the space we have for now. Hopefully, you are now thinking about some new and different ways you can use your GPS receiver. Whatever you do, remember to have fun! **NV**

Parts and Suppliers:

GPS Units:

Garmin International www.garmin.com
Magellan Systems Corp. www.magellandis.com
Trimble Navigation Ltd. www.trimble.com

Mapping Software:

Chicago Map Corp. (Precision Mapping Streets 3.0) www.chicagomap.com

Delorme www.delorme.com

GPS Data Cable - NMEA to PC

GPS	Signal	Adapter Cable Color	DB9	DB25
Magellan Meridian And XL	Data Out	Orange	2	3
	Ground	Brown	5	7
Garmin 12XL/45/45XL	Data Out	Brown	2	3
	Ground	Black	5	7

TEST EQUIPMENT *cont.*

EXCELLENT CONDITION TEST EQUIPMENT: HP 3488A switch/control mainframe $850 (cards available); **HP 3720A** HP-IB extender $235; **HP 59306A** relay actuator (6-SPDT) $175; **HP 59307A** dual VHF switch (2-SP4T) $175; **HP 59401A** HP-IB bus analyzer $250; **HP 8161A/020** 100MHz HP-IB dual channel pulse generator $3,000; **HP 5334A** 100MHz counter (rise/fall time, HP-IB, etc.) $850; **HP 5334A/030** as above with 1.3GHz channel C $1,250); **HP 5335A/020,040** 200MHz counter (rise/fall time, statistics, HP-IB, etc.) $1,200; **Stanford Research SR 510** lock-in amplifier $1,400; **HP 339A** distortion analyzer $1,500; **Tek 222A** handheld battery-operated digital storage scope $1,250 (many accessories available). **HP 8502A/H26** transmission/reflection test set $950; **HP 8748A/H26** S-parameter test set $1,550; **Tek AM 503, A6302** current probe, amplifier $850; **Tek FG 504** 40MHz function generator $675. Excellent condition! All with warranty. Pepper Systems, 214-353-0257 (Fax 214-902-9511).

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MISC: TEKTRONIX equipment: 577D1, 177, 178 curve tracer, $1,550; 8560, 8562 MSDU with TNIX OS, 8540 IU with 8080, 8085 and 68000 emulators, 8301 MDU and 8501 DMU, $offers: Fluke 335D DC voltage standard, $850; Fluke 5200A AC calibrator, $900; Saunders 150C crystal impedance meter, $925; Marconi equipment: TF2085 control unit with TF2091 noise generator and TF2092 noise receiver, $offers; TF1245 circuit magnification meter with TF1246 and TF1247 oscillators, $offers; GR 1454-A decade voltage divider, $85; Scientific Atlanta model 2900 auto-photometer, $offers; Narda 3072 high directivity reflectometer set, $offers: HP equipment: 394A attenuator, $75; 1602P3 variable air capacitor, $40; 400EL AC voltmeter, $125; 6255A dual power supply, $275; 9111A graphics tablet, $50. Processor Technology 516-567-7850 for information, offers or trades.

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WANTED: LATE model TEST EQUIPMENT and test equipment MANUALS, HP, Tektronix, and others. Fax your for sale list to 410-750-1192 or mail to US Surplus, PO Box 37, Ellicott City, MD 21041, Attn: Ron Baublitz. Phone # 410-750-1083, E-Mail: ussurplu@clark.net

KILOVOLT KV-30-100, 0-30KV 100mA power supply $1,000; Anritsu ML93A, optical power meter without head $400; Fluke 7261A universal counter $300; Fluke 1120A IEEE-488 translator $200; HP 7470A HPIB two pen plotter $200; Rockland 5100 synthesizer 1MHz-2MHz $200; HP 432A, 8478A power meter $400; Quest 215, ca-15B, sound level meter and calibrator $200; HP 3406A, RF voltmeter $400. A-Comm Electronics 303-290-8012.

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P6201 TEK 1.1GHz FET probe or HP 1120A 500MHz active probe, will swap for HP 8552B. Polarad 1105-B1 signal generator .8 to 2.4GHz, mint cond. 7704A with your choice of plug-ins: 7A11, 7A26, 7A16A, 7A12, 7B71, 7B70 (250MHz frame) $800. Tube SW radios: Hallicrafters model S120, Lafayette model KT320 9 tube communications rcvr. both .55 to 30MHz with band spread; S120 $100, KT320 $300. Kelvin-Varley 10K divider 4 dial $75. Vince Sexton, 445 Dalton St., Winnipeg, Manitoba, Canada R2X 2C5. PH 204-589-1162.

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by Ray Marston

SECURITY ELECTRONICS SYSTEMS AND CIRCUITS — Part 2

Ray Marston continues his explanation of electronic security system basics in this second episode of this new series.

INTRODUCTION

Last month's opening episode of this new series started off by looking at electronic security system basic principles, and went on to explain that all such systems contain a number of major elements, including a sensing unit, one or more data links, and some kind of alarm response unit. The episode then went on to look at various types of electromechanical and electrical sensor devices.

This month's episode continues this theme by looking at various types of electronic sensor devices, various types of data links, and various types of alarm response units.

Next month's episode will look at practical contact-activated security systems and alarm circuits.

ELECTRONIC SENSOR DEVICES

An 'electronic' sensor may take the form of a single semiconductor component such as a photodiode or phototransistor, or may be a combination of electrical and/or electronic components that together perform a particular sensing function; examples of the latter type are electronic keypad locks and light-beam alarms. The most important of such devices are described in this section.

PHOTODIODES

When p-n silicon junctions are reverse-biased, their leakage currents and impedances are inherently photo-sensitive; they act as very high impedances under dark conditions and as low impedances under bright ones.

Normal diodes have their junctions shrouded in opaque material to inhibit this effect, but photodiodes are made to exploit it and use a translucent casing material; some photodiodes are made to respond to visible light, and some to infrared (IR) light. *Figure 1(a)* shows the standard symbol of a photodiode.

In use, the photodiode is simply reverse-biased and the output voltage is taken from across a series resistor, which may be connected between the diode and ground as shown in *Figure 1(b)*, or between the diode and the positive supply line, as in *Figure 1(c)*.

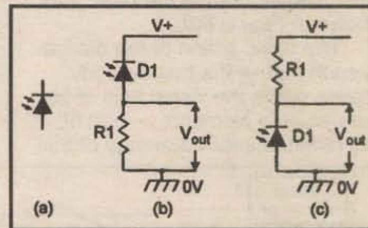

Figure 1. Photodiode symbol (a) and alternative ways ((b) and (c)) of using a photodiode.

PHOTOTRANSISTORS

Ordinary silicon transistors are made from an NPN or PNP sandwich, and thus inherently contain a pair of photo-sensitive junctions. Some types are available in phototransistor form, and use the standard symbol shown in *Figure 2(a)*. *Figures 2(b)* to *2(d)* show three basic ways of using a phototransistor. In each case, the base-collector junction is effectively reverse-biased and thus acts as a photodiode. In Figure *2(b)*, the base is grounded, and the transistor acts as a simple photodiode.

In Figures *2(c)* and *2(d)*, the base terminal is open-circuit and the photo-generated currents effectively feed directly into the base and, by normal transistor action, generate a greatly amplified collector-to-emitter current that produces an output voltage across series resistor R1.

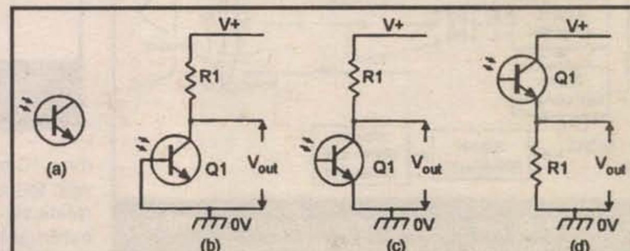

Figure 2. Phototransistor symbol (a) and alternative ways ((b) to (d)) of using a phototransistor.

The sensitivity of a phototransistor is typically 100 times greater than that of a photodiode, but its useful maximum operating frequency (a few hundred KHz) is proportionally lower than that of a photodiode (10s of MHz).

Some phototransistors are made in very-high-gain Darlington form.

A phototransistor's sensitivity (and operating speed) can be made variable by wiring a variable resistor between its base and emitter, as shown in *Figure 3*. With RV1 open circuit, phototransistor operation is obtained; with RV1 short circuit, photodiode operation occurs.

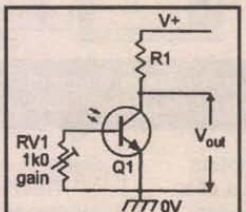

Figure 3. Variable-sensitivity phototransistor circuit.

OPTOCOUPLERS

An optocoupler is a device housing an LED (usually an IR type) and a matching phototransistor; the two devices are optocoupled, but are electrically isolated from each other and — in a normal type of optocoupler — are mounted in a light-excluding housing.

Figure 4 shows a basic optocoupler 'usage' circuit. The LED is used as the input side of the circuit, and the phototransistor as the output. Normally, SW1 is open and the LED and Q1 are thus off. When S1 is closed, a current flows through the LED via R1, and Q1 is turned on optically and generates an output voltage across R2.

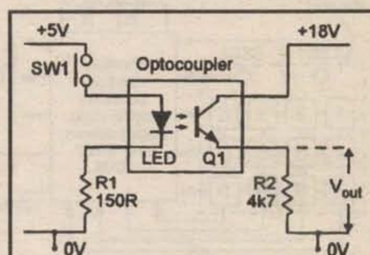

Figure 4. Basic optocoupler circuit.

The output circuit is thus controlled by the input one, but the two circuits are fully isolated electrically ('isolation' is the major feature of this type of optocoupler, which can be used to couple either digital or analog signals).

The *Figure 4* device is a standard type of optocoupler. There are, however, two special types of optocouplers that are of particular value in security electronics applications, and these are shown in *Figures 5* and *6*.

The *Figure 5* 'slotted' device has a slot molded into the package between the LED light source and the Q1 light sensor. Light can normally pass from the LED to Q1 via a pair of windows in the slot walls, but can be blocked by placing an opaque object in the slot. The slotted optocoupler can thus be used in a variety of 'presence detecting' applications, such as limit switching and dark-liquid level detection.

The *Figure 6* 'reflective' optocoupler has the LED and the Q1-Q2 Darlington light sensor optically screened from each other within the package, but arranged so that they both point outwards — via windows — towards an external point.

The construction is such that an optocoupled link can be set up by a reflective object (such as metallic paint or tape) placed a short distance outside the package, in line with the LED and Q1.

The reflective optocoupler can thus be used in applications such as tape-position detection, engine- or motor-shaft RPM measurement, or marked-object theft (illegal movement) detection, etc.

LIGHT-BEAM UNITS

Most modern 'light-beam' units work on the basic principle illustrated in *Figure 7*, in which a focused invisible beam of pulsed infrared light is generated by a transmitter unit, and is detected at a remote point by a matching lense and receiver/detector unit.

Normally, the unit is configured so that the receiver generates an alarm output if the IR beam is interrupted.

Such units have useful operating ranges of up to 30 meters and are often used in industry in automatic batch counting and safety-switch operating applications, and in commercial and domestic applications as intruder-detecting security alarms.

Simple single-beam alarms of the basic *Figure 7* type have fairly low values of reliability, since they can easily be triggered by insects

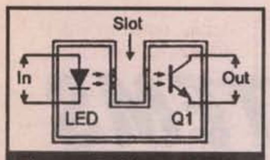

Figure 5. Slotted opto-coupler device.

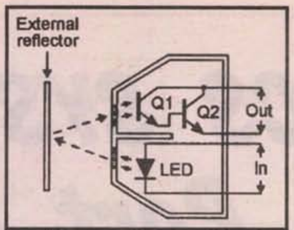

Figure 6. Reflective optocoupler.

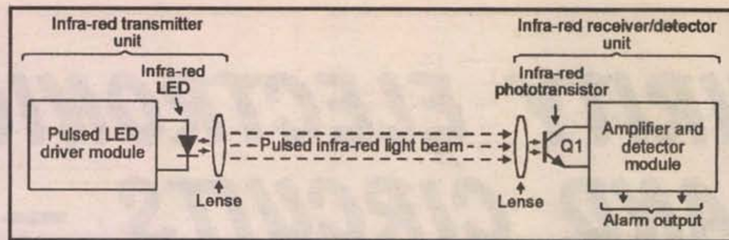

Figure 7. Basic infrared light-beam alarm system.

settling on one or other of the unit's lenses, but dual-beam types of alarm — in which both the transmitter and the receiver use two lenses placed a few inches apart — have high values of reliability.

PYROELECTRIC IR DETECTORS

Some special crystals and ceramics generate electric charges when subjected to thermal variations or uneven heating; this is known as a pyroelectric effect. Pyroelectric infrared detectors incorporate one or two elements of this type, plus a simple filtering lense and a field-effect transistor (FET), configured in the basic way shown in *Figure 8(a)*.

The basic action of the device is such that — if a human body moves within the visual field of its pyro-electric elements — part of the radiated infrared energy of that body falls on the surface of the elements and is converted into a minute variation in surface temperate and a corresponding variation in the element's output voltage.

When the unit is wired as shown in the *Figure 8(b)* basic usage circuit, this movement-inspired voltage variation is made externally available via the buffering JFET and capacitor C1 and can, when suitably amplified and filtered, be used to activate an alarm when a human body movement is detected.

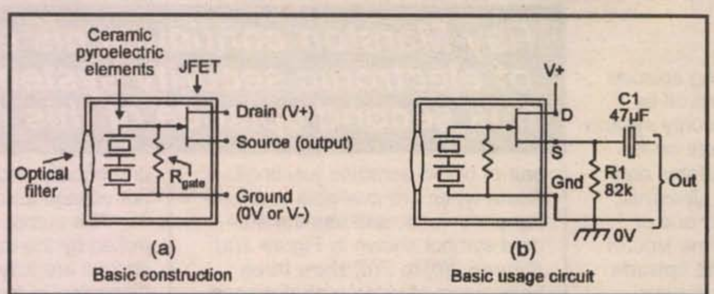

Figure 8. Basic construction (a) and usage circuit (b) of a pyroelectric infrared detector.

Note that pyro-electric IR detector circuits of the basic type described above have, because of the small size of the detector's light-gathering lense, maximum useful detection ranges of just over one meter, but that this range can be extended to more than 10 meters with the aid of a relatively large external light-gathering/focusing lense of the type used in modern passive infrared (PIR) movement detector systems (see last month's *Figure 4* and its associated text).

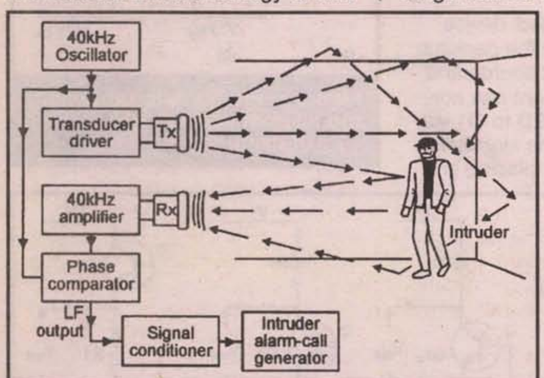

Figure 9. Block diagram of an ultrasonic (40KHz) doppler-effect intruder alarm system.

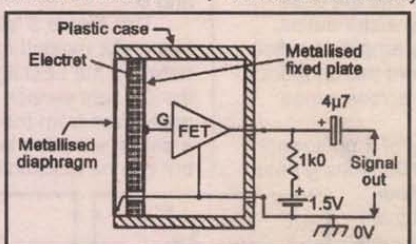

Figure 10. Basic elements of a modern electret microphone.

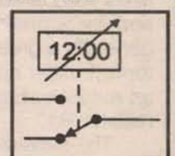

Figure 12. Symbolic representation of a digital time-operated SPST electric switch.

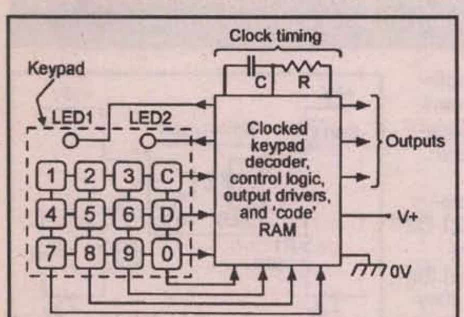

Figure 11. Basic elements of a key-pad security switch.

PIEZOELECTRIC TRANSDUCERS

A piezoelectric transducer is an electro-constrictive device that converts a varying electrical signal into a sympathetic set of fine mechanical variations, or *vice versa*.

Devices of this type include piezo sounders, 'crystal' earphones and microphones, ordinary quartz crystals, and ultrasonic transducers.

Most devices of the latter type are sharply tuned low-power units designed to peak at about 40KHz, and are supplied in matching pairs, with one optimized for use as a signal transmitter and the other as a signal receiver. They are useful in many remote control and distance-measurement applications, and in 'doppler effect' intruder alarm systems of the basic type shown in *Figure 9*.

The *Figure 9* intruder alarm system consists of three main elements.

The first is a transmitter (Tx) that floods the room with 40KHz ultrasonic signals, which bounce back and forth around the room.

The second is a receiver (Rx) that picks up and amplifies the reflected signals and passes them to a phase comparator, where they are compared with the original 40KHz signal.

If nothing is moving in the room, the Tx and Rx signal frequencies will be the same, but if an object (an intruder) is moving in the room, the Rx signal is doppler-shifted by an amount proportional to the rate of object movement (by about 66Hz at 10 inches/sec).

The IF output of the comparator is passed on to the third system element, the alarm activator, which is a signal conditioner that rejects spurious and out-of-limits signals, etc., and activates the alarm-call generator only if an intruder is reckoned to be genuinely present.

In practice, many systems of this basic type have poor reliability when set to high-sensitivity levels, since they can easily be false-triggered by draughts, central-heating air currents, and curtain movements, etc.

Low-sensitivity versions of the system are often used to protect small areas, such as the interiors of automobiles, however, and usually have high values of reliability.

ELECTRET MICROPHONES

Electret microphones are modern highly-efficient 'capacitor' microphones, and use the basic form of construction shown in *Figure 10*.

Here, a lightweight metallized diaphragm forms one plate of a capacitor, and the other plate is fixed and is metallized on to the back of a slab of insulating material known as electret; the capacitance value thus varies in sympathy with the applied acoustic (sound) signal.

The electret material holds a fixed electrostatic charge that is built in during manufacture and can be held for an estimated 100-plus years; this charge is applied between the two plates. The voltage across the capacitor equals this charge divided by the capacitance value and — since this varies in sympathy with the applied acoustic signal — varies in sympathy with the acoustic signal.

This signal is fed to the outside world via a built-in IGFET transistor, which needs to be powered externally from a battery (1.5V to about 9V) via a 1K0 resistor, as shown.

Electret microphones are robust and inexpensive and give a good performance up to about 10KHz; they are useful in many audio sound pick-up applications, particularly in sound-activated alarms and eavesdropping units.

KEYPAD SWITCHES

These are modern and greatly superior replacements for conventional electromechanical key switches, and are opened by typing a secret multi-digit code number into a simple keypad, rather than by the use of an easily lost or stolen mechanical key.

Typically, units of this type take the basic form shown in *Figure 11*, in which the keypad houses 12 push-button switches, notated with the numerals 0 to 9 and the letters C (change code) and D (disable/enable), plus two state-indicat-

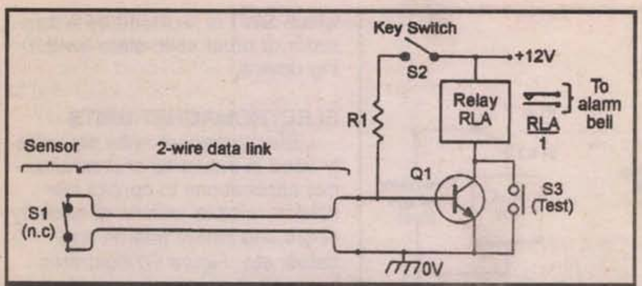

Figure 13. Two-wire data link used with a normally-closed sensor switch offers good security.

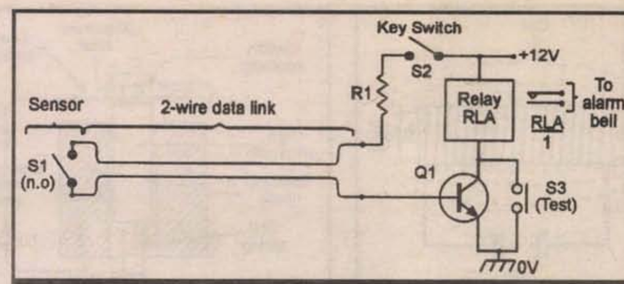

Figure 14. Two-wire data link used with a normally-open sensor switch offers very poor security.

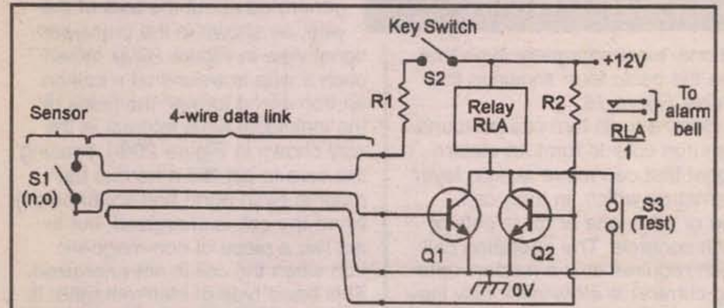

Figure 15. Four-wire data link used with a normally-open sensor switch offers excellent security.

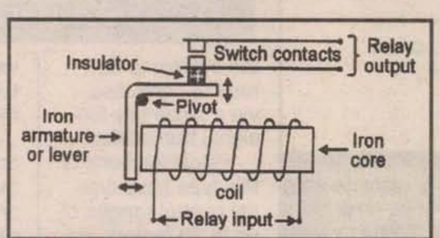

Figure 16. Basic design of a standard elecromagnetic relay.

ing LEDs.

The switches are (in this example) arranged in four vertical and three horizontal columns, which are wired to a clocked decoder and control logic network that converts each digit keystroke into a four-bit binary code, and compares it with the four-bit code that is stored in the matching line of the system's RAM. If the entire code number (which is usually four to eight digits long) is typed in without error, the switch opens and performs a useful function (opens a door or gives access to an engine's start-up system, etc.), but if the correct code is not entered within three attempts, the lock automatically goes into a time-controlled shut-down or alarm mode.

In the above system, the secret code number can be changed at any time by simply typing in the existing code, pressing the 'C' switch once (to gain direct access to the RAM), typing in the new code number, and then pressing the 'C' switch again (to return to normal operation). The entire keyswitch can be disabled (for a time-controlled period) or re-enabled at any time by operating the 'D' switch, which gives a toggling disable/enable type of action; the keypad switch's operating mode is displayed at all times via the two state-indicating LEDs.

DIGITAL TIME SWITCHES

Figure 12 shows a symbolic representation of a digital time-operated SPST electric switch, in which the switch arm is controlled via accurately-timed digital circuitry, and can be programmed to turn on and off at any desired times of the day or week.

Digital time switches offer far greater precision than normal analog types, and are used in many light-switching and solenoid-operating security applications.

MISCELLANEOUS ELECTRONIC SENSORS

A variety of special-purpose electronic sensors of value in security applications, but not so-far mentioned in this section, are also available from some specialist dealers. Amongst the most useful of these are radioactive 'smoke detector' elements that respond to various ionized particles, humidity sensors, strain gauges, Hall-Effect devices that respond to magnetic field strength (flux density), and 'gas' sensors that react to gases such as propane, butane, methane, isobutane, petrolium gas, natural gas, and 'town' gas. A few of these devices are described in some detail in later episodes of this series.

DATA LINKS

Data links are (apart from the actual signal processing unit) one of the three major elements of any electronic security system, the other two elements being the sensing unit(s) and the response unit.

All practical security systems use at least two data links (see last month's *Figure 1*), which may have individual lengths ranging from less than one millimeter to many thousands of kilometers, depending on the specific application.

Most data links fit into one or another of three basic types, being either hard-wired types, opto-coupled types, or wireless types, as described in the rest of this *DATA LINKS* section.

HARD-WIRED DATA LINKS

Most hard-wired data links take the form of a length of multi-cored cable, used to link a sensor or response unit to the alarm system's main control unit. *Figures 13* to *15* show examples of such cables used to link a sensor switch to the input of a simple burglar alarm unit.

In *Figure 13*, the sensor switch is a normally-closed one of the type used to protect doors or windows and is connected to the unit via a two-wire (or two-core) data link; this circuit's basic action is such that — when key switch S2 is closed — Q1 and the alarm both turn on if sensor switch S1 is opened or the data link is accidentally or deliberately cut. This circuit thus has an inherently good anti-tamper performance.

In the *Figure 14* circuit, the sensor switch is a normally-open type such as a pressure-mat switch, and is connected to the unit via a two-wire data link; this circuit's basic action is such that — when key switch S2 is closed — Q1 and the alarm normally both turn on if sensor switch S1 is closed, but will fail to operate if the data link is accidentally or deliberately cut; this circuit thus has a poor anti-tamper performance.

Finally, *Figure 15* shows a high-security version of the above circuit. In this case, the sensor switch is again a normally-open type such as a pressure-mat switch, but is connected to the unit via a data link that uses four wires, two of which serve an anti-tamper function; this circuit's basic action is such that the alarm normally turns on via R1-Q1 if sensor switch S1 and key switch S2 are both closed, but operates instantly (even if key switch S2 is open) if the four-wire data link is accidentally or deliberately severed. This circuit thus has an excellent anti-tamper performance and is often used in department stores and other places in which the public has easy access to parts of the alarm system.

OPTO-COUPLED DATA LINKS

Opto-coupled data links are often used in applications where it is not possible or convenient to use a hard-wired data link, and come in three basic types, being either infrared 'light-beam' types, fiber optic 'light guide' types, or laser beam types.

Light-beam types are used mainly in short-range (less than six meters) remote control applications, but can — if used with a good lense system — be effective at ranges up to about 20 meters. Units of the latter type are sometimes used (in domestic applications) as a data link between a shed or other remote building's intrusion

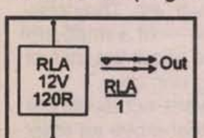

Figure 17. Representation of a 12V, 120R relay with one set of n.o. contacts.

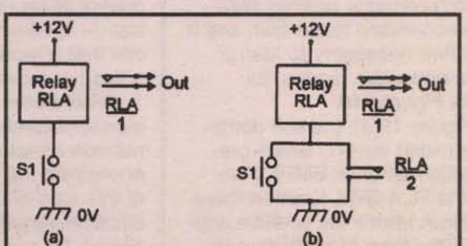

Figure 18. Relay switch used in (a) non-latching or (b) self-latching modes.

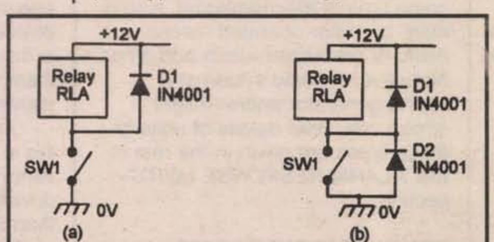

Figure 19. Relay coil using (a) single-diode or (b) two-diode coil damper.

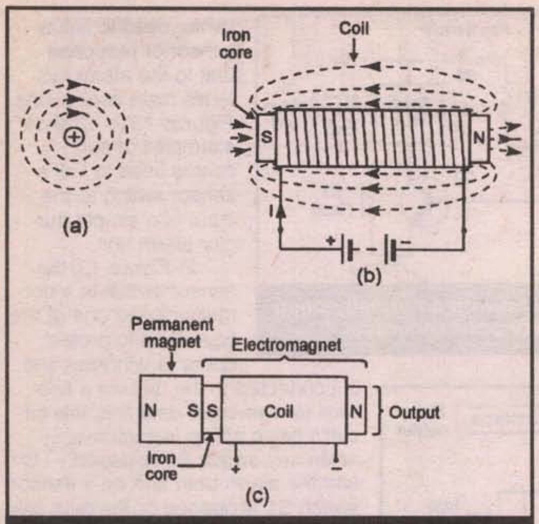

Figure 20. Diagrams showing the magnetic fields generated by (a) a current-carrying wire and (b) an electromagnet, and the basic construction of (c) an energize-to-release type of holding magnet.

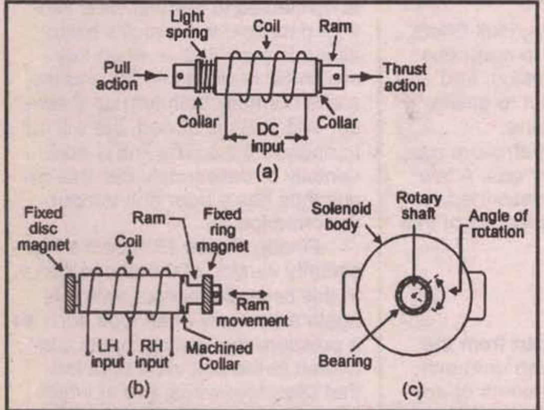

Figure 21. Simplified diagrams of (a) a conventional moving-core linear solenoid, (b) a magnetically latching split-coil moving-core linear solenoid, and (c) a rotary solenoid.

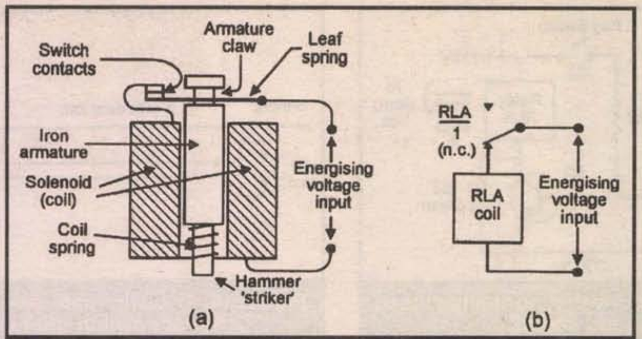

Figure 22. Typical basic construction (a) and equivalent circuit (b) of an electric bell or buzzer.

sensor and a main alarm unit.

Fiber optic light guide data links are used mainly in applications where the link is fairly long (greater than 10 meters) and needs a wide signal bandwidth.

Laser beam data links are used mainly in medium-range applications in which it is not possible to use a hard-wired data link. They are sometimes used (illegally) in remote eavesdropping applications, in which the beam is bounced off of the window of a room in which a secret conversation is taking place, the return beam being modulated by the window's acoustic pick-up signals.

WIRELESS DATA LINKS

Wireless data links — usually operating at 418MHz or 458MHz — are widely used in modern domestic burglar alarm systems (see last month's *Figure 5*) to link the system's various sensors to the main control unit, thus greatly easing installation problems and enabling the system to be remote-controlled via a small key-fob signal transmitter.

Most systems of this type have typical control ranges of up to 30 meters, but some sophisticated systems can be interfaced with both the domestic heating control unit and with the normal telephone system, enabling alarm and heating systems to be remotely monitored or controlled over a range of thousands of miles.

The owner of such a system can — while on holiday or working abroad — use a fixed or mobile 'phone to check the home's security at any time, or can use it to remotely turn on the building's central heating system prior to eventually returning home.

ALARM RESPONSE UNITS

Alarm response units are the final major elements in any electronic security system, and usually take the form of a simple relay, some type of electromagnet, a solenoid- or motor-operated mechanism, or (in burglar alarm and other high-level security systems) a sound-generator and/or a light strobe unit. Brief details of units of these types are given in the rest of this *ALARM RESPONSE UNITS* section.

RELAY RESPONSE UNITS

Relays are electrically-operated switches that can be used to activate virtually any external electrical devices (such as lamps, sirens, motors, etc.).

Relays come in two basic types, one being the 'reed' type that was shown in last month's *Figure 12(a)*, and the other being the conventional electromagnetic type that takes the basic form shown in this month's *Figure 16*.

Here, a multi-turn coil is wound on an iron core to form an electromagnet that can move an iron lever or armature which, in turn, can close or open one or more sets of switch contacts. The operating coil (which requires only a modest operating current) is electrically fully isolated from the switch contacts (which can control fairly high currents), and can be shown as separate elements in circuit diagrams, as shown in *Figure 17*, which represents a relay with a 12V, 120R coil, and a single set of normally-open (n.o.) switch contacts.

Relays with a single set of n.o. contacts are usually used in the basic non-latching mode shown in *Figure 18(a)*, in which the relay closes when S1 is closed and opens when S1 is opened. Relays with two (or more) sets of n.o. contacts can also be used in the self-latching mode shown in *Figure 18(b)*, in which n.o. contacts RLA/2 are wired in parallel with S1 so that they close and lock (latch) the relay on as soon as S1 is closed. Once the relay has locked on, it can be turned off again by briefly breaking the supply connections to the relay coil.

Relay coils are highly inductive and may generate back-EMFs of hundreds of volts if their coil currents are suddenly interrupted. These back-EMFs can easily damage switch contacts or solid-state devices connected to the coil, and it is thus often necessary to 'damp' them via protective diodes, as shown in *Figures 19*.

In *Figure 19(a)*, the coil damping is provided via D1, which prevents switch-off back-EMFs from driving the RLA-SW1 junction more than 600mA above the positive supply line. This form of protection is adequate for normal switching applications.

In *Figure 19(b)*, the damping is provided via two diodes that stop the RLA-SW1 junction swinging more than 600mV above the positive supply rail or below the zero-volts rail. This form of protection is recommended for all applications in which SW1 is replaced by a transistor or other solid-state switching device.

ELECTROMAGNET UNITS

Electromagnet units are widely used in industrial and commercial applications to control the hold or release actions of security doors and safety guards and gates, etc. *Figure 20* illustrates basic electromagnet operating principles.

When a current is passed through a wire, a magnetic field is generated about the axis of the wire, as shown in the cross-sectional view in *Figure 20(a)*. When such a wire is wound as a coil on an iron-cored former, the fields of the individual turns interact in the way shown in *Figure 20(b)*, causing the core to act like a normal bar magnet (with north and south poles) when the coil is energized, but to act like a piece of non-magnetic iron when the coil is not energized. This basic type of electromagnet is thus used in energize-to-hold applications.

Figure 20(c) shows a useful variant of the normal electromagnet. Here, a permanent magnet is fixed to one end of the electromagnet's iron core, in the polarity shown in the diagram, and the other end of the core forms the output of the unit.

When the electromagnet is not energized, its iron core acts as a simple extension of the permanent magnet, with its output acting as the southern pole of the magnet, but when the electromagnet *is* energized, its magnetic field opposes that of the permanent magnet, and (if the two opposing fields are of equal strength) the unit's output is thus demagnetized. This type of unit thus acts as an energize-to-release type of holding magnet.

SOLENOID-OPERATED UNITS

Solenoids are electromagnetic devices that are designed to move an iron ram or an armature and thereby activate a device such as a power switch, a safety latch, or a control valve or tap, etc. They consist — in essence — of a multi-turn coil that is wound about the axis of a fixed or moving iron core.

Fixed-core types act as simple electromagnets that move an external iron armature when the coil is energized; the best known example of this type of unit is the standard electromagnetic relay shown in *Figure 16*.

In moving-core types of solenoid, the coil is wound on a plastic or waxed-paper tube in which the iron core (which usually takes the form of a ram) is free to move; the basic action of this type of unit is such that center-of-mass of the iron core (ram) is forced into a central position within the coil when the coil is energized, but may be forced into a different position (via a spring, etc.) when the coil is not energized.

Moving-core solenoids come in several basic variants, and the three most widely used of these are shown in *Figure 21*.

The most widely used type gives a simple linear movement of the ram, as shown in *Figure 21(a)*. Here, the ram is normally biased to the left-of-center of the coil by two collars and a spring, but is forced to the right (to the coil's central position) when the coil is energized, thus giving a thrust action at the right-hand end of the ram and a pull action at the left-hand end. Many practical solenoids of this basic type are designed to give only a thrust action or only a pull action.

A useful variant of the moving-core linear solenoid is the magnetically latching split-coil type shown in *Figure 21(b)*. Here, when a pulse of energizing current is fed to the right-hand (RH) side of the split coil, the ram is forced to the right until a machined collar makes contact with a fixed ring magnet, which latches the ram in that position when the coil is de-energized.

Once the ram has latched into this position, it can only be unlatched by feeding a pulse of energizing current to the left-hand (LH) side of the coil, thus forcing the ram to the left until its left face makes contact with a fixed disc magnet, which latches the ram into this alternative position, and so on.

Magnetically-latching solenoids are useful where low mean power consumption is required. Note that simple split-coil solenoids are widely used as points-controllers in model railway systems, but do not incorporate magnetic latching.

Finally, the third type of moving-core solenoid is the rotary movement type shown in *Figure 21(c)*, in which the solenoid's linear action is converted into rotary form via a simple crank or link mechanism. These units typically give maximum shaft rotation angles in the range of 45° to 95°.

BELLS AND BUZZERS

Electric bells and buzzers are widely used sound-generating alarm response units. *Figure 22* shows their typical basic construction and electrical equivalent circuit.

They consist of an iron armature that can move freely within a solenoid that can be energized via a pair of normally-closed switch contacts and a leaf spring.

Normally, the armature is forced out of the solenoid by a light coil spring. When a suitable energizing voltage is connected to the circuit the solenoid pulls the armature downwards until its hammer striker hits a sounding board (in a buzzer) or metal dome (in a bell). At this point, a claw at the other end of the armature pulls open the switch contact via the leaf spring, and the armature shoots outwards again under the pressure of the coil spring until the switch contacts close again and the process then repeats *add infinitum*.

Electric bells and buzzers are thus self-interrupting inductive devices. Electric bells have their acoustic output energy concentrated into a narrow 'tone' band and are thus reasonably efficient, but electric buzzers generate a broad 'splurge' of sound and are very inefficient.

MOTOR-OPERATED UNITS

Electric motors are widely used in industry and commerce to give automatic operation of safety and security doors, and to automatically operate customer-access doors and gates under approved safety/security conditions.

SOUND-GENERATOR/ LIGHT-STROBE UNITS

All emergency-warning security and safety systems should (ideally) by fitted with an efficient attention-grabbing sound-generator system, to warn all and sundry of the existance of the emergency state, and with some form of light-strobe unit, to visually indicate the precise source of the emergency signals.

In buildings, the sound-generator may take the form of an electro-mechanical alarm bell or a piezo-electric or horn-speaker based electronic siren, and the visual warning may come from a special light-strobe. In automobiles, the sound-generator may take the form of a siren or a unit that pulses the vehicle's horn, and the visual warning should be obtained by flashing the vehicles lights.

In all cases, the alarm-condition indicator unit must be fitted with an automatic timing mechanism that shuts it down after a pre-set period (typically less than 15 minutes) of operation.

In burglar alarm systems, the sound-generator and light-strobe units should be fitted together in a special alarm box and mounted high up on an external wall that (ideally) faces onto a well-used street or passageway. The box should have a built-in back-up battery that is charged via the system's control panel cables, and the unit should automatically activate the alarm if this cable is cut. The alarm box should be fitted with some form of microswitch that automatically activates the alarm if any attempt is made to open its front cover or pull it from the wall. Units of this type are readily available from electronic alarm system suppliers. **NV**

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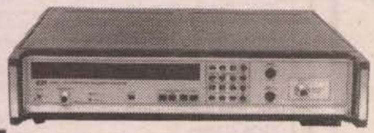

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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYERS, on the Internet at TJBYERS@aol.com, or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

What's Up:

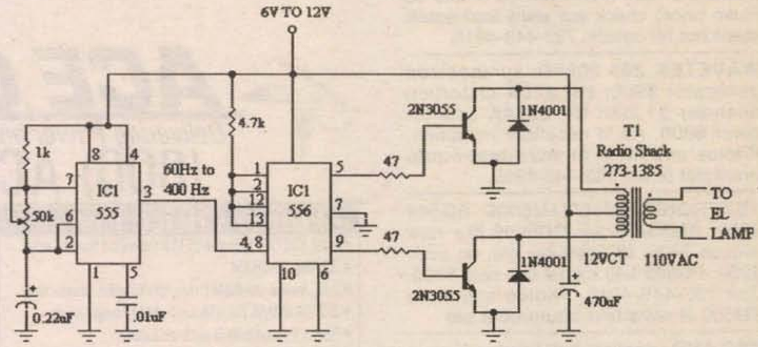
More circuits for stepper motor users, including a single-chip controller and three squarewave generators. Powering EL lamps from 9 volts. Laser toner refill cautions, home-brew PC tips, and virus programs revisited.

Electroluminescent Power Supply

Q. I once saw a small backlight panel (electroluminescent?) ad in an older issue of *Nuts & Volts* from a jobber that features the usual hobbyist stuff. I've looked at several of my back issues but never found the ad again. Do you have any sources that sell small backlighting panels that run off less than 20 volts and measure about 2 x 6 inches?

Max Seim
via Internet

***A.** I remember the ad well because I bought a couple of those panels. The advertiser was **All Electronics Corp. (800-826-5432**; http://www.allcorp.com), a surplus/retail outlet. While the panels you mention are sold out, All Electronics recently acquired a new batch that will be available by the time you read this. You can also buy electroluminescent (EL) panels from the following: **Eltech (512-252-1299**; http://www.thomasregister.com/olc/electroluminescent/), **LSI (603-448-3444**; http://www.lumsys.com/EL_Lamps.html), and **J.C. Whitney (312-431-6102)**. I've never looked at J.C. Whitney's (an auto parts mail-order retailer) ELs, but I'm told they are used by bicyclist and joggers and are suitable for experimenting. The other two companies are EL manufacturers which stock ELs in a wide range of colors and sizes. **Edmund Scientific (609-573-6250**; http://www.edsci.com) sells an EL panel (5" x 8"), too, but it's a pricey $95.00 – however, the kit does include the needed inverter. You see, EL lamps require about 100 volts AC, so to run off a nine-volt battery you need a DC-to-AC converter. Here's a simple circuit that let's you experiment with EL.*



This circuit is unique in that it uses the Reset (pin 4) and Trigger (pin 8) inputs of a 556 timer to switch the outputs in a complementary fashion. When these two pins are high, pin 5 is low and pin 9 is high. When Reset and Trigger are low, the outputs reverse their state. This see-saw motion causes the transistors to turn off and on alternately, which forces current through T1 (a simple power transformer, such as Radio Shack 273-1385) in what's called a push-pull mode. When the top half of T1's primary winding is conducting, the bottom half is off. This induces a positive-going voltage into the secondary of T1. When the 556 toggles, current ceases to flow in the top half of the primary and begins to flow in the bottom half – effectively reversing the magnetic field in the transformer's core. The output voltage now swings negative, not positive. The result is an AC voltage on the secondary that's equal to the frequency of the 555 timer, which is adjustable from about 60 Hz to 400 Hz via the 50K pot. As the frequency increases, the color of the EL lamp will change – and the light will grow brighter. Enjoy your new eye candy!

Audio Potentiometer Needed

Q. This may seem like a silly question, but can you tell me where one goes to purchase a dual potentiometer (i.e., volume controls) similar to those used in audio equipment manufactured in the 60s? I'm well aware that I can contact the finer manufacturers and have one special-built for big bucks, but what I'm looking for are the ones that used to cost in the $3.00 range. At the moment, I need a dual 16K unit (audio taper would be nice).

