Don Lancaster's

Tech Musings

Miracle energy sources
A history of color organs
Those great new baby PIC's
New consultant's insider mag
AC phase control fundamentals

January, 1997

Supposedly there is this magic "secret" Hindu plant. Make a tea out of it; then you sprinkle some lemon juice on it, steep it for a while. And Presto! It changes into a cheap gasoline substitute.

Or so the very latest pseudoscience techno-myth tries to tell us. Try the *Keelynet* for ongoing details. Use my link on *www.tinaja.com*

Er, this one obviously and totally fails my "looks like a duck, quacks like a duck, and is about to lay eggs" subjective pseudoscience test.

But how can you tell for sure?

Gasoline grows on trees. Just let them rot for a geological epoch or two. It turns out that *any* plant can be used to make gasoline. Kudzu, grass clippings, tumbleweeds, you name it. No big deal. But scant few plants are even remotely worth all the time and trouble for you to do so.

The key questons you have to ask are these: (A) How many pounds of plant will you need for one pound of gasoline? (B) How much total energy has to go into the process compared to the energy you get back? (C) How expandable is their process to larger scale production? (D) What is their time to economic breakeven for the labor and capital that has to go into the producton system? (E) What are the hidden and off-the-books societal costs for new infrastructure?

And, of course, (F) How badly will the government screw it up?

Yeah, those experts can *sometimes* be wrong. They typically overreact. But they'll usually end up back on target once *all* of these key questions get properly asked.

Ferinstance, what appeared to be an outright scam in the 1920's sort of wasn't. Magic tablets were sold that instantly changed water into a motor fuel. "They" said it was impossible. But they were all dead wrong. There definitely are magic tablets which let you convert water into motor fuel. I use these tablets all the time.

Uh, there are a few minor and tiny side effects. Such as getting only 25 miles per engine. Instead of 25 miles per gallon. But let's not quibble. The tablets work. Yes, you can still buy them today. Cheap, even.

Because these secret tablets are an underground product, only cavers use them. Ask any spelunker for details.

PIC's New Babies

We have already seen that the new PIC series of microcontrollers from *Microchip Technology* are easily *the* components of the decade.

To the point where it is insane to ever again use a 555 timer or other bits-and-pieces solution to most any electronic sensing or control app.

The new PIC's are incredibly fast, compact, and powerful micros which literally blow the competition away. We've also seen that the *Basic Stamp* from *Parallax* and the *Scott Edwards Tools* can be your quickest and best ways to get yourself PIC literate.

Well, there's now a brand new pair of baby PIC's. Per figure one.

Their PIC12C508 and PIC12C509 both cost under a dollar in quantity and come in an eight pin (!) minidip package. The '08 offers 512 bytes of EPROM and 25 bytes of RAM. The '09 doubles these values. You have several clock options: trimmable RC internal, external, or crystal. As with the other PIC's, their powerful RISC instructions are mostly single cycle. Often executing three times faster in one-third the usual space.

There are up to six programmable I/O pins. Pin 5 can be general I/O or a timer clock input. Pin 4 doubles as a master clear or an external wakeup call. You can hang a crystal on pins 2 and 3, or a system clock on pin 2.

Analog input interface is easy. All you do is connect a capacitor and a resistor to any pin. Just briefly pull the cap low and then loop recheck it until it charges to a logic one.

Although it may be a tad tricky to write a multitasking UNIX kernel for either chip (a free ISMM if you do), these baby PIC's open up whole new worlds of low end applications.

The free *PIC12C5XX Data Book* is published by *Microchip Technology*. Much more on PIC's in general on my new *Pick a Peck of Picks* library shelf of *www.tinaja.com*

Color Organs and Psychedelic Lighting

I guess its way past time to update certain ancient history. People have long wanted to relate music to colors in one way or another. On back in the sixteenth century, a Jesuit monk by the name of James Bertrand Castell created his *Clavier au Lumier*. This was sort of a harp with flat colored strings. The strings were viewed edge on. As the string was plucked, you could see all the vibrating colors.

