

Position sensitive detectors
 Error correcting code books
 Optical rangefinding secrets
 Noisy ac power measurements
 New stereolithography resins

An ability to exactly measure short distances is very much in demand. I do get a lot of *InfoPack* queries over this topic. It turns out there is one highly effective, eminently usable, and little known static optical rangefinding dx technique known as...

Position Sensitive Detectors

Look way on down the street. Now look at the tip of your nose. Do you see how your eyes tilt inward to view a closer object? This is the basis of the *parallax* distance measurement method of figure 1-A.

You probably also know this as the *split image* method, commonly used in military spotting and better grade cameras. If you know your baseline width and the tangent of the inward tilting angle, you calculate distance by using ...

$$\text{distance} = \text{baseline} \times \tan\theta$$

Your results can be quite accurate close in, but get progressively worse as the angle nears ninety degrees and its tangent approaches infinity.

The trick is to come up with some method that uses parallax but has no moving parts. And your secret lies in figure 1-B. Shine some infrared light on an object. Use a laser for accuracy or a plain LED in a cheaper system. Focus the returned light on a special semiconductor device. The *position* of the light should move from right to left across the device as a function of the distance. Measure position to sense distance.

In a totally static system.

Now your "special semiconductor device" could be nothing but a pair of side-by-side IR photodiodes. But it turns out there are *position sensitive detector* chips that do a better job.

There is one inside trick: How do you make the system respond only to the position of the reflected light and not to the intensity? Simply by use of *normalizing*. Let L be the intensity returned by the left side of the sensor and R be the intensity returned by the right side of the sensor. Then you can

go ahead and calculate...

$$\text{position} = (L-R)/(L+R)$$

This returns an "amount of offset" independent of the actual strength of the light. The offset is then related to distance as a tangent function. Yeah, the division is hard to do analog, but is no big deal digitally.

Sharp Optoelectronics has a nice GP2D02 chip that can do all the work. Details are shown in figure two. You arrange your optics so the reflected infrared moves across their chip as a function of distance. The built-in IR diode pulses your target. The return image traverses across their internal position sensitive detector. Goodies in the chip do the needed difference sensing, A/D conversion and DSP.

Your output is a serial 8-bit digital

number. This number is easily related to distance using a calibration curve and table lookup. A *Basic Stamp* or a PIC is ideal to gather and display the range info. See the Sharp data sheet for timing and readout info.

The measurement cycle takes 70 milliseconds, followed by eight clock pulses of 0.2 milliseconds maximum and a stop pulse of 1.5 milliseconds.

The effective range of this chip is 8 to 120 centimeters, or roughly three to forty inches. The supply current is 17 mils operating and 8 mils standby on a five volt supply.

A few obvious uses include camera autofocus, parking lot or garage auto obstacle avoidance, and autopower for hand driers. Plus, of course, scads of close-in robotic sensing apps.