Will Byers
via Internet

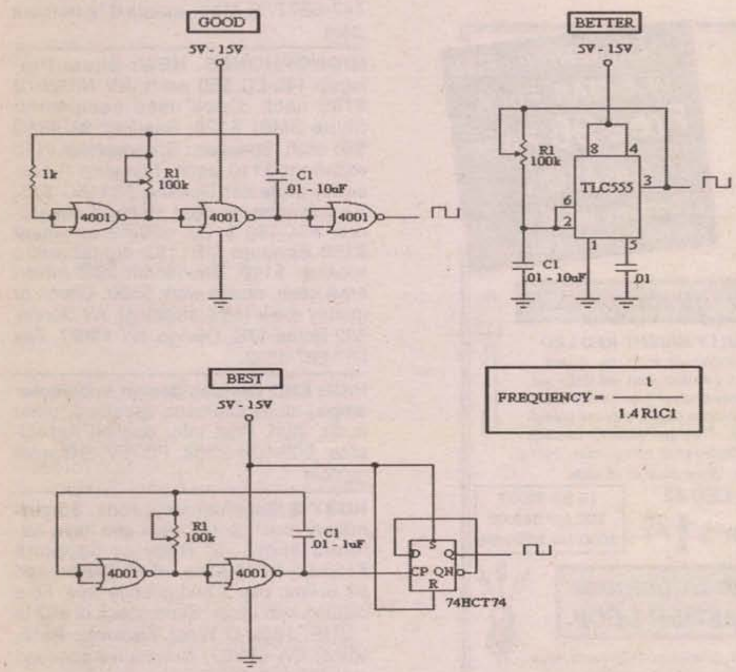
***A.** There are two avenues available to you. You can buy a rather expensive dual-pot, made by Clarostat (model D381N), from Allied Electronics for about $30.00, but you already knew that. Happily, several surplus houses stock these babies in depth. All Electronics (see their ad on page 38), for example, always has them in stock for about 50 cents each. However, you're not going to find a dual 16K unit from either source. Fortunately, you should be able to use any value between 10K and 50K without a problem.*

Simple Squarewave Generator

Q. I need a variable-frequency signal generator for a circuit I'm breadboarding. I've tried using various 555 oscillators, but they make my design unstable at lower pulse rates. I've concluded that the problem is with the duty cycle of the pulse generator. Obviously, my circuit needs a squarewave input. Are there any simple solutions? I don't want something complicated because the generator will ultimately be incorporated into the end product, so simpler (and cheaper) is better.

Terry Harvey
via Internet

A. *Better yet, I'll give you a medley of squarewave generators to choose from. As the quality of the squarewave increases, so does the price of the parts. They go (from left to right): good, better, and best.*



The first circuit uses one IC (with four logic gates), two resistors, and one capacitor. The logic gates are configured as inverters and wired in a feedback configuration. In this mode, the circuit is unstable because the output of the second gate is tied to its inverting input through C1 and R1. Let's assume the output of the second inverter is high. C1 now starts to charge through R1, which is holding the output of the first inverter low. When the voltage across R1 exceeds the input trigger voltage of the first gate (about 1/2 Vdd), its output flips high, which, in turn, causes C1 to discharge through R1. The cycle is repeated when the input voltage of the capacitor decreases to the point that the input of the first gate recognizes it as a logic 0. And so it goes as the first inverter gate alternately changes charges and discharges C1. The resultant squarewave is buffered by the third gate to prevent variations in the load from affecting the frequency. Any inverting logic gate will work, including a 4049 if you need more power. The third circuit (Best) works the same as the first, but this time the output drives a flip-flop, which outputs an absolutely perfect squarewave. This let's us eliminate the buffer and 1M resistor because the oscillator doesn't have to be as symmetrical as in the first design. In-between these two is a 555 squarewave generator (Better). The problem with standard 555 astable oscillators is that the variable resistor is put between the discharge (pin) and threshold (pin 6) pins. The trick is to tie the discharge path to the output (pin 3) and ignore the discharge path altogether. However, this by itself isn't enough because bipolar 555 chips are notoriously non-linear. By using a CMOS 555 instead, like the TLC555 which has a rail-to-rail output swing, the squarewave becomes nearly perfect.

PC Viruses Revisited

Q. I was greatly disturbed by that sick character who tried to sabotage your excellent E-Mail response to Q & A readers. You mentioned the use of several antivirus programs. Are they stored on the hard drive and invoked individually, or is one or all selected to scan data automatically?

Jim Scardino
Hollister, CA

A. *Antivirus programs are usually installed on the hard disk and set for automatic detection. In this mode, the program scans all floppy disks as they are inserted and checks incoming Internet files for a virus. The program also automatically scans the hard disk and computer memory when the system is booted. Viruses are detected by matching their fingerprint to those stored in the program. When a virus match is found, you are alerted and given the opportunity of removing the virus, the file, or both. My favorite virus killers are Norton's AntiVirus (800-441-7234; http://www.symantec.com/trialware/index.html), McAfee VirusScan (408-988-3832; http://www.mcafee.com/main.asp), and Dr. Solomon (888-377-6566; http://www.drsolomon.com/home/home.cfm).*

All About Stepper Motors

Q. Thank you for publishing the JPL stepper motor circuit in the Feb. '98 issue — but isn't it for unipolar motors? The reader who asked the question is looking for a circuit to drive a four-wire bipolar stepper, as am I, so I read your answer with great interest. But it appears the circuit will only work with a five-wire unipolar stepper motors, not a two-coil bipolar. Am I right? Do you have a similarly convenient circuit for bipolars?

Alan McFarland
Sherman Oaks, CA

A. *Jeeze, I was hoping it wouldn't go this far because the answer is more complicated than it first appears (and my page space is limited). But now that I've opened Pandora's box, I must close it. Please bear with me, it's gonna be a fast ride.*

Bipolar permanent magnet stepper motors are constructed with exactly the same mechanism as is used on unipolar motors except that there are only two windings instead of four. Thus, the motor is simpler — but

(Continued on page 105)

SATELLITE EQUIPMENT *cont.*

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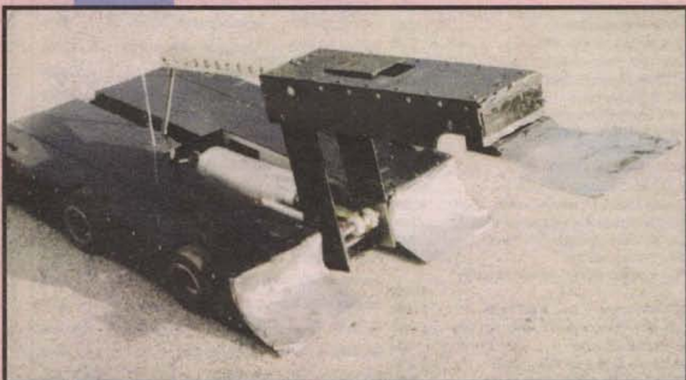
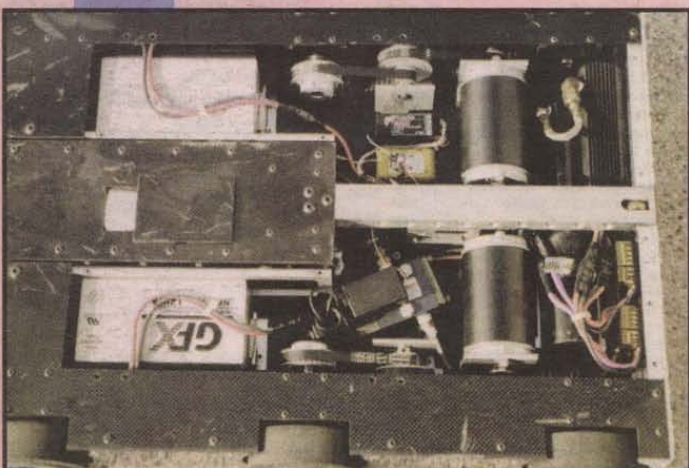
Robot Wars 1997: The Defiant



by Dan Danknick

At age 14, James Underwood helped his dad rivet aluminum fuselage panels to a restored F86 Sabre aircraft in his Lancaster backyard. Thirteen years later, he riveted carbon fiber laminate to a 50-lb. robot named Defiant and swept through the lightweight class at Robot Wars 1997. Though nine months in the making and gobbling up $2,500.00 in materials, Defiant put on the kind of show usually reserved for movies.

Named after the starship from the Star Trek DS9 series, the box-like exterior of James' creation hides its true power to toss ringside opponents into next week. The traction motors drive 80 lbs. of force to the ground while the six-wheel steering design allows it to change direction at a moment's notice. "I wanted to build something reliable and learn to drive it well," explains James as we relax in the file server lab at Canon Information Systems, where he works as a network systems analyst.



In addition to maneuverability and acceleration, Defiant is equipped with a fast acting arm, not unlike a high-speed spatula. In the ring, the goal is simple: drive into the opposing robot, wedge Defiant's protruding blade under some solid point, and press the "fire" button to extend it 16 inches high with 75 lbs. of force. An onboard tank of liquid CO_2 is switched through a pneumatic cylinder to produce the flipping action while springs automatically retract it flush with the body when depressurized. It is quite possibly the ultimate Aunt Jemima treatment.

With the top panels removed, the strength of the design emerges. Each side relies on a high torque DC motor which is speed-reduced through toothed belts to drive all three wheels via roller chain. For reliability, each side is mechanically and electrically isolated. Huge gel-cell batteries provide the juice for at least two five-minute battles between recharges, an important advantage when the spacing between final battles begins to shrink.

If this all sounds strange to you, perhaps you've not yet heard of Robot Wars, the yearly robotic brawl held in San Francisco, CA. Originally created as a way for friends to let off some steam, the event has ballooned from a dozen entrants in 1994 to nearly 100 this past year, and attracted a worldwide following. Those seeking battle have their entries classified by weight, from the 25-lb. featherweights to the 170-lb. heavyweights. Though most are RC-operated, special consideration is given to autonomous acting designs.

A Plexiglas wall separates the oft excited audience from the mayhem in the arena which frequently resembles a radio-controlled bar fight. Dangerous and messy weapons are not permitted: glue, string, flame, explosives, ballistics, or electricity. Creator Marc Thorpe describes it as the "right kind of violence" since no one gets hurt. Between rounds, the competitors repair and upgrade their machines, frequently loaning tools and giving advice to potential foes. True sportsmanship abounds, especially when it leads to an exciting battle.

After attending in 1996, James was hooked. "I had some good ideas after seeing all the other robots, and felt I could improve on some of the designs." Perhaps his most interesting decision was to rely on carbon fiber laminate panels to form the exoskeleton of the machine. Having worked with this material on RC helicopters, he explains that it exhibits a strength similar to aluminum, but at one half the weight — a significant plus. Extreme caution must be taken when cutting and drilling the material, as free carbon fibers make the ultimate finger splinters.

James' biggest obstacles were finding both the supplies and the time to build Defiant, which he did in his garage. "I wanted to make as few custom machined parts as possible," he explains, though he eventually purchased a small vertical mill. From the start, this was an "unlimited resource" project; money was no object.

In the arena, he recalls his toughest battles as those with "Pretty Hate Machine," a 100-lb. walking robot sporting arrays of circular saws.* The gashes and scratches on his machine clearly prove this point. But Defiant held together, collecting trophies for both the face-off and melee rounds in his class.

"Build something reliable and learn to drive it well," is his advice for hopeful competitors. Though ready to fight again in 1998 with few needed repairs, James doesn't plan on returning to Robot Wars. "I'll be entering the 7-lb. flesh and blood class" he laughs, explaining that he and his wife are expecting their first child about the time of the event. "Though I expect to have a tougher time in this new class." NV

* "Pretty Hate Machine" was featured in *Nuts & Volts* Dec. '97 issue. James Underwood can be reached on the Internet at junderwood@home.com. Dan Danknick, a software engineer for Walt Disney Imagineering, maintains a Robot Wars related website at http://www.teamdelta.com/. You can receive more information about the upcoming 1998 competition if you send E-Mail to robotwars@aol.com. Helpful sources for some parts used on Defiant: Carbon composite laminates: Kinetic Composites, Inc. (619) 945-4470 http://www.kcinc.com/. DC motor speed controllers: Tekin Electronics (714) 498-9518 http://www.tekin.com/. Power transmission components: MSC Industrial Supply (800) 645-7270 http://www.mscdirect.com/. Rubber drive wheels: Colson Caster (800) 643-5515 http://www.colsoncaster.com/.

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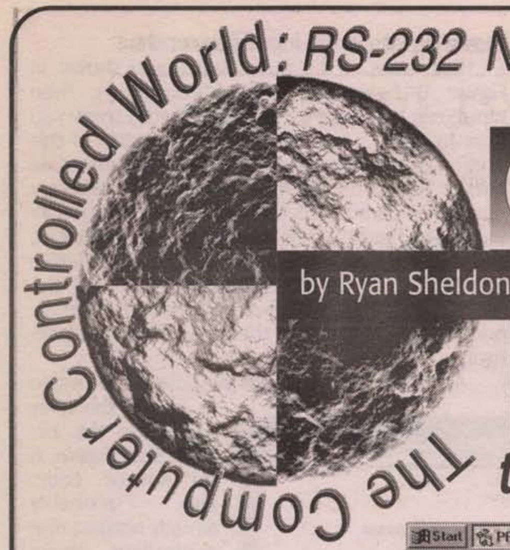


The Computer Controlled World: RS-232 Network Control Methods and Applications

OPEN WINDOWS TO THE WORLD

by Ryan Sheldon, National Control Devices (404) 244-2432 http://members.aol.com/ncdcat

Bridge the Gap between Customized Hardware and the End-User with a Powerful Graphical User Interface

In my first *Nuts & Volts* article, I talked about controlling mechanical relays from an RS-232 serial port (Dec. '97). Because of the number of questions I received, I thought I would address the subject of computer control. I would like to encourage readers to continue to call with questions and ideas. In return, we will publish articles that answer the most commonly-asked questions.

The two biggest questions I received on the RS-232 Relays were: "How do I control the serial port from Windows95?" and "How can I read data into the computer?"

Both of these questions require some degree of detail to answer, so this article should be looked upon as a reference guide for any future articles.

Windows95 provides the perfect host for computer control applications. My language of choice is Basic. And, for Windows95, Visual Basic 4 Professional is an excellent program for providing a powerful graphical user interface (GUI) for just about any control application.

VB4 presents an intimidating set of cryptic tools when opened for the first time. Intimidation quickly gives way to curiosity and nervous anticipation once you've had a chance to futz around with the interface.

For those non-VB programmers (but curious nonetheless), I'll show you a few of the basics. Keep in mind this is just an article written by one guy, and that teams of people have devoted years in writing 3" thick books on this subject.

In case you didn't know, VB4 is an object-oriented programming language. Objects are traditionally known as pre-compiled subroutines that may be accessed by several programs. Object-oriented programming has adopted a more literal meaning in VB4. The use of graphical icons, buttons, sliders, and a vast array of user-interface tools are your objects. These objects can be moved, named, hidden, and programmed to perform just about any task imaginable.

VB4 allows you to literally draw the interface exactly as it will appear to the end-user. When you add a button to your program (or other object), you have complete control over what it does. The purpose of this article is to show you how to draw buttons that can be used to control external real-world devices.

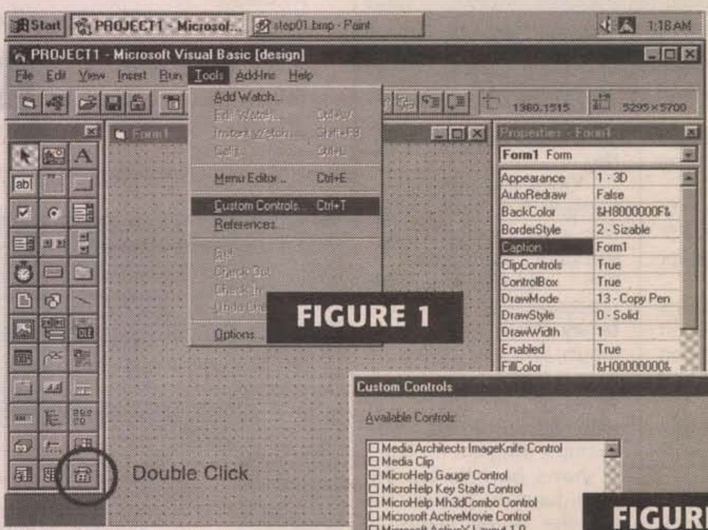


FIGURE 1

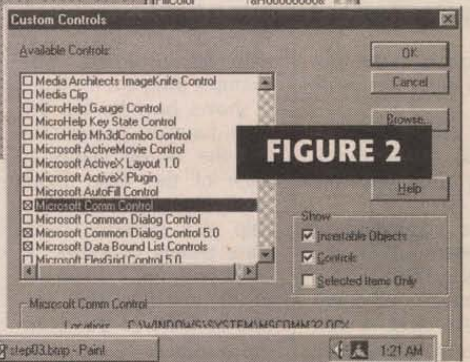


FIGURE 2

The Project

My approach to programming in this article will provide a step-by-step guide to building a simple GUI for computer control applications under VB4. We will use our GUI to read eight inputs, and turn on and off a set of eight relays. I'll show you just enough to be dangerous and I'll leave it up to you to be creative in applying it to your latest project.

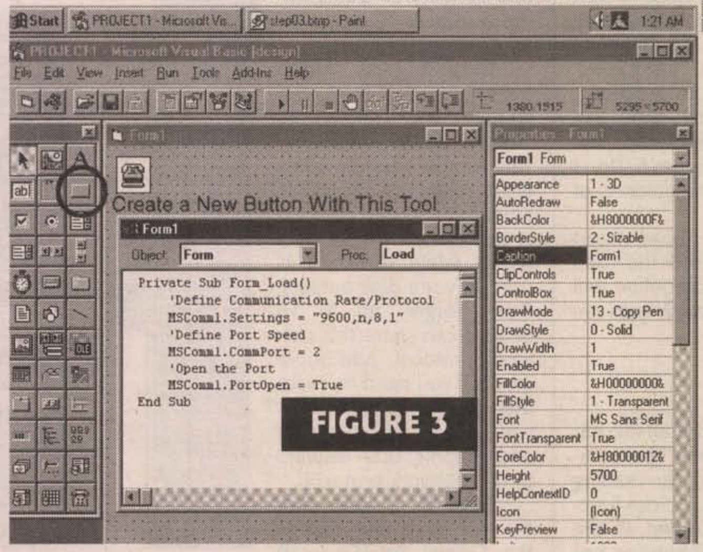


FIGURE 3

Using Objects in VB4

Our first goal is to open VB4 and add the telephone object to your program. The telephone object represents serial communications, and must be used for controlling external real-world devices. Before we get started, there are a few ground rules you must always remember.

1) Every element you add to your program (buttons, RS-232 communications, scroll-bars, or whatever) are called objects.

2) Every object has a name.

3) Always speak to an object by its name.

Now follow these two simple steps to add the Microsoft Comm Control object (used for RS-232 communications) to your VB4 program.

Step 1. Start a new project in VB4. Select Custom Controls under the Tools menu item to add new controls or objects to your application. See Figure 1.

Step 2. Put an X in the Microsoft Comm Control box as shown in Figure 2 and select OK. Next, a telephone appears in your toolbox. Double-click the telephone icon to add it to your project. Other third-party communications packages are available for RS-232 communications under VB4. One of my favorites is PDQComm. It offers higher baud rates and integrated file-transfer protocols making it the most powerful communications package available.

Two uncommonly known RS-232 facts: Windows bottlenecks outgoing RS-232 transmissions reducing the actual throughput to 38K baud on a Pentium 200 system. At 115.2K, your computer will send a character, and wait the length of six character transmissions before sending the next character.

In contrast, the nearly-obsolete Amiga computer system running Amos Pro produces no delays between transmissions (which I use to acid-test new products). It also supports a user-programmable baud-rate generator allowing data transmission at unusual speeds.

Step 3. Don't forget the purpose of the telephone icon that appeared on Form1 (Figure 3). It represets the addition of RS-232 communications to the program. It is very important to remember the name of this telephone icon, MSComm1.

Double-click anywhere on the grid of Form1. This opens the Form Lode program code window – code you want to execute as soon as the program starts can be entered in this window.

For our purposes here, we need to tell the MSComm1 object the speed and protocol for RS-232 communications. The standard settings are 9600 baud, no parity, eight data bits, and one stop bit.

Next, we need to tell MSComm1 which port to access. On my system, COM2 is available for RS-232 communications. I have my modem set for COM4 and my mouse at COM1.

Now that set-up of the communications object (MSComm1) is complete, it's time to open the port. This part is self-explanatory; however, an error may be displayed if the program cannot find your serial port.

Step 4. Next select the Button tool in the tool bar. Draw a button labeled "Read Input Device 0" as seen in Figure 4.

To name the button or any other object in VB4, click the object one time to select it. Scroll through the Properties window until you see Caption. Change the caption.

Step 5. Double-click on the blank grid of Form1. Change the Object to (General) as shown in Figure 4. Set the "Proc" to (declarations). Now select "Procedure" from the "Insert" pull-down menu to add a subroutine to the project. A window will be displayed for the properties of the routine to add. Select "Function" as the "Type" of procedure and name the function "InputScan." Select "OK" to add the function to your program.

You should now see the Form1 code box appear. Make sure "Proc" is set to "InputScan" and enter the code exactly as shown in Figure 5. Don't forget to add the word "Device" in the brackets of the first line of the program.

Step 6. Double-click on the "Read Input Device 0" button that you created. Enter the code directly as shown in Figure 6 This subroutine will read the input scanner and display which lines are currently turned on.

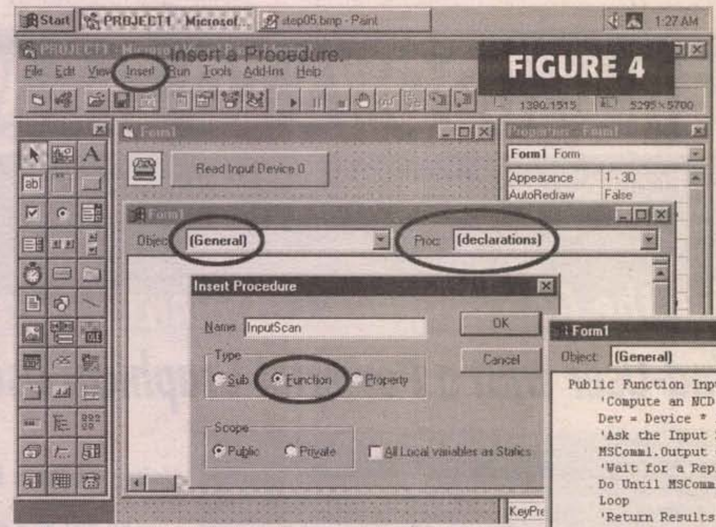


FIGURE 4

Explanations

So far, the InputScan function does all the RS-232 communications in this program. The comments explain the process involved for reading data into the computer. To use the InputScan function, a device number must be provided. In the example in Figure 6, the InputScan(0) function call asks for the status of eight inputs of device 0. Keep in mind that 16 input scanners can be attached to a single RS-232 serial port, and that 0 can be any number from 0 to 15. This method permits 128 inputs to be read from a single RS-232 serial port. Also keep in mind that the device number in software must match the jumper settings in hardware. This will be explained in greater detail in the schematics for this article.

Once the InputScan function has been called, the variable "InputScan" will store a value from 0 to 255 ... which is a numeric representation for the binary status of the eight inputs. When all inputs are low, a 0 will be returned. When all are high, a 255 will be returned. The example program in Figure 6 shows how to use the AND function to test for the the on/off status of each of the eight input pins. The input scanner chip also supports hardware testing of individual input pins, but I chose not to demonstrate this feature in favor of exploiting the resources of a powerful desktop system.

Step 7. Next, add a button to your form and change the caption to "Trigger Relays Device 1." This simple button turns eight relays on, then off. Keep in mind that device 0 is used to read eight data inputs while device 1 is used to write data outputs. Don't forget, up to 16 devices can share this network protocol. Add more inputs if you need to, more outputs, and later I'll show you how to add character and graphic LCD displays to this network protocol.

Step 8. Double click on your form and change the Object to (General) and the "Proc" to (declarations). Now select "Procedure" from the "Insert" pull-down menu. Name the procedure "Relay8" as shown in Figure 7 and select "OK." The Relay8 procedure will be used to speak directly to the RS-232 relay driver circuit in much the same way the InputScan procedure speaks to the input scanner chip.

Take note of the pull-down menu shown in Figure 8 beginning with (declaration), then InputScan and Relay8. For every device I show you how to build, a subroutine will be added to this portion of the program allowing simple subroutine calls to control the device. Keep in mind that every device has parameters that must be sent to it. The InputScan function only needed a device number. The Relay8 subroutine will also need a device number. In addition, you will need to tell the Relay8 subroutine which relay to control (1 to 8), and the on/off status of the relay (1 or 0, respectively).

Add the source code for the Relay8 subroutine to control the relay portion of this circuit. See Figure 8 for source code. You probably already noticed that controlling these devices requires a minimal amount of actual programming. Using a modular programming style significantly reduces the amount of code required to speak to each individual device.

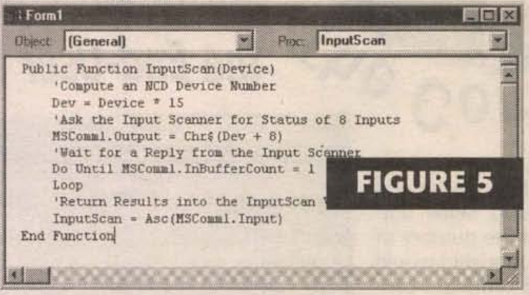


FIGURE 5

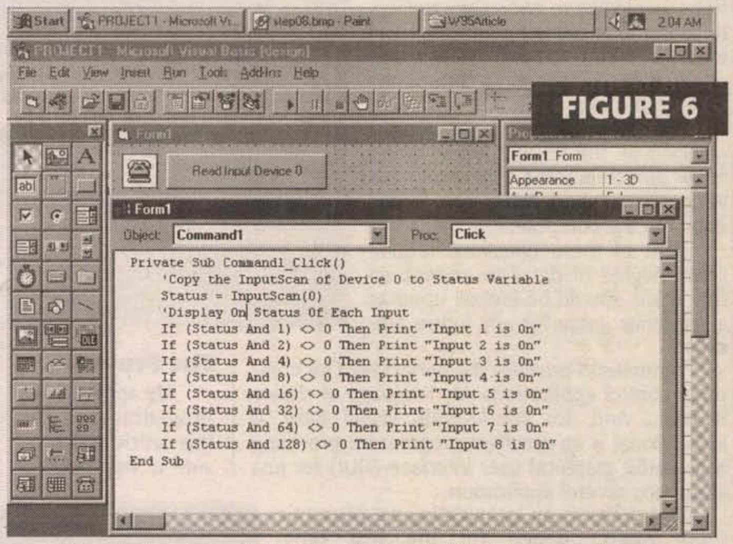


FIGURE 6

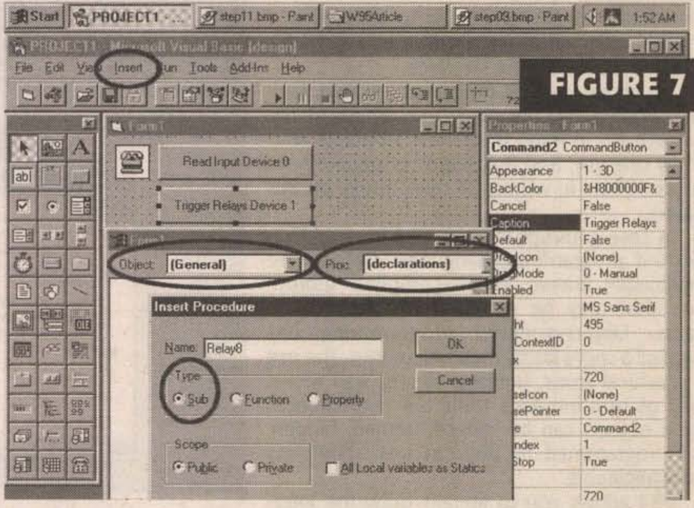


FIGURE 7

Step 9. Next double-click your newly added relay control button labeled "Trigger Relays Device 1" to access the source code that will be executed when the button is clicked. Here, you will add the

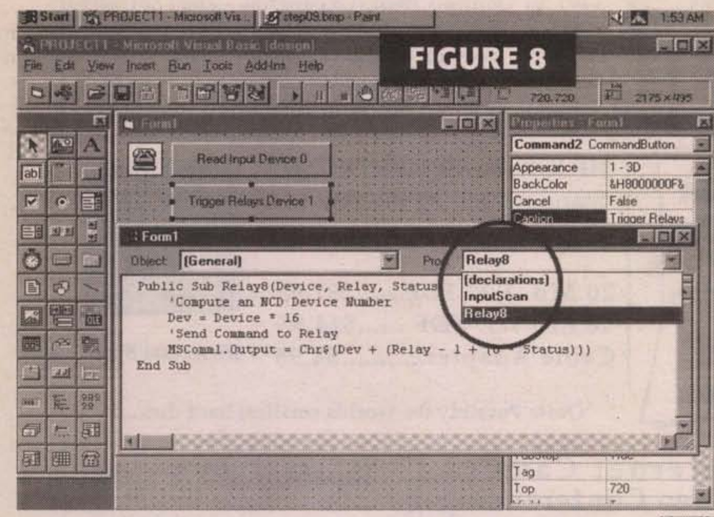


FIGURE 8

source code shown in Figure 9. When the relay button is clicked, this short program will tell the Relay8 subroutine what to do with the relays. Note that the three required parameters are passed to the Relay8 subroutine in the form of Device, Relay, and Status.

A creative programmer may choose to add additional buttons for speaking to additional relay drivers. The beauty of this system is, the Relay8 subroutine is used to speak to any relay device on the network, just like the InputScan function is used to access any input scanner on the network.

You could even create buttons that read an input scanner, then change the status of the relays based on the status of the inputs. You could create detailed file logs recording the status of inputs at different times throughout the day. There is virtually no limit to the applications for this type of system.

If you have ever built your own security system, then you can just imagine the potential this network protocol has to offer.

Speak to any device using a simple subroutine, add subroutines for every new device, and add buttons to customize input and output functions to your exact project requirements.

Creating the program shown here requires about 20 minutes to complete. New users may require an hour or two to navigate the programming environment.

Now that you have gotten your feet wet in the world of VB4 programming, it's time to move on to the hardware.

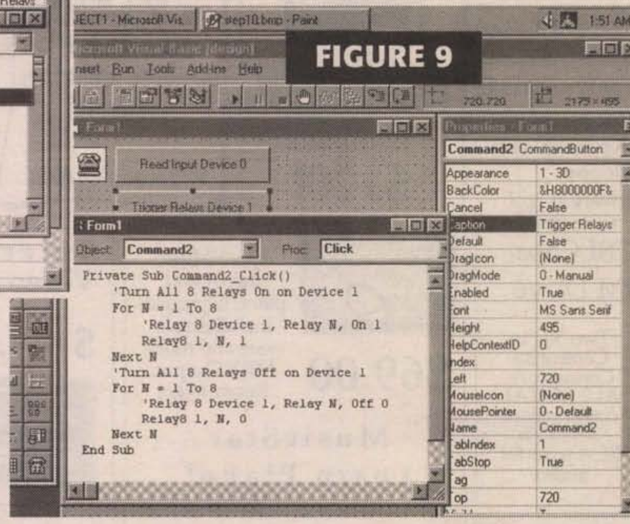
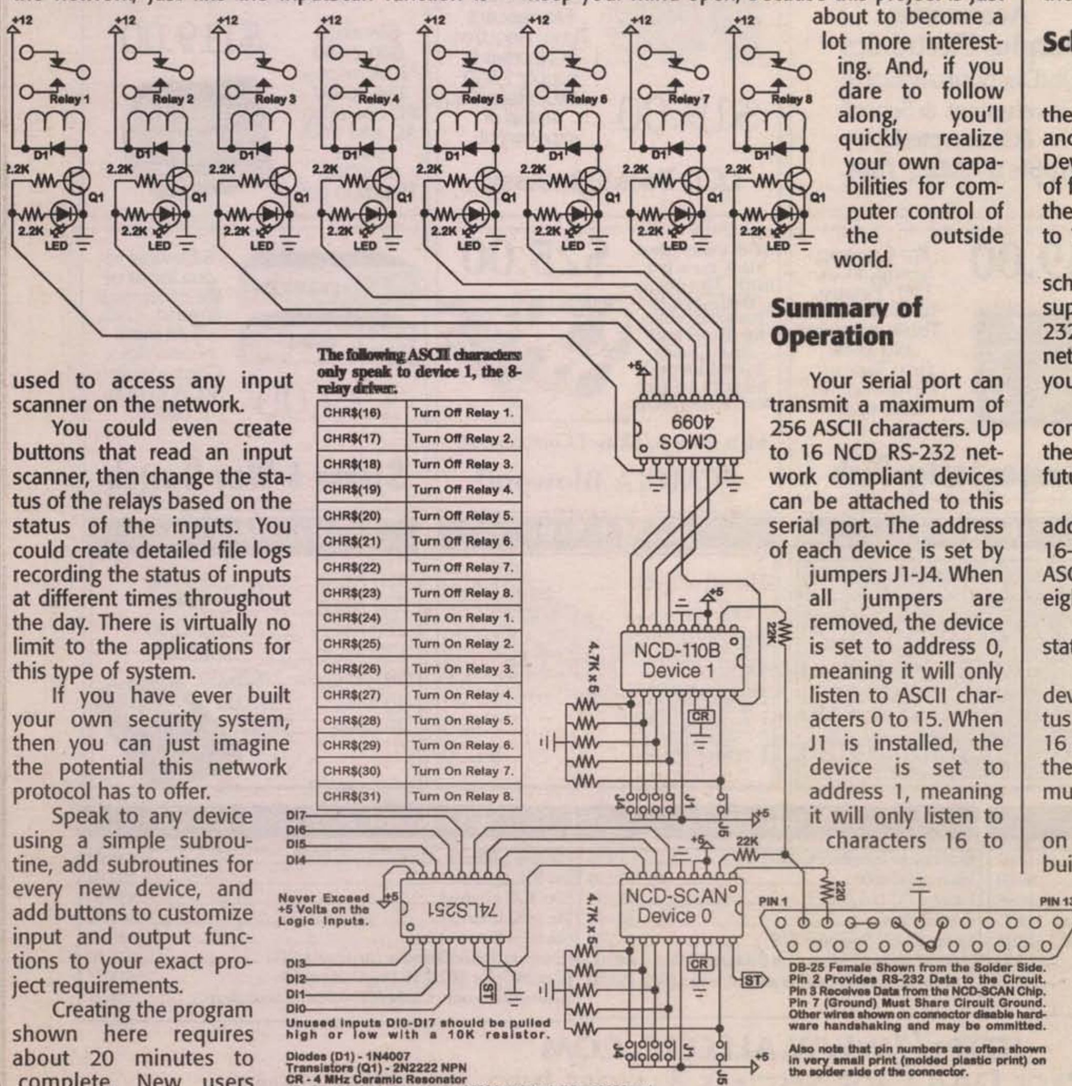


FIGURE 9

I think you will be surprised at the simplicity of the circuit. Like the program, there are only a handful of components required to make this thing work. So keep your mind open, because this project is just about to become a lot more interesting. And, if you dare to follow along, you'll quickly realize your own capabilities for computer control of the outside world.



The following ASCII characters only speak to device 1, the 8-relay driver.

CHR$(16)	Turn Off Relay 1.
CHR$(17)	Turn Off Relay 2.
CHR$(18)	Turn Off Relay 3.
CHR$(19)	Turn Off Relay 4.
CHR$(20)	Turn Off Relay 5.
CHR$(21)	Turn Off Relay 6.
CHR$(22)	Turn Off Relay 7.
CHR$(23)	Turn Off Relay 8.
CHR$(24)	Turn On Relay 1.
CHR$(25)	Turn On Relay 2.
CHR$(26)	Turn On Relay 3.
CHR$(27)	Turn On Relay 4.
CHR$(28)	Turn On Relay 5.
CHR$(29)	Turn On Relay 6.
CHR$(30)	Turn On Relay 7.
CHR$(31)	Turn On Relay 8.

Summary of Operation

Your serial port can transmit a maximum of 256 ASCII characters. Up to 16 NCD RS-232 network compliant devices can be attached to this serial port. The address of each device is set by jumpers J1-J4. When all jumpers are removed, the device is set to address 0, meaning it will only listen to ASCII characters 0 to 15. When J1 is installed, the device is set to address 1, meaning it will only listen to characters 16 to 31. In the schematic, device 0 is an input scanner. When ASCII character 8 is received by the input scanner chip (at device 0), the 74LS251 is used to scan the inputs and sends an ASCII character back to the computer. The number that is sent back is the binary representation of the eight inputs. If all inputs are low, a 0 will be returned. If all eight inputs are high, a 255 will be returned.

Device 1 in the schematic is an eight-relay driver and will only listen to characters 16 to 31. Characters 16 to 23 turn off each of the eight relays, while characters 24 to 31 will turn on each of the eight relays.

The VB4 program uses subroutines to control each device in the schematic. Each subroutine requires a device number from 0 to 15 that must match the device jumper settings (J1-J4). See the Dec. '97 article for details on using jumpers to set the address of networkable devices.

Schematics

The schematic shows two devices attached to the serial port. The first device is an input scanner, and the second device is an eight-relay driver. Device numbers are set for each device using a set of four jumpers (J1-J4). Remove all jumpers to set the device to 0, install J1 to set the device number to 1.

Again, refer to the Dec. '97 article. The schematic (as well as all custom NCD processors) supports a simple "drop" network. Chain the RS-232 output pin 2 of the DB-25 female) to as many network interface processors as may be needed by your application.

Optoisolation should be used to protect your computer just in case there is a malfunction with the circuit. This will be demonstrated in detail in future articles.

Remember, ASCII characters 0-15 speak to address 0 (the SCAN chip) and ASCII characters 16-31 speak to address 1 (the eight-relay driver). ASCII character 8 asks the SCAN chip to read all eight inputs.

ASCII characters 0-7 ask the SCAN chip the status of each individual input, respectively.

If a second SCAN chip were to be added as device 2, ASCII character 40 would ask for the status of the eight inputs. (add 16 for device 1, add 16 for device 2, add 8 for the command to read the inputs, 16+16+8=40.) Note that the address must be set to 2 by installing jumper J2 only.

Next time, I want to begin a multi-part series on character LCD displays. I'll show you how to build a simple RS-232 networkable LCD display controller for less than $12.00. **NV**

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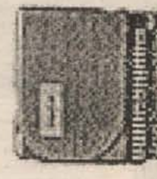

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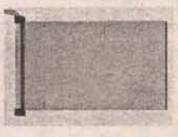

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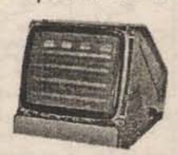

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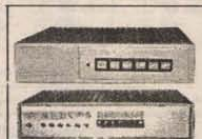

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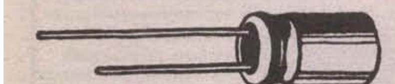

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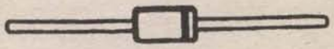

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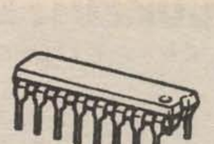

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8G23 $34.99 23-pcs *Contents*: IC inserter/extractor with securer & bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/ 1/8" slot-ed screwdriver, #0/#1 phillips, reversible T10/T15 bits, re-versible #2 phillips/¼" slotted bits, tweezer, long-nose plier, cutter, 6" adj. w-rench, soldering iron, solder, crimping tool, zipper case, manual.
Different packages available, call/write/e-mail/fax for detail.

STEREO/ALIGNMENT/SWEEMAR SCOPE

STEREO SCOPE OS-7505B $369.00, 0-10MHz/20mV.
ALIGNMENT SCOPE OS-7001A $369.00, 0-200KHz/1mV.

SWEEMAR SM-6225B/C $1999.95
Freq Range: (AM)490KHz; (FM)10-11.4MHz; *Accuracy*: ± 0.1%; *Marker*: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

RF SIGNAL GENERATOR

SG-4160B $124.95, 100KHz-150MHz up to 450MHz on 3rd harmonics in 6 ranges; AM modulation; *Accucy*: ±5%. *RF Output*: 100mVrms to 35 MHz; *Modulation*: Int. 1KHz (AM) =30%; Ext. 50Hz-20KHz, at least 1V_{rms} input. *Audio Output*: 1KHz, 2V_{rms} minimum.
SG-4162AD (with Freq. Counter) $229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz; *Max. Input*: ≤3V effective *Gate Time*: .1, 1sec. *Input Sensitivity: 35mV, 10Hz-200MHz.* *Input Impedance*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs.

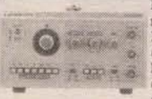
AM/FM STD SIGNAL GEN.

SG-4110A $1799.00, *Freq*: 0.1–110MHz; *Display*: 6-digit LED; Resolution: 100Hz (0.1–34.999MHz); 1KHz (35MHz–110MHz). *Accuracy*: <±(5x10^5 ±1 count); *Output*: -19dBu—99dBu, 1dB steps. *Impedance*: 50Ω VSWR 1.2; 100 preset frequency & store functions

AUDIO GENERATOR

AG-2601A $124.95, 10Hz–1MHz in 5 ranges; *Output*: sinewave 0–8V_{rms}; square 10$V_{p\text{-}p}$. *Output Imped*: 600 Ohm. *Distortion*: <0.05% 500Hz–50KHz; <0.5% 50KHz–500KHz.
AG-2603AD $229.95, with 6-digit, Int/Ext. Freq Counter, 10Hz–150MHz, *Output Control*: 0/-20/-40dB & Fine adjuster. Spec. see AG-2601A.

FUNCTION GENERATOR



FG-2100A $169.95, 0.2Hz-2MHz in 7 ranges; sne, square, triangle, pulse & Ramp; *Output*: 5m$V_{p\text{-}p}$-20$V_{p\text{-}p}$, 1% distortion. *VCF*: 0-10V/freq. to 1000:1.
FG-2102AD $229.95 see FG-2100A; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
FG-2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG. *Freq. Counter*: Int. 0.5Hz-5MHz; Ext. 5HZ-10MHz.
FG-513 $769.95, 13 MHz, Microprocessor embedded dgital sweep; , Sine, Square, Triangle, Pulse, Ramp, TTL & DC; ±(.01%+1dgt). *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits. x1/x20 attenuatn

AC MILLIVOLT METER

MV-3100A $159.95 wide band 5Hz–1MHz; 3 scales, mV, dB &dBm; 300μV–100V in 12 ranges, 10μV resolution; -70–40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedance 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement.

OSCILLOSCOPES

OS-7305B $249.00 DC–7MHz; 3" CRT; *Horz*: .25V/div; 10Hz–100KHz in 4 ranges; *Vert*: 10mV/div; Int. & Ext. Sync.; *Input*: 1MΩ/35pF.
OS-7010A $299.95 10MHz, 5"CRT, *Horz*: .2V/div; *Vert*: 10mV–10V /div.
OS-622G $389.95 20MHz, 2 CH/X-Y Alt trigger, trigger lock, hold OFF, TV syn., 8x10 div., 1mV/div., *Horz*: .2μs–.5s/div; *Vert*: 1mV–5V/div.
OS-653G $699.95 50MHz, 2 CH/delay sweep, Alt trigger, TV syn.
OS-6101G $1499.95 100MHz, 4ch/8 traces, delay sweep, cursor readout. *2 years warranty for OS-622G, OS-653G, & OS-6101G.*

UHF ATTENUATORS

RT-8815U (50Ω) $299.00 / RT-8817U (75Ω) $299.00, 950MHz, 81dB, 0.5W max.; *Steps*: 1/2/3/5/10/20/20/20, 8 switches.
085E-2 (50Ω) $399.00 / 087E-2 (75Ω) $399.00, 950MHz, 81dB, 0.5W max.; *Steps*: 10dB+7.1dBx10, Electronic adjustment knob.

MICROPROCESSOR TRAINER

BGC-8088 $699.00, learn computer theory. Excelle-nt for school & individual who want to learn about ROM, RAM, I/O ports, programming, & run a 8088 Microprocessor. An easy to understand step-by-step manual guides you to achieve your goal. 56-key keyboard, LCD display, RS-232, UART...

GRID DIP METER

DM-4061 $89.95 1.5-250MHz, 6 bands; 6 plug-in coils, 2 transistor, and 1 diode. *Modulation*: = 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. 9VDC battery.