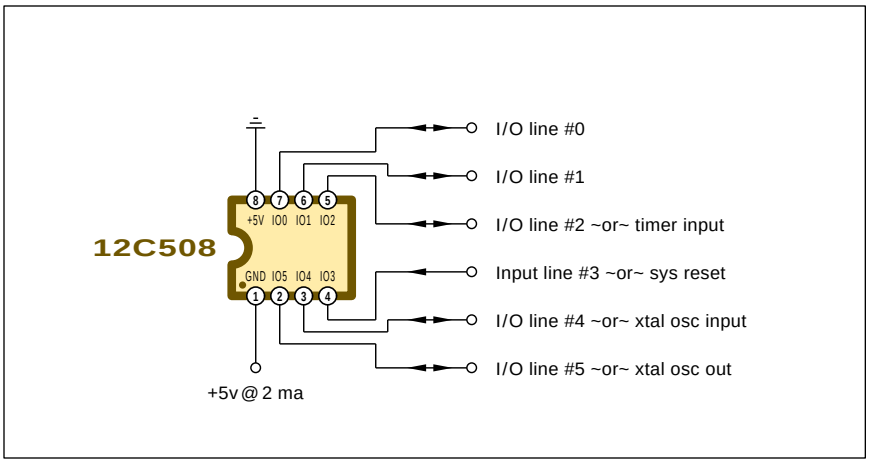

Fig. 1 – MEMBERS OF THE "BABY PIC" family are among the smallest and the cheapest of microcontrollers. Yet their capabilities are astounding.

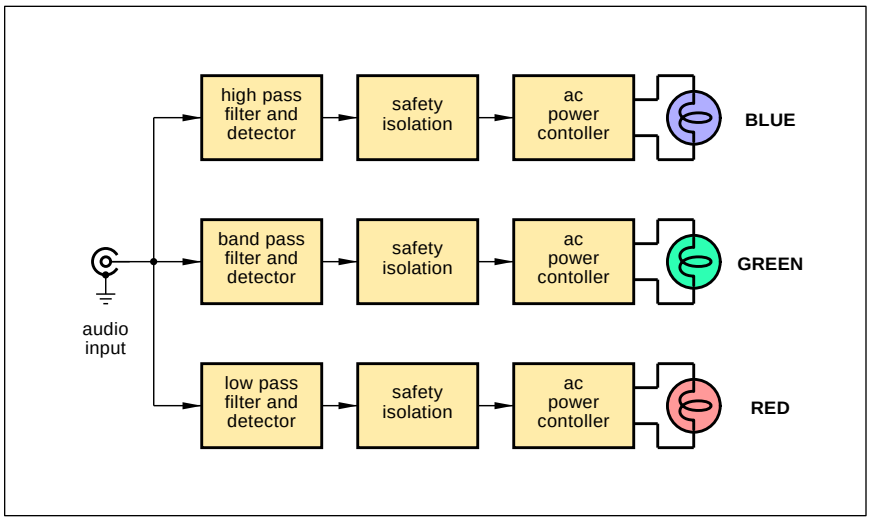

Fig. 2 – BLOCK DIAGRAM of a classic color organ. The audio input gets filtered into three or more channels. Audio energy in each filter band sets the dynamic brightness of the chosen lamp color for that channel.

The first "classic" electronic color organ designs appeared in the 1950's. One used *thyratron* "vacuum" tubes in a half wave design that only lit the lamps to partial brightness. Another used high-mu pentode audio output vacuum tubes to drive scads of series connected and easily burned out #49 pilot lights strings.

Figure two shows you that block diagram for the classic lamps-style color organ. Your speaker level input audio is somehow safety isolated and then lowpass, bandpass, or highpass filtered into (usually) three or more channels. Each channel's output is then converted into some dc control voltage. That dc control voltage then modulates a "power amplifier" of some sort. Which in turn relates the amount of audio energy in the band to the brightness of one or more colored lights. For instance, the lows might be red, the mids green, and the highs blue. Or whatever.