These work best with *specular* or

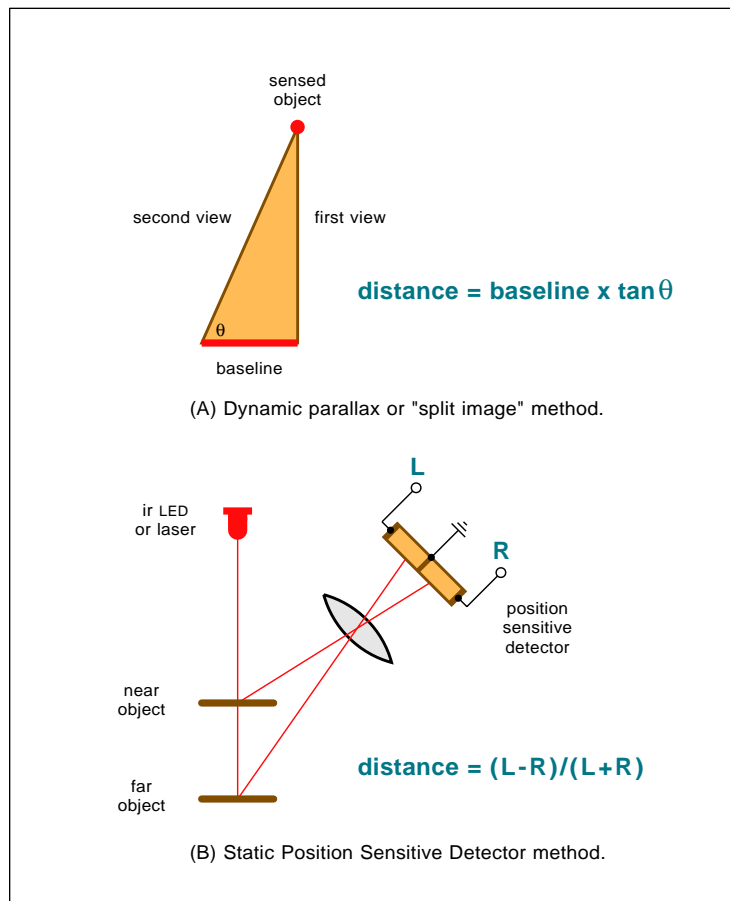


Fig. 1 – TWO METHODS of optical rangefinding.

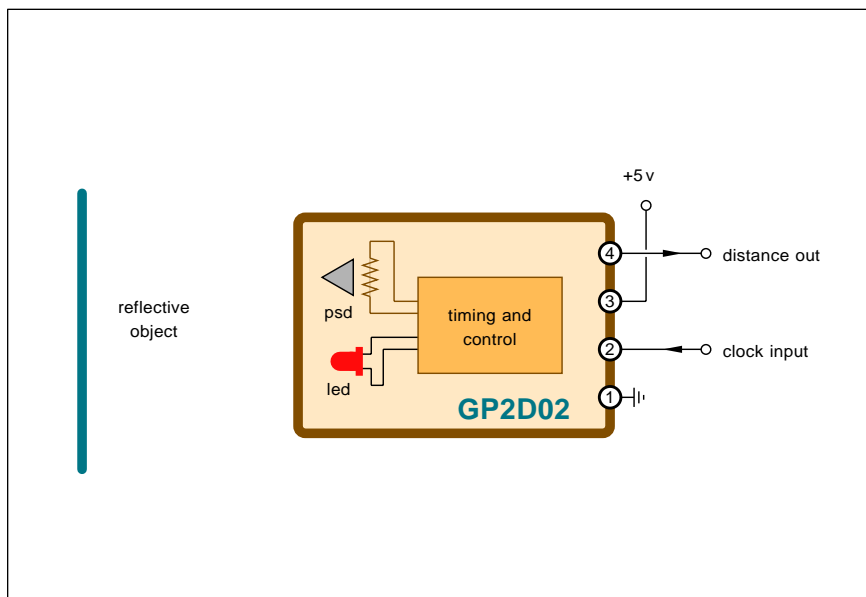


Fig. 2 – POSITION SENSITIVE DETECTOR (PSD) module from Sharp accurately measures short distances with no moving parts.

diffuse reflection. Yes, any hot spots could be a problem. But the infrared system is largely color independent. Fancier techniques can get added if other ranges are needed.

Sharp also has announced GPD212 analog and GPD215 digital devices. These are stand-alone and need no external computer control. They also offer PD3101 and PD3151 detector PSD chips they intended for camera auto-focus uses. One competitor is *Hamamatsu* with their S4282-11 and S4282-72 devices. A second alternate PSD supplier is *Ricoh*.

One source for further PSD info is *SPIE*, also the *Society of Photo Optic Engineers*. Their Proceedings #2002 on *Photodetectors and Power Meters* is one possible starting point. A PSD fundamentals tutorial can be found at www.nts.mh.se/~johma/psd

An really great FAQ on just about everything involving LED's can be downloaded at www2.whidbey.net/ptoinfo/LED_FAQ.html I have got a detailed custom *InfoPack* available on optical rangefinding.

See www.tinaja.com/info01.html

Another Look at AC Power Measurement

Until quite recently, it had been very difficult to accurately measure ac power. Especially in the presence of any strange waveshapes, reactive energy, noise, or sparking. Nearly all casual measurements tend to end up *low*. Often ridiculously so. Leading to all sorts of pathetic claims which relate to circuit "efficiencies" and to "overunity" operation.

All average responding voltmeters and ammeters are useless for much of real world power measurement. So is staring at some oscilloscope without having the foggiest clue what you are looking at. All of which leads us to beginning e.e. student blunder #01-A.

That of confusing average and rms voltage or current.