FREQUENCY COUNTER

FC-5250C $119.95 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10-200MHz. *GateTime*: .1, 1sec. *Max. Input*: 10$V_{p\text{-}p}$ *Input Sensitivity*: 35mV/10Hz-200MHz *Input Imped.*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs; 9V adapter **($6)**

FC-5260A $129.95
10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95
10Hz-1.2GHz; 8-digit LEDs.
FC-5600B $229.95
10Hz-600MHz; 10-digit LEDs.
FC-5700 $299.95 10Hz–1.3GHz; 10-digit LEDs. Period measure.

SIGNAL TRACER/INJECTOR

SE-6100 $134.95 (9VDC adapter, $6.0)
TRACER: Gain 60dB **maximum.**
Attenuation: 0/20/40/60dB
Input Imped: 100KΩ; *Meter*: Vu 100μA
Output Imped.: 600Ω; *Speaker*: 8 Ω.
INJECTOR: =1KHz Squarewave;
Output Level: Continuously variable 0 ~ 4.5$V_{p\text{-}p}$; 9V battery/adaptor

LCR METERS

MIC-4070D $179.95, *Induct.*: 0.1μ–200H, *Capacit.*: 0.1p–20mF, *Resist.*: 1mΩ–20MΩ, 2Ω range, Dissipation factor measurement, Zero adjust; Surface mount device (SMD) test probe: **LT-06 $21.95**

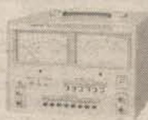
DIGITAL MULTIMETER

DMM-120 $24.95, 3½ digit, 600VDC, 2ADC 500VAC, 2MΩ, hFE/diode/continuity test.
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/600VAC, 10ADC/AC, 2GΩ, 20μF, hFE/diode test, continuity beeper.
DMM-124+Cap.+Temp.+Freq Cntr $69.95, 3½ dig, 600VDC/500VAC, -58–752°F, 2GΩ, 20mF, 200KHz, 3φ phase/diode/continuity test.
DMM-125 $54.95, Autorange/Bargraph, 32MΩ, 600VDC/AC, 10ADC/AC, diode/continuity test.
MIC-35 $59.95, Autorange, 3½ digit LCD, 1000VDC/750VAC, 20MΩ, 20ADC/AC, diode/continuity check, data hold, free holster.
MIC-39 $129.95, Autorange/Bar Graph, True RMS, 3¾ digit, LCD, 40MΩ, 40μF, 1000VDC/750VAC, 20ADC/AC, 600KHz freq. cntr, data hold, drop-prove, sleep mode, memory, read functions, holster.

AUTO. CAPACITANCE METER

CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic.
Resolution: 0.1pF lowest, 0.1% full scale.
Accuracy:
0.5% of full scale ±1 digit to 99.9μF,
1% of full scale ±1 digit to 99.9μF.
Display: 3 digit LED.
Unit: pF, nF, μF, mF, Overrange indicators.

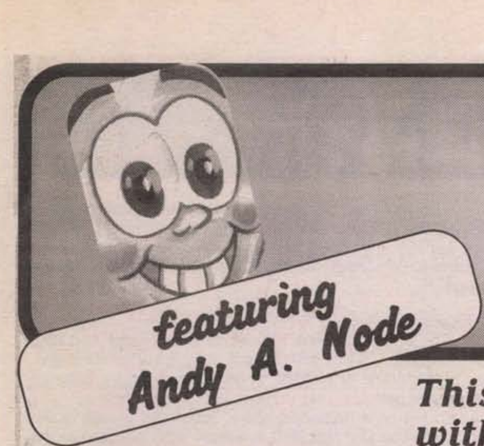
AUTO DISTORTION METER



DM-3104A $799.95
DISTORTION MEASURE
Range: 0.01% to 30%, 0.1/0.3/1/3/10/30% 6 ranges.
Freq: 400Hz±10%, 1KHz±10%(HPF).
Input: 3mV-100V; Ratio measure 20dB.
Auto. Freq. Switching Ranges:
Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
LEVEL MEASURE *Range*: 0 to 100V in .03/.1/.3/1/3/10/30/100V
Freq Response: ±0.5dB/20–50kHz; ±1dB/20–100kHz.
DM-3204 $1,599.00 dual channels; Spec see DM-3104A.

WOW-FLUTTER METER

WF-3103A $699.95 *Freq. Range*: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN.
Measuremt: .03/.1/.3/1/3% full scale.
Accuracy: ±5% of full scall.
WF-3105A $799.95, digital display;
Function: LIN/WOW/Flutter/WTD.
Freq Counter: 10Hz-9.99MHz.
Indication: CCIR/DIN/JIS.



THE WEEKEND WORKBENCH

This month finds Andy (our workbench warrior) toying with a simple lie detector. While it's unlikely that Andy will actually catch somebody in a "real" lie (the project is for entertainment purposes only), it's based on scientific principles that are used in commercial lie detectors. Let's see what he's up to ...

Greetings, everyone! Let's begin!

This Month: Lie Detector

Truth and Consequences

Unlike court-approved lie detectors, which monitor at least five physiological functions, my lie detector simply measures skin resistance. Typically, when a person is embarrassed or lies, he or she will break out in a sweat which, in turn, causes the galvanic skin resistance (GSR) to decrease. In most cases, the degree of perspiration depends on the size of the lie; e.g., the bigger the lie, the more you sweat.

This change in skin resistance is detected by electronics and displayed on an analog meter — you know the kind, those with a pointer like a gas gauge.

I chose an analog meter over a digital display for two reasons. First, the "guilt" response is often a momentary reaction, and analog meters can respond to instantaneous changes a lot faster than digital displays. Second, the human brain is better at processing analog information than it is at digital (probably because nature is analog, and she's been around a lot longer than computers).

Construction

Like all of my projects, the lie detector is built around parts that you can find at Radio Shack or order through Digi-Key (800-344-4539; http://www.digikey.com). Only three semiconductors, two diodes, an op amp, and a handful of resistors and capacitors are needed. The project can be put together for about $15.00, not including the cabinet.

Just about any off-the-shelf op amp can be used, but a JFET (junction field-effect transistor) such as the TL082 is a preferred choice because of its high input impedance (greater than 1 trillion ohms), low noise, and low current requirements (typically 3.2 mA). Suitable substitutes are the LF353 and the NTE 858M.

The original circuit was cobbled on a solderless breadboard, but any construction method will work. The parts layout isn't critical, and the only rule you have to observe is to place the bypass capacitors (C1, C2, C3, and C4) as close as possible to their related IC pins, otherwise they lose their decoupling effect.

For the same reason, C5 should be soldered directly across the meter's terminals at the meter. For your convenience, I've made arrangements with Circuit Design (541-664-7904; http://www.cdsnet.net/Business/circuits/) to provide an etched and drilled circuit board for $6.00 plus shipping and handling (see Parts List). The parts layout is shown in Figure 3. Artwork for the PC board can also be found on our web site (http://www.nutsvolts.com) under the name LIES.ZIP. This file contains the foil pattern, a parts layout, and schematic of the lie detector.

Analog Meter

While analog meters are still very popular, Digi-Key no longer stocks them. Fortunately, you can buy them from several of our advertisers, such as All Electronics (800-826-5432; http://www.allcorp.com) and Mouser Electronics (800-346-6873; http://www.mouser.com). I used a 0-1 mA meter from Radio Shack.

If you select the Radio Shack meter, ignore the fact that it reads 0-15 volts and toss the included 15K resistor in your junk box for another project.

Depending on the meter you buy, you may have to mechanically modify it for center-scale null. Balance meters, such as the kind found in some stereos, are already set up for null (zero crossing) display.

If you use a panel meter like the one from Radio Shack you need to mechanically move the pointer to center scale. This is done by snapping off the plastic cover and gingerly bending the pointer near where it attaches to the deflection coil using a pair of tweezers or small long-nose pliers. Be particularly careful not to disturb the coil winding or coiled hair spring; doing so can destroy the delicate meter movement.

While you have the cover off, remove the scale plate and reverse it so the back side is now the front. With a felt-tipped marker or dry transfer decals (you can get both from an arts supply store), mark off the middle of the scale and label the left side TRUE and the right side FALSE.

Skin Sensors

There are several ways to monitor skin resistance, but the easiest is to use finger electrodes. I made finger sensors from metal fingerpicks that I bought at a local music store. These metal "sleeves" easily slip over the tip of your finger, and the pick portion readily accepts

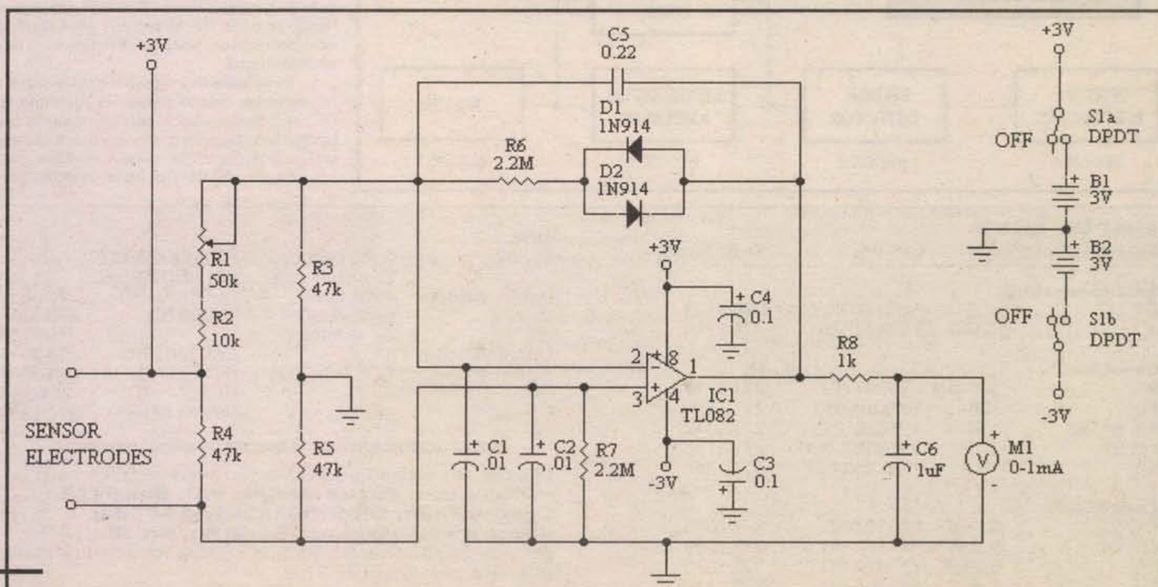


Figure 1. The battery-operated lie detector uses a single operational amplifier.

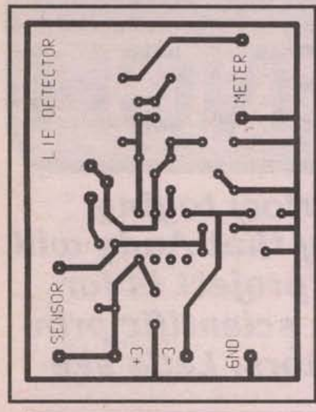


Figure 2. Actual-size foil pattern of the Weekend Workbench lie detector.

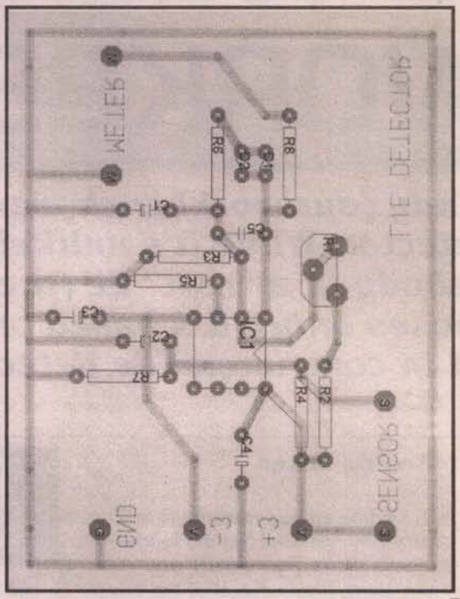


Figure 3. Component layout.

flexible, stranded wires. The wires can be either permanently soldered to the fingerpick or attached via alligator clips.

Power Supply

Whenever you apply electricity to the human body — as we will to measure the skin resistance — you have to be extra careful. This is why the lie detector is battery-powered: to eliminate the possibility of shock. My choice is four "AA" batteries nestled in a standard plastic battery holder.

However, the current requirements are low enough that you can use a couple of lithium cells instead. Moreover, the lithium cells weigh less and take up less space than the "AA" batteries.

Regardless of your choice, you need to attach a ground wire to the center tap of the batteries because the circuit requires a split power supply.

That is because the op amp works best with a positive voltage (+3) and a negative voltage (-3) source.

With a four-cell "AA" battery holder, the center-tap is a wire soldered to the spring that bridges the second battery to the third. If you opt to use lithium cells, the ground tap is the common wire between the two batteries.

HOW IT WORKS

The Weekend Workbench lie detector consists of five stages: the sensors, a bridge detector, a differential amplifier, variable-gain feedback loop, and an analog display. Central to the design are the bridge circuit and differential amplifier.

Wheatstone Bridge

The bridge detector (Block 2) is the heart and soul of this design. Bridge circuits are unique in that their geometry can detect very minor changes in voltage or current. A good analogy is a balance scale, like the kind used to weigh gold and gems.

Basically, it consists of two pans hung on a balanced beam. When the weight in the pans is equal, the pointer reads mid-scale. The slightest shift in weight from one pan to the other, though, tips the pointer to the right or left.

A bridge circuit does the same thing. When the measured values are equal, the output is zero. Tip the balance either way, and the indicator moves left or right.

Although a bridge can be composed of any combination of active or passive devices, it's most often made up of four resistors. Our circuit uses a Wheatstone bridge, a resistive sensor named for Sir Charles Wheatstone, an English physicist who invented it more than 150 years ago.

Looking at Figure 5, you see that the current flows through two legs: branch A (R1 and R3) and branch B (R2 and R4). When current flows through a resistor, it develops a voltage (E) that is proportional to the resistance (R) times the current (I), or

$$E = IR$$

If one amp flows through a one-ohm resistor, the current generates one volt across the resistor. This is called Ohm's Law, named for the mathematician who discovered the relationship.

If the total resistance of R1 plus R3 equals the total resistance of R2 plus R4, then equal amounts of current flow through branches A and B. In our example, the current through each branch is 5 mA ($I = E/R = 10/2{,}000 = .005$) for a total current draw of 10 mA from the battery. Since all four resistors are 1K, the voltage drop across each resistor is 5 volts ($E = IR = .005 \times 1000 = 5.0$). The net result is no voltage difference between Point A and Point B, and the bridge is in balance.

If we reduce the value of R1 to 500 ohms, the current through Branch A increases to 6.7 mA, which means the voltage drop across R1 is 3.3 volts and the voltage across R3 is 6.7 volts. If we subtract Point B (5.0 volts) from Point A (6.7 volts), we discover there is a 1.7-volt difference between the two points. In other words, the bridge is out of balance.

Differential Amplifier

The signal from the bridge is processed by an instrumentation amplifier (Block 3), which is better known as an op amp. Op amps have two inputs (not one) that are differential: one is inverting and the other is non-inverting.

When a positive voltage is applied to the inverting input, the output goes negative; apply a positive voltage to the non-inverting input, and the output goes positive. If a voltage of equal value is applied to both inputs, the output is zero.

Typically, the Point A and Point B outputs feed the inverting and non-inverting inputs. When the bridge is in balance, the input voltages are equal and the op amp output voltage is zero. An out-of-balance condition produces a voltage difference across the two inputs of the op amp, which causes the output to swing positive or negative, depending on the polarity of Points A and B. The amount of swing depends on the voltage difference between Points A and B and the gain of the amplifier.

Feedback Loop

The gain of the op amp is determined by a feedback voltage from the output (pin 1) to the inverting input (pin 2). If the feedback voltage is equal to the input voltage, the amplifier has a gain of one (often called unity gain). If the feedback voltage is one-tenth that of the output, the gain is 10.

The feedback voltage is determined by the ratio of the input resistor to the feedback resistor. For example, if the input resistor (Rin) is 23.5K (the parallel equivalent of R4 and R5) and the feedback resistor (Rf) is 2.2M, the gain (Av) is 93.6 (see equation below).

Now back to the bridge. As the bridge approaches balance, the differential output voltage between Points A and B grows ever smaller, going from volts to microvolts and finally zero. So the closer you get to null, the more amplification you need to detect the ever-decreasing voltage difference. The solution is to increase the gain as you approach null.

To provide this variable-gain feature, the op amp's feedback path needs a dynamic resistance that increases as the input signal drops. Two small-signal diodes, D1 and D2, in a back-to-back configuration in the feedback loop fill the bill nicely. When the bridge is unbalanced, the feedback current forward biases either D1 or D2, depending on the polarity of the output, and the gain is equal to the equation above.

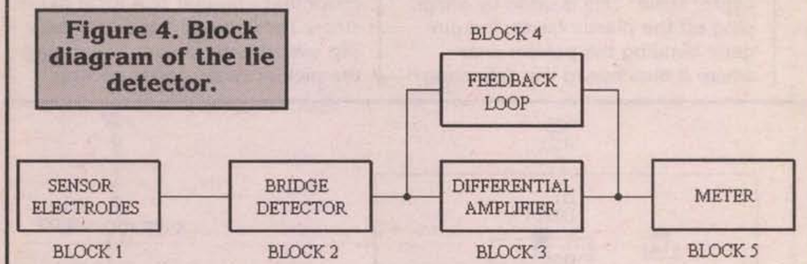
As the differential input approaches a balanced state (zero-voltage), the diodes lose their forward bias, which causes their resistance to increase dramatically. This increases the op amp's gain which, in turn, increases the sensitivity of the lie detector.

Analog Display

The analog display is a standard panel meter with a full-scale value of 1 mA. By inserting a 1K resistor (R8) in series with the meter, it becomes a 0-1 volt voltmeter. Capacitor C6 smoothes out any transients or spikes that may be present.

$$Av = \frac{Rf}{Rin} = \frac{2{,}200{,}000}{23{,}500} = 93.6$$

Figure 4. Block diagram of the lie detector.



Parts List

Reference/Description		Digi-Key	Radio Shack
Semiconductors			
D1, D2	1N914	1N4148DICT-ND	276-1122
IC1	TL082	TL082CP-ND	276-1715
Resistors			
R1	50K pot	CT2207-ND	271-1716
R2	10K	10KQBK-ND	271-1335
R3, R4, R5	47K	47KQBK-ND	271-1342
R6, R7	2.2M	2.2MQBK-ND	271-1135
R8	1K	1.0KQBK-ND	271-1321
Capacitors			
C1, C2	0.01uF	EF1103-ND	272-1065
C3, C4	0.1uF	EF1104-ND	272-1069
C5	0.22uF	EF1224-ND	272-1070
C6	1uF	EF1105-ND	272-1434

Misc.			
B1, B2	4 AA cells or	P103-ND	23-782
	2 Lithium cells	P117-ND	23-166
Battery holder	4 AA cells	BH24AAL-ND	270-383
	Lithium cell	BH906-ND	270-430
M1	0-1 mA meter	—	270-1754
On/off switch	S1	CKC5101-ND	275-407
Sensor connector	RCA jack/plug	SC1133-ND/ SC1137-ND	274-346/ 274-384
Cabinet	See text	HM104-ND	270-1803

Note: An etched and drilled printed circuit board is available from **Circuit Design, P.O. Box 5415, Central Point, OR 97502 (541-664-7904; http://www.cdsnet.net/Business/circuits/).** The price is $6.00 plus $1.00 S/H ($3.00 for Priority Mail). Request part number TS-2.

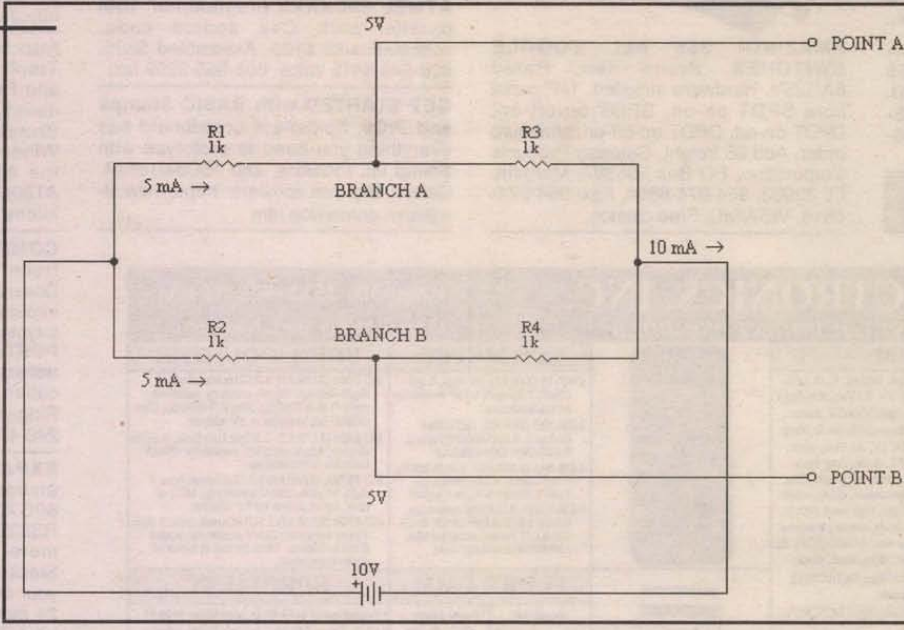


Figure 5. The "brains" of the lie detector is a Wheatstone bridge. When the bridge is in balance, no voltage appears between the Branch A and Branch B outputs.

Put a Lid On It

To use this gadget as a parlor game, you want to put it in an enclosure, either metal or plastic. Plastic is cheaper and easier to work with because of the large hole you'll need for the meter. Just make sure the box is big enough to hold the circuit board, the potentiometer (R1), and the batteries. I sized the circuit board to slip into the slotted groves of a Radio Shack 270-1803 plastic enclosure, but other boxes will work.

Don't forget to allow enough panel space for the ON/OFF switch and a connector or binding posts for the sensors leads, too. Binding posts are more versatile, but require more panel space than a connector. An excellent connector for this project is an RCA jack — the kind found in stereo systems. They are small, inexpensive, and easily installed (see Parts List).

Let the Games Begin

To use the lie detector, simply slip on the finger sensors and plug the wires into the lie detector. While the sensors can be placed on any digit, the most responsive GSR area of the body is usually the palm of the hand, so you will want to position the electrodes to measure across this area — usually from thumb to pinkie. However, different parts of the body react differently in different people, so feel free to experiment with electrode placement.

Have the subject relax then adjust R1 so that the meter reads zero — the balanced condition. Don't worry if the pointer bangs a bit as you zero in; the meter can take it. Now ask away and note the reactions. Movement to the right indicates lower skin resistance (a possible lie), and deflection to the left (below zero) shows an increase in skin resistance.

You will probably have to recalibrate the meter as the grilling proceeds because the skin moisture tends to accumulate. If 60 Hz hum is a problem, use a shielded cable for the sensor wires. "Now, son, explain these report card grades to me! Remember, you are under oath ..." **NV**

COMPONENTS *cont.*

WANT TO Buy: ICs, military & aircraft relays, diodes, transistors, Cannon, TRW, Amp, Burndy, Deutsch, Bendix connectors, electronic test equipment & most components. Hoffy Electronic Ent., 818-718-1165, FAX 818-341-5506.

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

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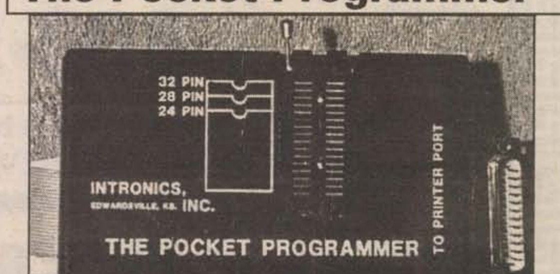

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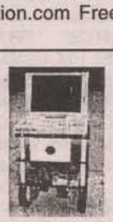

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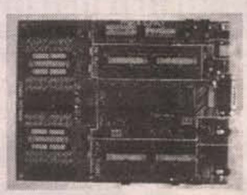

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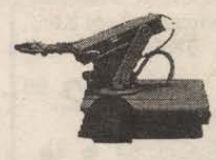

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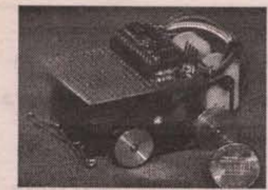

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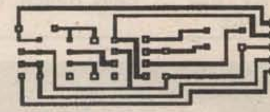

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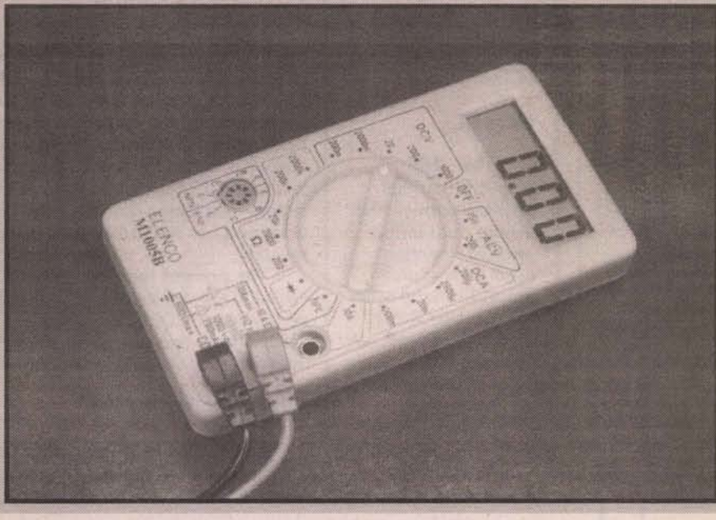
by Fred Blechman

Build the Elenco $20.00 Digital Multimeter Kit



As digital multimeters (DMMs) have become more common, they have dropped in price. This article describes building a 3-1/2 digit LCD DMM from a $20.00 kit. Using a 21-position rotary selector, it measures AC volts to 200V, DC volts to 1000V, DC amps to 10A, resistance to two megohms, as well as testing transistors and diodes.

From novices to professionals, the digital multimeter (DMM) has become the most commonly used test instrument. While low-end DMMs measure AC and DC voltage, DC current, and resistance, many other functions are common in higher-priced DMMs. For example, it is not uncommon for a DMM to measure transistor gain, and to test diodes and continuity.

Since the digital conversion circuitry and display are already in a DMM, some more elaborate units include capacitor and inductor measurement as well. It is unusual, however, to find a 3-1/2 digit DMM, such as the Elenco Model M-1005K, with transistor and diode tests in addition to the more conventional voltage, current, and resistance measurements, selling for only $19.95!

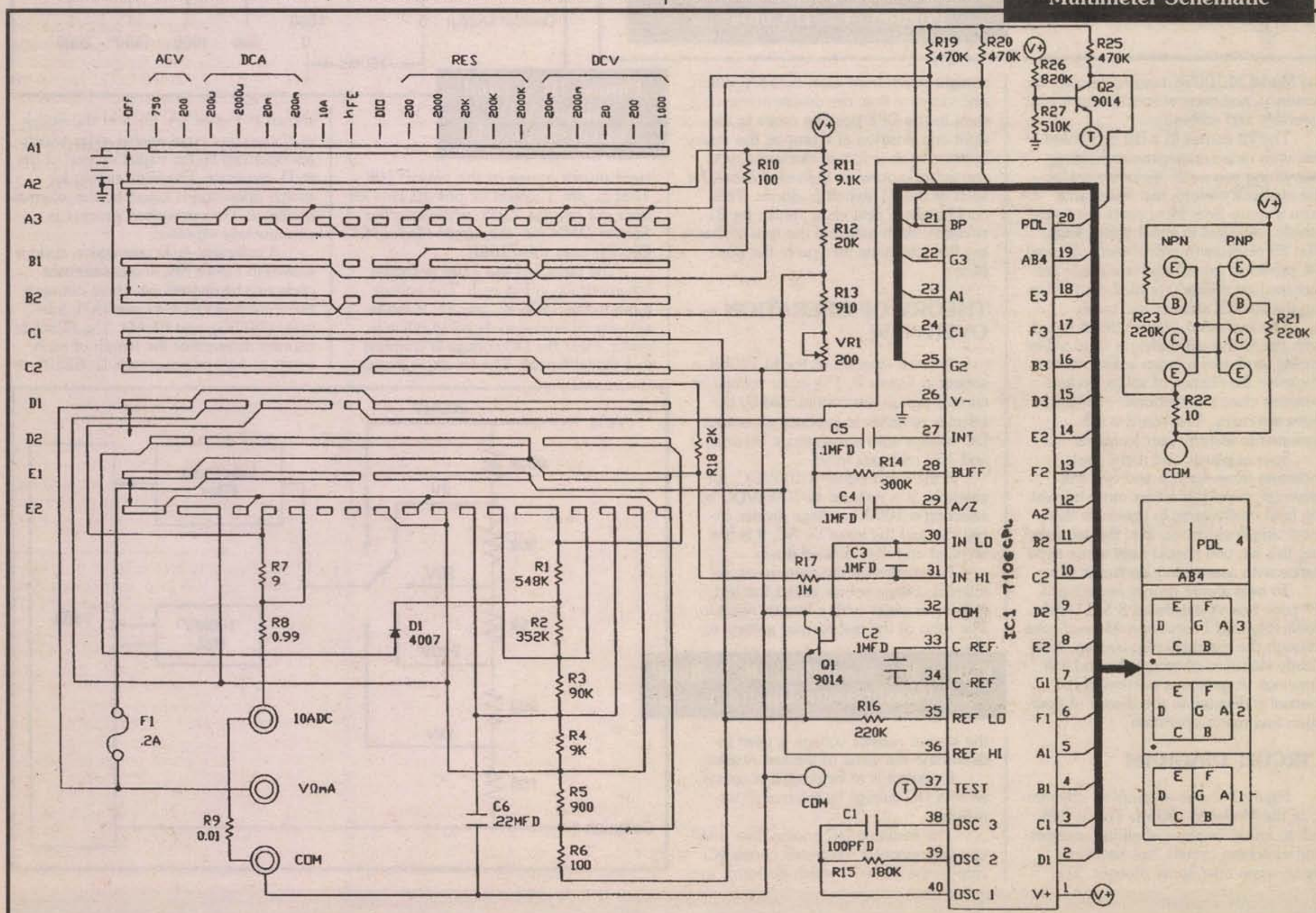
Although the M-1005K comes in kit form, the same DMM can be purchased already assembled (as the Elenco Model M-1000B) for the same price. However, you learn a lot more from building a kit than just using a piece of test equipment — so I chose to assemble the kit.

By assembling the M-1005K, we learned how the heart of a typical DMM — the analog-to-digital converter — works. Also, since our assembled kit initially didn't operate properly, we learned how to troubleshoot the popular 7106 3-1/2 digit LCD DMM integrated circuit chip with an oscilloscope.

ABOUT THE DMM KIT

The bright yellow pocket-size Elenco M-1005K Digital Multimeter Kit is 4.85-inches high, 2.65-inches wide, and 1-inch thick. It features a .5-inch high liquid crystal display (LCD) with 3-

Figure 1 — M-1005K Digital Multimeter Schematic



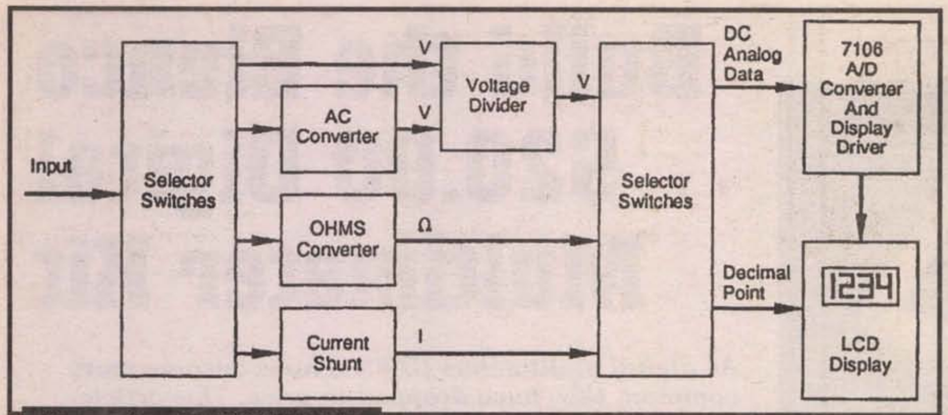


Figure 2 — M-1005K DMM Block Diagram

1/2 digits that will read to 1999, with a decimal point properly placed by the 21-position selector switch. Table 1 shows the Model M-1005K ranges, resolutions, accuracy, and general specifications after assembly and calibration.

The kit comes in a flat cardboard box with nine compartments holding everything you need, including solder, the nine-volt battery, test leads, and even a spare fuse. Most parts are conveniently packaged in small plastic bags. The 25 resistors (many of them .5% and 1% precision values) and one diode are mounted on a clearly-printed card showing the symbol number and value.

The two-sided printed circuit board, with plated-through holes, is of excellent quality, and uses a green solder mask to minimize the chance of solder bridges between close connections — of which there are many. The board is silk-screened to identify part locations.

Special plastic and metal parts, including three springs and two ball bearings, make this kit far more interesting (and challenging) to assemble than most simple electronic kits. Before tackling this kit, you should have some experience with assembling electronic kits.

To help assure proper assembly, a 20-page heavily-illustrated 8.5x11-inch *Assembly and Instruction Manual* goes through the assembly step-by-step, with clearly identified photographs and line drawings. A generous portion of the manual is devoted to the theory of operation and meter operation.

CIRCUIT DIAGRAM

Figure 1 shows a complete schematic of the Model M-1005K. This is difficult to follow because of all the resistors and switching circuits, but begins to make sense after some thought. The buss bars, drawn here horizontally, are etched on the actual circuit board in concentric circles to mate with six metal sliding contacts positioned under the rotary switch knob.

On the schematic, if you draw lines straight down from each switch position, and visualize how the double-arrow contacts in the OFF position move to the right one position at a time as the rotary selector knob is turned clockwise, you can actually draw an individual circuit for each of the 21 switch positions. This could make a neat class project for 21 students, each assigned the task of drawing the schematic for one of the positions.

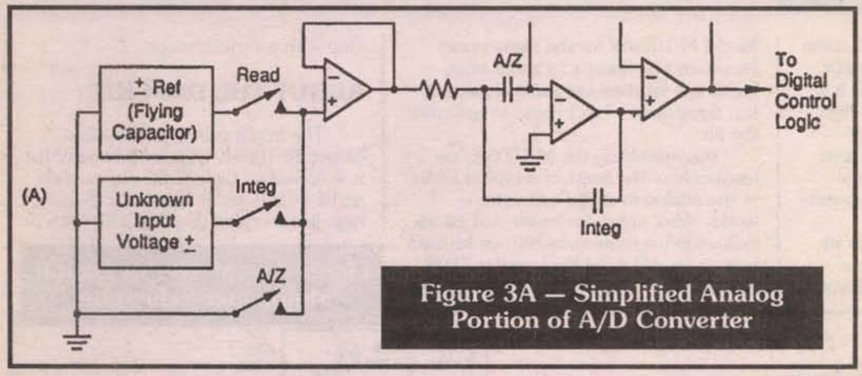


Figure 3A — Simplified Analog Portion of A/D Converter

THEORY OF OPERATION — OVERVIEW

A block diagram of the M-1005K is shown in Figure 2. The input voltage or current signals are conditioned by the selector switches to produce an output DC voltage with a magnitude between 0 and 199 millivolts (mV).

If the input signal is 100VDC, for example, it is reduced to 100mVDC by selecting a 1000:1 voltage divider circuit. Should the input be AC, it is first rectified and then divided down.

For resistance measurements, an internal voltage source drives the test resistor in series with a known resistor. The ratio of the test resistor voltage to the known resistor voltage is used to determine the value of the test resistor.

If current is to be read, it is converted to a DC voltage by internal shunt resistors.

The resulting DC analog data is fed to a very popular integrated circuit (IC) chip — the 7106 — which performs the functions of converting the analog data to digital, and also provides the seven-segment decoder and display drivers for the LCD display.

NOTE!

The 7106 IC comes in various physical forms. The 40-pin dual-inline pin (DIP) version used here — and found in many other inexpensive 3-1/2 digit LCD DMMs — is the 7106CPL. If you try to buy this IC separately from any of the several manufacturers, it costs almost as much as this entire kit! Some DMMs use the 7106R, with the "R" indicating that the pinouts are a reversed left-right mirror-image of the plain 7106. That is, pin 1 would be pin 40. This kit uses the regular 7106, while another Elenco DMM kit, the larger Model M-2665K, uses the 7106R.

The pinout of the 7106 is shown schematically in Figure 1. The voltage input to the 7106 IC, pin 31, is fed to an internal analog-to-digital (A/D) converter. Here the DC voltage is changed to a digital format. The resulting signals are processed in the decoders and appear on pins 2-25 to light the appropriate LCD backplane (pin 21) and segments.

Timing for the overall operation of the A/D converter is derived from an external oscillator (pins 38, 39, and 40). The external resistor R15 and capacitor C4 values result in an oscillator frequency of around 25KHz. In the IC, this frequency is divided by four to 6250Hz, and fed to dual-slope integated A/D circuitry — explained shortly — that provides an LCD readout about twice per second.

The digitized measurements are presented to the display as four decoded seven-segment digits, plus polarity. The decimal point position on the display is determined by the selector switch setting.

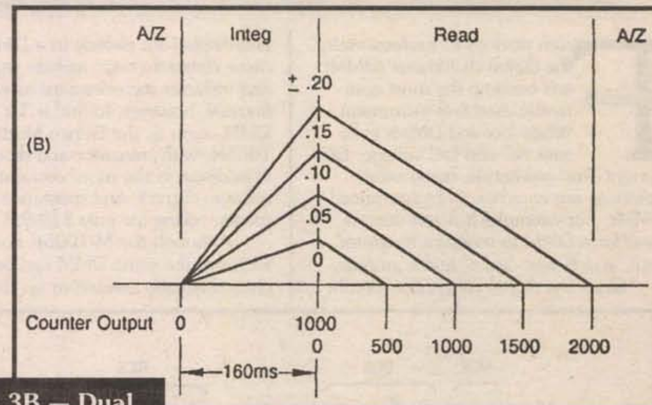


Figure 3B — Dual Slope A/D Conversion Cycle

A/D CONVERTER

A simplified circuit diagram of the analog portion of the A/D converter is shown in Figure 3A. Each of the switches shown represent analog gates which are operated by the digital section of the A/D converter. The basic timing for switch operation is keyed by the external oscillator. The conversion process is continuously repeated.

A complete A/D conversion cycle is shown in Figure 3B. A measurement cycle can be divided into three consecutive time periods: auto-zero (AZ), integrate (INTEG), and READ. The 6250Hz counter determines the length of each count as 160 microseconds (1/6250), or

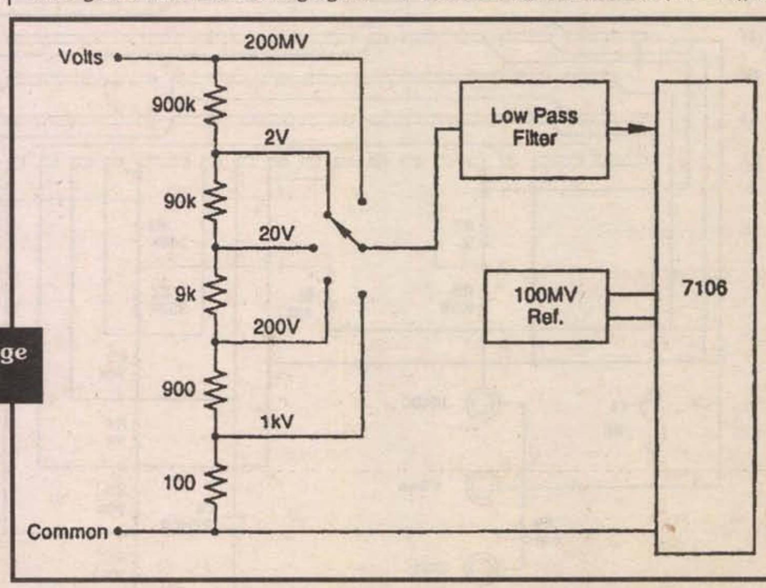


Figure 4 — Simplified DC Voltage Measurement Diagram

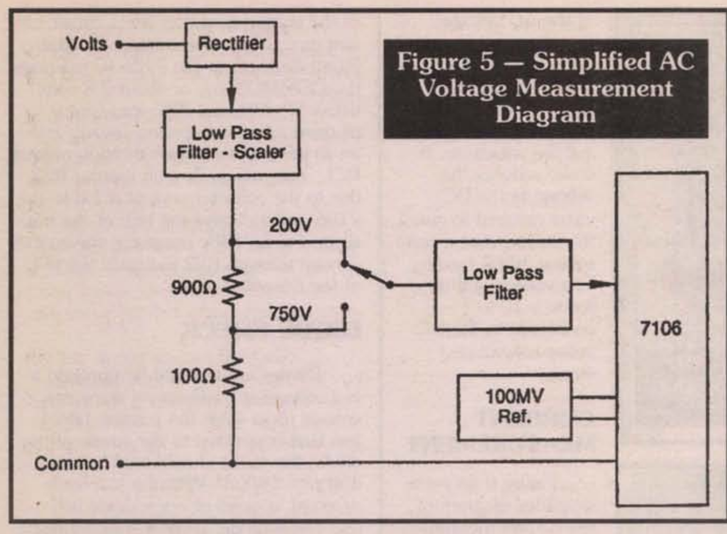


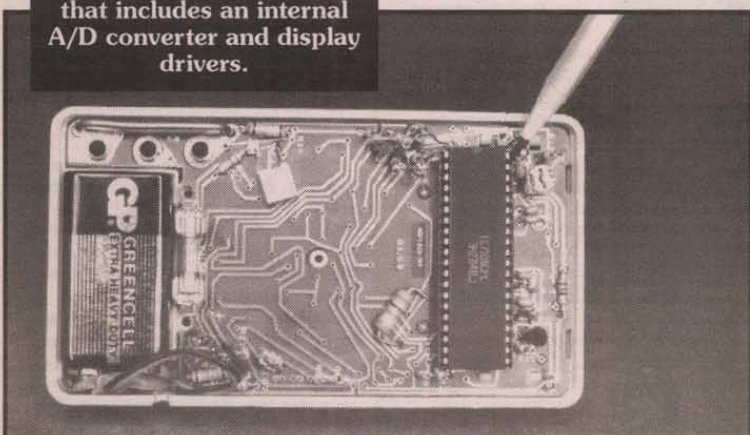
Figure 5 — Simplified AC Voltage Measurement Diagram

160 milliseconds for 1,000 counts.

The AZ period varies from 1,000 to 3,000 counts. The INTEG period is fixed at 1,000 clock pulses (160 milliseconds) during which the unknown input voltage builds up to some level between 0 and 2000mV. The greater the input voltage, the higher it will build during the fixed INTEG period.

The READ period is a variable time that is proportional to the integrated input voltage — the larger the input voltage, the longer the READ time. It can vary from zero counts for zero input voltage to 2,000 counts for a full scale input voltage. The value of the voltage is then determined by simply counting the number of clock pulses that occurred during the READ period. For an input voltage less than full scale, AZ gets the unused portion of the READ period.

The heart of this DMM is the 7106CPL 40-pin chip that includes an internal A/D converter and display drivers.



MORE DETAIL

During auto zero, a ground reference is applied as an input to the A/D converter. Under ideal conditions, the output of the comparator would also go to zero. However, input-offset-voltage errors accumulate in the amplifier loop and appear at the comparator output as an error voltage. This error is impressed across the AZ capacitor (C4, pin 29) where it is stored for the remainder of the measurement cycle. This stored evel is used to provide offset voltage correction during the INTEG and READ periods.