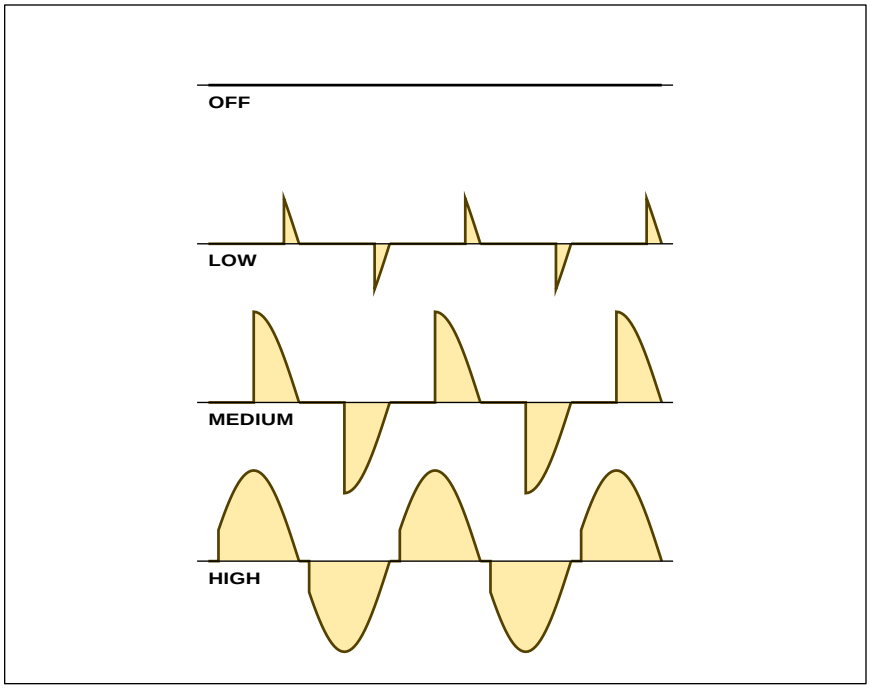

Fig. 3 – THE FUNDAMENTALS BEHIND phase control of ac power. The turn on of a triac gets delayed after each ac half power cycle. The longer the delay, the lower the load current. Simple phase control is useful for lamps, heaters, and ac-dc motors. But NOT for fluorescents or induction motors.

I designed and published my first three channel solid state color organ in April of 1963. Back in *Electronics World*. This used brand new *Silicon Controlled Rectifiers* to control a few hundred watts of lamps per channel. The SCR's were preceded by a full wave rectifier. That let the lamps go more or less smoothly from zero to full brightness.

Input audio went through some LC ferrite cup core filters, was converted to dc with germanium diode rectifers, and then get used to control the phase advance of the unijunction transistor timing circuits.

This was followed a year later by a version which substituted neon lamp triggers for those costly unijunctions. In the Jan 1964 *Electronics World*.

The *Electronics Now* version came next. Actually found in our October 1965 *Radio Electronics* predecessor. This was the first unit to use voltage modulated four layer trigger diodes and the first to provide a line filter to attack the bad AM radio interference common to color organs.

Skipping a few forgettable designs which are best left forgotten, next in line was my *Musette*. In the July 1965 *Popular Electronics*. This was a five channel unit still featuring SCR's and trigger diode modulation. Filtering was by resonant transformers. Color coded background controls did get added to improve the sensitivity and linearity. Brand new *dichromic* filter spotlights were used to dramatically improve color purity.

What I first called *Stereo Lamps*, but some epsilon minus renamed *Hi Fi a Go Go* appeared in the July 1966 *Popular Electronics*. This was just a low priced, compact and unfiltered single channel version. It was useful for psychedelic lighting apps.

I considered my "definitive" color organ to be the *Psychedelia I*. From the Sept 1969 *Popular Electronics*. Innovations here included new low cost full wave triacs having built-in heatsinks, a brand new $1 integrated circuit phase controller circuit, and steep-skirted two pole active filters having broad tween-channel guard

bands. Use of prismatic lenses on the display gave the hex "flower power" type of patterns. You had a choice of three or six channels.