I'd like to return to this topic one more time, hitting it from a slightly different angle. We'll start with these fundamental rules...

$$\text{instantaneous power} = \text{instantaneous voltage} \times \text{instantaneous current}$$

and...

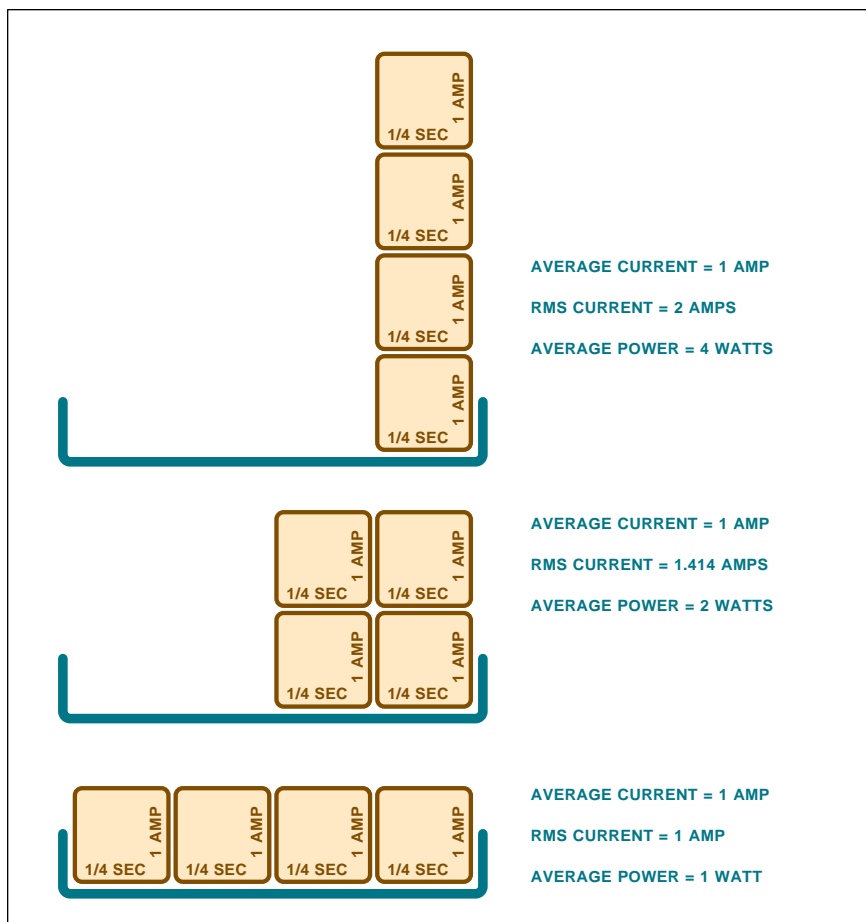


Fig. 3 – THE SHAPE OF A WAVEFORM very much determines its average power. Average current (common to most meters) is meaningless for most power measurements. This is a common beginner's mistake.

$$\text{efficiency} = \frac{\text{average power out}}{\text{average power in}}$$

The latter will *always* be a number from 0 to a tad under 1. This value often gets multiplied by one hundred to get a percent efficiency from 0 to 99.9. The losses will almost always be in the form of low grade heat.

Any percent efficiency above 100 is experimental error. Or (in the case of a heat pump) does not account for all of the energy inputs.

Every time. Fer sure.

Suppose you have a box with two terminals on it. Make a *very brief* and a *simultaneous* measurement of your voltage and the current. Brief enough that neither one changes much during your measurement time.

And clean enough that noise will not be a factor. Accurately multiply these two values together to get your instantaneous power. Sum these over time and then divide by the number of samples to get average power.

If the voltage and current samples are both positive or both negative, then your box is acting as a *load*. The box should be getting hot, adding to its internal E and H energy fields, doing work, or otherwise converting energy into some other form.

If measured voltage and current have opposite signs, your box acts as a *source*. Your box is cooling down, removing strength from its internal energy fields, is being mechanically worked upon, or otherwise should be converting energy from other inputs into output electricity.

Sometimes a box might *cyclically* accept energy and then later return it. Which happens when internal electric or magnetic fields are getting bigger or smaller. We refer to this back and forth process as *reactive energy*.

Because of reactive energy, an ac motor will typically act as a load for most of the time, but as a source for the remainder. We did see examples of this back in [MUSE123](#).

All reactive power will average to zero over the long term.