The INTEG period begins at the end of the AZ period. As the period begins, the AZ switch opens and the INTEG switch closes. This applies the unknown input voltage to the input of the A/D converter. The voltage is buffered (R14, pin 28) and passed on to the integrator to determine the charge rate (slope) on the INTEG capacitor (C5, pin 27). At the end of the fixed INTEG period, the capacitor is charged to a level proportional to the unknown input voltage.

During the READ period, this voltage is translated to a digital indication by discharging the capacitor at a fixed rate and counting the number of clock pulses that occur before it returns to the original auto zero level.

As the READ period begins, the INTEG switch opens and the READ switch closes. This applies a known reference voltage to the input of the A/D converter. The polarity of this voltage is automatically selected to be opposite that of the unknown input voltage, thus causing the INTEG capacitor to discharge at a fixed rate (slope). This rate is determined by the known reference voltage (C2, pins 33 and 34).

When the charge is equal to the initial starting point (auto zero level), the READ period is ended. Since the discharge slope is fixed during the READ period, the time required for discharge is proportional to the unknown input voltage.

The AZ period and thus a new measurement cycle begins at the end of the READ period. At the same time, the counter is released for operation by transferring its contents (the previous measurement value) to a series of latches. This stored data is then decoded and buffered before being used to drive the LCD display.

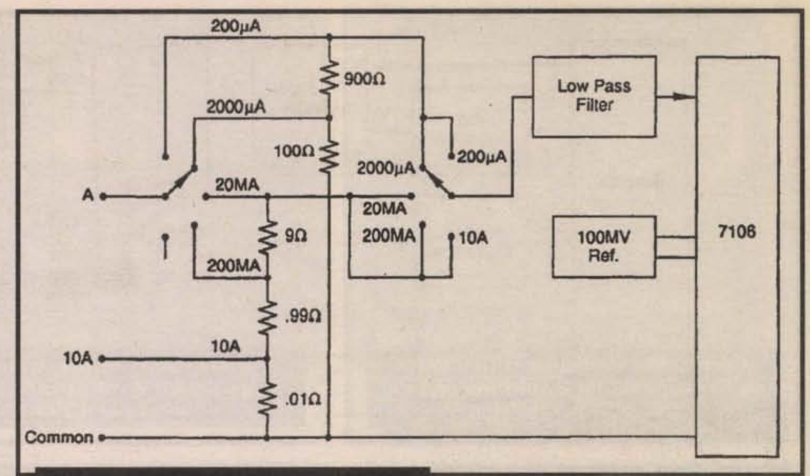


Figure 6 — Simplified DC Amps Measurement Diagram

DC VOLTAGE MEASUREMENT

Figure 4 shows a simplified diagram of the DC voltage measurement func-

SPECIFICATIONS

TABLE 1 MODEL M-1005K

GENERAL

DISPLAY	3-1/2 digit LCD, with polarity
OVERRANGE INDICATION	3 least significant digits blanked
MAX. COMMON MODE VOLTAGE	500V peak
STORAGE ENVIRONMENT	-15°C to 50°C
TEMPERATURE COEFFICIENT	(0°C to 18°C and 28°C to 50°C) less than 0.1 x applicable accurancy specification per °C
POWER	9V alkaline or carbon zinc battery
DIMENSIONS	128 x 75 x 24 mm

DC VOLTAGE

RANGE	RESOLUTION	ACCURACY
200mV	0.1mV	±0.5% rdg±2d
2000mV	1mV	±0.5% rdg±2d
20V	10mV	±0.5% rdg±2d
200V	100mV	±0.5% rdg±2d
1000V	1V	±0.5% rdg±2d

MAXIMUM ALLOWABLE INPUT 1000VDC or peak AC
INPUT IMPEDANCE 1MΩ

DC CURRENT

RANGE	RESOLUTION	ACCURACY	MAX FS VOLTAGE DROP
200μA	0.1μA	±1% rdg±2d	0.25V
2000μA	1μA	±1% rdg±2d	0.25V
20mA	10μA	±1% rdg±2d	0.25V
200mA	100μA	±1.2% rdg±2d	0.25V
10A	10mA	±1% rdg±3d	0.5V

OVERLOAD PROTECTION
NOTE: 10AMP SOCKET MAXIMUM OPERATING TIME — 5 MIN.

AC VOLTAGE

RANGE	RESOLUTION	ACCURACY
200V	100mV	±1.2% rdg±5d
750V	1V	±1.2% rdg±5d

MAXIMUM ALLOWABLE INPUT 750Vrms
FREQUENCY 45-450Hz

RESISTANCE

RANGE	RESOLUTION	ACCURACY
200Ω	0.1Ω	±0.8% rdg±2d
2000Ω	1Ω	±0.8% rdg±2d
20KΩ	10Ω	±0.8% rdg±2d
200KΩ	100Ω	±0.8% rdg±2d
2000KΩ	1KΩ	±1% rdg±2d

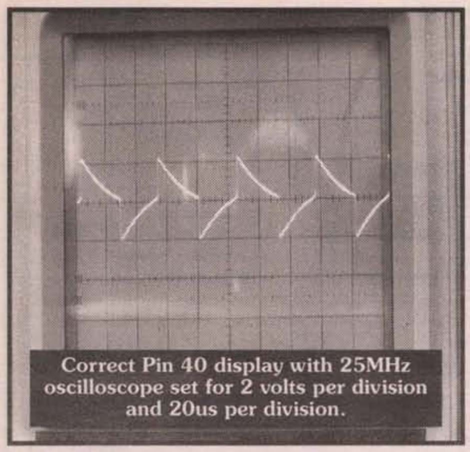
MAXIMUM OPEN CIRCUIT VOLTAGE 2.8V

DIODE CHECK

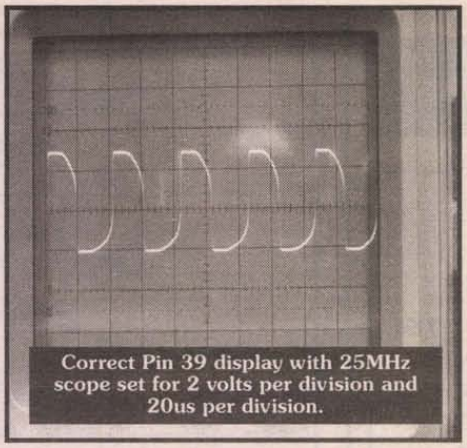
RANGE	RESOLUTION	MAX TEST CURRENT	MAX OPEN CIRCUIT VOLTAGE
DIODE	1mV	1.4mA	2.8V

TRANSISTOR h_{FE} TEST

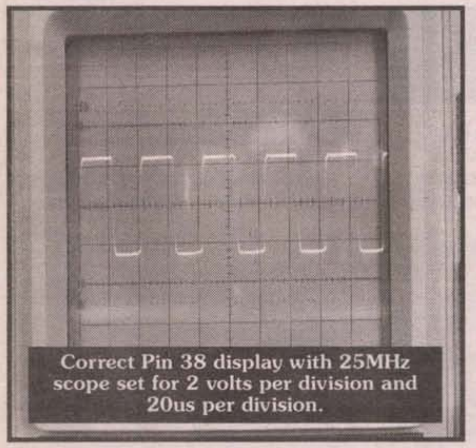
RANGE	TEST RANGE	TEST CURRENT	TEST VOLTAGE
NPN/PNP	0-1000	Ib = 10μA	Vce 3V



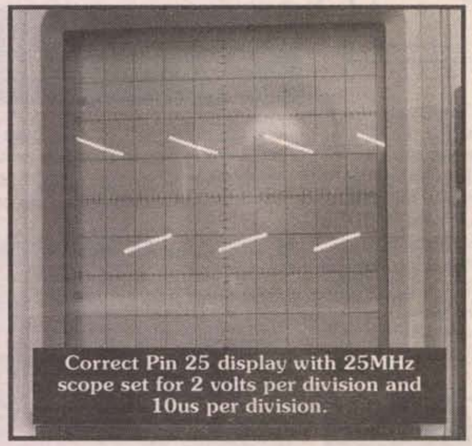
Correct Pin 40 display with 25MHz oscilloscope set for 2 volts per division and 20us per division.



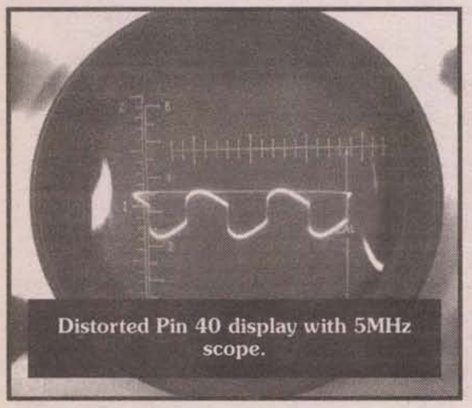
Correct Pin 39 display with 25MHz scope set for 2 volts per division and 20us per division.



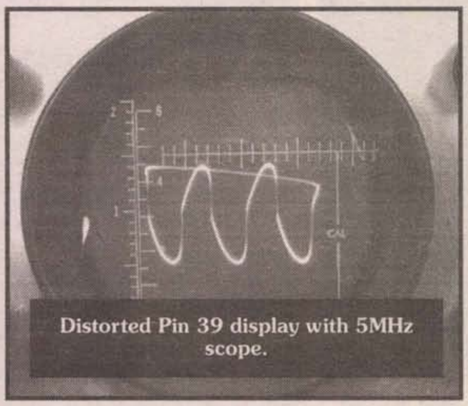
Correct Pin 38 display with 25MHz scope set for 2 volts per division and 20us per division.



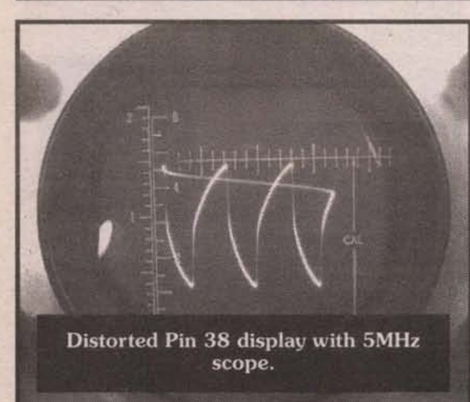
Correct Pin 25 display with 25MHz scope set for 2 volts per division and 10us per division.



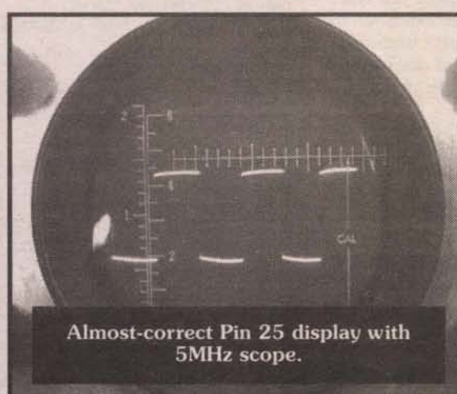
Distorted Pin 40 display with 5MHz scope.



Distorted Pin 39 display with 5MHz scope.



Distorted Pin 38 display with 5MHz scope.



Almost-correct Pin 25 display with 5MHz scope.

tion. The input voltage divider resistors add up to 1 megohm. Each step down divides the voltage by a factor of 10. The divider output must be within the range -0.199 to +0.199 volts or the overload indicator will function. The overload indication consists of a 1 in the most significant digit, and blanks in the remaining digits.

AC VOLTAGE MEASUREMENT

Figure 5 shows a simplified diagram of the AC voltage measurement function. The AC voltage is first rectified and passed through a low-pass filter to smooth out the waveform. A scaler reduces the voltage to the DC value required to give the correct root-mean-square (RMS) reading. The voltage is then fed to a 10-to-1 divider, as in the DC voltage measurements.

CURRENT MEASUREMENT

Figure 6 shows a simplified diagram of the current measurement function. Internal shunt resistors convert the current to between -0.199 to +0.199 volts, which is then processed in the 7106 IC to light the appropriate LCD segments.

RESISTANCE MEASUREMENT

Figure 7 shows a simplified diagram of the resistance measurement function. A simple series circuit is formed by the voltage source, a reference resistor from the voltage divider (selected by the selector switches), and the test (unknown) resistor. The ratio of the two resistors is equal to the ratio of their respective voltage drops.

Therefore, since the value of one resistor is known, the value of the second can be determined by using the voltage drop across the known resistor as a reference. This determination is made directly by the A/D converter.

Overall operation of the A/D converter during a resistance measurement is basically as described earlier with one exception. The reference voltage present during a voltage measurement is replaced by the voltage drop across the reference resistor. This allows the voltage across the unknown resistor to be read during the READ period.

hFE MEASUREMENT

Figure 8 shows a simplified diagram of the common-emitter short circuit current gain (hFE) measurement function. Internal circuits in the 7106 IC maintain the COMMON line at about 2.8 volts below V+. When a PNP transistor is plugged into the transistor socket, emitter to base current flows through resistor R21. The voltage drop in resistor R22 due to the collector current is fed to the 7106 and indicates the hFE of the transistor. For an NPN transistor, the emitter current through R22 indicates the hFE of the transistor.

DIODE CHECK

Diodes are checked by applying a test voltage and measuring the forward voltage drop. With the positive DMM test lead connected to the anode of the diode, the meter should read between 450 and 800mV. With the test leads reversed, a good or open diode will show over-range, while a shorted diode will show a low value, close to 000.

ASSEMBLY

The Assembly and Instruction Manual made the assembly of the M-1005K relatively painless. I say "relatively" since this was not a simple assembly. You must be very careful to get each of the components in the right place — incorrect resistor values will cause incorrect operation. Fortunately, the Manual carefully gives the color codes for each resistor, and having each mounted individually on a printed cardboard strip reduces the chance of error.

Similarly, the one diode and two transistors must be oriented properly, and the 40-pin integrated circuit must be properly oriented and inserted into its socket.

Many of the parts are very close together, and it is easy when soldering to bridge two leads that should not be bridged! I did this in two places, which gave me grief later. Unfortunately, the Manual does not show the two-sided printed circuit board layout, so it is sometimes difficult to determine where leads can be soldered together without a bridging problem.

After all the soldering is done, you assemble the display to the printed circuit board. A special plastic frame with four legs is used to sandwich the LCD window plate and two contact strips (called "zebras") to the printed circuit board. The stiff legs of the frame can easily be bent and broken, so do this carefully.

The trickiest part of the assembly is the mounting of the selector knob. First you insert six small formed metal slide contacts to the underside of the knob, then use the supplied grease, and place two small springs in two holes on the top of the knob. Then you place two small steel balls into opposite detents in the case cover, invert the knob, and place the knob springs onto the balls. When the printed circuit board is placed over the back of the knob and fastened down, the knob should turn smoothly and stop positively in each detent position.

I had trouble with this. When I turned the knob, one of the steel balls would pop out. This happened several times. I had to use more grease and stretch the ball spings a bit before the knob turned smoothly and stopped positively at each detent.

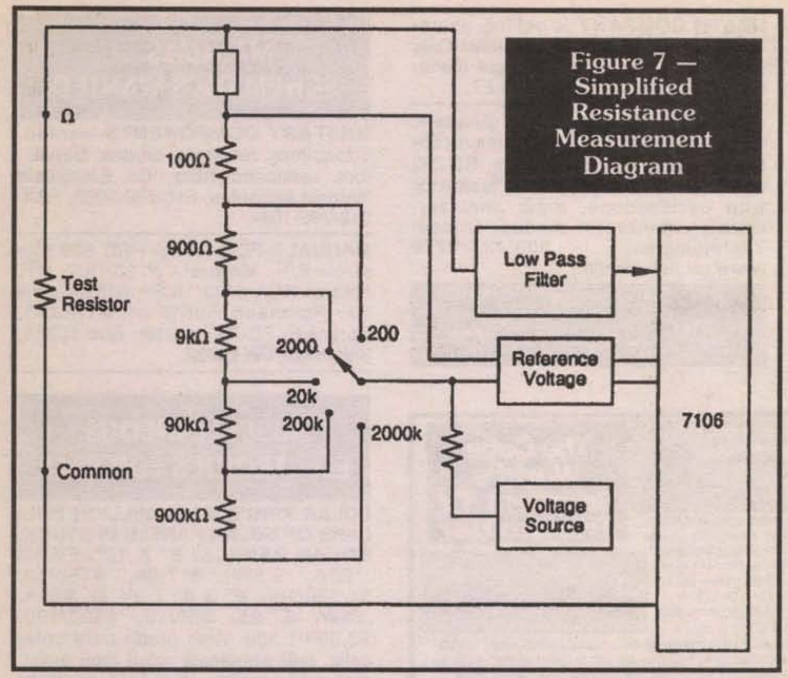


Figure 7 — Simplified Resistance Measurement Diagram

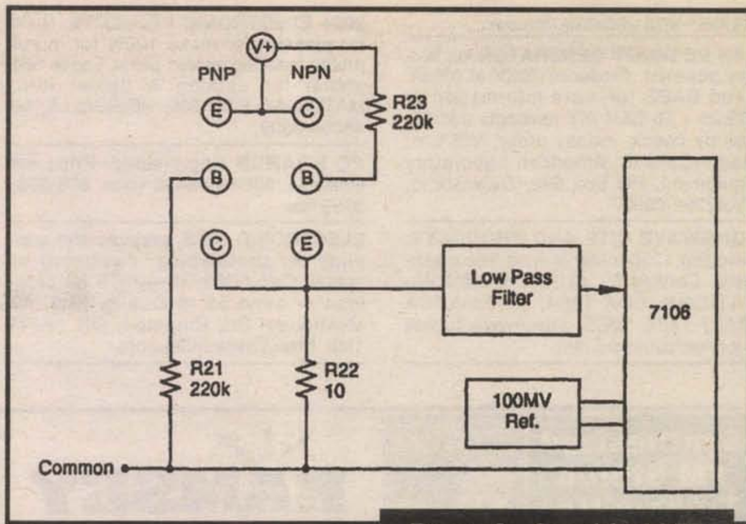


Figure 8 - Simplified hFE Measurement Diagram

TESTING

Finally, the moment of truth. I snapped the 9V battery terminals to the supplied battery, and switched the selector knob from OFF to the first position clockwise position, 750VAC. Instead of the display showing 000, it showed 015. As I switched clockwise around to the hFE position, the only change was that the decimal point was either not there at all, or in one of two locations.

At the diode test position, a 1 appeared on the display by itself. In the 200-ohm switch position, a 1 appeared with a decimal point before the final blank digit. Around the rest of the switch positions there were various displays — but none showing 000, which is what it should show in all positions except off!

Hmmmm. This was bad. The unit did not auto-zero. I tried adjusting the one potentiometer, R12, but it had no effect.

The Manual makes no mention of this, but there is an easy way to test the LCD display. With a jumper between pin 37, the TEST terminal of the 40-pin 7106 IC, and pin 21, the LCD backplane terminal, the display should light ALL the LCD segments except the decimal points, showing -1888 on the display whenever the selector switch is in any position except OFF. I did this, and I got the -1888 display, showing that at least all the display drivers in the 7106 IC were operating.

TROUBLESHOOTING AND SCOPES

I performed a very careful inspection with a magnifying glass, checking the value of all components, and the soldering. I found no parts out of place, but there were two places where solder had bridged where it shouldn't have. I confirmed this by referring to the schematic and using an ohmmeter to show continuity where there should be none! I cleared the solder bridges and, convinced this was the problem, I tested the DMM again — with the same bad results!

Time for the oscilloscope to see if I had the proper trace on each pin. Although the Manual did not show these traces, I had a properly working DMM using the same 7106 IC. Its manual showed the proper traces on some significant pins, so I compared traces. I found that six pins (27, 28, 29, 33, 34, 35) on the defective unit were drastically different from the properly working unit. This certainly made the 7106 IC suspect.

I should note here that I used two analog scopes during this troubleshooting. The first, an RCA WO-33A with a low 5MHz bandwidth (adequate 40 years ago) showed traces that did not look like they should. When I used a modern B+K Model 2120B 25MHz scope, the traces were just like the manual that showed the traces. See the photos. Digital signals, except at low frequencies, do not display properly on low bandwidth scopes.

I carefully checked the circuitry feeding the 7106 and could find no errors, so I called C&S Sales, the kit source, and told them my problem. They sent me a replacement 7106. When I used this to replace the original 7106, the meter worked perfectly!! Was the original 7106 defective, or did my two solder bridges destroy some internal functions? We'll never know ...

Now it was simply a matter of calibrating the DMM by feeding in a known voltage around 10 volts DC (using a known accurate digital voltmeter for reference) to the M-1005K with the switch in the 20DCV position, and adjusting R12 so that the display shows the known voltage. All other ranges automatically adjust with this calibration.

The M-1005K uses very little battery power — and none when it is OFF. With the switch in the diode test or 200-ohm positions, about 3.5 milliamperes is drawn from the 9V battery. In all other operating positions, only from 1.3 to 1.5 milliamperes are used. This should give the battery many 10s of hours of use.

FINAL COMMENTS

After assembling the M-1005K and getting it working properly, I tested resistors, diodes, transistors, power supplies, etc., using the supplied leads. The unit worked well, and readings compared very favorably with my other more expensive DMMs.

If your needs are not critical, your budget is modest, and you like building and troubleshooting electronic kits, you should be very pleased with the M-1005K Digital Multimeter Kit. **NV**

Source

The Model M-1005K Digital Multimeter Kit is available from **C&S Sales**, 150 W. Carpenter Ave., Wheeling, IL 60090, for $19.95 plus $5.00 shipping. The identical assembled unit is the Model M-1000B, same price and shipping. Call **800-292-7711** to order, or for a free 60-page catalog loaded with test equipment and kits from major manufacturers.

PLANS – KITS – SCHEMATICS *cont.*

VAN DE GRAFF GENERATOR kit. Battery powered. Produces 70KV at 0.6uA. Send SASE for more information or $29.95 + $5 S&H (KY residents add 6% tax) by check, money order, VISA, or MasterCard to: American Laboratory Equipment, PO Box 592, Owensboro, KY 42302-0592.

LONGWAVE KITS AND PRODUCTS. Including 1750 meter license-free equipment. Catalog $1. CURRY COMMUNICATIONS, BOX 1884, Burbank, CA 91507-1884. WEB: http://www.fix.net/~jparker/currycom.htm

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PC BOARDS single-sided. Price list available. 808-949-5410 voice. 808-955-3959 fax.

ELECTRONIC KITS, projects and supplies for prototyping, designing or hobby. Call 1-888-GO-4-KITS for catalogs or send $3 to Quality Kits, 49 McMichael St., Kingston, ON., K7M 1M8. **http://www.qkits.com**

HEATH COMPANY is selling photocopies of most Heathkit manuals. Only authorized source for copyright manuals. Phone: 616-925-5899, 8-4 ET.

QUICKEST PROTOBOARDS available, compatible with most small microcontrollers. Also, PIC monitor kits, RS-232 instrumentation chips, pocket testbench with oscilloscope, logic analyzer, counter, generator modes. Oricom Technologies, 303-444-9776 (www.sni.net/~oricom).

MANUALS – SCHEMATICS WANTED

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

MANUALS FOR folling: PRD 809 Klystron P/S, Motorola P-13-IA-L HT, radars: RCA AVQ 10,55 military APN 59, Raytheon 50KW HTMTRLOG, Sorensen FC-75 inverter. Box 10215, Pittsburgh, PA 15232.

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SOLAR-POWERED FAN HAT. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

ELECTRON TUBES: All types bought and sold. Daily Electronics, B-6 10914 NE 39th St., Vancouver, WA 98682. 1-800-346-6667, 360-896-5476 FAX.

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ELECTRONIC ASSEMBLY MACHINERY. We buy and sell assembly machinery including solder machines and board cleaners, insertion machines and lead formers. Petlock Inc., Rialto, CA. 909-877-8900, FAX 909-877-8902.

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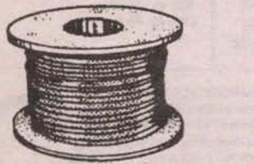

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MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

CLOSEOUT ITEMS, Tesla coil kit world famous $19, $55/3; wind speed indicator kit $5, $13/3; fan/motor speed control $3, $10/4; solder melting pot 2-1/2"ID, 1-1/2"D $3, $13/3, voice/sound activated switch modu. $1, 2 speed SW. Motor/lamp control $1/2,12/$5; Mallory Sonalert SC628 $3.50, $16/5, security keylock switch w/2 keys $3/2. WWW.BNFE.COM BNFE, Rte. 1S, Peabody, MA 01960. T978-236-2000 F978-536-7400, WWW.BNFE.COM Estab. 1964.

ESI DIGITAL LRC meter #296 $500; 2 HP 6261B DC power supplies $250; Racal-Dana mod 5002 wideband level meter $275; HP 6940B multi-programmer $150; HP 7550A & 7474A plotters $450 ea. Credit cards accepted! ISE: Ph: 956-350-5555, Fax: 956-350-5574.

ELECTRON MICROSCOPE, Hitachi model H-600, transmission type, 1981. Resolution to 1.4A, CPU controlled $3,500 obo. 817-279-9005 pm's.

BNC BARREL connectors, Amphenol UG914/u, female to female, new surplus in original Amphenol package, $10 dozen plus $2 shipping, check/money order only, w/customers add 5.5% tax (55¢ dz.). Essential Technology, PO Box 772, Superior, WI 54880.

HP 8640B-002 $2,100; Sony LPD 2000-02 new $750; 3M-UCA-60s new w/s-cases $10. Videoshow-HQ loaded call, plus laptops, HP calculators, DVMs, computer misc. negotiable. 719-630-1492.

HONEYWELL 101 28 track IRIG recorder with manuals, extra parts and tapes. New $40,000, excellent condition $795. 412-431-9180.

TV & VCR tuners $20 ea. 6LQ6 $25 ea. GE & Zenith modules $20 ea. 1418 Hwy. 199 South, Dublin, GA 31027. 912-272-6561.

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WANTED: MORSE code equipment for learner. Please call 978-453-2833 or fax 978-441-9468 for further info.

WESTERN ELECTRIC audio equipment wanted. 1927-1960's. Amplifiers, "receivers," speakers, x-overs, tubes, etc. 1-800-251-5454.

TESTERS WANTED: Immediate offers made for Ultrasonic, Magnetic Particle, Eddy Current, X-Ray and Borescopes, 24hrs. Leave detailed message with make/model. 1-800-530-3371.

EXCESS INVENTORY WANTED: Transistors, semiconductors, capacitors, PC boards, & diodes. We buy it all!! Contact: **SEMITECH, INC.**, 381 Roberts Road, Oldsmar, FL 34677. Phone 813-854-3311, FAX 813-854-3422.

WESTERN ELECTRIC audio equipment wanted. 1926-1960s amplifiers, speakers, pre-amps, tube, transformers, etc. 1-800-old-mics 1-800-653-6427 Great Wireless Museum.

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WANT USED or surplus DC motor controls or adjustable frequency AC drives, 1/2 HP and up. DC motors fractional to 3 HP. C. Woodruff, 5507 55th Ave. So., Seattle, WA 98118. Voice/Fax 206-723-8487.

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 91719, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

What is the simplest and cheapest way to create waveforms with the following specs: from 1 or 2 Hz to at least 30 Hz (or higher); with 1/100 Hz resolution (i.e., able to produce 7.83 Hz)? Would it be a function or signal generator, a dedicated IC, a microcontroller, or a PC software program? I would appreciate any info including the program(s), spec(s), plans, or sources of the same.

3981 **Steve Burgess**
Pinetops, NC

I am interested in any published data on equipment (to buy or build) specifically for "cleaning up" old records — 78s mainly — and enhancing the sound to transfer to magnetic tape; especially to get "clean" sound like the new CD re-issues of very old recordings — but for the home hobbyist.

3982 **Gary A. Micanek**
Manchester, MO

A "differential temperature controller" (Dynatech Energy Controls model SC30) on my solar heat system failed. The manufacturer is apparently out of business. Can someone provide a schematics and parts list to make a replacement for the encapsulated module, or provide details to build a new controller?

Each controller turns on a circulating pump when one heat source is hotter than the next. One operates when my solar panel is hotter than the reservoir water. Another operates when the reservoir water is hotter than the hot water heater, but shuts off when the hot water heater reaches a preset temperature, like 140 degrees F.

3983 **Oliver Curtis Powell**
Rocky Mount, NC

Can someone supply a schematic for an adjustable power resistance soldering unit handling up to about 200W? Primary power is 110V AC. (Low voltage — high-current device.) American Beauty makes such a unit, but it's very expensive. I can find a foot switch and probably purchase the insulated tweezer or single-point electrode. Any help would be appreciated.

3984 **Andy Pratsh**
Northridge, CA

How can I learn the Morse Code better? What is the difference between the international Morse Code and the real Morse Code? Can someone tell me why I cannot copy the Morse Code at a faster speed?

3985 **George E. Tarbox**
Auburn, ME

I have a Zenith laptop model: ZWL-0200-02; serial: 906DE019467 EIA-416; FCC ID: BJ468E-557C PP82.

I would like to expand the memory on it. Can someone give me the pinout information and/or a schematic for a memory expander board?

3986 **Robert W. Ritchey**
Vandalia, IL

On a code-a-phone model 1750 two-line answering machine with six contacts for the phone line connection; which two are tip green and red ring for each of the two lines?

3987 **K. Marchant**
Coshocton, OH

I hope you can help me with this printer problem. I have a Toshiba Dual Mode WS5271A printer that I purchased at a garage sale several months ago. (The dual mode refers to the fact that it operates on AC or the built-in rechargeable battery.) The printer powers up and seems to work, but I can't get the computer to recognize its presence.

My guess is that the DIP switches on the rear are not set properly and I have no documentation for them. Moreover, the printer panel buttons are written in Japanese, the only English is the make and model number. There's also a nine-pin round connector to the right of the DIP switches, if that helps any.

3988 **lfostano@juno.com**

Where can I get copper enameled wire for winding RF coils? All I can find is enameled magnet wire.

3989 **Joe Kearney**
Brockton, MA

I am trying to design an improved pocket alarm clock because this one will include a calendar with two segments per day,

I need a controller that can interface 240 LCD segments.

There will be 10 input lines from the control keys. I also need time keeping, of course. Operation on zero current at three volts is preferred. The device should be mask programmable, with an affordable development kit available.

Does anybody know of such a device? It is nice to get everything on a single chip.

39810 **Richard Schwartz**
via Internet

I am looking for a circuit to use on rechargeable battery packs such as cordless drills, camcorders, ham radio's, etc.

I have seen device's advertised that are suppose to reset the memory of the battery so it operates like new, does this really work and if so what is the concept?

39811 **Larry Mynk**
via Internet

I am looking for a source that carries the GEC Plessey ZN414Z transistor. This is a three-pin TO-92 package "radio on a chip." Originally designed for the BC band, it also makes an excellent shortwave receiver. All Electronics (California), DC Electronics (Arizona), and Circuit Specialists (Arizona) no longer sell this item. Does anyone know of any other suppliers? I need about a dozen, but will be happy with any amount I can find.

39812 **Jeff Helgoe**
Deerfield, IL

I build test equipment that times sporting events. I have been using expensive Universal Counter chips, but I have an idea for an alternative.

There are complete LED panel-mounted digital voltmeters available for around $10.00. Most of the periods I measure are less than two seconds. Why not convert milliseconds to millivolts! I could feed in a pulse, convert it, and display it on the voltmeter. Except I, and an EE friend, cannot figure out how to do it digital. All we can come up with, used the RC time constant of a capacitor, which is not linear enough.

39813 **Paul Frankle**
via Internet

In the Nov. '96 issue, a question was posed as to a blank page being printed before the actual print job when using Windows 3.11 or Windows 95 (Question 11967). Our printer (HP Deskjet IIID) has a similar problem. However, instead of printing a blank page, our printer prints a single character (usually E or 4). How can we remedy this problem? It seems our MIS Department is stumped (big surprise!), but we would like to reduce the amount of wasted paper.

39814 **Patrick A. Reagan**
via Internet

I have a HP 2686 laser printer that I do not have a book for. It has DIP switches on the back under the cover. Do you have any idea what these are for? The printer does not work on the

Continued on page 103

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.
- 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.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- 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.

#170 MISC. ELECTRONICS WANTED *cont.*

WANTED: ELECTRICAL materials, Allen-Bradley, Agastat, Appleton, Crouse-hinds, T&B, Square D, Pyle National, Russel & Stoll, circuit breakers, fuses, connectors. Call Beiner Sales, 805-376-9044, FAX 805-376-8207.

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WANTED: BALANCING machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

WILL PAY cash for electronic related business. Inventory, machinery, or equipment. ISE 956-350-5555 FAX: 956-350-5574.

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DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

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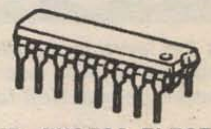

WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 562-494-4851 OR FAX 562-494-4913.

WANTED: TUBES, radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Cranbury, NJ 08512-4212. Phone: 609-395-1116, FAX 609-395-1117.

RADAR/MICROWAVE equip: Aviation, marine, fire control. Like TPS 21, APS 10, 42 APG 30. Parts, TM's, etc. Radar, Box 10215, Pittsburgh, PA 15232.

WANTED: TUBES, NIB connectors, MS (military), tube shields, ceramic sockets. Tubes for sale. Send SASE for new list "V." Typetronics, PO Box 8873, Ft. Lauderdale, FL 33310-8873. 954-583-1340 fax 954-583-0777. Fred Schmidt N4TT.

SOFTWARE WANTED for operation of Andros exhaust gas analyzer model 6330. Uses M68HC11A1 uncontroller with RS232 interface. Call Jim at 510-447-4982 with price, etc.

MISSED HEYDAY of new math! Any extra slide rules for purchase/trade /whatever. Please E-Mail: Brian64268@AOL.com

WANTED PIONEER 5XXX-6XXXX SERIES CONVERTERS, RAW, LOTS 5 OR MORE, TOP CASH PAID. 702-642-0325.

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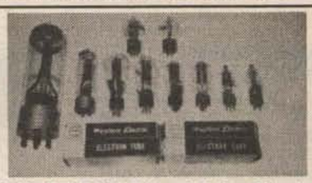

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BUYING USED and excess memory, EPROMs, circuit boards, etc. SMA 812-849-0007 fax lists 812-849-4035.

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- SGC SG-500
- MFJ/Ameritron 600

HIGH-FREQUENCY MOBILE ANTENNA COMPARISONS

by Gordon West

THE NEW SGC-2020 COMPACT HF SSB TRANSCEIVER

The ultimate dream of an avid ham radio operator might be driving down an expressway or lonely road, staying in touch with another ham station halfway around the world. For emergency communicators at the Red Cross or FEMA, mobile radio operators want to pick up the mic and be able to establish emergency-comms 500 miles to 3,000 miles away — all the time. A CB radio operator at 27 MHz driving an 18-wheeler or the family sedan would love to talk with other radio operators thousands of miles away, too.

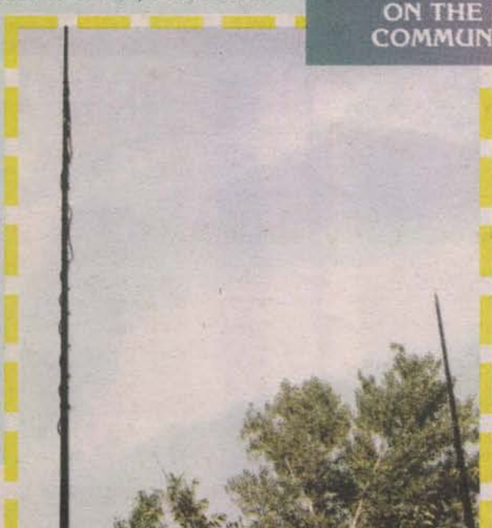
This may not necessarily be a wild dream — it may be a daily occurrence on the 1 MHz-54 MHz ham and commercial bands. It's a proven fact that radio signals refract off of the ionosphere's E-layer and F-layer for reliable skywave communications over a certain distance at a particular time during the day or night. The ionosphere is not only effected by day or night ionospheric changes, but also the seasons, your latitude, and our upward progression on new solar cycle 23. Solar cycle 23 will peak around the year 2002 for extraordinary long-range, high-frequency communications.

Ham radio, commercial radio, and CB radio high-frequency equipment is relatively easy to mount in almost any kind of vehicle.

But now the big question — what's the best way to get these high-frequency, single-sideband, double-sideband, CW, and digital watts up into the ionosphere with a good powerful bounce? Of course, it is the mobile ANTENNA and the associated ground plane that can give you a rock-solid signal halfway around the world, or a puny signal that can barely be heard 100 miles away. Another challenge for this mobile antenna is to send out a signal in all directions. This rules out achieving "gain" by going to a directional Yagi-type antenna on your vehicle.

Another challenge is to keep this mobile antenna short enough so it won't be hitting overpasses at 16 feet above the roadway. And how are you going to mount one of these heavy mobile antennas on your vehicle? Must you really bore holes in the vehicle to get a high-frequency antenna onboard?

And finally, what type of high-frequency mobile whip will work best for you?



THE OUTBACKER "OUTREACH" ON THE BACK OF THE COMMUNICATIONS VAN

FIRST, SOME SIMPLE MATH

The velocity of radio waves in free space is 300 million meters per second. Ham radio bands are spread out from 160 meters through six meters for worldwide high-frequency propagation. There are shorter wavelength ham bands, but these bands do not normally support skywave refraction. The high-frequency bands between 160 meters and 10 meters also include specific frequencies for emergency FEMA communications, ship-to-shore, Red Cross, and the 11-meter band for CB communications.

The frequency of a signal determines the exact spot on the radio dial where a transmission is going to take place. The wavelength of a signal is an approximate area within a BAND that may support this type of communications. For instance, ham operators wanting long-range, mobile-to-mobile communications might choose the 20-meter ham band, setting their radio dial to an exact frequency of 14,302.5 MHz. It takes a General class ham license to work on these frequencies. A no-code Technician ham operator might choose six meters, 50.125 MHz to listen for some single-sideband skywave signals. CBers might choose the 11-meter band centered around 27 MHz for mobile communications.

Frequency and wavelength are inversely proportional. The higher you go in frequency, the shorter the wavelength. To convert the frequency MHz into the meter band, divide MHz into 300. To convert a specific wavelength band in meters into MHz, divide meters into 300.

TABLE 1

Meter Band	MHz Frequency	1/4 Wavelength in Feet
6 meters/ham	50.125 MHz	4.6 feet
10 meters/ham	28.400 MHz	8.0 feet
15 meters/ham	21.400 MHz	10-3/4 feet
16 MHz FEMA/Red Cross	16.500 MHz	14 feet
20 meters/ham	14.300 MHz	16-1/4 feet
8 MHz FEMA/Red Cross	8.200 MHz	28-1/4 feet
40 meters/ham	7.250 MHz	32-1/4 feet
4 MHz FEMA/Red Cross	4.100 MHz	56-3/4 feet
75 meters/ham	3.950 MHz	59-1/4 feet
160 meters/ham	1.900 MHz	123-1/4 feet

Got it figured out? If I said there was some great automatic packet reporting system digital long-range signals on the 30-meter band, you would tune around 10 MHz for this activity (300 ÷ 10). If there is great nighttime communications on the 7 MHz band, 7 MHz works out to be the 40-meter ham band (300 ÷ 7 = 40).

Mobile antennas offer the best performance when they are electrically one-quarter wavelength of the signal of transmission, and have the metal car below equalling or exceeding an additional one-quarter wavelength. This means your entire mobile station must look like a halfwave antenna — one-quarter is the whip, and the other quarter wavelength is the car chassis.

Keeping in mind that frequency and wavelength are inversely proportional, we can calculate the optimum resonant one-quarter wavelength whip by the formula 234 ÷ MHz = one-quarter wavelength in feet whip. This formula is based on the assumption that the mobile whip will be mounted on the top of your vehicle or on the trunk lip. The top of the vehicle will be preferred, but the trunk lip will be more practical. But the trunk lip requires an RF safety evaluation because of the proximity to folks sitting in the back seat. More about that later.

So here is this whip, theoretically mounted in the center of your roof, capable of worldwide high-frequency communications via skip off the ionosphere, one-quarter wavelength long *(see Table 1)*.

So come on now, be a REAL long-range radio operator and put one each of these one-quarter wavelength long whips on your vehicle — all at once! Okay, not practical. How about just one whip? You will go for that? Okay, let's operate long-range nighttime comms on 75 meters. Let's see now, the chart says that my 75-meter whip will be about 60 feet long. Guess that shoots the 16-foot height limitation, doesn't it?

And this has been the perplexing problem for hams using multi-band equipment wanting long-range communications from six meters all the way down to 160 meters. What to do about whips too long, and too many whips for all the bands.

On six meters, 42 MHz Red Cross frequencies, 10 meters, and 11 meters CB, a one-quarter wavelength stainless steel whip will be the optimum performer with zero dB loss in any loading coils. You don't need to electrically shorten these antennas with coils, so go for a "natural" one-quarter wavelength whip, and try to mount it with as much metal below it in all directions as possible.

On the ham 15-meter band, the 11-foot stainless steel whip (if you could find one) mounted on the trunk lip is going to put you right at the 16-foot State highway limits. But good news — an unloaded whip on 15 meters positioned over a good metal car ground plane will outperform any other 15-meter whip that is shorter in length.

You see, we need to physically shorten one-quarter wavelength mobile whip antennas for the wavelength bands 20 meters, 40 meters, 75 meters, and 160 meters ham. A series inductance loading coil will cause a relatively short mobile whip to become one-quarter wavelength resonant on one specific frequency. The more inductance, the lower the frequency of resonance. Less inductance, higher resonance on a physically shortened whip.

And where the inductance goes is important, too. Most antenna manufacturers will never base-load a high-frequency whip because loading coil losses are exaggerated at a high-current spot at the feedpoint.

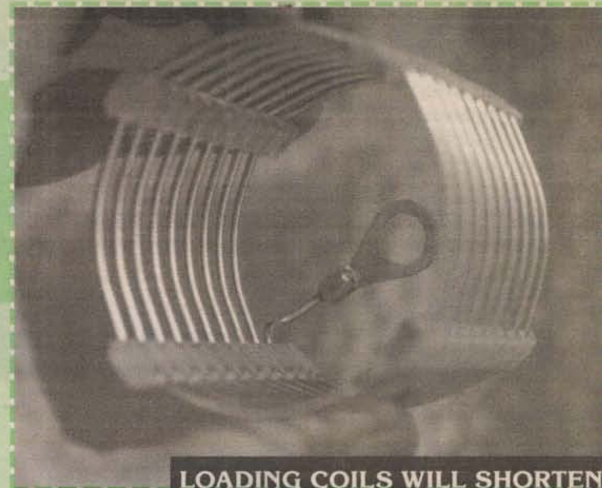
Center-loading a high-frequency whip for a specific frequency of operation is a popular method of achieving resonance.

- Hustler Newtronics
- MFJ
- Kenwood
- Comet
- Homebrew

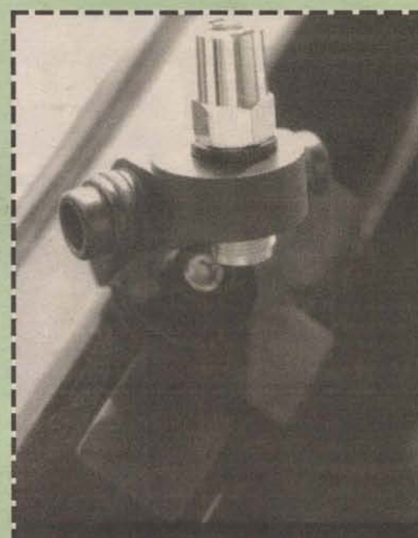
Center-loading a mobile high-frequency whip is a good technique to keep loading coil losses to a minimum, wind resistance tolerable, and aesthetics marginal. The larger the loading coil, the less i^2r losses, and a slight increase in radiation resistance. Despite the word "resistance," the higher the radiation resistance, the lower the i^2r losses.