Phase Control Fundamentals

The fundamentals of an ac power *phase control* appear in figure three. A *triac* is a fast, efficient, and high voltage power ac switch. One that is turned on by a brief and low level pulse on its gate. The triac then *stays* on for the remainder of the power line half cycle. It automatically turns off when your main current drops to zero on the half cycle zero. Triacs are fully bidirectional. Either polarity of gate pulse can be applied on either polarity cycle.

If the triac is pulsed very late in each half cycle, the duty cycle is very low, and very little power reaches the load. The lamp lights only dimly.

When the triac gets pulsed in mid cycle, around one half of the power reaches the lamp. When it gets pulsed very early, the lamp lights to nearly full brightness.

Thus, you might want your input control voltage to determine the *time delay* after a zero crossing when the triac turns on. The higher the voltage the *less* your delay.

A modern triac circuit appears in figure four. For most applications, safety isolation is *essential* to prevent deadly "hot chassis" shock hazards. That is the purpose of the *Motorola* MOC3010 optotriac isolator. While you can get triacs from *Radio Shack* or *Texas Instruments* or *Motorola*, the definitive source is *Teccor*.

Usually, you will want to run your optoisolator "backwards" as shown. So that a *low* or logic zero input turns the triac *on*, and vice versa. Simply because many microcontrollers and other digital integrated circuits are better at sinking current to ground.

Two sources of specialized phase control integrated circuits are *LSI/CSI* and *Signetics Philips*. You can also get one-piece modules which include both triac and optoisolation. From *CP Claire*, *International Rectifier*, *Crydom*, or *NTE*. They are sometimes called *dc-in ac-out solid state relays*.

A minimum rating of 200 volts is needed for ac line operation, with 400 recommended.

But at $8 to $12 each, the one piece modules might not be cost effective against a pair of one dollar parts. The heatsinking options are also limited using modules. The smaller module power limit is a few hundred watts.

I have gathered several ac power control suppliers together for you as this month's resource sidebar.

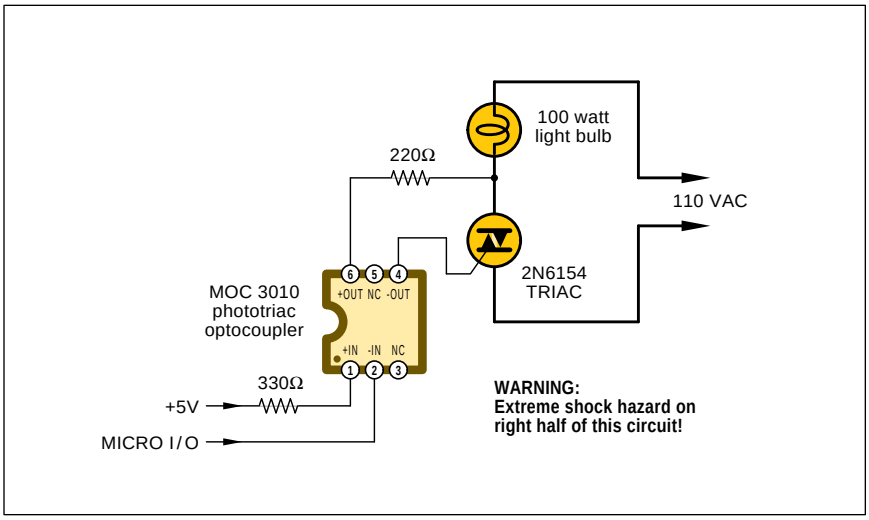

Fig. 4 – TYPICAL OUTPUT INTERFACE between a microcontroller and an ac power load. A one-piece solid state relay could be substituted. For a proportional phase control, a zero crossing reference must be provided.

Back to the Present

What can we do to further improve color organ designs? Obviously, the new baby PIC is screaming to be used as a phase controller. With care, you might even get three channels out of a single low cost chip!