For accurate results, *you multiply first and average last*. Why? Because average first and multiply last almost always gives you *low* results.

The average of products is *not* the same as the product of averages!

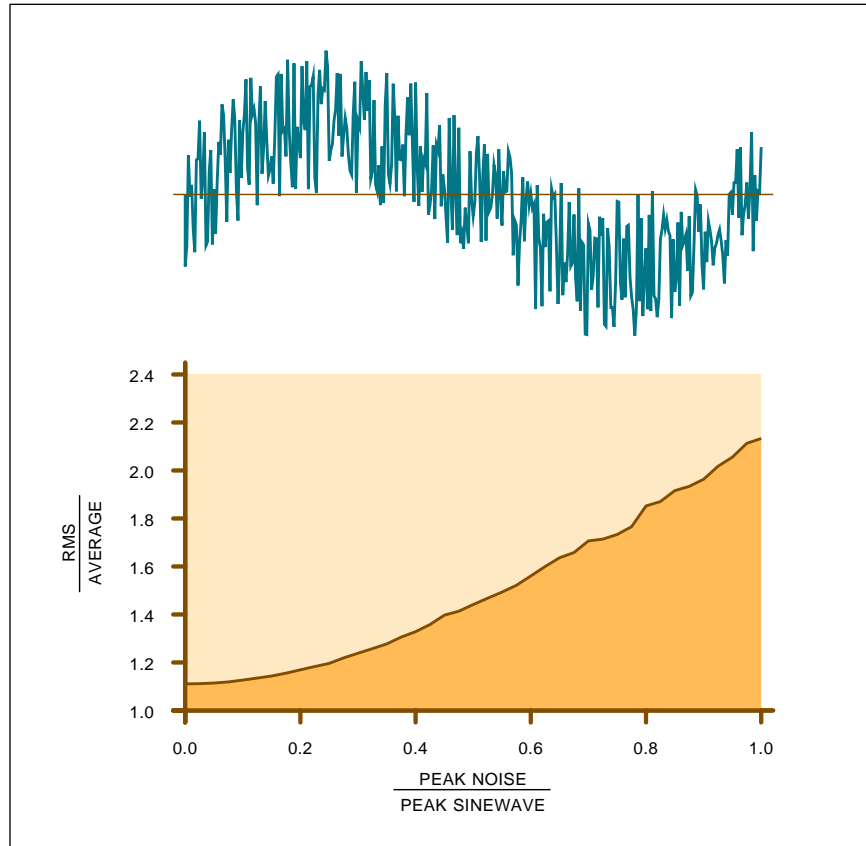


Fig. 4 – ADDING NOISE to a sinewave increases the energy and raises its rms to average ratio. Noisy systems often lead to wildly wrong conclusions about power and efficiency. And to outrageous "overunity" claims.

Playing With Blocks

Suppose you have got four wooden blocks. Each block is labeled as 1.0 ampere of current high and is labeled as 0.25 seconds of time wide.

Suppose further that you've got a time bin which is one second wide. Should it matter how you pile your blocks into your bins? Can the exact *arrangement* of the four blocks affect your circuit power?

Assume a one ohm resistive load for now. Later on, the type and size of load will not matter.

In Figure 3, we first place all four blocks side by side. Uh, the average current is obviously one ampere. The energy in your first quarter second will be 0.25 watt seconds. The energy in quarters two through four should also be 0.25 watt seconds. Your total energy will be one watt second, and the average power will be one watt.

So far so good. If we replaced our blocks with a continuous block that had *equivalent heating power*, it also

would result in an average current of one amp and an average power consumption of one watt.

Now stack your four blocks up two high, and an amazing thing happens. You still have one ampere of average current, because we have two amps for half a second and zero amps for half a second. But during your active half second, either the input voltage had to double or else the circuit load resistance halved. Using our above formula, the power in the first quarter second will now be *two* watts.

The power in your second quarter second should also be *two* watts. The power in the third and fourth quarter seconds should be zero. *The average power should be TWO watts!*

Hmmm. In one group, a one amp average current gives us one watt of average power. In the second, a one amp average current will give us two watts of average power.

Average current is meaningless when calculating power.

We instead have to find out what

continuous equivalent current would give us the identical average power.

Well, our power turns out to be current *squared* times load resistance for a resistor. Or input current *times* input voltage for any load.