Another technique of achieving mobile antenna resonance with a whip under 10 feet long is helical loading in the center of a fiberglass shaft.

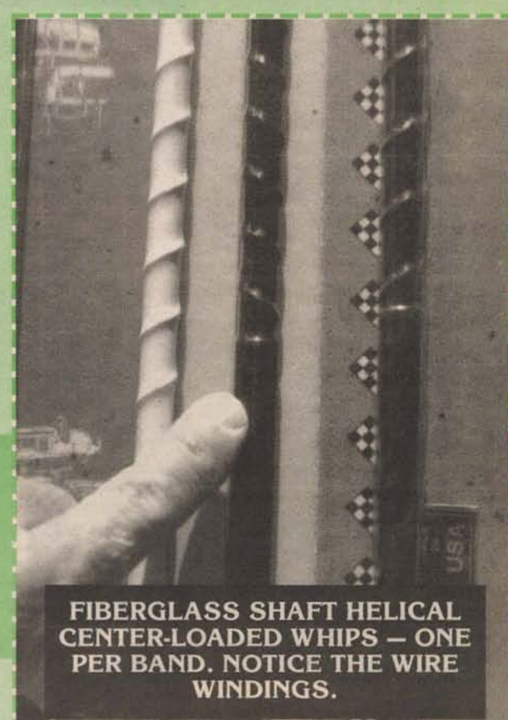
- Antennas West flexi-stick antennas
- Kenwood
- Lakeview ham sticks
- Valor
- WinnTenna
- Other look-alikes



LOADING COILS WILL SHORTEN THE OVERALL HEIGHT OF THE MOBILE WHIP.



THE STRONG HATCH MOUNT WILL HOLD BIG WHIPS.



FIBERGLASS SHAFT HELICAL CENTER-LOADED WHIPS — ONE PER BAND. NOTICE THE WIRE WINDINGS.

These sleek, lightweight, fiberglass-shaft antennas have a series loading coil, helically wound, in the center, with an adjustable yard-long stainless steel tip whip. This concept of helical center-loading decreases wind resistance dramatically over a larger center loading coil, and the antenna is extremely lightweight, too, making for easy hatchback-mount connection. When they tangle with trees, there is no big center loading coil to get snagged.

But I have found one precaution — make sure you seal the point where the stainless steel whip screws into the lower fiberglass shaft. If you don't, rain water can accumulate on the whip tip, drip down into the hollow center of the fiberglass shaft and, like a rain gauge, collect water at the feedpoint until the characteristic impedance of the feedpoint changes dramatically and your radio refuses to load up properly. I have poured out over a half cup of water on some of these antennas that were not shipped with a red weatherproofing boot.

These antennas are a great consideration if you want to get on the air with five different bands and five different antenna shafts, for under $100.00 for the lot. They also come in a variety of shaft colors, too!

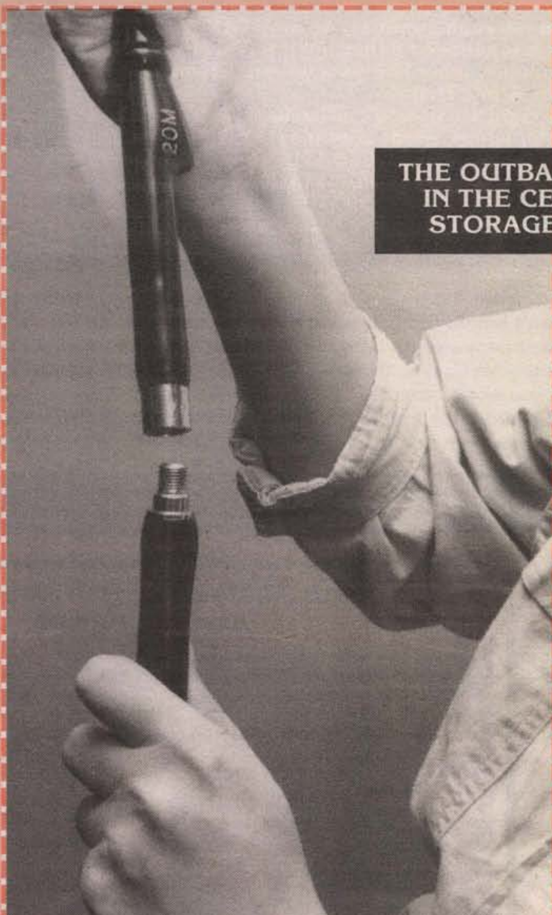
Another way of loading a high-frequency whip for mobile operation on a single band is top helical loading.

- Spider multi-band antennas
- Mobile Mark mobile antennas

Antenna experts claim there are lower losses and increased bandwidth with top-loading techniques where no stainless steel whip is seen protruding from the shaft. I like top loading, although the antennas are a little heavier than helical center loading. Top loading gets the RF power up the shaft, and out from anyone seated down below near the feedpoint. It's a safe antenna because there is no stainless steel whip that could accidentally ignite a low-hanging dry tree branch, or jab somebody in the face during antenna whip changes.

There is a lot of voltage at the end of the top-loaded whip, so great care must be taken when fine-tuning the little wire coil at the top to prevent flash-over to the rubber boot. I usually use high-voltage dope to treat the end of a freshly pruned HF top-loaded helical whip. Mobile Mark (formerly Anixter Mark) is best known for their one-quarter kilowatt and ONE kilowatt HF top-loaded helical whips. They are virtually indestructible — you can bend them to 270 degrees of their radius.

Then there are the multi-band mobile whips that are so unique in their design that you really can't call them center loaded, helical center loaded, or top loaded.



THE OUTBACKER SEPARATES IN THE CENTER FOR EASY STORAGE IN THE TRUNK.

The Alpha Delta Outbacker whips, brought in from Australia, feature a combination of center band tap loading with center helical windings, with a stainless steel top whip that can generate enough RF to set a dry tree branch on fire! To change the Outbacker band setting, you simply unplug a "fly lead" wire and replug it into the band of your choice. You wind up the fly lead wire on the outside of the OUTBACKER for those band taps that are down close to the feedpoint. As you go higher in frequency, most band taps are higher, and you unwind the fly lead, and push the banana plug into the band of your choice.

The Outbacker comes in many different power handling models, plus many different models for ham, ham and marine, commercial, ham and commercial, FEMA, Red Cross, and special order.

I run two Outbackers on my communications van: one on the ham bands, and another one on long-range emergency Red Cross and marine SSB frequencies. I like the performance of the Outbacker, a lot, and I also like the fact that I don't need to carry a handful of whips for several different bands of operation. All of the bands I need on the Outbacker are right there with the appropriate band tap.

You can also go motorized for multi-band operation with the T.J. Antenna Company "Broadbander BB-23." A screw driver motor runs a tap up and down the long loading coil, achieving remote-controlled resonance on any specific frequency. Nifty, but big and heavy.

You can also get plans to build the DK motorized antenna; and if you like "homebrewing" your own gear, this is a great way to go.

WHICH ONE WORKS BEST?

If you want the ultimate in mobile high-frequency recovered signal strength at the distant skywave receiving station, pump your signal into the biggest, ugliest antenna that your better half will let you put on your car or motorhome. The Texas Bug Catcher generally fits into the most massive antenna category with the largest loading coils available, along with capacitive top-hat loading, too. You'll look like Voice of America driving down the street, but you'll have the loudest signal of any mobile on the specific band that you have tuned your Texas Bug Catcher to. And there are variations of the Texas Bug Catcher by other manufacturers, but why not go for the real thing?

If you're looking for a lightweight antenna that can fit on a hatch mount from Comet or Diamond, get those helical-loaded, fiberglass-shaft whips, and screw on the band of your choice. We tested the performance of the helical loading versus the center loading techniques, and the same length whips with their different loading schemes have almost identical transmit and receive performance. Same thing with top loading — we got the same signal reports with a top-loaded antenna as center loading. However, we DID find that top loading gave us a slightly broader bandwidth down on the lower frequencies.

If you want multi-band operation without having to stop your vehicle to change antennas, you might want to go for the Spider, Hustler, Comet, Kenwood, or Valor multi-resonator mobile HF antenna systems where the signal automatically goes to the right resonator. Performance is slightly down over a single whip, but what the heck, you can switch from 20 meters to 40 meters without having to stop the car. Pretty neat, huh?

If you are extremely serious about your performance, and the capability of multiple bands on one nice, neat antenna, my favorite is the Alpha Delta Outbacker. The six-foot Outbacker with its many bands puts out a good signal, but the 11-foot Outbacker "Outreach" puts out a signal that is generally one S-unit stronger. The taller "Outreach" Outbacker antenna also offers increased bandwidth. If you mount the OUTREACH Outbacker antenna off the fender of your car, it should not exceed the 16-foot overall height limit.

SEAL THIS CONNECTION TO KEEP WATER OUT ON THE INSIDE OF THE HOLLOW SHAFTS.

However, on our communications van, mounting it up high (see pictures) caused it regularly to bang on low clearance bridges and do a number on overhanging tree branches. But the "Outreach" is tough enough to take any of these encounters in stride, and the worst we did was to knock off the corona ball at the flexible stainless steel whip tip.

"I have always found that the taller the HF mobile antenna, the better its performance," comments Bob Davis K7IY, out of Reno, NV. "My wife, Marina, and I regularly conduct high-frequency nets while operating mobile, and we can always hear a big difference in signal reports when we switch from a relatively short center-loaded antenna to a much taller helical-load or top-loaded HF whip," adds Davis.

Bob Davis can be heard every Tuesday evening, 7:30 p.m. California time, operating lower sideband on frequency 3868 KHz running a net that regularly rates mobile HF signal quality.

"The taller the HF mobile whip, and the higher up it is located on a vehicle, the better signal strength I'm going to get from those mobile stations checking in," finalizes Davis. If you check in, be sure to get a relative signal strength measurement on his CAT meter.

Except for the massive Bug Catcher type of HF whips, most of these described antennas may be affixed to your vehicle or motorhome using gutter mounts or lip mounts. These $50.00 (approximately) mounts from Comet and Diamond hold onto your vehicle with two or four inside Allen screws and a short piece of thin coax that won't get crunched when you close the door or slam the trunk. The coax then merges into larger low-loss coax that goes to your HF transceiver.

These gutter mounts and lip mounts are extremely strong, and can even hold one of the tallest of HF mobile antennas, the Outbacker OUTREACH. If the mount is placed in a position where the wind will naturally pivot the antenna backwards on its adjustable ratchet, it may be necessary to run some monofilament fishing line to give it a little added extra support. This is what we did on the comm van. While the mount is extremely strong and won't break, the little teeth that grip the vertical adjustment are not hardy enough to keep it absolutely vertical at 65 mph wind speed. The fishing line works wonders.

Next month, we'll talk about the amazing fully automatic antenna tuner on a non-resonant mobile whip or recreational vehicle all-around long wire. We will talk technical on how the automatic antenna tuner achieves the right amount of inductive reactance and capacitive reactance to create a perfect match between your HF radio and that big tall whip that appears non-resonant until the tuner at the feedpoint clicks in. **NV**

To get more information about many of the antenna products I talked about, try these following resources:

- CQ Amateur Radio Equipment Buyer's Guide (the ultimate source book), 516-681-2922. It's not free, but well worth the cost.
- Ham Radio Outlet Communications Equipment Catalog (free), 800-444-4799 (East); 800-854-6046 (West)
- Amateur Electronic Supply Equipment Catalog (free), 800-558-0411
- Alpha Delta Outbacker/Outreach Antenna (my favorite), 606-598-2029
- Antenna Sales & Accessories (ASA), 800-722-2681
- Antenna Supermarket, 847-359-7092
- Antennas West (great catalog!), 801-373-8425
- B & W Coils (wind-your-own catalog), 407-639-1510
- Diamond Antennas (great HF mobile antenna mounts), 619-744-0900
- High Sierra Antennas (screw driver motor type), 916-273-3415
- Hustler Antenna (white coil center loaded), 800-949-9490
- Kenwood Corporation (ham gear and mobile HF antennas), 310-639-4200
- Lakeview (another favorite) ham sticks, 864-226-6990
- Maldol (power lay-down antenna mounts), Answer/FAX 206-525-1896
- Mobile Mark (very tough top-loaded heli-whips), 847-671-6690
- NCG Comet (great HF mobile mounts plus a unique HF multi-band antenna, 714-630-4541
- Outbacker Antenna (see Alpha Delta)
- Palomar (similar lightweight version to Outbacker), 760-747-3343
- Pro Am (They make Valor whips; great antennas), 937-778-0074
- Spider Antenna (multi-band HF whip), 818-341-5460
- TJ Antenna (screw driver motor type), 800-443-0966
- Ten-Tech (center helical whips), 423-453-7172
- Texas Bug Catcher (the ultimate monster big antenna/big signal), 254-771-1188

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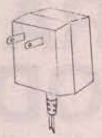

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8Vdc 500Ma	$2.00 Ea.
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9Vdc 450Ma	$3.50 Ea.
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12Vdc 200Ma	$1.50 Ea.
12Vdc 500Ma	$2.95 Ea.
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NEW NISCAN/GS PLUS OCR/ 256 GRAY SCALE SCANNER
Brand New True 256 Gray Scale Hand Scanner.
Resolution: 25-400 DPI.
Scan Width: 4.2 In. Scan Length: 11 In.
Interface: 16 Bit high speed (ISA) card, 64K SRAM. System Requirements: 286/386/486 PC Compatible (16MHz).

Available 16-Bit Interface slot.
Windows 3.1, 4 Meg RAM.
10 Meg of Available HD space (Min.).
Mouse or Other pointing device.
Software Included: Picture Publisher LE 3.1, (Imaging Software), Perceive Personal 2.1, (OCR Software)

Niscan/GS Plus .... $29.95 Ea.

NEW TANDY SUPER VGA 1 MEG DRAM
(16-Bit ISA Bus Type)

This board is your basic super VGA video board with 1 meg of DRAM type memory. (ISA BUS TYPE.) Core Logic Chip: WD90C31-ZS-00-02. Resolution/Color: 640x480/256C, 800x600/256C, 1024x768/256C, 1024x1024/16C. Note: Software drivers included with board. Windows 3.1, VESA, Autocad, etc.

Tandy SVGA 25-4055 .... $12.95 Ea.

NEW 300W BABY SWITCHING POWER SUPPLY UL & CSA RATED 110-220VAC
Input voltage: 110-220VAC 50Hz/60Hz UL & CSA. Output voltage: +12VDC @ 12 amp/-12VDC @ 0.5 amp: +5VDC @ 30 amp/-5VDC @ 0.5 amp.

Model # Hipro HP-300PPFS .... $39.95 ea.

NEW INTEL N80287XLT MATH CO-PROCESSOR
New retail box Intel math co-processor comes complete with used guide, utility and diagnostic software. Great price on a hard-to-find part for 286 laptops. (Chip package 44 pin PLCC.)

N80287XLT .... $19.95 Ea.

NEW CYRIX FASMATH COPROCESSOR CX-83D87-33-GP
New Cyrix FasMath coprocessors for 80386DX16-33 systems. This FPU unit is used in place of Intel's 80387DX16-33 part. Originally priced at $100.00, a steal $10.95. Case: 68 pin grid array.

Cyrix CX-83D87-33-GP .... $10.95 Ea.

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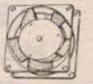

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12 Vdc 2-3/8"	$4.95 Ea.
12 Vdc 2-5/8"	$6.00 Ea.

HARVARD GRAPHICS 4.0 (CD-ROM)
The easy way to create professional presentations. Designed exclusively for Windows 95. Pentium 75 or better. 13MB to 44MB hard disk space, SVGA display, Windows 95, mouse. New retail box

Harvard Graphics 4.0 (CD-ROM) .... $24.95 Ea.

512K PCMCIA SRAM CARD
New 512K PCMCIA SRAM card made by Fujitsu. Will work in most laptop, PDA, or handheld computers with PCMCIA socket and socket management software. HP100/200, OmniGo, Zaurus, Etc.
Requires one lithium coin battery (BR2325/CR2325).
Note: Battery not included.
Fujitsu (512K SRAM PCMCIA) .... $24.95 Ea.

NEW 28.8/V.34 PCMCIA MODEM/FAX MADE SIMPLE TECHNOLOGY
New 28.8/V.34 PCMCIA modem/FAX, cellular ready (MNP10-EC & TX-CEL Protocol) with Flash upgradeability to 33.6. Windows 95 Plug n' Play, Hot swap capabilities. Bitware Fax software included.
Note: Separate purchase of connecting cable from Simple Technology needed for cellular operation.

28.8 Communicator (Simple Tech.) .... $49.95 Ea.

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5-1/4" Half Height Teac. Model #FD-55GFR.
Tan face plate only.
1.2M TEAC FD-55GRF .... $14.95 Ea.

NEW 500MEG SCSI 3.5" SEAGATE
ST1480N .... $74.95 Ea.

NEW 16-BIT 256K ISA VGA CARDS
Designed for the PC-XT/PC-AT & compatibles, this is a basic low cost VGA video card. 256K DRAM with chips & technology 82C451. Full backward compatibility with EGA, CGA, MDA, and Hercules modes. Card type: ISA 16-bit.

Model # VGA 300 (VGA Card) .... $9.95 Ea.

FIRST AID 95 BY CYBERMEDIA
New retain boxed CD-ROM version for Windows 95 and 3.1. Fixes Windows problems automatically. System Req. IBM Compatible 386 or higher PC with Windows 95, 3.1, 3.11 / 4MEG RAM / 7MEG HD Space.

FirstAID 95 Ver. 2.0 .... $9.95 Ea.

QUARTERDECK WINprobe4 (3.5" Disk)
Powerful troubleshooting software tool for Windows and Windows 95 operating systems. Program can run over 200 individual tests to keep your system running at full speed. 1MB free HD space required. New retail box.

WINprobe 4.0 (3.5" Disk) .... $9.95 Ea.

NEW INTERNAL IMES 6X IDE CD-ROM DRIVE
New 6X IDE interface, Caddyless design. Drive comes with instructions sheet, IDE cable, and driver disk for DOS and Windows. Unit is Windows95 Plug & Play compatible.

IMES 6X CD-ROM Drive .... $49.95 Ea.

NEW MICRONICS PENTIUM HX CHIPSET MOTHERBOARD
New Micronics Model D5CUB Pentium AT style motherboard. This motherboard comes with built-in I/O support for 4) IDE devices, 2 com ports, floppy controller, and printer port. The motherboard is built around the Intel HX Chipset and can support MMX and NON-MMX Pentium CPUs and Cyrix 6X68 CPUs 100MHz through 200MHz, 256K cache, 4) 72-pin SIMM sockets.

Micronics D5CUB .... $74.95 Ea.

NEW 1.44 MEG 3.5" FLOPPY DRIVE
New 1.44 Meg 3.5" floppy drive with gray face plate.
Floppy 1.44/Gray .... $19.95 Ea.

NEW INTEL PENTIUM 60/66 CPU HEATSINK 12VDC FAN COMBO
New Pentium 60/66 heatsink 12VDC fan combo for cooling the older, hotter, CPUs. Low profile type with seven inch wires. Can be used on other CPUs if you have the physical space..
Pentium 60/66 CPU Cooler .... $4.95 Ea.

NEW TEAC COMBO 700 TAPE BACKUP AND FLOPPY DRIVE 1.44 3.5"
The Teac combo is a 3.5" floppy drive and QIC tape backup unit built into 5.25" half height frame. Great for systems with limited drive bays. Tape backup unit utilizes the PC's existing floppy controller. Capacity: 680MB compressed/340MB uncompressed. Tape Format: QIC-3010-MC. Data Trans. Rate: 0.5 & 1Mbps. Tape Media: 3M MC3000XL (400 ft.). Software Incl.: Arcada Backup for Windows 95, Windows 3.1 & DOS (1.44 Meg floppy). (Note: Back-up tape or cables not included with drive.)

FF-3101/700 Combo .... $69.99 Ea.

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Events

CALENDAR

MARCH 1998

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

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

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

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

MARCH 1

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

IL - PALATINE - Computer Show & Sale. Harper College. Bldg. M (Phys Ed Bldg.). Roselle & Algonquin Rds. 9:30am-3pm. Computer Central Shows 847-940-7547

NH - NASHUA - Computer Show. Sheraton Tara Hotel. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

NY - SYRACUSE - Computer Show. Four Point Hotel. 9:30am-4pm. MarketPro 201-825-2229. http://www.marketpro.com

MARCH 6-7

ME - LEWISTON - Maine State Convention. Ivan Lazure N1OXA, 207-784-0350. E-Mail: ilazure@gwi.net Web: http://www.agate.net/~w1npp

MARCH 6-7-8

MI - MT. CLEMENS - Computer & Technology Show. Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

NE - NORFOLK - Nebraska State Convention. Fred Wiebelhaus N0VLX. 402-379-1929

MARCH 7-8

NC - CHARLOTTE - Mecklenburg ARS Hamfest. Charlotte Merchandise Mart, 2500 E. Independance Blvd. Tim Slay WO4G, 704-948-7373. http://www.w4bfb.org

NY - SYRACUSE - Computer Show. NY State Fairgrounds, Int'l Bldg. 10am-5pm Sat. 10am-3pm Sun. Peter Trapp Shows. 603-272-5008. www.petertrapp.com

MARCH 7

AL - TUSCALOOSA - Black Warrior Swapfest. Kelly Bruce WD4DAT, 205-339-7882. E-Mail: bwhamfest@juno.com Web: http://tusc.net/~rkbruce/waars_radio/

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - BROOKSVILLE - Hamfest. Lee Kent WA3YMV, 352-799-1638. E-Mail: 1kent@innet.com

FL - EAST ENGLEWOOD - HamCom. Tringali Community Ctr. 8am-3pm. George Shreve KA4JKY, 941-697-3445. E-Mail: gshreve@ewol.com

FL - NEW PORT RICHEY - Ridgewood Hamfest. Ridgewood High School, 7650 Orchid Lake Rd. Rick Brown 813-842-2127. E-Mail: Richar@gte.net

FL - WEST PALM BEACH - Computer Show. Palm Beach Airport Hilton. 150 Australian Ave. Narisaam Computer Show 770-663-0983

IN - LAFAYETTE - AGI Computer Fair. Tippecanoe Co. Fairgrounds. 10am-4pm. 317-299-8827. E-Mail: agi@trader.com Web: http://www.surf-ici.com/agi

KY - CAVE CITY - Mammoth Cave ARC Hamfest. Bill Wilkinson KE4KRN, 502-651-6561. E-Mail: bwilkinson@glasgow-ky.com Web: http://www.scrtc.blue.net/mcarc/

MI - ROSEVILLE - L'Anse Creuse ARC open house. Macomb Mall. Diane Scalzi WI8K, 810-296-6623. E-Mail: dms@match.org

NH - LACONIA - Computer Show. Guilford Hills Tennis Club. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

NJ - ABSECON - Hamfest. Holy Spirit High School, Rte. 9. Eva Mangeri KB2QXU, 609-407-2923. E-Mail: jjjbar@worldnet.att.net

NJ - NEWARK - Computer Show. Robert Treat Hotel. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NJ - PARSIPPANY - Split Rock ARA Hamfest. Mark Turner KB2VKO, 973-347-3195. E-Mail: mlturner@bellatlantic.net Web: http://home.hsix.com/sara/hamfest.html

NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

OK - ELK CITY - West Central OK ARC Hamfest. Earl Bottom N5NEB, 405-473-2572

WA - PUYALLUP - Electronics Show & Flea Market. W. WA Fairgrounds, Pavilion Exhibition Hall. E-Mail: mwdink@eskimo.com Information 253-631-3756 6pm-9pm PST

MARCH 8

FL - FT. LAUDERDALE - Computer Show. Holiday Inn West. 5100 N. St. Rd. 7. Narisaam Computer Show 770-663-0983

IN - INDIANAPOLIS - Morgan Co. Repeater Assn. Hamfest & Computer Show. State Fairgrounds. Dennis Baurenfiend WB9ZNZ 317-996-3782. E-Mail: dbauernfiend@cleveland.Dfas.mil

NH - LEBANON - Computer Show. Lebanon High School. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

NJ - WHIPPANY - Computer Show. Hanover Marriott. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NY - BUFFALO - Computer Show. The Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NY - LINDENHURST - Hamfest. Walter Wenzel KA2RGI, 516-457-0218. E-Mail: Tom Carrubba: ka2d@li.net Web: http://www.li.net/~tom car/hamfest.htm

OH - CONNEAUT - ARC Hamfest & Computerfest. Human Resource Center, 327 Mill St. Clarence Baugher W8FAS, 216-593-3038

WI - WAUKESHA - Hamfest and Computer Expo. Co. Expo Center, N1W24848 Northview Rd. 8am-2pm. Mary J. Adams KB9IFF, 414-358-1003. E-Mail: mjadams@execpc.com

MARCH 13-14

OK - TULSA - Hamfest. Maxwell Convention Ctr. 700 S. Houston Ave. 918-622-2277. E-Mail: megriffin@ionet.net Web: http://www.greencountry.com/hamfest

MARCH 13-14-15

LA - LAFAYETTE - Acadiana ARA Hamfest. Nolen D. Griffith K5ARH, 318-989-9039. E-Mail: k5dpg@aisp.net Web: http://www.acadian.net/w5ddl/

MI - TAYLOR - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 313-287-2000

NE - OMAHA - Super Computer Sale. Omaha Civic Auditorium. 1804 Capital Ave. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

MARCH 14

AZ - SCOTTSDALE - AZ Network Intertie Grp. & AR Council of AZ. Hamfest. Daniel J. Meredith N7MRP, 602-980-7626

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

CO - CASTLE ROCK - Denver Radio League Hamfest. Al Cooley N0AUS, 303-777-2428. E-Mail: ALN0OAUS@aol.com

FL - SEBRING - Highlands Co. ARC Hamfest. Dennis Koranda KF4JTM. 941-382-9560. E-Mail: kf40strato.net Web: http://www.strato.net/~hamradio/

IN - GREENFIELD - AGI Computer Fair. Hancock Co. Fairgrounds. 10am-4pm. 317-299-8827. E-Mail: agi@trader.com Web: http://www.surf-ici.com/agi

MI - MARSHALL - ARC Hamfest. Marshall High School. 8am-3pm. Wes Chaney N8BDM, 616-979-3433

MO - KANSAS CITY - Ararat Shrine ARC Hambash. Ararat Temple, 5100 Ararat Dr. 8am-2pm. Steve Dowdy WJ0I, 816-941-3392. E-Mail: sdowdy@qni.com

NH - SALEM - Computer Show. Rockingham Park Race Track. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

NY - ALBANY - Computer Show. Polish Community Center. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NY - BROOKVILLE - Computer Show. C.W. Post College. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

TN - KNOXVILLE - Hamfest. Kerbela Shrine Temple, 8am-4pm. Paul Baird K3PB, 423-986-9562

MARCH 14-15

TX - MIDLAND - Hamfest & W. TX State Conv. Midland County Exhibit Bldg., E. Bus. 20. Sat: all day, Sun: 8am-3pm. Beverley Harwood KC5BNT, 915-686-1841. E-Mail: shamrock@apex2000.net Web: http://www.lx.net/edge/midswap.html

MARCH 15

IL - STERLING - Hamfest. High School Field House, 1608 4th Ave. Lloyd Sherman KB9APW, 815-336-2434. E-Mail: lsherman@essexl.com

IN - NOBLESVILLE - AGI Computer Fair. Hamilton Co. Fairgrounds. 10am-4pm. 317-299-8827. E-Mail: agi@trader.com Web: http://www.surf-ici.com/agi

MA - SWANSEA - Computer Show. Venus DeMilo Convention Center. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

MA - WEST SPRINGFIELD - Computer Show. Eastern States Exposition Ctr. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NJ - FAIRFIELD - Computer Show. Fairfield Radisson. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

OH - MAUMEE - Hamfest. Lucas Co. Recreation Center, 2901 Key St. 8am-3pm. Paul Hanslik N8XDB, 419-243-3836

PA - MONROEVILLE - Hamfest & Computer Show. Palace Inn. 8:30am-3pm. Bill Hetrick N3LQC, 412-754-0562. E-Mail: w3oc@nb.net Web: http://codger.physics.duq.edu/trarc/hamfest.html

PA - YORK - Hamfest and Computer Show. York County Vo-Tech School. 8am-3pm. Ted Rodes KE3SO, 717-259-8063. http://members.aol.com/yorkfest

WV - CHARLESTON - Hamfest & Computer Show. Jimmie Hewlett WD8MKS, 304-768-9788

WI - JEFFERSON - ARC Hamfest. Jefferson County Fairgrounds Activity Ctr. Hwy 18 W. 8am-2pm. 414-563-6502 evenings

MARCH 20-21-22

FL - FT. WALTON BEACH - Playground ARC Hamfest. Clyde Gowdy KE4FLC, 850-314-3337. E-Mail: parcfest@aol.com

WI - WEST ALLIS - Super Computer Sale. WI State Fairgrounds. 8100 W. Greenfield Ave. Blue Star Productions 612-788-1901. Web: http://www.supercomputersale.com

Continued on page 86

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TEK 7A26 200 MHz Dual Trace Amplifier $175.00
TEK 7B15 1 GHz Delaying Time Base $450.00
TEK 7B80 400 MHz Delayed Time Base $175.00
TEK 7B85 400 MHz Delta Delaying Time Base $175.00
TEK 7B92A 500 MHz Dual Time Base $275.00

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TEK 7633 100 MHz Storage Oscilloscope frame $650.00
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HP 1122A Probe Power Supply $200.00
TEK 1101 Accessory Power Supply, for FET probes $250.00
TEK P6201 900 MHz 1X/10X/100X FET Probe $450.00
TEK P6202A 500 MHz 10X FET Probe $300.00
TEK P6701-opt.02 O/E Converter, ... $675.00
450-1050 nm/0-1 mW: DC-700 MHz, ST conn.

CALIBRATION

TEK 067-0587-01 Signal Standardizer $300.00
Calibration Fixture, 7000 series
TEK CG5001-opt.01/TM5006 Programmable $6,000.00
Oscilloscope Calibrator, with power module
TEK SG503 Level Generator, 250 kHz-250 MHz, TM500 series $600.00

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HP 3310A 5 MHz Function Generator $250.00
HP 3310B 5 MHz Function Generator, ... $325.00
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TEK FG501 1 MHz Function Generator, TM500 series $225.00
TEK FG503 3 MHz Function Generator, TM500 series $250.00
TEK RG501 Ramp Generator, TM500 series $225.00
WAVETEK 186 5 MHz Phaselock Function Generator $350.00

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Generator, 0-100 mS, 1 nS res.,5 Hz-5 MHz
HP 214B-001 10 MHz Pulse Generator, ... $2,000.00
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HP 8007B 100 MHz Pulse Generator $650.00
HP 8012B 50 MHz Pulse Generator, variable transition time $600.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator $950.00
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1 mHz-50 MHz, log sweep, rear out
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TEK AWG5105-opt.02 Arbitrary Waveform $1,900.00
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HP 3456A 6-1/2 Digit Voltmeter $750.00
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SOLARTRON 7081 8-1/2 digit Voltmeter $3,900.00

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FLUKE 515A Portable Calibrator, ... $1,000.00
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HP 6114A Precision Dual Range $850.00
Power Supply, 25V 2A / 40V 1A
HP 6115A Precision Dual Range $875.00
Power Supply, 50V 0.8A / 100V 0.4A

CURRENT METERS & SOURCES

HOLT HCS-1AF Primary Current Shunt Set, ... $750.00
0.02/0.2/0.5/2/5/20 Amp
HP 4140B Picoammeter / DC Voltage Source $4,000.00
HP 6177C DC Current Source, to 50V, 500mA $500.00
HP 6181C DC Current Source, to 100 V, 250 mA $500.00
HP 6186C DC Current Source, to 300V, 100mA $750.00
KEITHLEY 225 Current Source, ... $500.00
0.1 uA-100 mA, 10-100 V compliance
KEITHLEY 227 Current Source, 1 uA-1 A, 0-50 V compliance $800.00
KEITHLEY 228 Programmable Voltage/Current Source $2,500.00
KEITHLEY 261 Picoampere Source $375.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA $325.00
KEITHLEY 614 Electrometer $800.00
KEITHLEY 642 Electrometer $2,900.00
TEK AM503/A6302/TM501 AC/DC Current Probe System $1,000.00
TEK CT-5 -opt.05 High Current $500.00
Transformer for P6021/A6302, to 1000A
VALHALLA 2301 Programmable Single Phase Power Analyzer $1,250.00
VALHALLA 2575A AC/DC Wideband Current $950.00
Shunt, 20 mA-100 A, DC-10 kHz

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH $550.00
ESI 2160 LCR Bridge, 20 Hz-150 kHz, GPIB $2,000.00
HP 4262A-101 3-1/2 digit LCR Meter, ... $2,250.00
120 Hz/ 1 kHz/ 10 kHz test, HPIB
HP 4275A-001 5-1/2 digit LCR Meter, ... $6,000.00
10 kHz-10 MHz, 0-35 V int. bias

STANDARDS

E.S.I. SR1010 Resistance Transfer $700.00
Standards, 1 Ohm-100 K/step
E.S.I. SR1050-10M Resistance Transfer Standard, ... $2,500.00
10 Megohms/step
E.S.I. SR1050-1M Resistance Transfer $2,000.00
Standard, 1 Megohm/step
E.S.I. SR1-set Set of eight Standard $900.00
Resistors, 1 Ohm - 10 Megohms
GR 1404-A 1000 pF Reference Standard Capacitor $700.00
GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc. $375.00
GR 1412-BC Decade Capacitor, 50 pF - 1.11115 uF $350.00
GR 1432-U 4-Decade Resistor, ... $125.00
0-111.10 Ohms, 0.01 Ohm resolution
GR 1433-J 4-Decade Resistor, ... $350.00
0-1,110 Ohms, 1 Ohm resolution
GR 1433-N 5-Decade Resistor, ... $400.00
0-11,111 Ohms, 0.1 Ohm resolution
GR 1433-U 4-Decade Resistor, ... $350.00
0-111.0 Ohms, 0.01 Ohm resolution
GR 1433-X 6-Decade Resistor, ... $450.00
to 111,111.0 Ohms, 0.1 Ohm res.
GR 1482-series Standard Inductors $275.00
VALHALLA 2724A Programmable $1,675.00
Resistance Standard, 0-11 Gigaohms, GPIB

HI & LO RESISTANCE

GR 1666 DC Resistance Bridge, 1 Micro-Ohm - 100 Kilohms $600.00
HP 4328A Milliohmeter $1,300.00

CURVE TRACERS

TEK 577D1/177 Storage Curve Tracer, with standard test fixture $2,250.00
TEK 577D2/177 Curve Tracer, with standard test fixture $1,850.00

T.D.R.

TEK 1503-opt.04 Time Domain Reflectometer, ... $1,400.00
0-50,000 feet,chart recorder

POWER SUPPLIES

SINGLE OUTPUT

HP 6200B Dual Range Supply, ... $200.00
0-20 V 0-1.5 A/ 0-40 V 0-750 mA CVCC
HP 6201B 0-20 V 0-1.5 A CV/CC Power Supply $175.00
HP 6206B Dual Range $200.00
0-60 V 0.5 A / 0-30 V 1 A CV/CL Supply
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply $300.00
HP 6260B-027 0-10 V 0-100 A CV/CC $675.00
Power Supply; 208 VAC line
HP 6261B-027 0-20 V 0-50 A CV/CC $675.00
Power Supply; 208 VAC line
HP 6263B 0-20 V 0-10 A CV/CC Power Supply $400.00
HP 6267B 0-40 V 0-10 A CV/CC Power Supply $550.00
HP 6269B-028 0-40 V 0-50 A CV/CC $950.00
Power Supply; 230 VAC line
HP 6281A 0-7.5 V 0-5 A CV/CC Power Supply $175.00
HP 6284A 0-20 V 0-3 A CV/CC Power Supply $225.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply $225.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply $125.00
KEPCO ATE 100-10M 0-100 V 0-10 A CV/CC $900.00
Power Supply, 120 VAC 20 A line
KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC $900.00
Power Supply, 120 VAC 20 A line
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply $375.00
SORENSEN DCR 20-25B 0-20 V 0-25 A CV/CC Power Supply $550.00
Power Supply, 120 VAC 20 A line
SORENSON DCR 300-1.5B 0-300 V $600.00
0-1.5 A CV/CC Power Supply
SORENSON DCR 600-0.75B $600.00
0-600 V 0-750 mA CV/CC Power Supply
SORENSON SRL 20-12 0-20 V 0-12 A CV/CC Power Supply $500.00
SORENSON SRL 60-8 0-60 V 0-8 A CV/CC Power Supply $750.00
TEK PS501-1 Power Supply, ... $175.00
0-20 V, 2 mV res., 400 mA, TM500 series

MULTIPLE OUTPUT

HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply $600.00
HP 6253A Dual Output 0-20 V 0-3 A CV/CC Power Supply $550.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series $750.00
TEK PS503A Dual Power Supply, TM500 series $200.00

MISCELLANEOUS

ACME PS2L-500 Programmable $400.00
Load, 0-75 V / 0-75 A / 500 Watts max.
ELGAR 501C/400SD AC Power Source, ... $1,200.00
0-135 VAC, 500 VA, 20 Hz-10 kHz
HP 59501B HPIB Isolated DAC/Power Supply Programmer $175.00
TRANSISTOR DEVICES DAL-50-15-100 .... $200.00
Programmable Load, 0-50 V, 0-15 A, 100 Watts max.

TIME & FREQUENCY

UNIVERSAL COUNTERS

FLUKE 1910A-02,03 125 MHz/ 500 nS $175.00
Universal Counter, TCXO reference
HP 5315A 100 MHz/100 nS Universal Counter $500.00
HP 5315A-002,003 100 MHz/100 nS $750.00
Univ. Counter, battery power, 1 GHz C-ch
HP 5315B 100 MHz/ 100 nS Universal Counter $600.00
HP 5316A 100 MHz/100 nS Universal Counter, HPIB $700.00
HP 5316A-003,006 100 MHz/100 nS Counter, ... $1,000.00
1 GHz C-ch., offset/normalize
HP 5316B 100 MHz/ 100 nS Universal Counter, HPIB $1,000.00
HP 5334A 100 MHz Universal Counter, HPIB $875.00
HP 5334B-010,060 100 MHz $1,000.00
Universal Counter, HPIB, OCXO
HP 5335A 200 MHz Universal / Statistical Counter $1,200.00
RACAL 1996 200 MHz/1 nS $1,000.00
Universal Counter, 1.3 GHz C-channel
RACAL-DANA 1992-04 100 MHz/1 nS Univ. $750.00
Counter, 1.3 GHz C-channel, OCXO
TEK DC5004 Programmable $250.00
100 MHz/100nS Counter/Timer, TM5000 series
TEK DC5009 Programmable $500.00
135 MHz Univ. Counter/Timer, TM5000 series
TEK DC5010 350 MHz / 3.125 nS $1,200.00
Universal Counter, TM5000 series
TEK DC503A 125 MHz/ 100 nS $275.00

FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB $3,250.00
EIP 578-opt.02,05 26.5 GHz Source $5,000.00
Locking Counter; power meas., OCXO
FLUKE 7220A 1.3 GHz Communications Counter $500.00
HP 5340A-011 18 GHz Frequency Counter, HPIB $1,250.00
HP 5342A 18 GHz Frequency Counter $2,400.00
HP 5342A-001 18 GHz Frequency Counter, OCXO reference $2,500.00
HP 5342A-003 18 GHz Freq.Counter, ... $2,400.00
+22 dBm,-20 dBm dynamic range
HP 5342A-01,04,05 24 GHz $3,250.00
Frequency Counter, OCXO, DAC
HP 5343A-006 26.5 GHz Frequency Counter; limiter option $4,500.00
HP 5345A/5355A/5356B $4,000.00
26.5 GHz CW/Pulse Frequency Counter

STANDARDS

HP 105A Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz $750.00
HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power $1,500.00
HP 5061A Cesium Beam Frequency Standard $8,500.00
HP 5087A-opt.033 Distribution Amplifier; $1,750.00
12 outputs at 10 MHz

AUDIO & BASEBAND

SELECTIVE LEVEL METERS

HP 3586C Selective Level Meter, ... $1,500.00
50 Hz-32.5 MHz, 50 & 75 ohms

DISTORTION ANALYZERS

HP 333A Distortion Analyzer, 10 Hz-600 kHz $450.00
HP 339A Distortion Analyzer, ... $1,800.00
built-in low distortion osc.
HP 8903A-001 Audio Analyzer, ... $2,600.00
20 Hz-100 kHz; rear panel input
HP 8903B-001,013,051 Audio Analyzer, ... $4,250.00
20 Hz-100 kHz; C-message, CCITT
TEK DA4084 Programmable Distortion Analyzer $1,000.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, ... $600.00
180 uV-700 V, 10 Hz-20 MHz
FLUKE 8922A True RMS Voltmeter, ... $600.00
180 uV-700 V, 2 Hz-11 MHz

Write in 37 on Reader Service Card.