You would first have to question whether you'd prefer to use a classic design or something new. The crucial key to a classic color organ is some effective display. Even with the best designs, viewing can get boring.

At any rate, if I were doing a new "classic" color organ, two features I

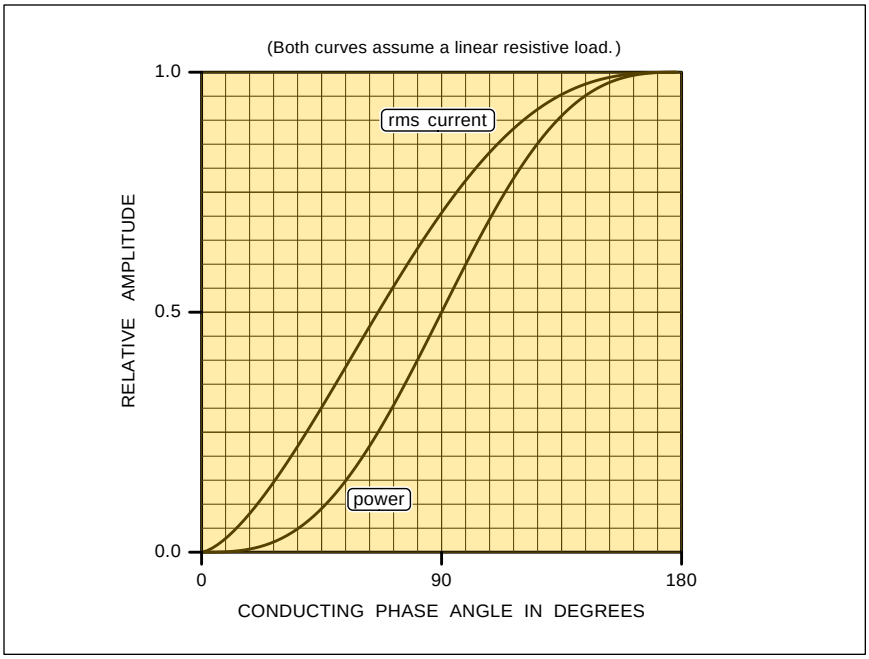

Fig. 5 – THE "LINEAR" PORTION of an ac phase control has a sorely limited dynamic range of a mere ten to fifteen decibels. Linearity and dynamic range can both be greatly improved by using table lookup in a baby PIC.

AC PHASE CONTROL RESOURCES

CP Claire
107 Audubon Road #8
Wakefield MA 01880
(617) 246-4000

Crydom
411 N Central Avenue
Glendale CA 91203
(818) 956-3900

Galco
26010 Pinehurst Dr
Madison Heights MI 48071
(800) 521-1615

Grainger
2738 Fulton St
Chicago IL 60612
(312) 638-0536

Intl. Rectifier
233 Kansas St
El Segundo CA 90245
(310) 322-3331

LSI/CSI
1235 Walt Whitman Rd
Melville NY 11747
(516) 271-0400

Motorola
5005 E McDowell Rd
Phoenix AZ 85008
(800) 521-6274

Mouser Electronics
11433 Woodside Avenue
Santee CA 92071
(800) 346-6873

NTE Electronics
44 Farrand St
Bloomfield NJ 07003
(201) 748-5089

PCIM
2472 Eastman Ave #33-34
Ventura CA 93003
(805) 658-0933

SGS-Thomson
1000 E Bell Rd
Phoenix AZ 85022
(602) 867-6259

Signetics/Philips
PO Box 3409
Sunnyvale CA 94088
(408) 991-2000

Siemens Components
2191 Laurelwood Rd
Santa Clara CA 95054
(408) 980-4500

Teccor Electronics
1801 Hurd Dr
Irving TX 75038
(214) 580-1515

Texas Instruments
PO Box 809066
Dallas TX 75380
(800) 336-5236

Thomson CFS
40G Commerce Way
Totowa NJ 07511
(201) 812-9000

would add are *input compression* and *linearization*. As figure five shows us, typical audio has ridiculously too much dynamic range for useful phase control of lights. Your lamps will be off or on most of the time, instead of smoothly tracking the music. *Analog Devices* has their low price *SSM2165* speech compression chip that should be ideal for this.