Done either way, your equivalent "dc" continuous current needed turns out to be related to the *square root* of your average power. In this case, an average input current of 1.414 amps gives you an average output power of exactly two watts.

You might visualize this average continuous current as an "equivalent dc heating power" waveform. Or you can call this current the *rms* current. And short for *root-mean-square*. And *rms* is simply the results you'll get from counting the blocks and seeing what each one does.

Reviewing: Your stacked average current will be 1.00 amp, but the rms current is 1.414 amps. Clearly, any average responding ammeter (typical of most meters in use today) ends up reading low by 41%!

Wait. It gets worse. Stack all four blocks up on top of each other. Your average current is still one amp. The power in the first quarter second will be *sixteen* watts. But the power in the other time slots will end up zero. The average power will be *four* watts!

Once again, your average current reads low enough to be meaningless. The equivalent dc heating current or the rms current will be two amps. *An average meter here gives you a one hundred percent error!*

What about sine waves? We did lots of fancy block piling on back in [MUSE112.PDF](#). You can pile up tiny blocks or use fancy math or use the simulator we will look at below to conclude that the average value of a half sinewave is 0.684 of peak; that the rms value of a sinewave is 0.707; and that the ratio of peak to average is found to be 1.1106.

But *only* for *whole* cycles!

Cheap averaging meter suppliers cheat and relabel their ac scales high by eleven percent. Such an averaging meter is *totally* useless to measure ac power. First because of partial cycles or possible strange waveforms. And second, because of reactive currents that place instantaneous voltages and currents out of phase.

Summing up: Your average power

SOME ERROR CORRECTING CODE BOOKS

Principles of Digital Communication (Andrew Viterbi)

1997 Error Correcting Code Symposium (Harold Mattson)

Algebraic Algorithms and Error-Correcting Codes (John Alton)

Applicable Algebra Error-Correcting Code Algorithms (Beth Th)

CDMA; Principles of Spread Spectrum Comm (Andrew Viterbi)

Coded Modulation for Fading Channels (Hamidreza Jamali)

Data & Computer Communications (William Stallings)

Engineer's Error Coding Handbook (A Houghton)

Error Correcting Codes (John Baylis)

Error Control Coding (Shu Lin)

Error Control Systems for Digital Communications (Stephen Wicker)

Error Control Techniques for Digital Comm (Arnold Michelson)

First Course in Coding Theory (Raymond Hill)

Introduction to Error-Correcting Codes (Michael Purser)

Intro to Error Correcting Codes (Scott Vanstone)

Intro Theory of Error-Correcting Codes (Vera Pless)

Theory & Applications of Error-Correction Codes (Jiri Adamek)

Trellis Coding (Christian Schlegel)

Voice & Data Communications Handbook (Regis Bates)

Understanding Data Communications (Gilbert Held)

For more details, see www.tinaja.com/amlink01.html

depends upon the *duty cycle* and the *shape* of the waveform involved. One proper way to measure your average power is to take many narrow e and i samples. You multiply your samples together to find instantaneous power, sum the samples to get accumulated power, and divide by the number of samples. Carefully done over either a very long time or an integer number of full cycles.

Since analog multipliers get into severe *crest factor* problems, digital is the only way to go here.

A number of effective low cost ac power measurement tools are found at *Brand Electronics*. And, yes, these can easily deal with strange or

unusual waveforms. Click their banner link at www.tinaja.com

These days, it is simple enough to use a PIC and simultaneous A/D chips like the *Maxim* MAX125/126 to make the 12,000 or more *minimum* samples per second and the digital multiplies needed to do the job right. Most any better grade PC data acquisition plug in can also be used with care.

Regardless, *knowing your precise waveforms* is crucial.

What About Noise?

A question came up on the web over what effect noise has on power waveforms. Such as noise caused by the bubbling in a cold fusion cell or the cavitation in a Griggs pump.

Figure four shows what happens if you add random noise energy to any sinewave. As expected, the ratio of rms to average goes up. Causing any average responding meter to further under-report.

By an astounding coincidence, the under-reporting seems to end up the same size as certain overunity claims. Proving that free energy enthusiasts are a source of noise.

Such simulations can be both trivial and fun to do using PostScript.

NEED HELP?