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION

TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

OSCILLATORS

HP 204C Oscillator, 5 Hz-1.2 MHz, 5 VRMS $150.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator $200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max. $225.00
HP 3336C-004,005 Synthesizer/Level Generator, 10 Hz-21 MHz, 50 & 75 ohms $1,750.00
HP 652A Test Oscillator, 10 Hz-10 MHz $250.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 .... $200.00

MISCELLANEOUS

HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display option $850.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal. $175.00
HP 461A Amplifier, 20/40 dB, 1 kHz-150 MHz, 0.5 V/50 Ohms $125.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave $500.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave $1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct. $700.00
ROCKLAND 852 Dual Highpass/ Lowpass Filter, 0.1 Hz-111 kHz $1,000.00
TEK AF501 Tunable Bandpass Filter / Amplifier, 3 Hz-35 kHz $300.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series $475.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz $450.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554,8568,etc. $1,250.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A $650.00
HP 8553B/8552B/8443/141 Spectrum Analyzer, 0.1-110 MHz, with tracking generator $2,500.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. $4,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $8,500.00
TEK 119-0098-00 WR42 Single Ended Mixer, 18.0-26.5 GHz, for Tek 491 .... $200.00
TEK 119-0099-00 WR28 Single Ended Mixer, 26.5-40 GHz, for Tek 491 .... $200.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6 .... $1,375.00
TEK WM490A WR28 Harmonic Mixer, 26.5-40 GHz $850.00
TEK WM490K WR42 Harmonic Mixer, 18.0-26.5 GHz $850.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $2,000.00

NETWORK ANALYZERS

HP 11665B Modulator, 0.15-18.0 GHz, N(m/f) $325.00
HP 11666A Reflectometer Bridge, 0.04-18.0 GHz, for HP 8755/6/7 .... $1,100.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB $2,750.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res,GPIB $2,000.00
FLUKE 6062A Signal Generator, 0.1-2100 MHz, 10 Hz resolution $5,500.00
FLUKE 6070A Synthesized Signal Generator, 0.2-520 MHz, 1 Hz res. $2,000.00
GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 MHz res., GPIB $2,600.00
GIGATRONICS 605/10-18 Synthesized Source, 10-18 GHz, 1 kHz res., GPIB $3,000.00
GIGATRONICS 605/2-8 Synthesized Signal Gen., 2-8 GHz, 1 kHz res., GPIB $3,000.00
GIGATRONICS 840-01 Freq. Doubler, 26.5-40 GHz (WR28) out, 13-20 GHz in $2,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm $3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs $5,000.00
GIGATRONICS 910/12-18,opt6,14,16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO $3,500.00

SWEEP GENERATORS

HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $750.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm $4,250.00
HP 8640B-001,002 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc. $2,200.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM $550.00
HP 8660C/86602B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod. w/86635A $3,250.00
HP 8350B/83592C-004 Sweep Oscillator, 10 MHz-20 GHz, +10 dBm levelled $18,500.00
HP 8600A Digital Marker, for HP 8601A $400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $400.00
HP 8620C Sweep Oscillator Frame $550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable $675.00
HP 86222A-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten. $1,600.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $675.00
HP 86235A-001,002 RF Plug-in, 1.7-4.3 GHz, +14 dBm levelled, 70 dB atten. $1,000.00
HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled $1,000.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $500.00
HP 86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled $500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled $1,100.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled $675.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled $800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled $800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $2,000.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. $1,500.00
WILTRON 560/ 3x 560-7S50 Scalar Network Analyzer, w/(3) 0.01-18.5 GHz detectors $1,750.00

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm $2,500.00
ANRITSU MP-82B/ML-83A Power Meter, 90-140 GHz (WR8) pin flange, -20, +20 dBm $3,250.00
BOONTON 4200-01A,03/&-4A x2 Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors $1,500.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor $375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm $300.00
HP 432A/8478B Power Meter, -25 to +10 dBm, 10 MHz-18 GHz $450.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm $900.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -10 to +34 dBm $950.00
HP 8477A Power Meter Calibrator, for HP 432 series $500.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 .... $1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series $350.00

RF MILLIVOLTMETERS

BOONTON 9200A-01 RF Millivoltmeter, 10 kHz-1.2 GHz, GPIB $900.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB $875.00

AMPLIFIERS, MISCELLANEOUS

BOONTON 82AD-opt.01A Modulation Meter, AM, FM, 10-1200 MHz, GPIB $900.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms $125.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz $450.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $3,750.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO $6,750.00
HP 8970A Noise Figure Meter $6,000.00
HUGHES 1177H01F000 TWT Amplifier, 2.0-4.0 GHz, 10 Watts output $1,500.00
HUGHES 1177H02F000 TWT Amplifier, 4.0-8.0 GHz, 10 Watts output $1,500.00
HUGHES 1277H02F000 TWT Amplifier, 4.0-8.0 GHz, 20 Watts output $2,500.00
HUGHES 8020H02F000 TWT Amplifier, 4.0-8.0 GHz, 20 Watts output $2,750.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts $800.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts $800.00
MICROWAVE SEMI.CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC $275.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz $6,000.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* $95.00
BIRD 8329-310 30 dB Attenuator, 2000 Watts, DC-1 GHz, LC(f)/N(f) $650.00
FLANN MW. 20110 WR42 Rotary Vane Attenuator, 0-60 dB, 18.0-26.5 GHz $2,000.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f) $125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $400.00
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 .... $450.00
HP 11612A Bias Network, 45 MHz-26.5 GHz, APC3.5 .... $550.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 11904B APC2.4(f) x K(f) Adapter, DC-40 GHz $225.00
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, 0.1-2.0 GHz, APC7/N(f/f/f) $450.00
HP 8470B Crystal Detector, 10 MHz-18 GHz, neg. pol., APC7 .... $250.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA $400.00
HP 8495G-002 Programmable Step Attenuator, 0-70 dB, DC-4 GHz, SMA $300.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA $400.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz $750.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $350.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz $375.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz $400.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz $500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz $450.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $900.00
HUGHES 45721H-2000 WR28 Precision Rotary Vane Atten., 0-50 dB, 26.5-40 GHz $1,200.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz $250.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity $600.00
HUGHES 47323H-1211 WR19 Flat Broadband Detector, negative, 40-60 GHz $650.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response $375.00
INSULATED WIRE SPRR-175-78 Low Loss Coaxial Cable, 78 in., DC-18 GHz, SMA(m/ram) $45.00
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC $100.00
KRYTAR 1818 Directional Coupler, 16 dB, 2-18 GHz, SMA(f) $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
MIDWEST MICROWAVE 3537 DC Block, 0.1-12.4 GHz, SMA(m/f) *NEW* $40.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) $25.00
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f) $100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) $200.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $300.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368NM Coaxial High Power Load, 500 Watts, 2.0-12.4 GHz, N(m) $400.00
NARDA 369BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f) $325.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz $1,250.00
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f) $225.00
NARDA 4245-10 Directional Coupler, 10 dB, 4-12 GHz, SMA(f) $100.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f) $135.00
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $135.00
NARDA 766-10 10 dB Attenuator, 20 Watts, DC-4 GHz, N(m/f) $100.00
NARDA 768-20 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f) $125.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz $375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f) $50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz $250.00
SONOMA ENG. S-4901 WR15 Junction Isolator, 57-59 GHz, 30 dB isolation $125.00
SONOMA ENG. S-4906 WR15 Junction Isolator, 60-62 GHz, 30 dB isolation $125.00
SONOMA ENG. S-4907 WR15 Junction Isolator, 62-64 GHz, 30 dB isolation $125.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz $125.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz $400.00
SPACEK LABS K-2X Frequency Doubler, 9.0-13.25 GHz in/ 18.0-26.5 GHz out $350.00
SPACEK LABS KA-3X Frequency Tripler, 8.83-13.33 GHz in/ 26.5-40.0 GHz out $350.00
TRG B528 WR22 Direct Reading Phase Shifter, 0-360 deg.,33-50 GHz $1,250.00
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB $250.00
WEINSCHEL 1515 Power Divider, 2-Way. DC-18 GHz. SMA(m/f/f) $125.00

LOGIC

HP 10343B/10269C SCSI Bus Preprocessor, w/probe intfc., for 1630 series $300.00
HP 5005A Signature Multimeter $350.00
HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option $1,200.00
TEK 1240D2/1D 10-channel 50 MHz D/A Module for 1240, without probes $50.00
TEK 30DM08 80286 Probe, for Tek Prism $50.00
TEK DP186P 80186 / 80188 Probe, for Tek 1230 .... $50.00
TEK DP286P 80286 Probe, for Tek 1230 .... $50.00
TEK DPHC11 68HC11 Probe, for Tek 1230 .... $50.00
TEK P6454 100 MHz Clock Probe, for DAS $50.00

COMMUNICATIONS

HP 4972A LAN Protocol Analyzer $1,500.00
HP 59401A HPIB Bus Analyzer $700.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars $800.00
TEK 1411R PAL Gen.,w/SPG12 sync; TSG11 color bars;TSG13 linearity $750.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG13,TSG15,TSG16 .... $1,000.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16 .... $1,100.00
TEK 1411R-opt.04 PAL Test Gen., w/SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 .... $1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal $800.00
TEK 148 PAL Insertion Test Signal Generator $700.00
TEK 1750 NTSC Waveform / Vector Monitor $2,250.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

P.A.R. 5206-95,98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB $1,500.00
P.A.R. 5209 Lock-in Amp., 0.5 Hz-120 kHz, 130 dB dynamic reserve $2,500.00
TEK TM5006 5000-series 6-slot Programmable Power Module $600.00
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 $275.00

Write in 37 on Reader Service Card.

Don Lancaster's

RESOURCE BIN

number seventy four

Shaking down some seismic and earthquake info.

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

Seismography and Earthquakes

An *earthquake* is the sudden release of the stress that was previously built up across subsurface terrestrial plates. These subsonic or *seismic* waves can be extremely destructive. There are two types of waves involved, called the P wave and the S wave. When you measure their different properties, the exact location and the strength of an earthquake can be determined.

Seismography seems to be one of the few sciences in which amateurs are strongly encouraged. You can be of help in monitoring, networking, and in emergency preparedness. And the thinking is that there is a remote chance that you may eventually play a role in earthquake prediction.

A *seismometer* is the standard way you measure earthquake waves. This is basically a mass that is resonant at somewhat under one Hertz or so. By measuring the relative motion of the earth to the mass, a *seismic history* can be plotted and analyzed.

Sometimes "fake" earthquakes are intentionally created for geophysical exploration. This might get done by dropping a truck a few feet or setting off some dynamite. Slightly different sensors called *geophones* are used for this task. Their resonant frequencies are somewhat higher. Other methods for earthquake sensing might include long distance lasers, ultra sensitive pressure sensors, or microphones.

A *seismograph* is a special type of seismometer that does its own paper chart recording. They are now largely being replaced by newer models that allow full computer networking and manipulation of data.

Seismometers

Some traditional manufacturers of seismometers include ...

Bison Instruments
Dascor
EG&G
Engdahl Enterprises
Geometrics
LaCoste & Romberg
Shaw Industries
Sprengnether Instruments
Streckeisen STS
Teledyne
Terra Technology
Western Atlas International

Of these, the name brand "best of breed" appears to be various models offered by Streckeisen.

Here are some low-end instrument sources favored by amateurs ...

Amateur Seismologist
R.T. Clark
GEOSense
GeoTool
Vernier

NEXT MONTH:
Don finds some illusions involving the virtual reality scene.

Seismic Associations

The *Seismological Society of America* from El Cerrito, CA publishes their *BSSA* bulletin. They call it the premier English language journal of research for earthquake seismology and related disciplines since 1911.

They also publish their *Seismological Research Letters*, intended as a general forum for informal comm between seismologists and non-specialists. The same site has lots of links for sources of general earthquake information, lots of preparedness stuff, and other resources for seismologists.

Of particular interest is their great *Seismology Resources for Teachers*, that you'll find at *www.geo.purdue.edu/seismology_resources.html.* This is a major seismic access point.

The fine *International Association of Seismology and Physics of the Earth's Interior*, or *IASPEI* for short, gets into earthquakes and seismo in a big way.

The *IRIS Consortium* is a group of *Incorporated Research Institu-tions for Seismology*. They focus on exploring the interior of the earth through the collection of seismic data.

AGU, or that *American Geophysical Union*, form an international scientific society dedicated to advancing the understanding of the earth and its environment.

The *IRIS PASSCAL Instrument Center* gets hosted by Stanford University's School of Earth Sciences. They have fleets of portable digital seismographs and associated equipment. This lets them conduct their ongoing seismic research programs. Their website is *macpasscal.standofr.edu.*

The feds run the USGS, short for *US Geological Survey*. You'll find their home page at *usgs.gov/body.html*. They also operate the National Earthquake Information Center for Seismology by way of the *wwwneic.cr.usgs.gov* web site. And a *USNSN United States National Seismograph Network* home page at *gl dss7.cr.usgs.gov/neis/usnsn_home.html.*

A pair of mailing lists are offered: QEDPOST is their daily earthquake summary while BIGQUAKE sends out messages should a large earthquake release be issued. Their subscription sites are *qedpostrequest@neis.cr.usgs.gov* and *bigquake-request@neis.cr.usgs.gov.*

Another handy service of the USGS — which has nothing at all to do with earthquakes — is their "live" real-time stream monitors. These are useful to find which rivers you can and cannot 4WD drive across, and monitor floods as they move through the valley. I've linked some interesting examples at *www.tinaja.com/beewb01.html.*

Magazines and Journals

Let's look at a few more periodical resources ...

Seismo-Watch Newsletter — Which is basically a series of maps that show you all of the worldwide earthquake activity on a week-by-week basis. No predictions or forecasting. Just those actual events as they happen. Subs are $27.00 for six months.

Geo-Monitor — A newsletter dedicated to earthquake prediction, to amateur geophysical monitoring, and to earth mysteries. Monthly at $15.00 per year.

Seismograph Report — An association newsletter hosted by West Virginia University School of Journalism that covers the earthquake times, phases, locations, and

RESOURCE BIN

SOME SEISMIC AND EARTHQUAKE RESOURCES

Abst Jnl Earthquake Eng Earthquake Eng Univ CA Berkeley CA (510) 231-9413	**RT Clark** PO Box 20957 Oklahoma City OK 73156 (405) 672-9400	**Geometrics** 395 Java Drive Sunnyvale CA 94089 (408) 734-4616	**LaCoste & Romberg** 4807 Spicewood Spr Rd B2 Austin TX 78759 (512) 346-0077	**Soc Amateur Scientists** 1549 El Prado San Diego CA 92101 (800) 873-8767
Acta Seismologica Box 945 New York NY 10159 (212) 633-7300	**Dascor** 1125 Camino Del Mar, #G Del Mar CA 92014 (800) 739-9182	**GEOSense** 115 W California #304 Pasadena CA 91105 (818) 388-2826	**PASSCAL Instrument Ctr** Stanford U, Mitchell Rm A05 Stanford CA 94305 (415) 723-9325	**Sprengnether** 4150 Laclede Ave St Louis MO 63108 (314) 535-1682
Am Geophysical Union 2000 Florida Ave NW Washington DC 20009 (800) 966-2481	**Earthquakes & Volcanos** Sup of Documents Washington DC 20402 (202) 783-3238	**GeoTool** 455 Vista Roma Newport Beach CA 92660 (714) 759-3166	**Review of Sci Insts** 500 Sunnyside Blvd Woodbury NY 11797 (800) 344-6902	**Teledyne/Hastings** PO Box 1436 Hampton VA 23661 (757) 723-6531
Amateur Seismologist 2155 Verdugo Blvd #528 Montrose CA 91020 (818) 249-1759	**Earthwatch** 680 Mt Auburn St Watertown MA 02272 (800) 776-0188	**Geo-Monitor** 65 Washington St #400 Santa Clara CA 95050 (408) 749-6770	**Seismological Soc of Am** 201 Plaza Prof Bldg El Cerrito CA 94530 (510) 525-5474	**Terra Technology** 3854 148th Ave NE Redmond WA 98052 (425) 883-7300
Bell Jar 35 Windsor Dr Amherst NH 03031 (603) 429-0948	**EERC News** Earthquake Eng Univ CA Berkeley CA (510) 231-9413	**Geoscience Books** 319 Mineral Ave Libby MT 59923 (406) 293-2982	**Seismo-Watch Newsletter** PO Box 18012 Reno NV 89511 (800) 852-2960	**USGS** Denver Federal Center Denver CO 80225 (303) 273-8422
Bison Instruments 5610-T Rowland Rd Minneapolis MN 55343 (612) 931-0051	**EG&G Marine Insts** 217 Middlesex Tpk Burlington MA 01803 (781) 270-9100	**IASPEI** Box 25046, Mail Stop 967 Denver CO 80225 (303) 273-8422	**Seismograph Report** WVU School of Journalism Morgantown WV (304) 293-5603	**Vernier Software** 8565 SW Bv-Hd Hwy Portland OR 97225 (503) 297-5317
Bull Global Volcanism Smithsonian Institution Washington DC 20560 (202) 357-1511	**Engdahl Enterprises** 2930 E Grace Ln Costa Mesa CA 92626 (714) 540-0398	**IRIS Consortium** 1200 New York NW #800 Washington DC 20005 (202) 682-2220	**Shock & Vibration** 605 3rd Ave Fl 5 New York NY 10158 (212) 850-6000	**Western Atlas Intl** 10205 Westheimer Rd Houston TX 77042 (713) 266-5700

depths. Semi-annual.

Shock & Vibration — Scholarly journal from *Wiley* covering shock, vibration, acoustics, structural dynamics, and earthquake engineering.

The Abstract Journal in Earthquake Engineering — A scholarly pub which summarizes world literature relevant to mitigation of earthquake hazards. At $100.00 per copy.

EERC News — From the University of California at the Berkeley Earthquake Engineering Research Center. Includes publications, computer applications software, and other activities. Also publishes *EERC Reports.*

Earthquakes and Volcanoes — Useful consumer-oriented journal provides current information on earthquakes, volcanoes, and ongoing seismological activities. $11.00 per year, bimonthly.

Bulletin of Seismographic Stations — By the University of California Earth Sciences department. Primarily about Northern California earthquake lists and the phase readings for worldwide earthquakes. $10.00 copy.

ACT Seismologica Sinica — Expensive journal from *Elsevier* on research in seismology, theories of geophysics, seismo-tectonics, and on earthquake engineering. $265.00 per year.

The Bulletin of the Global Volcanism Network — This newsletter describes current volcanic activities and major earthquakes. Monthly at $18.00 per year.

Bell Jar — While primarily an amateur journal on high vacuum techniques, Steve Hansen sometimes does get into microbarographs and other seismic-related topics.

Journal of Geological Education — By the National Association of Geology Teachers. Their goal is improving the teaching of earth sciences.

The Review of Scientific Instruments — Original papers on new developments in scientific instrumentation, on their application, and use. In particular, do check the seismic laser inferometer on pages 1337-1346 of their May 93 issue, vol. 64 number 5.

Books

One all-time classic book is the 1958 *Elementary Seismology* by C.F. Richter. Two more recent choices are *Modern Global Seismology* by Lay and Wallace. And *Earthquakes & Geological Discovery* by Bruce Bolt.

Here are a few more book titles of possible interest ...

Acquiring Better Seismic Data
Anatomy of Seismograms
Designing Seismic Surveys
Digital Seismology and Lithosphere Modeling
Earthquakes
Earthquake Forecasting & Warning
Earthquake Prediction & Seismicity Patterns
Earthquake Public Information Materials
Earthquake Survival Manual
Earth Soundings Analysis
Encyclopedia of Earthquakes & Volcanoes
Exploration Seismology
Geology of Earthquakes
How to build Earthquake monitors
Seismology
Seismology and Plate Tectonics
Why the Earth Quakes

Many of these titles are available by way of the *Amazon Books* link I have set up at *www.tinaja.com/amlink01.html.* There is also *GeoScience Books* who do specialize in a 35,000 title selection of hard-to-find geological texts.

Amateur Seismologist

You can easily build your own seismometer. One fairly simple AS-1 vertical design can be found at Jeff Batten's *Amateur Seismologist* website at *www1.primenet.com/~seismo.* This device is simply a suspended mass on a sprung support. A strong magnet at the end interacts with a sensing coil to generate motional data. Sensed data is 12-bit A/D converter and routed to a personal computer for plotting and further processing.

While simple and easy to build, it supposedly can record 3.5 magnitude quakes at a distance of 100 miles or more. The magnet and the sensing coil are offered at $25.00 each by way of *seismo@primenet.com.*

A second do-it-yourself instrument is known as a *Lehman Seismometer* and ran in the July 1979 *Scientific American.* More details can be found through *psn.quake.net/lehman.html.* Kits and key parts are available. Word has it the AS-1 is more sensitive.

A laser seismograph project can be found in *www.ece.orst.edu/~ee482/laser s/ee48894/lesfin.htm* and a *Build Your Own Seismograph* project is found at *www.cea.berkeley.edu/Education/lessons/indiv/davis/Seismograph.html.*

Another homebrew seismometer appeared in *Science Teacher* magazine in a G.E. Averill story titled *Build your own Seismograph.* See vol. 62 #3 pages 48-52 for March of 1995.

Several frequently asked questions on homebuilt seismographs appear at *psn.quake.net/info/homefaq.txt.*

Association of Amateur Scientists

This is an organization headed up by the *Amateur Scientist* editor of *Scientific American.* This includes Forest Mims and many other name brand science writers and popularizers as members. The website is *web2.thesphere.com/SAS.*

One of their many offerings is the *Amateur Seismology Network,* reachable through *seismo@sas.org.*

EarthWatch

This one is a "rent an expedition" service that lets you participate as a serious amateur in worldwide science research, seismic and otherwise. For the price of a regular vacation, you become a grunt on a research team. Years ago, Bee and I went on a fuzzy elephant hunt with them on down in Wyoming's Natural Trap Cave.

The Web

I found a really impressive "links to links" site up at *www.uio.no/~hansjb/earthqu.htm* that's got many hundreds of active seismo and earthquake links. One shorter listing that seems to lead you to all the biggies real quick-like is found at *epsc.swustl.edu/seismology/links.html.* Check this out.

This site also stocks recent abstracts and papers from the Department of Earth and Planetary Sciences from the Washington University in St. Louis.

Steve Malone's *Surfing the Internet for Earthquake Data* also offers many hundreds of active links, all arranged geographically

HomeRisk is found at, of all places, *www.homerisk.com.* This is an Internet resource for assessing your home's seismic risk factors.

All of the usual search engines are also helpful. I found *Inference Find* to generate a few well arranged links. Access to these search services can be reached by way of my hot buttons at *www.tinaja.com/webwb01.html.*

Newsletters and Newsgroups

The leading newsletter and forum on earthquakes appears to be Larry Cochrane's *Public Seismic Network* that you'll find at *psn.quake.net.* You'll find many hundreds of pages of "them that's doin" ongoing projects.

Both amateur and professional.

Actually, there are several different Public Seismic Networks. This one is in Redwood City, CA. Links to other networks are found here which lead you to the Fairbanks, Memphis, Dunedin, Pasadena, Kalamunda, and San Jose locales. A dozen "additional earthquake information" site links are also provided.

Disaster Research is a free electronic newsletter you can reach by way of *adder.colorado.edu/~hazctr.Home.html* and hosted by the Natural Hazards Information Center.

Lots more where these came from.

A QUAKE-L mailing list is available at LISTSERV@VM1.NODAK.EDU. They advise you of recent earthquakes and include discussions from people in the field of seismology.

A collection of the more popular newsgroups include ...

alt.disasters.earthquake
ca.earthquakes
ca.environment.earthquakes
sci.geo.earthquakes
sci.geo.geology
seismic
seismic.general

Except that those last two do not seem very active at present.

This Month's Contest

I live in a seismically quiet part of the country, so earthquakes are not that big a deal around here. Which leaves me with the hollow feeling that I might have missed a few obvious biggies in this short survey. So, tell me about any seismic or earthquake resources that I may have missed.

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

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

Let's hear from you. There's some exciting new opportunities here. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 35 books and countless tech articles. Don maintains his no-charge US tech helpline found at ***(520) 428-4073****, besides offering all of his own books, reprints, and consulting servicesl. Don also offers a free catalog full of his unique products and resource secrets. The best calling times are 8-5 on weekdays, Mountain Standard Time.*

Don is the webmaster of his Guru's Lair found at http://www.tinaja.com

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

Events CALENDAR

Continued from page 79

MARCH 21

AR - JONESBORO - ARC Hamfest. Roger Wann KC5AOF, 870-935-9429

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - STUART - Martin County ARA Hamfest. David Millard KE4AMW, 561-288-7100

GA - MARIETTA - Kennehoochee ARC Hamfest. Jim Cummings KT4MM, 770-517-0073. E-Mail: jjmmc@juno.com Web: http://qsl.asti.com/hootch/KARC.html

IA - OSKALOOSA - Mahaska Hams. Vern N0SJF, 515-634-2724

NH - HUDSON - Interstate Repeater Society Hamfest. John Brunelle KA1FYB, 603-881-5796. E-Mail: brunelle@tiac.net

NH - SEABROOK - Computer Show. Seabrook Greyhoud Racetrack. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

NJ - WEST ORANGE - Hamfest. West Orange High School, 600 Pleasant Valley Way. 8:30am-1pm. Jim Howe N2TDI, 973-402-6066

NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

MARCH 21-22

GA - DALTON - Computer show. North GA Fairgrounds. Georgia Mountain Productions 706-838-4827

NY - LAKE GROVE - Computer Show. Sports Plus. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

OH - TALLMADGE - Computer Show. Summit Co. Fairgrounds. 10am-4pm Sat. 10am-3pm Sun. Peter Trapp Shows. 603-272-5008. www.petertrapp.com

MARCH 22

CT - BRISTOL - Insurance City Repeater Club. Pete Brunelli N1QDQ, 860-620-0176. E-Mail: pcb@connix.com

IL - GRAYSLAKE - LAMARSFEST 98. Lake Co. Fairgrounds. 8am-2pm. Dave Gudewicz KB9KDA, 847-937-8227

NH - MANCHESTER - Computer Show. Center of NH Expo. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net

NJ - WESTFIELD - Computer Show. Westfield Armory. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

NC - KINSTON - Down East Hamfest. Doug Burt W4OFO. 919-524-5724

NY - YONKERS - Westchester Emergency Communications Assn. Hamfest. 8am-2pm. Yonkers Raceway. Thomas Raffaelli WB2NHC, 914-741-6606. Web: http://www.wec.org

OH - MADISON - Lake County ARA Hamfest. Roxanne 440-256-0320

MARCH 28

IN - COLUMBUS - Hamfest. Bartholomew County 4H Fairgrounds, Community Bldg. 8am-2pm. Marion

Winterberg WD9HTN, 812-342-4670. winter be@hsonline.net
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827. E-Mail: agi@trader.com Web: http://www.surf-ici.com/agi
IN - MICHIGAN CITY - ARC Hamfest. Ron Stahoviak N9TPC, 219-325-9089
KY - ELIZABETHTOWN - Lincoln Trail ARC Hamfest. Harold Bennett AF4AC. 502-351-9599. E-Mail: hbennett@bbtel.com
NH - KEENE - Computer Show. Cheshire Fairgrounds. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
OR - EUGENE - Hamfest. John Brambora KB7SXS. 541-747-2898
PA - YORK - Computer Show. York Fairgrounds, Old Main Bldg. 10am-3pm. Peter Trapp Shows. 603-272-5008. www.petertrapp.com
TN - TULLAHOMA - Middle TN ARS Hamfest. Larry Marshall WB4NCW, 931-455-0070. E-Mail: 1marsh@edge.net
TX - WEATHERFORD - ARC of Parker County Hamfest. Elizabeth Hunkele N5ONE, 817-594-1700. E-Mail: eliz@neurotech.net Web: http://www.flash.net/~jbledsoe/ham/98ParkerHamfest.html

MARCH 28-29

MD - TIMONIUM - Greater Baltimore Hamboree & Computerfest. Timonium Fairgrounds. William Dobson N3WD. 410-HAM-FEST. E-Mail: gbhc@concentric.net Web: http://www.concentric.net/~gbhc
NY - WHITE PLAINS - Computer Show. Westchester County Center. 9:30am-4pm. MarketPro 201-825-2229. Web: http://www.marketpro.com

MARCH 29

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
CT - SOUTHINGTON - Flea Market. Southington High School. 9am-1pm. Chet KA1ILH, 860-628-9346
IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
IL - TAYLORVILLE - Christian County Hamfest. David E. Nation, Sr. KA9JHW, 214-824-3707. E-Mail: ka9jhw@mindless.com
MI - FLINT - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988
NH - PORTSMOUTH - Computer Show. Yoken's. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
NY - BINGHAMTON - Computer Show. The Showplace. 10am-3pm. Peter Trapp Shows. 603-272-5008. www.petertrapp.com
OH - CIRCLEVILLE - Hamfest & Computer Show. Pickaway Co. Fairgrounds. Roy Ulko KG8EK, 614-477-8310. E-Mail: royulk@scioto.net

APRIL 1998

APRIL 3-4

AL - ALBERTVILLE - Hamfest. Albertville Recreation Center. Fri: 5-9pm, Sat: 8am-3pm. Buddy Smith KC4URL, 205-593-2516. E-Mail: kc4url@air net.net
AR - SHERWOOD - Central AR Radio Emergency Net Hamfest. J. C. Smith N5RXS, 501-568-7982
GA - ATLANTA - Southeastern VHF Conference. Sandy Donahue W4RU, 404-875-9450. E-Mail: w4ru@arrl.org

APRIL 3-4-5

GA - AUGUSTA - Annual Worldwide Break. Radisson Hotel & Conference Ctr. Two 10th St. Sam Hacker 706-790-6213
MI - MT. CLEMENS - Computer & Technology Show. Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

APRIL 4

CA - ARMONA - Hams & Hackers Swap Meet. Hanford Fraternal Hall, 10th Ave. at Florinda, Rick WB6VFZ, 209-945-2266
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CO - BOULDER - Longmont ARC Hamfest. Jim Walker, E-Mail: walker.jim@usa.net
CT - WATERFORD - Ham Radio Auction. Waterford Senior Center on Rte. 85. Tony Griggs AA1JN, 860-859-0162. Web: www.ims.uconn.edu/~rason
FL - FT. LAUDERDALE - Computer Show. Holiday Inn West. 5100 N. St. Rd. 7. Narisaam Computer Show 770-663-0983
NC - MORGANTON - Catawba Valley Hamfest and Computer Fair. Burke Co. Fairgrounds Hwy. 181N. Thomas Taylor KC4QPR. 704-433-6205. E-Mail: kc4qpr@vistatech.net
NH - TWIN MOUNTAIN - Hamfest & Computer Fair. Twin Mountain Town Hall. 8am-3pm. Richard Force WB1ASL, 603-788-4428 bhabooks@together.net
OH - BEREA - Computer Show. Cuyahoga Co. Fairgrounds. 10am-3pm. Peter Trapp Shows. 603-272-5008. www.petertrapp.com
PA - FREDERICKSBURG - Appalachian AR Group Hamfest. Paul Felty WB3HEC. 717-566-2606
WA - SPOKANE - Lilac City ARC Hamfest. St. Anns Parish Hall, E. 2120 First Ave. 9am-5pm. 509-327-7196
WA - VANCOUVER - Clark Co. ARC Hamfest. Luther Brisky KC7KVL, 360-896-8909. E-Mail: 1wayne@worldaccessnet.com Web: http://www.w7aia.org

APRIL 4-5

GA - KENNESAW - Computer Show. Outlet Mall, I-75 @ Exit 117. Georgia Mountain Productions 706-838-4827

APRIL 5

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
FL - PALM BEACH GARDENS - Computer Show. Palm Beach Gardens Marriott. 4000 RCA Blvd. Narisaam Computer Show 770-663-0983
IA - DELOIT - Denison Repeater Assn. Hamfest. John Amdor KD6MXL. 712-748-8162. E-Mail: johnmxl@netins.net Web: http://www.netins.net/showcase/johnmxl/deloit98. html
MA - TAUNTON - Computer Show. Holiday Inn. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
NC - RALEIGH - Hamfest. NC State ARRL Convention & Computer Fair. Jim Graham Bldg., State Fairgrounds. 8am-4pm. Wilbur Goss WD4RDT, 919-266-7883
NJ - TRENTON - Delaware Valley Radio Assn. Hamfest. Tall Cedars of Lebanon picnic grove, Sawmill Rd. Darryl Foyuth N2JVP, 609-882-2240. Web: www.slac.com/w2zq
OH - AKRON - Computer Show. Tadmor Shrine Temple. 10am-3pm. Peter Trapp Shows. 603-272-5008. www.petertrapp.com
WI - MIDDLETON - Madison Area Repeater Assn. Swapfest. John Q. Hammons Trade Center. Jeremy Charles N9VHT. 608-245-8890 http://www.cs.wisc.edu/~jeremyc/mara/swapfest

APRIL 10-11

MS - TUPELO - Tupelo, Booneville and Union Co. ARCs Hamfest. Jack Ellis KI5QV, 601-842-7255. Web: http://www.tupelofest.org

APRIL 11

AR - BENTONVILLE - Benton County Radio Operators. BCRO, P.O. Box 883, Pea Ridge, 72751
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
FL - MIAMI - HamSwapfest. U. of Miami Coral Gables Campus, Physics Parking Lot. 8am-12pm. Walt W4DWN 305-895-0398
OK - LAWTON - Lawton Ft. Sill ARC Hamfest. Bob Morford KA5YED, 580-355-6120. E-Mail: w5ks@rli.net
OR - PENDLETON - Hamfest & Computer Fair. Conv. Center. 8am-4pm. Denton WB7TDG, 541-276-8319. E-Mail: denton@oregontrail.net
TN - CLINTON - Oak Ridge ARC Hamfest. Jim Whittlesey KC4RHW. E-Mail: kc4rhw@bellsouth.net

APRIL 17-18-19

MI - TAYLOR - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 313-287-2000

APRIL 18

AZ - PHOENIX - ARC Hamfest. George Cooney KQ7C, 602-274-6212. E-Mail: georgie@aztec.asu.edu
CA - SACRAMENTO - River City ARC Hamfest. Roy Rudebaugh KD6LLE, 916-427-6852. E-Mail: kd6lle2@juno.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
ME - AUGUSTA - Computer Show. Civic Center. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
MN - FERGUS FALLS - Lake Region ARC Hamfest. William Morgan AA0AX, 218-736-4448
MO - JOPLIN - ARC Hamfest. Andy Gabbert KA0TUD, 417-673-8371. E-Mail: agabbertka0tud@hotmail.com
TN - DAYON - Rhea County ARS Hamfest. Tom Mize 423-570-0840. Web: http://www.volstate.net/~ko4sy
TX - BELTON - Spring Fest. Bell County Expo Center. Mike Lefan WA5EQQ, 254-773-3590. E-Mail: hamexpo@vvm.com Web: http://www.tarc.org

APRIL 18-19

AL - BIRMINGHAM - Southeastern Div. Conv. Bill Levey WA4FAT, 205-97-0622. E-Mail: barc@bro.net Web: http://bro.net/barc
CT - HARTFORD - Trinity College Fire Fighting Home Robot Contest. 12pm-5pm. www.trincoll.edu/~robot JMENDEL141@AOL.COM
IL - ELGIN - CoCofest. Holiday Inn, Holidome Indoor Recreation Ctr. Sat: 10am-5pm, Sun: 10am-3:30pm.

Continued on page 90

New Product News

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

NUTS & VOLTS MAGAZINE
NEW PRODUCT EDITOR,
430 PRINCELAND CT., CORONA, CA 91719

ID BAND MARKERS

Plastic Extruded Parts, Inc., introduces ID Band Markers.

ID Band Markers provide a simple, permanent wire identification system. The oval shape permits direct application to a wide range of wire sizes (0.160"-0.280") or assembly ribbon may be used to mount ID Band Markers on larger diameter cable.

Large codes are hot stamped into the plastic and are visible over great distances. Stock numeric (0-9), alpha (A-Z), and electrical symbol codes are available in either white or yellow with black markings.

Assembly ribbon is slotted every inch and sold as a continuous black strand which is cut to the desired length by the user. Wire ties or other materials may be used to attach assembly ribbon with mounted ID Band Markers to larger diameter cable, conduit, or tubing.

Markers are sold in strands of 100 and 500. Ribbon is sold in lengths of 10 feet, 33 feet (10 meters), and 50 feet. Both products are manufactured of durable FR-1 Rated FPVC.

For more information, contact:

PLASTIC EXTRUDED PARTS, INC.
5229 NY 203, P.O. BOX 540
DEPT. NV
NASSAU, NY 12123-0540
518-766-9878 FAX: 518-766-3229

SG-2020 HF TRANSCEIVER

SGC, Inc. annouces its newest HF transceiver — the SG-2020. The SG-2020 is designed and built to meet the needs of both the experienced and the casual radio operator. Both will find that the controls and functionality make the SG-2020 a "user-friendly" radio.

Features include: 1.8 to 29.7 MHz frequency range, 0 to 20 watts PEP transmitter power, 40 simplex or semi-duplex memories, built-in fully adustable IAMBIC "A" mode keyer operating under microprocessor control from 5 to 60 WPM, typical 300 mA total consumption in receive mode, and 2-Hz steps frequency resolution.

Whether installed in a vehicle or packing through the mountains, the SG-2020's rugged construction is excellent for extreme mobile and portable conditions. Use the SG-2020 in locations where space is as precious as a dependable transceiver.

The SG-2020 HF transceiver is available for the suggested retail price of $595.00.

For more information, contact:

SGC, INC.
P.O. BOX 3526, DEPT. NV
BELLEVUE, WA 98009
425-746-6310 FAX: 425-746-6384
1-800-259-7331
E-MAIL: SGCMKTG@aol.com
WEB: http://www.sgcworld.com

MICROPLATE TRANSMITTER

Supercircuits' new Microplate Video Transmitter combines micro size, solid performance, and low price. Weight is only 1/2 ounce and size is super tiny, only 2" x 1.25" x .16" thick.

Transmitting frequency is 434 MHz, which means it can be received by any cable ready television at channel 59, or just below UHF channel 14 on most slide-rule type analog tuning portable or pocket televisions.

Rock-solid stability is provided by an advanced Surface Acoustical Wave (SAW) resonator circuit.

Range is up to 700 feet with standard antenna and over 2,500 feet line of sight with a Yagi-type antenna. Output power is 200 milliwatts and power requirement is 12 volts DC at 100 milliamps.

One tiny AAA battery pack will operate the unit for hours. The unit is encased in tough thinline metal housing and comes complete with pre-installed power and video cables, and flexible 6.5" whip antenna.

It's also available with audio. The audio version is same size, but .35" thick.

License required for legal operation in the US.

For more information, contact:

SUPERCIRCUITS, INC.
ONE SUPERCIRCUITS PLAZA
DEPT. NV
LEANDER, TX 78641
512-260-0333 FAX: 512-260-0444
1-800-335-9777
WEB: www.supercircuits.com

WORLD-WIDE RADIO IN A LITTLE BLACK BOX

ICOM America, Inc. introduces a new product, the IC-PCR1000, a "black box" communications device that transforms a computer screen into a high-quality wide band receiver.

The PCR1000 connects to computers externally, providing compatibility with many different PC models, even laptops, and offers both band scope functions and exceptional receiver/scanner performance.

The IC-PCR1000 receives local radio and television broadcasts, as well as high-frequency/shortwave broadcasts that carry data transmissions, news, music, and events from other countries.

Plus, the PCR1000 enables PC users to listen to, or "scan," public safety services (fire, police, search and rescue), commercial, military, aircraft, and marine communications.

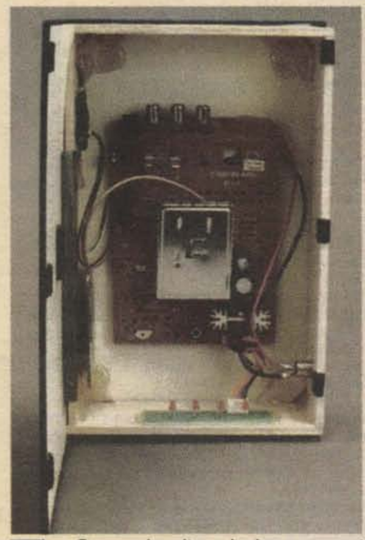
With a good antenna, the PCR1000's reception covers the globe, enabling a computer with Microsoft Windows 3.1X or Windows 95 to become an HF shortwave receiver. Plus, the IC-PCR1000 makes world-wide mobile reception a reality since it may be used in a car by simply connecting it to a laptop and using the power from a 12-volt cigarette lighter.

Cellular blocked: unblocked versions available only to FCC-approved users.

For more information, contact:

ICOM AMERICA, INC.
2380 116TH AVE. N.E., DEPT. NV
BELLEVUE, WA 98009
425-454-8155 FAX: 425-454-1509
WEB:
http://www.icomamerica.com

WIRELESS BOOK CAMERA



The Supercircuits wireless covert book cam features new 2.4 GHz FM synthesized technology for long range and solid video performance.

Wide angle camera is a strategic 110-degree wide angle, which delivers a commanding view of most rooms. High gain microphone and preamp are built in. Also available in color.

Use the Supercircuits' new MVR-3 super high-gain receiver/antenna for unbelievable range up to 2,500 feet plus!

For more information, contact:

SUPERCIRCUITS, INC.
ONE SUPERCIRCUITS PLAZA
DEPT. NV
LEANDER, TX 78641
512-260-0333 FAX: 512-260-0444
1-800-335-9777
WEB: www.supercircuits.com

WORLD'S SMALLEST VIDEO TRANSMITTER

Supercircuits announces a video transmitter, claimed to be the world's smallest.

Operating at 900 MHz, the TXB transmitter weighs only .33 of an ounce. Size is .37" in diameter by 1.3" long, approximately the same size as a 9 mm bullet.

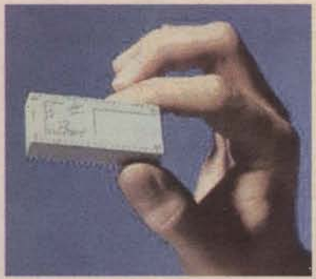
Range is a conservative 500 feet, using the Supercircuits RV-2000A FM receiver and standard antennas. Range can be extended with the use of high-gain Yagi antennas.

The transmitter accepts standard NTSC video, great for use with covert pinhole cameras for undercover investigations.

For more information, contact:

SUPERCIRCUITS, INC.
ONE SUPERCIRCUITS PLAZA
DEPT. NV
LEANDER, TX 78641
512-260-0333 FAX: 512-260-0444
1-800-335-9777
WEB: www.supercircuits.com

TINY TIGER® MICROCONTROLLER



Kg Systems, Inc. announces the TINY Tiger® microcontroller — a multitasking module in miniature.

The Tiny Tiger covers a wide range of features and abilities. Features include:

Windows BASIC development system; multitasking ability; source-level debugging; powerful functions; selectable device drivers; 128K FLASH memory; 32K to 128K SRAM; four A/D channels; two PWM channels; two serial ports; digital I/O; real-time clock (128K version); low-power consumption; compact 44-pin package; cost-effective (32K RAM $59.00), (128K RAM and RTC $79.00), and development kit $99.00 (FOB East Hanover, NJ).

For more information, contact:

KG SYSTEMS, INC.
DORINE IND. PARK
#3 MERRY LN., DEPT. NV
EAST HANOVER, NJ 07936-3901
973-515-4664 FAX: 973-515-1033
URL:
www.industrialcontroller.com
E-MAIL:
TIGERsales@kgsystems.com

SLIM UV PROBE

The SSD301A Super Slim UV Probe is under 2.5 mm thick x 29 mm x 38 mm, permitting it to perform continuous monitoring in microlithography and photoresist production lines. Featuring a heat and optical radiation resistant surface which protects the input optics, it maintains <1% per year change in stability in hostile environments, depending upon dose.

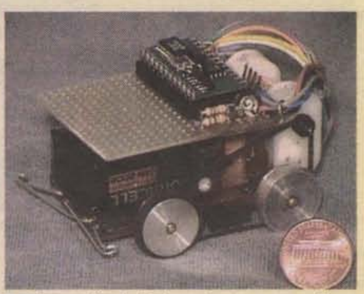
Providing a spectral response from 260 nm to 400 nm over a 3 µW/cm² to 1W/cm² dynamic range, the SSD301A Super Slim UV Probe is compatible with the firm's IL1400A and IL1700 research radiometers which provide direct readouts in actual units. Supplied with a 7' shielded and insulated cable, it fits under the vacuum frame of PCB production equipment.

The SSD301A Super Slim UV Probe is priced at $328.00, and a complete system is priced at $1,050.00.

For more information, contact:

INTERNATIONAL LIGHT, INC.
17 GRAF RD., DEPT. NV
NEWBURYPORT, MA 01950
978-465-5923 FAX: 978-462-0759
E-MAIL: ilsales@intl-light.com
WEB: http://www.intl-light.com

POCKET-BOT



Diversified Enterprises now offers Pocket-Bot, an advanced miniature robot.

Pocket-Bot includes an on-board BASIC II microcontroller.

This miniature robot is only slightly larger than the nine-volt battery that powers it, and Pocket-Bot's intricate design, sturdy construction, example programs, and concise documentation make it ideal for researchers, educators, and hobbyists.

The unit is powered by a standard nine-volt alkaline battery which lasts for many hours due to a highly efficient design requiring minimal current draw.

The unit is thoroughly documented and includes example programs that can be run on and downloaded from any standard personal computer. The design is highly expandable from both the hardware and software standpoint.

Independent two-stage gear reduction motors provide extraordinary power, maneuverability, and navigation accuracy. Shaft encoders providing feedback to the microcontroller further improve Pocket-Bot's movement accuracy. Pocket-Bot is ideal for use in behavior studies and other experiments needing precise, yet complex motions. Navigation accuracy is maintained by its four wheel drive design which also enables Pocket-Bot to climb over comparatively large obstacles with ease.

Left and right obstacle sensors allow Pocket-Bot to be programmed for obstacle detection, location, and avoidance. Options for line following thermal sensitivity, and light/dark detection are also available.

A large prototyping area allows users to design in custom circuitry for their specialized application.

To accommodate any budget, Pocket-Bot is available both fully assembled and in kit form. Prices start at just $245.00.

For more information, contact:

DIVERSIFIED ENTERPRISES
158 AERO CAMINO RD.
DEPT. NV
SANTA BARBARA, CA 93117
805-968-5182
E-MAIL:
marketing@diversified.org

NEW PICMASTER™ IN-CIRCUIT EMULATOR

Microchip Technology, Inc., announces its new PICMASTER® In-Circuit Emulator System.

The PICMASTER system includes: an emulator control pod, target-specific emulator probe kit, PRO MATE® II programmer, PC host-interface card, PC host emulation control software, demonstration hardware and software, and complete system documentation. The development tool runs under Microchip's MPLAB™ Integrated Development Environment (IDE), a software productivity tool which gives PICmicro developers the flexibility to edit, compile, and emulate all from a single user interface.

Operating on IBM-compatible PCs under the Microsoft Windows® environment, PICMASTER includes MPLINK linker; MPASM, a PC-hosted symbolic macro assembler; and MPLAB-SIM, a discrete event software simulator for the PIC17C75X microcontrollers.

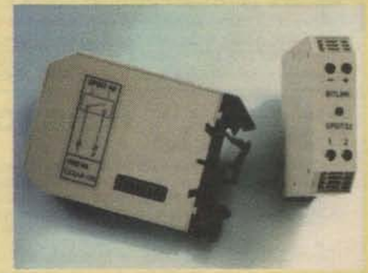
Microchip's probe kit provides the interface connection to the target microcontroller device that is being emulated. The probe kit configures the emulator system for emulating a target PIC17C756 microcontroller and connects to the ribbon cable from the emulator. Interchangeable probes allow development engineers to easily reconfigure the emulator system for emulating different PICmicro microcontrollers.

Current PICMASTER owners can easily upgrade their system for full PIC17C756 family compatibility by ordering the new PIC17C75X probe kit.

For more information, contact:

MICROCHIP TECHNOLOGY, INC.
2355 W. CHANDLER BLVD.
DEPT. NV
CHANDLER, AZ 85224-6199
602-786-7200 FAX: 602-899-9210
WEB: www.microchip.com

BITLINK™ INTERFACE COMPONENTS



BITlink™ makes it easy to build a remote digital or analog I/O or fieldbus system because communication and power is transmitted using only a two-wire connection.

For applications from industrial control, agricultural installations to modem-controlled remote datagathering, BITlink components make system design simple.

Driven from a standard RS232 port or an internal PC card, BITlink components are available for almost any task. Up to 256 components may be separately addressed on the bus. Easy to set up and use, the two-wire BITlink bus system can be up to 2000m in length.

Whether you need digital input and output, counters, remote A/D up to 16-bits, D/A with 12-bit resolution, relay drivers, thermocouple temperature sensing or many other functions, DIN rail-mounting BITlink modules are available for many functions.

Windows software makes it easy to program all the I/Os you need. DLLs and DDE functions are provided so you can import data directly into Excel or other software. DLLs also allow you to export calculations from speadsheets so that your entire industrial operation can be dynamically controlled.

BITlink modules start at $79.00.

For more information, contact:

THE SAELIG COMPANY
1193 MOSELEY RD., DEPT. NV
VICTOR, NY 14564
716-425-3753 FAX: 716-425-3835
E-MAIL: saelig@aol.com
WEB: www.memo.com/saelig

Continued on page 107

Events CALENDAR

Continued from page 87

Tony Podraza 847-428-3576. TONYPODRAZA@ JUNO.COM

APRIL 19

IL - STICKNEY - Ham and computer show. Hawthorne Race Course, 3500 S. Cicero Ave. 8am-2pm. DARC, 7511 Walnut Ave., Woodridge, IL 60517-2818. http://homepage.interaccess.com/~geirh/

MA - CAMBRIDGE - Flea Market. Kendall Square area. MIT. Nick Altembernd KA1MQX, 617-253-3776

MI - FLINT - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988

MI - ST. JOSEPH - Blossomland ARA Hamfest. James Hoffer KW8T, 616-429-6527. E-Mail: W8JSJ@ juno.com

MN - SHAKOPEE - Hobby electronics show. Canterbury Park. 12pm-5pm. Helen WB0HOX, 612-361-6782

MO - CEDAR HILL - Jefferson County ARC Hamfest. Jim Autery KA0WXN, 314-296-3473

APRIL 24-25

AR - LITTLE ROCK - Hamfest. The Expo Center, Interstate 30. Fri: 4pm-9pm, Sat: 8am-5pm. Jim Blackmon KB5IFV, 870-246-6734. E-Mail: 1rham fest@usa.net Web: http://www.aristotle.net/~n5 xay/lrh98.html

FL - GAINESVILLE - ARS Hamfest. Larry Walker WB4VAU, 352-377-0683

APRIL 25

CA - SONOMA - Hamfest. Sonoma Valley Veteran's Memorial Bldg., 126 1st St. W. 8am-noon. Darrel

WD6BOR, 707-996-4494.
IA - DES MOINES - RAA Hamfest. Ron Hobbs N0XWI, 515-255-4020. E-Mail: rwhobbs@aol.com
MN - ROCHESTER - ARC Hamfest. John Scott N0HZN, 507-285-6522. E-Mail: n0hzn@aol.com Web: http://members.aol.com/rarchams
NH - DURHAM - Computer Show. Whittemore Arena @ UNH. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
NJ - HARMONY TOWNSHIP - Cherryville Repeater Assn. Hamfest. Marty Grozinski W2CG, 908-788-2644, 908-788-4080
NM - ALBUQUERQUE - ARC & AR Caravan Club Hamfest. Chuck Opdyke KC5GA, 505-858-0306
OR - KLAMATH FALLS - Keno ARC Hamfest. Tom Hamilton WD6EAW. 541-883-2736. E-Mail: wjonesjr@cdsnet.net Web: http://home.cdsnet.net/~wjonesjr/kenoarc.htm
PA - BLOOMSBURG - Columbia-Montour ARC Hamfest. Dave Schack WC3A. 717-752-6851
RI - WEST GREENWICH - WA County & Fidelity ARC Hamfest. Everett Lovenbury N1VEZ, 401-539-1107. E-Mail: N1VEZ@juno.com

APRIL 26

DE - NEW CASTLE - State Conv. Nur Temple, Rte. 13 N. 9am-3pm. Hal Frantz KA3TWG, 302-793-1080. E-Mail: hfrantz@magpage.com Web: http://www.magpage.com/penndel
IL - ARTHUR - Moultrie ARK Hamfest. Moultrie/Douglas County Fairgrounds. 8am-1pm. Ralph Zancha WC9V, 217-873-5287 or 217-543-2178
IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
IL - KEWANEE - Area Amateur Radio Operators. Bill Anderson WB9TEW, 309-932-3023. E-Mail: bill@inw.net
MA - WORCESTER - Computer Show. Centrum Centre. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
NY - POUGHKEEPSIE - Mt. Beacon ARC Hamfest. Ken Akasofu KL7JCQ, 914-485-9617
OH - ATHENS - ARA Hamfest. Drew McDaniel W8MHV, 614-592-2106. E-Mail: mcdanied@oak.cats.ohiou.edu Web: http://www.seorf.ohiou.edu/~xx017/hamfest.html
OH - CANFIELD - Hamfest & Computer Flea Market. Canfield Fairgrounds, Rt. 46. 8am-3pm. Don Stoddard N8LNE, 330-793-7072

MAY 1998

MAY 1-2-3

CA - VISALIA - International DX Convention. Rick Samoian W6SR, 714-993-0713 or 310-616-3912

MAY 2

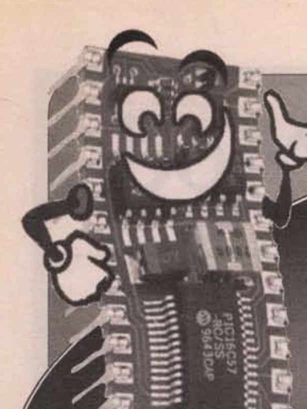
AZ - SIERRA VISTA - Cochise ARA & SE Hamfest. Ronald Slominski KC7QXJ. 520-378-3018
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CO - COLORADO SPRINGS - Pikes Peak RAA Hamfest. Ron Deutsch NK0P, 719-593-8352
CO - GRAND JUNCTION - Western CO ARC Hamfest. Diana Dodd KB0REW, 970-243-7441
KY - OWENSBORO - ARC Hamfest. George Stokes KD4CKT, 502-683-2169. E-Mail: w4nho@occ-uky.campus.mci.net
MD - GRASONVILLE - Anne Arundel RC & Kent Island ARC Hamfest. Glenn Durbin WN3G, 410-643-1125. E-Mail: K3ORC@amsat.org or pvtpilot@friend.ly.net
MI - CADILLAC - Hamfest. Cadillac Middle School. 8am-1pm. Dan KE8KU, 616-775-0998. E-Mail: ke8kudan@juno.com
NH - SEABROOK - Computer Show. Seabrook Greyhoud Racetrack. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
RI - SMITHFIELD - City Slickers Radio Operators. Frank Grzych KE1FJ, 401-231-3993 E-Mail: cobra@ibm.net
WI - CEDARBURG - Ozaukee RC Hamfest. Gabe Chido, 414-377-2784 or 414-284-3271
WI - SUPERIOR - Arrowhead RAC Hamfest. Jeff Daniels N0VQF, 218-485-8131

MAY 2-3

GA - LAWRENCEVILLE - Computer show. Gwinnett Fairgrounds. Georgia Mountain Productions 706-838-4827
TX- ABILENE - Hamfest. Civic Center. Sat: 8am-5pm, Sun: 9am-2pm. Peg Richard KA4UPA, 915-672-8889.

MAY 3

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
MD - HAGERSTOWN - Hamfest. Junior College Athletic and Recreation Community Center. 8am-3pm. Donald Jones KB8WHW, 304-728-7769. E-Mail: kb8zqm@intrepid.net
ME- LEWISTON - Computer Show. Central Maine Civic Center. Northern Computer Shows 978-744-8440. E-Mail: tchc@iamerica.net
NY - YONKERS - Flea Market. Lincoln High School. Kneeland Ave. 9am-3pm. Otto Supliski WB2SLQ. 914-969-1053



Stamp Applications!

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

by Jon Williams

Graphical User Interfaces (GUIs) have been a PC standard for some time and, with the cost of intelligent graphic displays on the decline, GUIs are making their way into embedded applications. This month's project is a very simple pumping station simulator using the G12864 as the display. Since the circuitry is so simple, I assembled the project on Parallax's BASIC Stamp Activity Board (BSAC).

Goin' GUI

I've known Scott Edward for a few years now, and I've got to say one thing: the guy solves problems. A little over a year ago, I was considering a project using a graphical (versus character-based) LCD. It didn't take much research to convince myself that the project wasn't really practical, considering the Stamp's limited resources. Not long thereafter, I was chatting with Scott and asked him if he'd ever considered a backpack for graphic LCDs. I could sense Scott grinning as he said, "Be patient, Jon – I'm working on something you'll like." He wasn't kidding.

Scott's latest serial marvel is the G12864 Serial Graphics LCD. The module combines a 128x64-pixel backlit LCD with a serial interface. The G12864 can simultaneously display text (four lines of 16 characters) and graphics. Serial commands even allow you to draw lines with code. Since the G12864 comes with an excellent reference and code samples, our focus will be applying the combined text/graphics capability in a project. Let's get started.

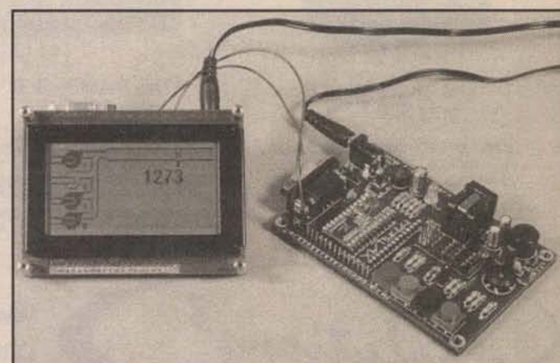
Goin' GUI

All projects require planning, and this one is no exception. In fact, the use of a graphics display and the creation of those graphics requires even more planning and work. Here's an overview:

- Plan the project.
- Develop the graphics.
- Download graphics to the G12864.
- Write and test code.

The Project

As I just stated, our project is a very simple pumping station simulator. Please keep in mind that the purpose of this project is to demonstrate some of the capabilities of the G12864. Actual pumping station controls are much more sophisticated than what we'll present here.



Our project simulates a flow sensor by reading a potentiometer with the RCTIME function. The input is scaled to a maximum flow of about 1600 units. The program takes the flow reading and turns on up to four pumps to meet the demand. The pumps are capable of supplying 100, 200, 400, and 800 units, respectively, for a maximum combined output of 1500 units. If the flow demand exceeds the combined pump output by 25 units, the next pumping level is selected. If the total demand exceeds 1520 units, our station is shut down and must be reset.

For the display, I wanted a graphic that showed each of the four pumps, their status, and the flow demand. Pump status is displayed graphically – sort of (more on this later). The flow demand is output as a four-digit number.

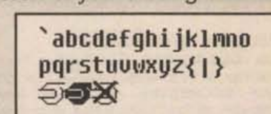
While the G12864 is capable of displaying graphic images, it does not have the ability to display "sprites" (portions of a graphic page). So how am I going to display my pump status graphically? With text, that's how! Okay, okay, I know this sounds a bit confusing. Let me elaborate.

The G12864 contains 16 pages of non-volatile flash memory, with each page holding a 128x64 bit graphic image. The first three pages of memory are special. Pages zero and one contain the font used for text displays. The image on page two is called the splash screen. Configuration switch 6 on the G12864 allows the splash screen to be displayed at power-up. We'll set this switch on to automatically display our pump station graphic.

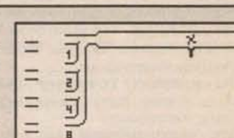
Each character on the font pages is eight pixels wide by 16 pixels tall, and all the characters up to ASCII 127 are predefined. This leaves room (on page 1) for up to 32 custom characters (ASCII codes 128 to 159). Since text and graphics can be combined on the G12864, custom characters will be used to indicate pump status. I designed my graphic so that each pump occupies a 16x16 pixel region. This means that two characters are needed to display each pump state: off, on, or error.

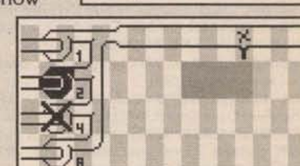
Developing G12864 Graphics

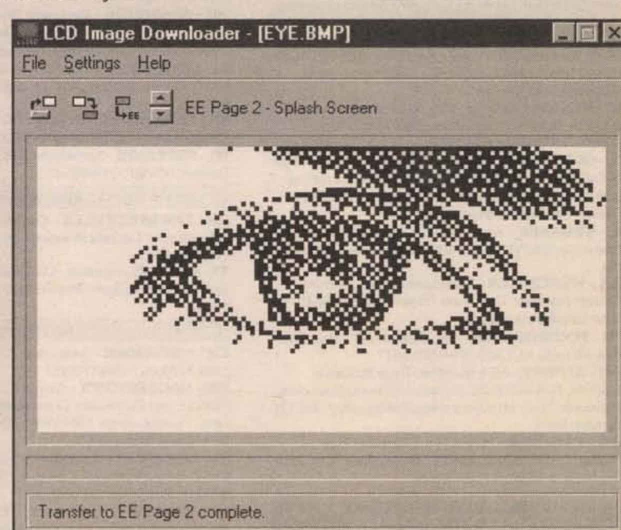
As with text editors, everyone has their favorite graphics program. Mine happens to be Paint Shop Pro (PSP) from Jasc, Inc. (see sources). PSP is one of the most popular shareware programs available today. I use it daily in my professional and personal projects – it's that good. In the following description, PSP key commands are indicated in parentheses. If you're using another graphics program, please refer to its documentation.



I start by creating a 16-color image (File | New) that is 128 pixels wide by 64 pixels tall. Since I'm going to combine text and graphics, I paint a checkerboard pattern to show







me where the characters will fall. Each checker is eight pixels wide by 16 pixels tall (the same size as a character). I used white and light cyan as my checker colors. Use what you want, but keep these background colors very light. This will make the conversion to a two-color graphic – necessary for the G12864 – easier. I saved (File | Save As) this template as G12864.BMP.

With the template saved, I make a copy (Shift-D) and create my pump station master graphic. There's not a heck of a lot I can tell you here; if you're not particularly good at graphics design, you may want to enlist the help of a friend who is. Start with a sketch on paper or a white board. As you make progress, make a copy (Shift-D) so that you're not forced to start all over from a mistake. Once you've got your master graphic complete to your liking, save it (File | Save As). My project master is called PUMPSTA0.BMP (Figure 1).

You may be a bit puzzled by my master as it shows two pumps off, one on, and one with an error. Again, this is my master graphic and won't be downloaded to the G12864. Notice that I also defined where my flow value will be displayed by changing the appropriate checkers to yellow.

I made a copy of this image and cut out all of the pumps (background color is white; make selection then press Delete). Now I convert to a two-color image (Colors | Decrease Color Depth | 2 Colors). With light background colors, I used the Gray Values/Weighted/Nearest Color method. The resulting image is saved as PUMPSTA1.BMP (Figure 2). When converting photos (like Scott's cat in the demo) use the Error Diffusion method. You may need to experiment with the brightness and contrast of the image to get the desired result.

With our background image complete, the last step in the graphics process is to add the pump graphics to font page 1. Start by making back-up files of the font pages that come with the G12864 (ALPHA0.BMP and ALPHA1.BMP). I made another copy of the master graphic, reduced it to two colors, then copied (select the area, then Ctrl-C) the pumps and pasted (Ctrl-E) the font page. The custom characters will have ASCII codes of 128 to 133. Be very careful not to disturb the other characters – you could get unexpected results when attempting to display text. With the pump images in place, the new font page is saved as ALPHA1PS.BMP (Figure 3).

With the graphics complete, we need to download them to the G12864. If you're using Windows 3.x, you can use BMPX.EXE, a DOS command-line utility supplied with the G12864. Start by removing power from the G12864 and setting configuration switch 5 (Protect/Write) and switch 6 (Blank/Screen 2) to ON. Connect the G12864 to your PC (Com1 or Com2) with a nine-pin serial cable and power it up.

To download the updated font page at 9600 baud, you'd use the following syntax:

BMPX COM1 9600 ALPHA1PS.BMP

If everything is connected properly, the image will show up in the display. When the download is complete, you will be prompted to save the image

Continued on page 107

Sources

For more information on the BASIC Stamp, contact:

Parallax, Inc.
3805 Atherton Road, #102, Rocklin, CA 95765
phone **(916) 624-8333**
Internet **http://www.parallaxinc.com**

Scott Edwards Electronics
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Internet archive *(catalog, user manuals, samples)* located at **ftp.nutsvolts.com** in directory **/pub/nutsvolts/scott**
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Internet: **http://members.aol.com/jonwms**
ftp://members.aol.com/jonwms/stamps

Jasc Software, Inc.
http://www.jasc.com

```
' Listing 1
' Nuts & Volts: Stamp Applications, March 1998

' -----[ Title ]-----------------------------------------------------------
'
' File...... PUMPS.BS2
' Purpose... SEE G12864 Serial Graphics LCD Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' WWW....... http://members.aol.com/jonwms
' Started... 24 JAN 98
' Updated... 15 FEB 98


' -----[ Program Description ]---------------------------------------------
'
' This program is a very simplistic pumping station demonstration that
' takes advantage of the graphics capabilities of the Scott Edwards
' Electronics G12864 Serial Graphics LCD. "Flow" demand is sensed by the
' BS2 (potentiometer input) and converted to a group of pumps. The flow
' and pump status is displayed on the G12864.
'
' Two custom screens are downloaded to the G12864: the pumping station
' graphic and an updated fonts screen. Graphics animation is accomplished
' by adding custom characters to the second fonts page and combining the
' custom characters with the pump station graphic.
'
' G12864 Configuration Switch Settings:
' 1 : Off         (Run)
' 2 : On (9600 baud)
' 3 : On (BL On)
' 4 : Off         (Esc)
' 5 : Off         (Protect EE - must be On to download custom graphics)
' 6 : On (Screen 2)


' -----[ Revision History ]------------------------------------------------
'
' 25 JAN 98 : Version 1 complete
' 15 FEB 98 : Added filtering to smooth sensor input


' -----[ Constants ]-------------------------------------------------------
'
FloSnsr  CON      7                      ' RCTIME input for "flow" (on BSAC)
HiFlow   CON      1520                   ' highest allowable flow

GxLCD    CON      2                      ' serial output on pin 2
N9600    CON      $4054                  ' 9600-bps output
FloPos   CON      64+25                  ' Print flow at position 25

' G12864 codes
ClrLCD   CON      12                     ' Clear LCD text screen
PosCmd   CON      16                     ' Position cursor

' Custom character addresses
Pmp0a    CON      128                    ' pump off, left
Pmp0b    CON      129                    ' pump off, right
Pmp1a    CON      130                    ' pump on, left
Pmp1b    CON      131                    ' pump on, right
ErrorA   CON      132                    ' pump with X, left
ErrorB   CON      133                    ' pump with X, right


' -----[ Variables ]-------------------------------------------------------
'
rawFlow  VAR      WORD                   ' raw flow from "sensor" (RCTIME)
oldFlow  VAR      WORD                   ' last flow reading
newFlow  VAR      WORD                   ' new flow reading
fCheck   VAR      BYTE                   ' overflow check
pumps    VAR      NIB                    ' pump status
pump1    VAR      pumps.Bit0
pump2    VAR      pumps.Bit1
pump3    VAR      pumps.Bit2
pump4    VAR      pumps.Bit3

x    VAR BYTE                            ' loop counter

' -----[ EEPROM Data ]-----------------------------------------------------
'

' -----[ Initialization ]--------------------------------------------------
'
Init:    PAUSE 1000                      ' let the G12864 initialize
      ' clear text; all pumps off
      SEROUT GxLCD,N9600,[ClrLCD]
      newFlow = 0
      GOSUB ShoFlo

' -----[ Main Code ]-------------------------------------------------------
'
Main:    HIGH FloSnsr                    ' discharge RC cap
      PAUSE 5
      RCTIME FloSnsr,1,rawFlow        ' read the sensor
      rawFlow = rawFlow */ $0043      ' scale to 0 - 1600 (approx)
                                      ' (rawFlow * 0.26)

      ' filter by combining in 60/40 (old/raw) ratio
      newFlow = (oldFlow */ $009A)+(rawFlow */ $0066)

      IF newFlow > HiFlow THEN OvrFlo      ' flow is too high -- shut down
      GOSUB ShoFlo                    ' update the display

      oldFlow = newFlow               ' save last flow reading
      PAUSE 500                       ' delay between readings
      GOTO Main                       ' do it all again


' -----[ Subroutines ]-----------------------------------------------------
'
ShoFlo: ' show flow
      SEROUT GxLCD,N9600,[PosCmd,FloPos,DEC4 newFlow]

      ' calculate pumps
      pumps = newFlow / 100
      fCheck = newFlow // 100
      IF fCheck < 25 THEN ShPmps   ' if over by 25+, inc pump level
      pumps = pumps + 1

      ' show pumps
ShPmps:  SEROUT GxLCD,N9600,[PosCmd, 65,(Pmp0a+(2*pump1)),(Pmp0b+(2*pump1))]
      SEROUT GxLCD,N9600,[PosCmd, 81,(Pmp0a+(2*pump2)),(Pmp0b+(2*pump2))]
      SEROUT GxLCD,N9600,[PosCmd, 97,(Pmp0a+(2*pump3)),(Pmp0b+(2*pump3))]
      SEROUT GxLCD,N9600,[PosCmd,113,(Pmp0a+(2*pump4)),(Pmp0b+(2*pump4))]
      RETURN


OvrFlo: pumps = %0000
      SEROUT GxLCD,N9600,[PosCmd,FloPos," Error"]
      FOR x = 1 TO 49 STEP 16
        SEROUT GxLCD,N9600,[PosCmd,(64+x),Pmp0a,Pmp0b]
      NEXT
      PAUSE 500
      SEROUT GxLCD,N9600,[PosCmd,FloPos, "      "]
      FOR x = 1 TO 49 STEP 16
        SEROUT GxLCD,N9600,[PosCmd,(64+x),ErrorA,ErrorB]
      NEXT
      PAUSE 500
      GOTO OvrFlo
```

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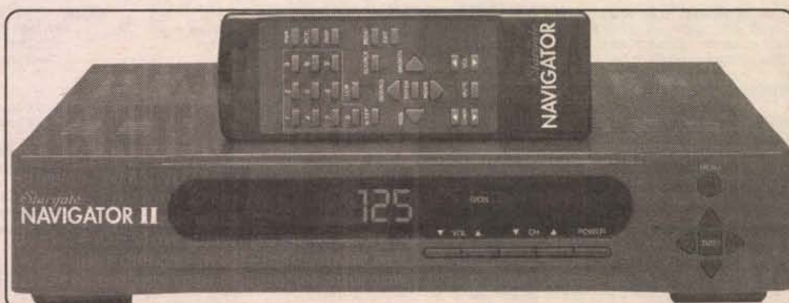

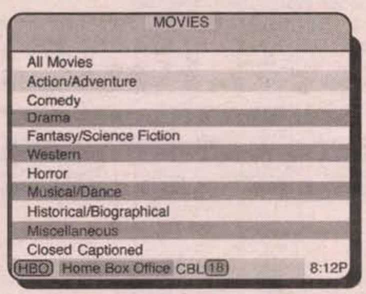

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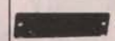

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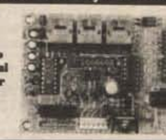

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Continued from page 6

load and power supply voltage, it may be necessary to have a current limiting resistor in series with the load to protect the transistor.

The logistical problem is that a visual indicator is a "binary" device – in other words, it is either on or off. If you trigger say, a light to come on when the doorbell rings, how do you reset it for the next turn?

Also, remember that your visual indicator will be triggered again when you open the mailbox to retrieve the mail, and it is very difficult to predict with complete accuracy whether the mail man will trigger any device twice reliably on each pass.

My simple solution (and again, you may very well have a better one), would be to use the transistor switch to charge a largish capacitor and discharge it slowly through a tiny load like a LED over the course of an hour or two.

This way, you would have a "window" of a couple of hours to see that the mail has been delivered before the capacitor is completely discharged.

This way you could see that the mail is in when you return from work, and you would not have to manually reset the indicator. I don't know about you, but I'm looking for ways to make my life more simple!

If you invent an elegant and simple way to accomplish your task, please share it with us!

Kenton Chun

AMATEUR ROBOTICS

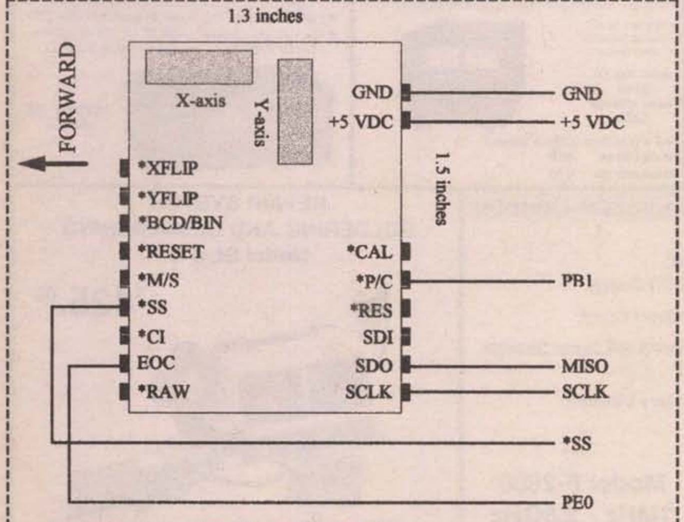
by Karl Lunt

A vision problem has hampered progress on my fire-fighting robot: I can't stay focused. It isn't that I don't want to work on the robot I'm due to enter in the Northwest Regional of the Trinity College Fire-fighting Robot contest. It's just that too many interesting diversions keep appearing.

For example, I recently received E-Mail from Christine Sherer of Precision Navigation, Inc., makers of the Vector-2X magneto-inductive compass boards. She wanted to know if I would be interested in trying out one of the low-end boards. We exchanged some E-Mail to the effect of, sure, I'd love to try one, and a few days later the package arrived on my doorstep.

The V2X compass board measures 1.3 by 1.5 inches and contains several surface-mount (SMT) parts, including what looks like a small microcontroller (MCU). The board also sports two slim coils of wire, oriented at right angles to each other. Seventeen pins on 0.1-inch centers along the board's perimeter provide electronic connections to the outside world.

Specifications for this board put it in the high-end of the hobbyist domain. For the retail price of $50.00, you get a small PCB that can resolve headings from due North to within one degree, draws less than six mA running and 100 uA when idle, and interfaces cleanly to many of the popular MCUs.



A minimal Vector-2X configuration for use with a 68hc11

The module's designers evidently put a lot of thought into making the board as flexible and powerful as possible, while keeping to a minimum the fuss of wiring it up. The V2X uses a serial bus — compatible with Motorola's SPI — for sending data to the host computer. Since the board doesn't accept incoming commands, you can get by with just the clock, outgoing data, and select lines. You also need to provide a polling signal to trigger a reading, and you need to monitor an end-of-conversion (EOC) signal to tell when the V2X has a valid reading available.

These five signals — plus +5 VDC and ground — constitute a minimal V2X configuration, capable of providing a compass reading at least twice a second. The remaining pins on the V2X board allow you to activate other options, such as performing a calibration for surrounding metal objects, selecting high or low resolution mode, selecting output data formats, or operating the V2X mounted upside down.

The package I received also included a copy of the Vector Electronic Modules' Application Notes, version 1.06. The app notes go into great detail on how to wire up and use the V2X module, and were invaluable in getting my board running. The notes discuss all the many options available to you when designing a V2X into your robot. For example, the V2X can output data to the host MCU in any of three different formats: binary, BCD, or raw. Each format has its strengths, and a quick rundown of each will show the care this board's designers took in their engineering.

If you strap the V2X for binary operation (its default mode), your MCU gets two bytes of heading information when it takes a reading. These two bytes — concatenated together — form a 16-bit binary number from 0 to 359. This is the integer value of the compass heading, where 0 is North and 90 is West, assuming the V2X is sitting with its pins pointed down. Binary mode makes the most sense when the MCU will perform some kind of computation on the returned value.

In BCD mode, the MCU also gets two bytes of heading data, but now the concatenated 16-bit number holds the compass reading as a three-digit BCD number. This format comes in handy when the V2X is driving a set of LED displays. The data can be clocked serially through a set of shift registers, then latched into the display, all without requiring an external MCU.

Raw mode may be the most powerful format of all. In this case, the V2X clocks out four bytes of data, arranged as two 16-bit signed integers. The first integer contains the orientation of the X-axis, in a range from -32,000 to 32,000, while the second integer handles the Y-axis. This format gives your MCU increased resolution of the readings, at a penalty of having to do some serious trig to compute an angular heading.

Where am I?

Enough of this esoterica, it's time to wire this hummer up. I started with a BOTBoard fitted with a 68hc811e2. After looking over the manual, I opted to wire my V2X in the minimal configuration. I soldered a 10-pin IDC male connector to the BOTBoard's prototyping area, then made the connections shown in the accompanying wiring diagram. I chose PE0 for my EOC signal, since all port E pins work as both analog and digital inputs, without having to monkey with a data-direction register. The same holds for PB1, an output line used to start a conversion. (I would have used PB0, but it's already wired to an LED on this BOTBoard.)

I rooted through my junk box and found a foot-long 10-wire ribbon cable, complete with a female connector on one end; those long-ago trips to the surplus stores always pay off. I stripped insulation from the appropriate wires on the other end of the ribbon, tinned the leads, and carefully soldered them to the proper pins on the V2X board. Take care during this step and any time you handle the leads of the V2X. The pins look like IC leads, but actually are quite soft and could break with rough handling.

As you can see, the wiring required isn't much; all the effort lies in the software. Since this didn't look like a tough problem, I fired up my SBasic compiler and hacked out the code you see here. Though the program isn't very long, it takes a bit of line-twiddling to get a reading out of the V2X, and a walk-through should prove helpful. Keep in mind that the V2X is strapped by default for binary mode, so my program will be reading two bytes of binary data that yield a 16-bit heading from 0 to 359.

As usual, I start by including the file regs11.lib, which contains SBasic declarations of all the 68hc11 I/O registers. This lets me refer to port B as PORTB, not as $1004; makes the program easier to follow. Next, I declare two variables, WAIT and VALUE. WAIT is a general-purpose variable that will act as a down-counting timer, while VALUE will store the heading returned by the V2X.

Next, I define an interrupt service routine (ISR) at address $fff0, the interrupt vector reserved for the real-time interrupt (RTI). The code for this ISR checks WAIT to see if it is already 0; if not, this code decrements WAIT. The code then rearms the RTI so it can generate another interrupt at the next interval. Since this program uses the default value for the RTI intervals, WAIT decrements at the rate of one count every 4.1 msecs. Setting WAIT to 250 means that it will take just about one second for WAIT to reach 0.

The first section of code after the label MAIN sets up the SCI so I can monitor my program using the PC's serial port. This section also sets up the RTI subsystem, clears WAIT to 0, then turns on interrupts. At this point, the RTI ISR can begin fielding interrupts and checking WAIT.

The next section of code sets up the SPI for communication with the V2X board. First, my code forces *SS high, then makes *SS (actually, PD5) an output. Doing these steps in this order insures that the V2X doesn't get a false slave-select signal during setup. Next, my code configures the SPI for the proper SCLK polarity, phase, and frequency. The V2X wants an SCLK signal that idles high (CPOL=1) and it will provide valid data on each rising edge of SCLK (CPHA=1). The frequency isn't that critical, since the V2X can handle clock rates of up to 1 MHz, so my value of 62.5 KHz is downright leisurely. My code then reads both SPSR and SPDR to clear the SPI registers, then pulls PB1 high to put the V2X in sleep mode. Finally, my code prints a line of text so I can see that control at least got this far.

The rest of the program is a large DO-LOOP that triggers whenever WAIT holds a 0, indicating that it is time to read the V2X. Taking a reading begins by pulling P/C low for at least 10 msecs, which forces the V2X to wake up and sample its sensors. When the sampling starts, the V2X pulls EOC (wired to PE0) low. After my code releases P/C, the V2X continues its conversion; when the conversion is complete, the V2X pulls EOC high. My code then adds an additional 10 msec delay before beginning the transfer of data from the V2X.

Data transfer is pretty straightforward; it starts when my code brings *SS low. Following a five msec delay required by the V2X, my code writes a 0 to the SPDR register, effectively sending a 0 out the SPI bus and fetching a byte of data from the SPI bus. The outgoing byte doesn't matter, as nothing is wired to the MOSI line; what really counts is the byte sent back by the V2X. This byte, the more-significant half of the 16-bit data value, is multiplied by 256 and stored in variable VALUE. My code then sends a second 0 out the SPI, collects the second byte from the V2X, adds that to VALUE, and pulls *SS high. All that remains is to print the value in VALUE to the screen so I can see where my compass points. Finally, this block of code stores 250 in WAIT, setting up a one-second pause before the next reading.

Getting my code to work proved quite simple, thanks to the well-done manual provided by Precision Navigation. I will point out one subtle element, however, that must be addressed or you won't be able to make the V2X give you data. I had to insert a five msec delay after bringing *SS low, but before I started an SPI transfer. Without this delay, the electronics behaved as if it was working, but I never got meaningful data. This requirement is mentioned in the app notes' text, but does not appear in any of the timing diagrams. I think PNI should make this requirement more obvious in their graphics. Refer to the accompanying timing diagram, which I've redrawn to show the needed delay.

That said, I'll conclude by saying that this compass module rates as a "must-have" for anyone looking to add navigation to a robot. The low cost, ease of use, flexibility of design, small size, and other features make this little board a tool well worth adding to your collection. You can contact PNI directly by calling 1-415-962-8777; see other contact info elsewhere.

The GameBoy

A couple of years ago, I did a series of columns on hacking a pair of Practical Peripherals external modems, turning them into excellent 8051 and 68302 development systems. Judging by the mail I received, these were some of my more popular columns. I never got around to building a complete robot using either board, but the hacks were great fun and I've always been on the lookout for similar projects.

But hacking modems into development systems has some disadvantages. Sure, you can save about 90% over the cost of a comparable development system for the same MCU, and nearly all of the hairy design work has already been done for you. But modem technology evolves at breakneck speed, with companies introducing a terrific product, then canning it after a few months in the market, in favor of the next terrific product. This leaves the hobbyist with a very small window of opportunity. By the time you buy a modem, hack it, document what you've done, and tell your friends, the market may have evolved to the point that no one else can buy the same modem and duplicate your hack.

So in these last couple of years, I've been on the lookout for another technology, some other device that, properly hacked, could serve as a robot platform or brain. I'd be willing to forego the latest high-speed chips in favor of guaranteed availability and a strong software toolset. Hopefully, if the device has been around long enough, the market's economies of scale could kick in and assure widespread availability for a low price.

Enter the Nintendo GameBoy. These devices have been around at least 10 years, an eternity in today's fast-mutating consumer electronics market. At a retail price of about $50.00, you get a black-and-white sprite-addressable screen with 160x144 pixel resolution, stereo sound, battery operation, ROM/RAM cartridge support, and a minimalist keyboard design, all in a handheld unit. If you hit some of the larger game stores, you can usually find clean, used GameBoys for $25.00 or less.

But I didn't really feel up to the challenge of buying a GB, opening it up, and doing the serious hacks to make it work, because I didn't even know enough about it to get started. My major concern centered around tools for writing GB software. After all, the electronics on something this old would probably be straightforward, but I didn't even know what MCU was inside, and I certainly didn't know where I could find software development tools.

And then I stumbled across the mother lode while surfing the Web. I was looking for something totally unrelated and, as usually happens on the Web, took a wrong turn on AltaVista. Jeff Frohwein's pages at http://fly.hiwaay.net/~jfrohwei/gameboy/home.html contain a TON of valuable inside information on the GB. Jeff's site covers both hardware and software, and includes several schematics for GameBoy-related hacks and projects. I learned that the GB uses a modified Z80 microcomputer running at 4.91 MHz, the ROM cartridge supports a variety of banked ROM and RAM schemes, and the GameBoy sports an external bidirectional serial port very similar to the Motorola SPI, though much slower.

Jeff has created several circuits for adding functionality to the GB, and his web site includes schematics, in the form of .gif files, for many of these projects. The most ambitious project is probably his Carbon Copy Card (C3), used to program a specially modified GameBoy cartridge with software of your own development. To use the C3 adapter, you first need to buy a GB cartridge that contains ROM, RAM, and a back-up battery for the RAM. You then replace the SMT ROM with an Atmel 29F040 flash EPROM of your own purchase. Once modified, you can download any GB program you care to write into the modified cartridge, using the C3 adapter, then play that game in any GameBoy machine. Jeff's site contains considerable details on which cartridges can be successfully modified, how to modify the cartridge, and how to build your own C3 adapter.

But hardware projects are only the beginning. On Jeff's site and other sites linked from there, I found scads of GameBoy-related software. Perhaps the most important development tool you can grab is one of the many GameBoy emulators. I'm using VGB-DOS version 0.86, released by Hans de Goede and based on the original work by Marat Fayzullin. Installation was a breeze, requiring little more than unzipping the VGB-DOS.ZIP file.

The emulator (VGB) turns your PC into a very faithful rendition of a GameBoy, complete with stereo sound effects. You use the PC's arrow keys, the Shift key, and the Alt key as the six keys on the GB keypad. The emulator supports many other options during runtime, all well designed and smoothly functioning. The emulation is so good, in fact, that the program will execute ROM images of about 85% of the GB games on the market. This means that if you write a program targeted for the GameBoy, you can probably test your program on the emulator before transferring it to a cartridge.

Which leads me to my last concern, namely software development tools specific to the GameBoy. The GB uses a microcomputer similar to the Z80, but the differences are great enough that Z80 assemblers and compilers won't work for software development. Not a problem, I just grabbed a copy of GBDK 2.0, the freeware GameBoy Developer's Kit distributed by Pascal Felber. I'm using version 2.0b11, updated 24 November 1997, so it looks like Pascal stays on top of bugs and design changes. You can get the latest GBDK by following the links on Jeff's web page.

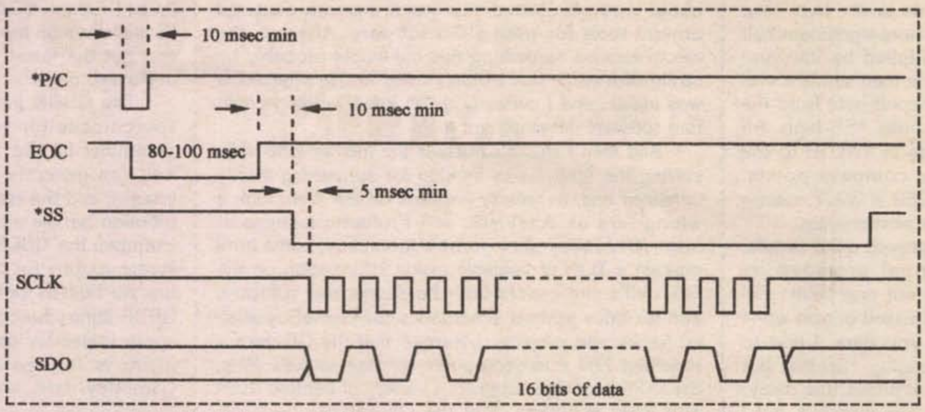
The GBDK includes an ANSI C compiler with source code for several common library files, an assembler for the GB microcomputer, and a linker. You can generate fully compatible GameBoy ROM images, and the library routines included with the distribution handle all the low-level chores for you. For example, the GBDK supports puts(), the standard C library routine for console text output. Since the GB has no built-in alphabetic or numeric symbols, the GBDK library functions automatically prepare the GB sprite tables for use as characters. Once your program is loaded into the GB emulator or the GameBoy itself, an invocation of puts() causes the

```
'
' vector2.bas   test file for the Vector-2X compass module
'
' This program uses a BotBoard (with a 68hc811e2) to talk to a
' Vector-2X compass module via the SPI. This is a bare-bones
' configuration, based on Appendix B of the Application Notes
' (Ver. 1.06) supplied by Precision Navigation, Inc.
'
' This program expects the following connections:
'
' Vector-2X    68hc11
' ———          —
' +5                    +5
' GND                   GND
' EOC                   PE0
' P/C                   PB1
' *SS                   *SS
' SCLK                  SCLK
' SDO                   MISO
'
' The program will output the compass heading as an integer
' from 0 to 359 to the SCI; use the TERM command in pcbug11
' to see the information. The heading is updated once per
' second.
'
include "regs11.lib"
'
' Declare variables used in this program.
'
declare wait                ' delay counter
declare value               ' holds returned value

'
' Declare the RTI ISR, used to generate timed delays.
'
interrupt $fff0             ' RTI ISR
if wait <> 0                ' if not done yet...
wait = wait - 1             ' count this tick
endif
pokeb tflg2, %01000000      ' clear RTI flag
end
'
' The main program
'
main:
pokeb baud, $30                        ' 9600 baud
pokeb sccr2, $0c                       ' turn on SCI
wait = 0
pokeb tmsk2, peekb(tmsk2) or $40       ' permit RTI interrupts
pokeb tflg2, %01000000                 ' clear RTI flag
interrupts on                          ' allow interrupts
pokeb portd, peekb(portd) or $20       ' force *SS high
pokeb ddrd, %00111010                  ' *SS=output
pokeb spcr, %01011111                  ' CPOL=1, CPHA=1, E/32
value = peekb(spsr)                    ' dummy read to clear SPI
value = peekb(spdr)                    ' dummy read to clear SPI
pokeb portb, peekb(portb) or $02       ' force P/C high
print "vector2.bas"                    ' announce our presence
do
        if wait = 0                                 ' if time to read...
        pokeb portb, peekb(portb) and $fd           ' force P/C low
        wait = 4                                    ' 10 ms delay (or so)
        do loop until wait = 0                      ' time it out
        pokeb portb, peekb(portb) or $02            ' force P/C high
        waituntil porte, $01                        ' wait until PE0 is high
        wait = 4                                    ' 10 ms delay (or so)
        do loop until wait = 0                      ' time it out
        pokeb portd, peekb(portd) and $df           ' force SS low
        wait = 3                                    ' 5 ms delay (or so)
        do loop until wait = 0                      ' time it out
        pokeb spdr, 0                               ' send a 0 to start xfer
        waituntil spsr, $80                         ' wait until xfer ends
        value = peekb(spdr) * 256                   ' get msb of data
        pokeb spdr, 0                               ' send a 0 to start xfer
        waituntil spsr, $80                         ' wait until xfer ends
        value = value + peekb(spdr)                 ' get lsb of data
        pokeb portd, peekb(portd) or $20            ' force SS high
        print "Value = "; value; "  ";
        outch $0d                                   ' make it pretty
        wait = 250                                  ' set up a 1-second delay
    endif
loop
end
```

specified string to appear on the GB graphics display as text.