Phone or write all your US Tech Musings questions to:

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US email: don@tinaja.com
Web page: www.tinaja.com

NAMES AND NUMBERS

Amateur TV Quarterly
5931 Alma Dr
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(815) 398-2683

Biomass & Bioenergy
PO Box 882
New York NY 10159
(212) 633-3730

Brand Electronics
421 Hilton Rd
Whitefield ME 04353
(888) 433-6600

Dallas Semiconductor
4401 Beltwood Pkwy S
Dallas TX 75244
(972) 371-4000

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(302) 774-1000

Flow Control
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Norwalk CT 06855
(203) 853-4266

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Rocky Hill CT 06067
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Wireless Integration
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Nashua NH 03062
(603) 891-0123

These models also let you use simple math to replace fancy calculus and related advanced calculations.

I've posted the sourcecode for the simulation and figure four artwork to my [MUSE131.PDF](#)

Error Correcting Codes

Say you add one bit to a data word designed to always make the number of ones in the word *even*. Test that bit on reception. Should you have an odd number of ones, then an error likely has occurred. You then can ask for a

correcting retransmission.

This gives an example of a simple *parity* check. Now arrange all of your words into blocks. Add parity to row and column. This time, on reception, a row parity violation and a column parity violation often can "point" to a problem bit that can be fixed. You've got an *error correcting code*.

By looking at fancier combinations of bits using *polynomial* math, you can conjure up codes that can correct themselves better and can do so even in the presence of multiple errors.

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Tech Musings

I've gathered together a few of the books on error correcting code as this month's resource sidebar. The classic text is A. Vitribi's *Principles of Data Communications*, but it is out of print and may be hard to find.

More info on all these titles is up at www.tinaja.com/amlink01.html

New Tech Lit

From *Phillips Business Info*, a free *North American Satellite Access* wall chart. From *Sensory Systems*, details on a *Voice Dialer* speech recognition chip intended for telephone uses.

From *Dallas*, the new booklet on *Thermal Management* chips. They've got some really interesting, accurate, and low cost chips here.

A well done tutorial on *RFID* radio frequency identification appeared in *R.F. Design* for July 98, pp 38-44.

More details on "pushme-pullyou" *Hexapod* machine systems that can be amazingly accurate, quite simple, and completely eliminate sliding ways are found at www.i-way.co.uk/~stors/lm e/LMEHexapodMachine.html

Some related tutorial info is found at www.tinaja.com/flut01.html

Tech magazine update: Check out

the *Amateur Television Quarterly*; a \$\$\$ *Fuel Cell Technology News*; that *MRT* which used to be *Mobile Radio Technology*; *Flow Control* on fluid handling; *Wireless Integration*; and *Biomass & Bioenergy*.

An *Electronics Bench Reference* has been labor-of-love published by Dick Tormet. It is full of useful data. Available through *RMT Engineering*. Low cost "Cash and Carry" *InfoPack* consulting services can now be found at www.tinaja.com/info01.html

From *Loctite*, a booklet on light cure technology. These are adhesives that set up in the presence of strong ultraviolet light. Also a good review of uv fundamentals. From *DuPont* details on their upgraded *Somos 7100* stereolithography resins. These can be used in Santa Claus machines. For other suppliers and background info, see www.tinaja.com/santa01.html

Lots of free samples this month. A large packet of Shottky power diodes from *International Rectifier*; some really good *NukeTape* silicon rubber splicing tape from *United Controls*; and *SiBar* thyristor surge protectors from the folks at *Raychem*.

Wireform is a new flexible screen

product from *Paragona Art Products*. This should have all sorts of mockup and prototyping uses as well.

For most individuals and smaller scale startups most of the time, any involvement whatsoever with patents is nearly certain to end up a net loss of time, energy, money, and sanity. Details in my *Case Against Patents* package, along with my tested and proven real-world alternatives.

See my nearby *Synergetics* ad for full details.

Bunches of surplus test equipment, optics, and robotics bargains are now up at www.tinaja.com/bargte01.html

Even a full PC plate-thru lab.

The latest additions to my *Guru's Lair* website include a free technical user forum; fast "power nav" buttons; more on buying military surplus; on finding test equipment manuals; new typesetting secrets; and some updates on *Book-on-demand* publishing.

As usual, most of these mentioned items appear in a *Names & Numbers* sidebar. Be sure to check here before calling our no-charge US technical helpline I've mentioned in that *Need Help?* box you'll find nearby.

Let's hear from you. ♦

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