The above elements comprise a full development package for the GameBoy. You write your software in either C or assembly language, using Pascal's GBDK. The resulting object file is a complete GB ROM image, in a PC file with a .gb extension. You then invoke the Virtual GameBoy emulator to test your program, then edit and retest as necessary. Finally, you can use Jeff's Carbon Copy Card to move your new GameBoy program into the 29F040 flash memory of a modified GB ROM cartridge, insert the cartridge into an unmodified GB, and away you go.



Timing diagram for transferring data from the Vector-2X compass

The GameBoy play unit has many, but not all, of the elements of a decent robot controller. You've got your ROM, RAM, and battery-backed RAM (in most game cartridges) for program and data storage. You've got your six keys on the keypad for rudimentary user input. You've got your low-res black-and-white graphics display with four shades of gray for pretty nice user output. About the only item lacking for a really good robot control is a wad of I/O, but the GameBoy's design gives you two ways to solve this lack.

First, you can attach memory-mapped devices to the GameBoy by wiring them into a game cartridge and using the address and data busses available on the cartridge connector. The information on Jeff's web page contains enough detail that you should be able to graft on devices such as output ports and A/D converters without much trouble. This should be even easier when you take advantage of the GameBoy's memory banking scheme. Though it's a huge waste of addressing space, you could assign a single A/D chip, for example, to RAM bank 1, then switch to that bank whenever you needed to talk to the A/D.

I should point out here that the GameBoy microcomputer, unlike the Z80, does not support INP and OUTP opcodes, normally used on Intel-style chips for accessing a dedicated set of I/O device addresses. This actually works to the hacker's advantage here, since it simplifies the addition of I/O devices; you don't need access to the I/O signals to get the job done.

The second way to add I/O to the GameBoy involves the link port. This port appears on the GB as a six-pin connector; it supports a serial bus very similar to the Motorola SPI. Like the SPI, this bus is bi-directional, with data going out on one pin and coming in on another, synchronized with a data clock provided on a third pin. There is even a chip-select line that goes low whenever the GB accesses the link port. About the only real difference between the GB's link port and the Motorola SPI is speed; the SPI can hit one MB per second transfer rate, while the GB is fixed at 120 usec per bit time, or 8.3 KB.

Transfer speed aside, you can still do all the standard SPI tricks with the GB's link port. If you need an eight-bit output port, just connect a 74hc595 to the port. If you need more output lines, daisy-chain a second or third 'hc595 to the port. You can add a serial DAC to the port so your GB can generate analog voltages. For a really sophisticated project, check the schematic on Jeff's page for adding two eight-bit output ports and two eight-bit input ports.

With all of this capability, the GB can indeed serve as the core to a powerful little robot. In fact, Jeff has photos of a small robot wired up to a GameBoy. His machine, a LynxMotion robotic gripper, looks especially cool with its little GameBoy controller alongside. I can imagine the GB's graphics display would make an excellent tool for showing gripper targeting, orientation, and force feedback information.

As if all this isn't enough, Jeff has created a floating-point (!) GB Basic interpreter. This interpreter executes out of GB ROM, accepts your program from any of several sources, stores it in RAM as tokens, then executes the tokens when you enter RUN or following power-up. I haven't tried his Basic yet, but the command summary and docs remind me of the old line-numbered Basics. Jeff has included commands in his Basic interpreter for drawing simple graphics images and for controlling R/C servo motors from the GB.

According to the GameBoy Basic (GBB) FAQ, you need to modify a GB cartridge such as Donkey Kong so it holds an EPROM, burn an image of GBB into the EPROM, and install this chip in the cartridge. You can enter your GBB programs into the GameBoy in a number of ways; perhaps the easiest involves a printer-cable-to-GameBoy hack called the GB Terminal for DOS. Once you have saved your program into the battery-backed RAM on the GB as a file of tokens, you can have the GB execute your program automatically on powerup. Check Jeff's web page for details on installing the Basic, wiring up the keyboard, and developing and downloading Basic programs.

Speaking of FAQs, be sure to grab a copy of the GameBoy FAQ, originally compiled by Marat; you can find links to copies all over the web. Last updated in 1995, it still answers a lot of questions, and contains excellent detail on some of the sophisticated video, sound, and I/O functions provided by the GB CPU.

I've always viewed the GameBoy and similar game machines as simple, single-function toys; boy, was I wrong! Other machines, such as the Super Nintendo Entertainment System, are also candidates for this kind of hacking, but people like Jeff and Pascal have provided such powerful tools for the GB that you could cover a lot of robo-ground simply by sticking with the GameBoy. Next time you need a nice-looking control center for your robot, give a thought to the GameBoy. All the tools and information already exist on the web; you just need to do a little design and some typing. Have fun! **NV**

As always, you can reach me at:

Karl Lunt

116 173rd St. S.W., Bothell, WA 98012

E-Mail: karllunt@seanet.com

Web: http://www.seanet.com/~karllunt

Tech Forum - Continued from page 70

parallel port. Self-test is okay. Is this printer capable of operating on a parallel port or is it designed to work on a serial port only? From what I can gather, this is the same engine as the HPI? I do realize it is old.

39815 **Don L. Engles**
via Internet

I just purchased a linesman telephone on a Internet auction.

This unit was manufactured by Metro Tel Corp. Model #MT-911G.

This unit takes a battery (was not included) and has a G/S and Mute button near the battery holder. I would like to know the function of the buttons and the type of battery (and its function).

I would also be interested in obtaining a copy of the instruction manual.

39816 **Vernon**
via Internet

ANSWERS

ANSWER TO #2988 - FEB. 1998

There does not seem to be any evidence that the TV broadcasters ever included a supersonic or subsonic signal during commercials. They did find commercial breaks a convenient time to crank up the volume, which prompted public complaint and FCC action.

Over the years, there have been a few products that did a reasonable job of masking commercials on VCRs and you may be able to use their techniques in your project. It appears that they used sound and video cues to detect commercials.

For example, upon a switch to commercials, the video may momentarily blank or undergo a sudden brightness level change and the sound level will change as well. Upon seeing these types of artifacts, the commercial killer circuits would start a 30 to 60 second timer that would mute the audio and/or pause the VCR tape.

Some did further analysis during the commercial to see if the pause time should be extended. There are often non-commercial video events that are mistaken for a station break, so don't be surprised if even a good circuit goofs from time to time.

T. Black
Folsom, CA

ANSWER TO #2985 - FEB. 1998

Your simplest way to make a stand-alone system for your midi or sound blaster board is to purchase a used 286 or 386 computer for around $50.00 to $100.00 and plug it in. For the money, it doesn't get any simpler.

The advantage of doing it this way is that you can store your work, expand with off-the-shelf equipment, patch or transfer files and data, upgrade software, down load files off the Internet, etc.

Chris
Bieber, CA

ANSWER TO #2981 - FEB. 1998

The latest *TechAmerica* catalog has an inexpensive solution for low power, low data rate applications. With the TX433 transmitter and RX433 receiver pair, you can transmit and receive data over a distance of about 200 meters at up to 3,000 bits per second.

The TX433 transmitter is only about 5/8 inch square. It operates from 1.5-12 volts and draws only 9 mA at 12 volts. You apply a TTL digital bit stream and the module transmits an 8 mW ASK (amplitude shift keying) signal at (433 MHz).

The RX433 receiver measures 0.4 inches in height and is about 1.7 inches long. It operates from five-volts at about 4.5 mA.

The raw received AM modulated signal and a demodulated TTL data stream are output from the module.

At $9.95 for each module, these are bound to generate a lot of interest among hobbyists. You can order the pair from TechAmerica at 1-800-877-0072. Order P/N 900-6895 for the receiver and P/N 900-6896 for the transmitter. The **TechAmerica** Web Page is at **http://www.techamerica.com**.

John Montalbano
Carmel, IN

ANSWER TO #29814 - FEB. 1998

Being subject to theft, laptop computers usually store their passwords in some type of non-volatile memory, such as EEPROM.

You can try disconnecting any batteries you find inside the computer (usually by desoldering or clipping a lead) and leave them disconnected overnight. If that doesn't do the trick, you'll have to get in touch with the service department of the manufacturer. Be prepared to provide proof of ownership.

What happens next depends on the computer maker. Some — such as Toshiba — include a "backdoor" in their computers that an authorized service facility can use to remove the password for a nominal charge.

These techniques are closely guarded and not available to the general public.

Hewlett-Packard, on the other hand, uses a clever "challange/response" back door which they can safely have a customer execute over the phone, since the supplied override password is only good for a one-time use.

The worst case is represented by some IBM models. They require an entire motherboard replacement to clear a forgotten password.

If the manufacturer is out-of-business, you are probably out of luck.

George Scott
Alexandria, VA

ANSWER TO #29810 - FEB. 1998

Sorry, no "simple circuit" exists to convert serial computer data to a parallel format. The process isn't just

Continued on page 107

DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

ALABAMA

Little Professor Book Center
2717 S. 18th St.
Birmingham 35209

RT Systems Amateur Radio Supply
8207 Stephanie Dr.
Huntsville 35802

ARIZONA

Batteries, Batteries
3415 W. Glendale Ave. #4
Phoenix 85051

1829 E. Southern Ave.
Tempe 85282

6245 E. Bell Rd.
Scottsdale 85254

Elliott Electronic Supply
1251 S. Tyndall Ave.
Tucson 85713

Tower Records
3 E. 9th St.
Tempe 85281

AUSTRALIA

DonTronics
P.O. Box 595
29 Ellesmere Cres.
Tullamarine 3043

CALIFORNIA

Abletronics
9155 Archibald Ave. Unit E
Cucamonga 91730

Advanced Computer Products, Inc.
1310 "B" E. Edinger Ave.
Santa Ana 92705

All Electronics
905 S. Vermont Ave.
Los Angeles 90006

14928 Oxnard St.
Van Nuys 91411

Allen's To Go
13461 Hwy. 88
Lockeford 95237

Alltronics
2300-D Zanker Rd.
San Jose 95131

Brand Newsstand
234-1/2 N. Brand Blvd.
Glendale 91203

Centerfold International
716 N. Fairfax Ave.
Los Angeles 90046

Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505

Digicity.Net
4549 Quail Lakes Dr.
Stockton 95207

Electro Mavin
2985 E. Harcourt St.
Rancho Dominguez 90221

Ford Electronics
8431 Commonwealth Ave.
Buena Park 90621

Harding Way News
113 W. Harding Way
Stockton 95204

Harold's Newsstand
524 Geary St.
San Francisco 94102

HdB Electronics
2860 Spring St.
Redwood City 94063

Hi-Fi Doctor
1814 E. Ball Rd.
Anaheim 92805

HSC Electronic Supply
4837 Amber Ln.
Sacramento 95841

3500 Ryder St.
Santa Clara 95051

5681 Redwood Dr.
Rohnert Park 94928

JK Electronics
6395 Westminster Ave.
Westminster 92683

Laurel Park News
4346 Laurel Canyon Blvd.
Studio City 91604

Lion Electronic Labs
4948 E. Townsend Ave.
Fresno 93727

Netseller
7207 Arlington Ave. Ste. G
Riverside 92503

Op Amp Technical Books
1033 N. Sycamore Ave.
Los Angeles 90038

Pace Electronics
369 Hampshire Rd.
Thousand Oaks 91361

Panorama Electronics
8737 Van Nuys Blvd.
Panorama City 91402

Porter Ranch News Stand
18473 Devonshire St.
Northridge 91325

Sandy's Electronics Supply, Inc.
20655 Soledad Cyn. Rd. #15
Santa Clarita 91351

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove 92643

Speakerworld Technology
2000 Warm Springs Ct. #6
Fremont 94539

Springbok News
55 N. Baldwin Ave.
Sierra Madre 91024

The Radio Place
5675-A Power Inn Rd.
Sacramento 95824

Tower Books
211 Main St.
Chico 95928

7840 Macy Plaza Dr.
Citrus Heights 95610

1280 E. Willow Pass Rd.
Concord 94520

630 San Antonio Rd.
Mountain View 94040

1600 Broadway
Sacramento 95818

5950 Florin Rd.
Sacramento 95823

2538 Watt Ave.
Sacramento 95812

2727 El Camino Real
San Mateo 94403

Tower Magazines/News
885 Riverside Pkwy.
West Sacramento 95605

Tower Records/Video
220 N. Beach Blvd.
Anaheim 92801

2520 Durant
Berkeley 94704

212 F St.
Davis 95616

5703 Christie Ave.
Emeryville 94608

5611 Blackstone
Fresno 93710

2052 Redwood Hwy.
Greenbrae 94904

6310 E. Pacific Coast Hwy.
Long Beach 90803

2280 Market St.
San Francisco 94114

3205 20th Ave.
San Francisco 94132

2525 Jones St.
San Francisco 94133

871 Blossom Hill Rd.
San Jose 95123

14570 Ventura Blvd.
Sherman Oaks 91403

1205 W. Covina Pkwy.
West Covina 91790

Valencia Newsstand
23164 W. Valencia Blvd.
Valencia 91355

Video Electronics
3829 University Ave.
San Diego 92105

CANADA

Com-West Radio Systems Ltd.
48 E. 69th Ave.
Vancouver, BC V5X 4K6

Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

Norlink Communications & Consulting
428 E. Victoria Ave.
Thunder Bay, Ontario P7C 1A5

COLOMBIA

Roboti-K
Carrera 38 No. 10-60,
Local 258, Bogota

COLORADO

Fistell's Micro Electronics
7023 E. Colfax Ave.
Denver 80220

International Tesla Society
2220 E. Bijou St.
Colorado Springs 80909

TH Electronics
216 Commerce Dr., Unit 2
Fort Collins 80524

Tower Records/Video
2500 E. 1st Ave.
Denver 80206

Western Test Systems
530 Compton #C
Broomfield 80020

CONNECTICUT

Archway News
64 Bank St.
New Milford 06776

Derric Electronics
1660 Whitney Ave.
Hamden 06517

DELAWARE

Newark Newsstand
70 E. Main St.
Newark 19711

DISTRICT OF COLUMBIA

Tower Records
2000 Pennsylvania Ave.
Washington 20006

FLORIDA

Alfa Electronic Supply
1502 S. St. Rd. #7
Hollywood 33023

Bob's News & Books
1515 S. Andrew Ave.
Fort Lauderdale 33316

Clarks Out of Town News
303 S. Andrews Ave.
Fort Lauderdale 33301

Mike's Electronic Distributing Co.
1001 N.W. 52nd St.
Fort Lauderdale 33309

Skycraft Parts & Surplus, Inc.
2245 W. Fairbanks
Winter Park 32789

Sunny's At Sunset, Inc.
8260 Sunset Strip
Sunrise 33322

GEORGIA

Tower Records
3400 Around Lenox Dr.
Atlanta 30326

HAWAII

SolarWorks!
525 Lotus Blossom Ln.
Ocean View 96737

Tower Records
4211 Waialae Ave.
Honolulu 96816

611 Keeaumoku
Honolulu 96814

IDAHO

Hi-Tech Surplus
605 E. 44th St.
Boise 83714

The Current Source
5159 Glenwood
Boise 83714

ILLINOIS

City Newsstand
4018 N. Cicero
Chicago 60641

Pick's Electronics
Lewis Park Mall
Carbondale 62901

Tower Records/Video/Books
383 W. Army Trail Rd.
Bloomingdale 60108

2301 N. Clark St. #200
Chicago 60614

1209 E. Golf Rd.
Schaumburg 60173

INDIANA

Harbourtown Sales
108 Park 32 W. Dr.
Noblesville 46060

KANSAS

Hollywood At Home
9063 Metcalf Ave.
Overland Park 66212

Lloyd's Radio & Electronic, Inc.
220 W. Harry St.
Wichita 67213

LOUISIANA

Lakeside News
3323 Severn Ave.
Metairie 70002

Tower Records
408 N. Peter St.
New Orleans 70130

MARYLAND

Silicon Valley Electronics
2014-A Industrial Dr.
Annapolis 21401

Tower Records/Video
2566 Solomons Island Rd.
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS

Full Spectrum Communications
244 Essex St.
Salem 01970

Newsbreak, Inc.
579 G.A.R. Hwy. Rt. 6
Swansea 02777

Tower Records #172
360 Newbury St.
Boston 02115

MICHIGAN

Family Electronics
111 E. Superior St.
Alma 48801

Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124

MW Electronics
229 E. Michigan Ave.
Paw Paw 49079

Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

Tower Records
1214 S. University Ave.
Ann Arbor 48104

MINNESOTA

Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI

Accurate Instruments
11201 E. 24 Hwy.
Independence 64054

Bob's Electronics
123 S. Main St.
Piedmont 63957

Electronics Exchange
8644 St. Charles Rock Rd.
St. Louis 63114

Stewart & Associates
204 Sonderen St.
O'Fallon 63366

NEVADA

Amateur Electronic Supply
1072 N. Rancho Dr.
Las Vegas 89106

Less Buster's Electronics
2930 N. Las Vegas Blvd. VSTG-22
North Las Vegas 89030

Radio World
1656 Nevada Hwy.
Boulder City 89005

Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 S. Virginia
Reno 89511

NEW JERSEY

Sys-Com
707 22nd St.
Union City 07087

JR Tech Systems
1309 Hwy. 71
Belmar 07719

NEW YORK

All Phase Video Security, Inc.
70 Cain Dr.
Brentwood 11717

Global News, Inc.
22 8th Ave.
New York, NY 10016

Ham Central
3 Neptune Rd.
Poughkeepsie 12601

Hirsch Sales Corporation
219 California Dr.
Williamsville 14221

Hi-Tech Repair, Inc.
270 Neelytown Rd.
Montgomery 12549

Tower Records/Video
105 Old Country Rd.
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO

Compustuff
241 Great Oaks Trl.
Wadsworth 44281

Digital One
7603 Mentor Ave.
Mentor 44060

Footsteps
4925 Jackman Rd. Store #58
Toledo 43613

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952

Keyways, Inc.
611 S. Main St.
Miamisburg 45342

Leo's Book Shop
330 N. Superior St.
Toledo 43604

Magazines & More
26880 Brookpark Rd. Ext.
North Olmsted 44070

Powermaxx, Inc.
1587 U.S. Route 68 N.
Xenia 45385

OREGON

News & Smokes
2295 W. Main St.
Medford 97501

News & Smokes #8
259-C Barnett Rd.
Medford 97501

Norvac Electronics
7940 SW Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial NE
Salem 97303

Powell's Technical Bookstore
33 NW Park
Portland 97209

Tower Books
1307 NE 102nd Ave.
Portland 97220

PENNSYLVANIA

Business & Computer Bookstores
213 N. Easton Rd.
Willow Grove 19090

Lehman Scientific
2997-F Cape Horn Rd.
Red Lion 17356

Penn Electronics
2310 A Walnut St.
Harrisburg 17103

Surplus Al
RR 1 Box 337
Hunlock Creek 18621

Tower Books
425 South St.
Philadelphia 19147

Tower Records
340 W. Dekalb Pike
King of Prussia 19406

SOUTH CAROLINA

555 Electronics
5646 Farrow Rd.
Columbia 29203

TENNESSEE

Tower Books
204 W. End Ave.
Nashville 37203

TEXAS

BDL News, Inc.
809 Pierce
Houston 77002

Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063

Tanner Electronics
1301 W. Beltline #105
Carrollton 75006

The Communication Source
2713 Galleria Dr.
Arlington 76011

Tower Records
2403 Guadalupe
Austin 78705

VIRGINIA

Satellite Headquarters
7920 Timberlake Rd.
Lynchburg 24502

Tower Records/Video/Books
6200 Little River Tpk.
Alexandria 22312

4110 W. Ox Rd. #12124
Fairfax 22033

1601 Willow Lawn Dr.
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

WASHINGTON

A-B-C Communications, Inc.
17541 15th Ave. NE
Seattle 98155

Bohica Concepts
214 2nd St.
Morton 98356

Cody Books Ltd.
1122 Fir Ave.
Blaine 98230

Supertronix
18650 68th Ave. S.
Kent 98032

Tower Books
10635 NE 8th St.
Bellevue 98004

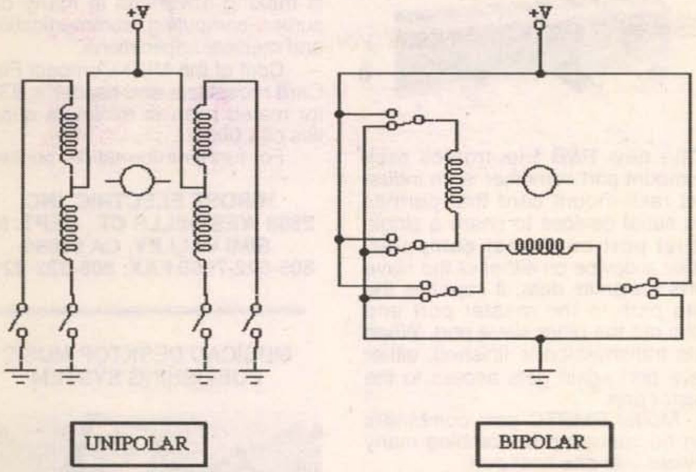
20 Mercer St.
Seattle 98109

WISCONSIN

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

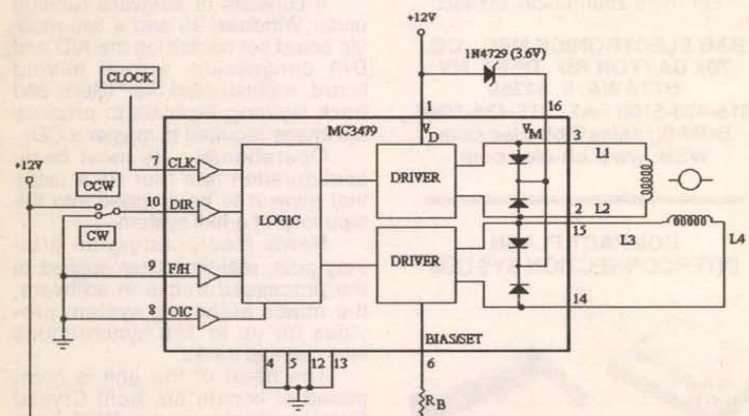
News & Hobby Center
4758 Packard Ave.
Cudahy 53110

the drive circuitry is more complex. The reason the circuitry is more complex for bipolar motors is because they don't have center taps on their windings. When the two coils are center tapped, you end up with four windings that alternate polarity when positive voltage is applied to the taps and each of the four windings are sequentially energized by simply grounding them. For a bipolar motor, you have to actually reverse the polarity of the coils in the proper sequence to step the motor, as shown below.



While the unipolar motor can use a simple switching transistor, the bipolar motor requires an H-bridge driver: a circuit that can connect either end of the winding to either the positive or negative power terminal. Ironically, the pulse sequence for unipolar and bipolar rotation is the same. To cut to the chase, the four TIP 120 switching transistors shown in the Feb. '98 circuit can be replaced with two H-bridges, such as an LM18293 (Digi-Key, 800-344-4539; http://www.digikey.com), and the circuit will work with four-wire bipolar motors.

But that's not what you wanted to hear, so I went digging through my catalogs and located a single IC from Motorola that fills the bill nicely. The MC3479 costs just $4.00 and is available from any Motorola distributor, including Allied Electronics (800-43-5700; http://www.allied.av net.com) and Jameco (800-831-4242; http://www.jameco.com), or you can use an NTE1857 from NTE Electronics (800-631-1250; http://www.nteinc.com). Here's how you hook it up.



In addition to containing two H-bridge drivers, the MC3479 provides all the logic needed to translate a clock pulse into signals that will operate a bipolar stepper motor. The higher the clock rate, the faster the motor spins. Motor direction is set via pin 10. A simple clock generator can be made using a single 555 chip (see "Simple Squarewave Generator"). The chip is capable of providing up to 350 mA of current (500 mA on short overloads) to the coil winding and is internally protected from inductive voltage spikes. Because some stepper motors require current limiting, the maximum current of the outputs is programmable via RB, the BIAS/SET resistor. The value of RB depends on the source voltage (which can range from 7.2V to 16.5V), the output current, and the operating temperature. The table below lists typical resistor values for 8-volt and 12-volt operation. The 4001 gate allows the chip to stabilize at startup before power is applied to the motor. For high-current operation, a heatsink, such as the Aavid 5802 or Thermalloy 6012, is recommended. While my design is for full-step operation, the MC3479 is capable of half-step operation. Simply tie pin 9 high and use the OIC input (pin 8) to set the idle output impedance of the H-bridge drivers. I know this explanation is short, so I plan on doing a feature article on stepper motors in the near future that fills in the missing pieces of the puzzle. Stay tuned.

Stepper Motor Current	***8 Volts***	***12 Volts***
100 mA	*82K*	*130K*
200 mA	*43K*	*62K*
300 mA	*27K*	*43K*
350 mA	*24K*	*36K*
400 mA	*20K*	*33K*

Refilling Toner Cartridges

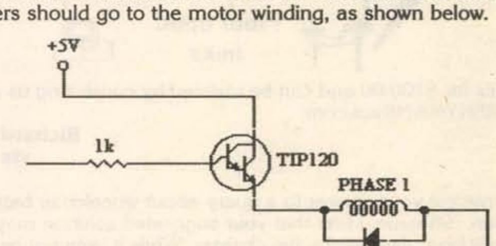
Q. Does anybody make refill kits for copier toner cartridges? Specifically, I'm referring to the Chenesko Products advertisement on page 17 of the Jan. '98 issue which claims to sell refill kits. But when I called them they told me that they only sell to commercial establishments. For a copier that cost about $200.00 (a Sharp Z-20 that I purchased refurbished from Damark in early 1996), a toner cartridge that cost $80.00 seems ridiculous.

Chuck Hursch
Larkspur, CA

A. *In defense of Chenesko Products and all the rest, they screen their customers for a reason. Refilling a laser toner cartridge involves drilling a hole in the case – which must be precisely located then properly sealed to prevent spillage and damage to the printer. Maybe you can and maybe you can't do it properly. But if you're willing to try, you can buy toner refill kits from* ***Global Computer Supplies (800-845-6225;*** *http://www.globalcomputer.com); they run about $20.00 and are good for one recharge. Don't worry that you don't see your model number listed. The toner itself is pretty much the same across the board (if you stick with your brand name), but the instructions may throw you because of the different case configuration. Here's a tip: It's important that you thoroughly remove the old toner before adding the new. Use the cotton swab provided to get into all the nooks and crannies, but be careful not to damage the cartridge. Good luck!*

CORRECTION

In the "Space-Age Stepper Motor Controller" on page 76 of the Feb. '98 issue, the TIP120 transistors are reversed. The collectors should go to +5V and the emitters should go to the motor winding, as shown below.



Home-brew PC Tips

Q. I would like to build a computer from "scratch." I'm sure I can handle the chores of installing the hardware (video, sound, and CD-ROM drive). What I want to do, though, is install Windows 95 from a CD and not as an upgrade from Windows 3.1 (e.g., cold turkey). How can I do this on a CD-ROM that's never been configured?

Joe Spinola
via Internet

A. *That all depends on the motherboard you plan on using. If it's a recent Pentium motherboard with Plug-n-Play, which I recommend, the BIOS will configure the CD-ROM every time you turn on the power switch. That's the beauty of Plug-n-Play (most of the time) in that the motherboard checks the system each time you boot to see if you've added or subtracted any hardware, and adjusts itself accordingly. I just bought an Asus motherboard with a 100-MHz CPU for just $100.00 – and that's off a dealer's shelf! If, on the other hand, your motherboard is a 386 (highly not recommended) or 486, you'll need to configure the CD-ROM using a CD-ROM setup program. Where can you find such a program, you ask? On our web site (http://www.nutsvolts.com), of course, under the name CD-ROM.ZIP. This is a DOS program, so you'll need to partition and format your hard disk first. Unzip the file using PKUNZIP.EXE (also on the web site) and type CD-ROM.BAT. Reboot the system and it will recognize the CD-ROM. To install Windows 95, though, you'll need a copy of Windows 3.1 on floppy disk (unless you pay $300.00 for the full Windows 95* *package; the Windows 95 Upgrade CD-ROM is only $80.00). Fortunately, you don't need a full set of Windows 3.1 diskettes, just the first floppy (Disk 1). Disk 1 from Windows 3.0 and 3.11 will work, too. Chances are you'll run across this diskette in your search for hardware. Be forewarned: It's been my experience that the time spent putting the hardware together is nothing compared to the time you'll spend on the software thereafter ... so, good luck and have fun!*

Mailbag

In response to Fred Chesson on "Converting HTML Files to Text," I know of a much easier way of converting HTML files to text files and it is costs nothing. Simply hightlight the text you want converted and copy it to the Windows Clipboard (Edit/Copy or Ctrl-C). Next paste (Edit/Paste or Ctrl-V) the text into a word processor program, such as Notepad or WordPad, and save it to a file. This method lets you convert the HTML text into any format (i.e., ASCII, WordPerfect, MS-Word — even Lotus 1-2-3 or MS-Excel).

John J. Lynch
via Internet

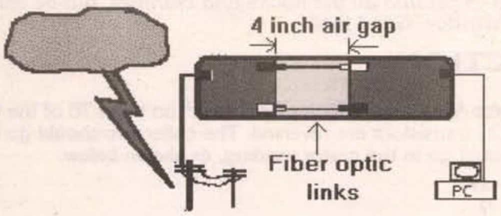
Response:

I always use this method to cut and paste parts of an HTML document into files. Unfortunately, it doesn't take into account the HTML's paragraph format. For example, if the text wraps around a drawing, you end up with a lot of two-word sentences with a blank area of where the drawing used to be. These carriage returns must be removed manually, which is very tedious and time consuming on a multiple-page document. An HTML converter program does this chore for you.

TJ Byers
Q & A Editor

Dear TJ Byers:

Your circuit for the "Road Warrior Needs Dial Tone" in the Nov. '97 column is useful for detecting most problems on a phone line, but it can't anticipate all possible modem-damaging situations. I'm a communications consultant with over 25 years of telephone experience. My son and I market a device called the Optelator that protects the modem from lightning, power surges, and most harmful voltages. Basically, it's an isolator that inserts a 4-inch length of fiber optics into the phone line, breaking the copper connection while maintaining the signal link.



The Optelator sells for $100.00 and can be ordered by contacting us at 800-942-2712 or via RSKYMAN@aol.com

Richard Clenney
via Internet

Dear TJ Byers:

I noted with interest your answer to a query about wheelchair battery charging in the Jan. '98 issue. I fear that your suggested solution may fail to protect the gel-cells from damage by the charger. While it may not be a good idea to charge gel-cells at too high a rate, I'm concerned that overcharging will pose a much greater risk. Placing a light bulb in series with the batteries will certainly reduce the initial current, but it will hardly have any effect on the voltage ultimately reached. Most likely, long before the cells approach full charge, the voltage will rise well above 2.35 volts per cell. A light bulb connected in series will also fail to protect the batteries from overcharging. Just what happens will depend on the battery charger being used, and on how long the battery is left connected. Outgassing of a lead-acid cell mainly occurs after the cell is fully charged. Even a fairly small current through a fully-charged cell will eventually dry it out and destroy it. To keep it safe, you would need to limit the voltage across the cell to the float voltage of about 2.3 volts per cell. So from the battery's point of view, a better solution might be to provide a circuit which limits the output voltage to 27.6 volts. This could be done with a series or parallel voltage regulator, but its design would not be a trivial matter, as it might have to be capable of dissipating 300 watts or more! I can't see any simple solution to this problem, and I suspect that paying the $400.00 to the wheelchair people might be the easiest way out.

Chris Corben
Rohnert Park, CA

Response:

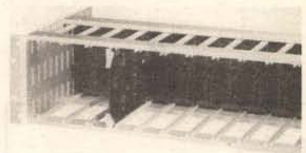
Actually, this idea came from a wheelchair repair shop who said the same thing as you – spend the $400.00. But after hashing it over for a while, we both agreed that this is the best fix given the situation. BTW, the recommended charging voltage of most gel-cells is 2.7 volts, with 2.35 volts as a maintenance current. Which means, you can't leave it on the light-bulb charger constantly. The best solution is a two-step fast/maintenance charger, which will cost $400.00.

TJ Byers
Q & A Editor

New Product News

Continued from page 89

PC PORT COMBINER CARD



The new B&B Electronics rack mount port combiner is an industrial rack mount card that permits two serial devices to share a single serial port on a host computer. When a device on either of the slave ports transmits data, it captures the data path to the master port and locks out the other slave port. When data transmission is finished, either slave port again gets access to the master port.

Model RMPTC port combiners can be cascaded to combine many devices into one host port.

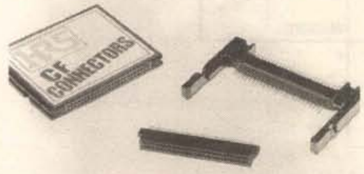
A typical application would be to allow the PC to handle several terminals, scanners, scales, or other devices. The cost for one RMPTC port combiner card is $45.95.

B&B can also supply a card cage to allow up to 11 of the cards to be mounted in a standard 19" rack. The Model RMP113 rack has a back plane that includes three DB-25 female connectors for each RMPTC. a 36-pin edge connector allows easy plug-in replacement of the cards from the front of the enclosure. Cost for the RMP113 card cage is $599.95.

For more information, contact:

B&B ELECTRONICS MFG., CO.
707 DAYTON RD., DEPT. NV
OTTAWA, IL 61350
815-433-5100 FAX: 815-434-7094
E-MAIL: sales@bb-elec.com
WEB: www.bb-elec.com

COMPACT FLASH INTERCONNECTION SYSTEM



Hirose introduces the MI20, a compact flash card interconnection system.

The MI20 offers surface mount terminations, two rows of 50-contacts on 1.27 mm spacing. The header (with built-in ground hold-down brackets) and receptacle, are surface mountable with all commercially available pick-and-place equipment. Selective contact plating reduces the cost of assemblies.

Meeting all requirements of the CFA standard, the MI20 offers sequential mating of ground, power, and signal contacts with a polarized card entry rail.

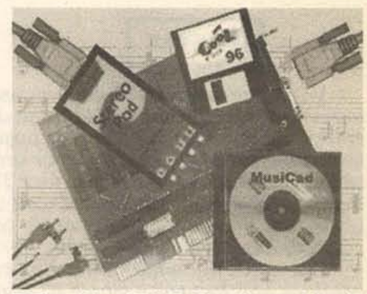
Ideal for digital cameras and computers, Hirose's CF card interconnection system is available at a time when compact flash technology is making advances in many consumer, computing, communications, and medical applications.

Cost of the MI20 Compact Flash Card receptacle and header is $3.30 for mated pairs in minimum quantities of 1,000.

For further information, contact:

HIROSE ELECTRIC, INC.
2688 WESTHILLS CT., DEPT. NV
SIMI VALLEY, CA 93065
805-522-7958 FAX: 805-522-3217

MUSICAD DESKTOP MUSIC PUBLISHING SYSTEM



The MusiCAD Desktop Music Publishing System by C-Lab Mountain Audio has been optimized for producing the only output worth producing in today's world — audio compact disks.

It consists of software running under Windows 95 and a two-module board set containing the A/D and D/A conversion, virtual mixing board, sophisticated DSP filters, and track layering facilities to produce the image required to master a CD.

Operationally, its most basic configuration has four RCA jacks that allow it to be plugged into the tape loop of a hi-fi system.

Newly incorporating an arbitrary-pole, real-time filter applied to the processed tracks in software, the music authoring system provides for up to 128 synchronous four-channel tracks.

The heart of the unit is composed of converters from Crystal Semiconductor and a DSP from Texas Instruments.

Due to the use of an outlying conversion pod, IMD and other harmonic distortion are not meaningfully measurable, and are below the 105 dB down noise floor even with special synchronous measurement techniques.

For more information, contact:

C-LAB MOUNTAIN AUDIO
RT HC 67 BOX 239, DEPT. NV
FLOYD, VA 24091
540-763-3753
E-MAIL: clab@swva.net
WEB: http://www.swva.net/mtnaudio/

to the EE memory. If you respond "Yes" (Y, then Enter), you will be asked for a page (0 to 15). Press 1, then Enter. Since page 1 is a font page, you will be asked to confirm the save to EEPROM. Press Y, then Enter, and the page will be written to memory. Repeat this process with PUMPSTA1.BMP and save it to page 2 (the splash screen).

While BMPX.EXE works fine from a DOS window in Windows95, I prefer graphical programs. Since Scott very generously supplied the source code for BMPX, I translated it and created a Win95 utility called LCDID (Figure 4). You can download LCDID.ZIP from my FTP directory (see sources).

After the images are downloaded and written, return configuration switch 5 to OFF (Protect), set switch 1 to ON (Demo), then cycle the power on the G12864. In demo mode, all 16 pages are displayed sequentially. This will let you check your new font page and splash page. Once you're satisfied, return switch 1 to OFF (Run) and cycle the power again.

The Code

With the real hard work done, it's time to write our program (refer to Listing 1). The program is very simple - as far as BS2 programs go - but there are a couple of things worth pointing out.

The G12864 uses ASCII character 16 (Ctrl-P) to position the text cursor. There are two ways to use the positioning command: text and binary. Using the text method, you would follow the positioning code with the ASCII text of the desired screen position (i.e., "25 "). The last character of the ASCII screen is a space to terminate the positioning mode.

In an embedded application like this one, the binary method is preferred. Simply add the desired cursor position (0 to 63) to 64 and send the byte after the positioning command. A constant, FloPos, is defined as 64+25. This will be sent after the positioning command to put the flow reading at character position 25.

Since my station only has four pumps, a nibble-sized variable is used to store the status of the pumps (0 is OFF, 1 is ON). I overlaid bit-sized variables to make displaying pump status easy.

The program starts by waiting for one second. This gives the G12864 time to initialize before sending commands. After the delay, we clear the text screen and update the display with the subroutine called ShoFlo. This routine starts by sending the new flow value. The DEC4 parameter in the serial output command causes the flow to be displayed with four characters (using leading zeros).

After displaying the flow, we calculate the status of the pumps. This is a simple matter of dividing the flow demand by 100 and storing this value in the variable called pumps. If the flow demand is greater than 25 units more than our current pump combination can supply, we move up to the next level. The status of each pump is displayed with our custom characters. Two characters are needed for each pump. This routine takes advantage of the overlaid variables to calculate the correct status character to display.

Our flow sensor is actually an RC circuit and the BS2's RCTIME function is used to return the value. RCTIME is a bit different that the BS1's POT function in that the value is not scaled. The maximum value is dependent upon the components used and the circuit configuration. I ran a small test on my BSAC and found that RCTIME returned a maximum value of 6150. Since I wanted the flow range to span from zero to 1600, I had to multiply the RCTIME value by 0.26. This is accomplished with the */ (star-slash) operator and a value of $0043 (0.26 * 256). Refer to the Feb. '98 issue for details on using the */ operator.

When I checked the code, I found that it worked fine, except that the response was jerky if I moved the potentiometer too quickly. I remember a trick that Scott Edwards described some time ago about simple digital filtering. Basically, you take a portion of the new reading and add it to a portion of the previous reading. After some experimenting, I found that a 60/40 (old/new) ratio and a slight pause between readings gave me a response that seemed realistic. Once again the */ operator was used to get the proportional values from each variable.

The last thing to do is check our flow for an error condition. If this happens, we transfer to an infinite loop called OvrFlo. The code in this loop will run until the Stamp is reset. A couple of small loops within this routine cause the pumps (error condition) and the word "Error" to flash.

Done. Simple program, not-so-simple task getting it all running, but a very worthwhile exercise in this age of graphical interfaces. Download the code and give it a try. Then change the graphics and roll your own. You'll find that the G12864 is very easy to use, and gives you tremendous versatility in user interface. Figure 5 is a photo of the completed project.

For those of you not using the BASIC Stamp Activity Board, connect the RC circuit shown in Figure I-14a of the BASIC Stamp Programming Manual (V 1.8) to pin 7. And for those of you that develop interesting new font pages, please drop me a copy - I'd love to see them. **NV**

Beginner's Corner

In the event you haven't heard, Parallax sponsors a listserv for Stamps. The listserv is an excellent resource for Stamp programmers of all levels. Check out the Parallax website for details on subscribing.

There have been several recent posts from beginners that have Stamps, but don't know what to do with them, or how to do it. This is not an uncommon problem - particularly for users that don't have a lot of electronics experience. What to do?

Shell out the $80 for Parallax's BASIC Stamp Activity Board. To those of you on a limited budget, the cost probably seems steep, but I can tell you that it will be money well spent. You'd spend much more than that in time and money trying to duplicate its circuitry and ease of use.

The BSAC can be used with the Stamp 1 or Stamp 2 (but not at the same time!), and has switches, LEDs, a potentiometer, a speaker, and RC network for smoothing PWM signals, and a lot more. The BSAC is ideal for testing sub-circuits and code fragments (a demo disk is included). It even comes with a "wall-wart" power supply so you won't go through too many batteries experimenting. If you want to stop worrying about circuits and start learning to code, get a BSAC.

TECH FORUM

Continued from page 103

changing voltage levels or adapting connectors to fit a different socket.

What occurs is single, time-spaced bits of data, travelling one after another ("serially") down a single wire, must be precisely clocked into a buffer and stored until an entire eight-bit "word" is constructed. That word is then sent out over eight separate wires in parallel, then the process must be repeated.

Serial-to-parallel converters are available for as low as $75.00 new if you shop around. I've seen them at hamfests and flea markets for as little as $20.00.

George Scott
Alexandria, VA

ANSWER TO #2982 - FEB. 1998

A stand-alone telephone call logger called Digi-Call Plus is available from Digital Products Company.

It uses a DOS program to retrieve and display the collected call data (up to 1,500 records).

It does almost everything you asked for — records DTMF and rotary dialed digits, incoming Caller-ID, call length, ring count, etc. However, it does not detect when the other party picks up or disconnects (it automatically detects the caller's end).

A high-quality kit is available for about $170.00. The fax number is 916-985-8460 and the web site is at www.digitalproductsco.com

T. Black
Folsom, CA

ANSWERS TO #2989 - FEB. 1998

This problem occurs when you try to format a disk (such as one formatted for a Macintosh) that DOS does not recognize.

If you just insert the bad disk and say "format a:," DOS attempts to read the disk. This is the cause of the problem.

Insert a known good disk (already formatted for DOS) in the a: drive, then issue the command: format a:

When DOS prompts for "Insert disk," remove the good disk, and insert the disk you were having problems with. The formatting should proceed normally.

David McSparron
via Internet

ANSWERS TO #2989 - FEB. 1998

There are only a couple of things that can cause this error message.

They are a bad floppy diskette, wrong FORMAT command (i.e., trying to format a low density diskette as a high density diskette), and a faulty disk drive.

Most common is the wrong command. For example, if you have a 720K 3.5" diskette and you try to format it with the command FORMAT A: you will probably get this error message because most newer systems default to the 1.44 MB format if you don't specify the disk format.

Check your diskette (you didn't say what kind you were using; 5.25", 3.5"). If there is no HD stamped on the diskette near the metal slide cover and no hole opposite the write protect hole, try this command: FORMAT A: /T:80 /N:9 /U. This will format the 3.5" diskette to a 720K format and should work on a non-HD diskette.

Gary Fuchikami
via Internet

Send your Tech Forum questions and answers to:
Nuts & Volts Magazine
430 Princeland Court
Corona, CA 91719
Or E-Mail to: forum@nutsvolts.com

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