The perceived brightness of a lamp is *not at all* linearly related to the phase angle. First because the phase angle versus power is an "S" shaped curve rather than linear. Secondly, because the eye is a nonlinear device that perceives light logarithmically. And thirdly, because an incandescent lamp has a very nonlinear resistance at low brightness levels.

So, we take our new baby PIC and convert each input control voltage into an 8-bit number 0-255. Then we *table lookup* a new number that sets up an acceptable phase delay for the desired *apparent* brightness level.

The table lookup would be closely matched to the lamps in use. Since your eye perceives equal brightness light in the ratio of one part green, two parts of red and three parts blue, you might want to select a *different* lookup for each color.

The aim is to let music produce as many different brightness levels as possible. As before, you'd never let the lamps go completely off. A very low background level is a first step towards linearization.

I guess I'd select digital bandpass filters these days. Both *Maxim* and *Linear Technology* have lots of fine selections for you here.

When you do your own design, do not forget to provide reliable safety isolation, always add some effective line noise filtering and shielding, and treat your input audio gently. Use the purest colors you can get.

Avoid yellow because it typically overwhelms. Since an incandescent lamp is pretty much yellow to start with, filtering for other colors very much limits the light output. Go out of your way to prevent any and all white light from any pinholes, leaks, color recombination, or poor filters.

We found a lot more on lamps and lighting resources in MUSE95.PDF. Available on *www.tinaja.com* or in the *Tech Musings* reprints. *Grainger*, of course, is your prime source for lighting options.

Going Non-traditional

What about non-traditional color organ architectures? LED's are one possibility. But power levels may be restricted and the blues will still be expensive. And you'd still be stuck with limited display options. Lasers are another possibility, but again the blues are a problem. More on laser approaches from *MWK Industries* or *Meredith Instruments*.

What if you instead combined a spectrum analyzer chip with a screen saver? The ultimate would be to use *very* sophisticated DSP techniques to attempt to isolate music instruments. Let each instrument be a color blob on the screen. Some kind of tracking comb filter, maybe. The louder the instrument, the bigger and brighter the chosen blob.

These blobs could wander around lava lamp style, continually showing new and interesting variations.

Different algorithms could also be keyed to mood or music style.

Texas Instruments has a new DSP demo board having a full real time audio spectrum analyzer built in. It might make an interesting front end for audio-to-color displays.

New Tech Lit

You can shortly expect the sudden demise of data books. Because they have become outrageously expensive to produce and maintain. New and free *Acrobat* based CD-ROM versions of full product data are freshly issued by *Texas Instruments* in a *Designer's Guide and Data Book*. And by *Linear Technology* in a similar publication.

A great source for the tech ed stuff is *Brodhead-Garrett*. Who publish a free catalog. They stock everything

NEED HELP?

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NAMES AND NUMBERS

Ace Plastics
26 North Avenue
Garwood NJ 07027
(800) 695-4223

Analog Devices
PO Box 9106
Norwood MA 02062
(617) 329-4700

Brodhead Garrett
PO Box 8102
Mansfield OH 44901
(800) 321-6730

Castcraft
Box 17000
Memphis TN 38187
(901) 682-0961

Contract Professional
125 Walnut Stret
Watertown MA 02172
(617) 926-7077

Scott Edwards
964 Cactus Wren Lane
Sierra Vista AZ 85635
(520) 459-4802

KeelyNet BBS
Box 1031
Mesquite TX 75149
(214) 324-3501 BBS

Lindsay Publications
PO Box 538
Bradley IL 60915
(815) 935-5353

Linear Technology
1630 McCarthy Blvd
Milpitas CA 95035
(408) 432-1900

Maxim
120 San Gabriel Dr
Sunnyvale CA 94086
(800) 998-8800

Meredith Instruments
5035 N 55th Ave #5
Glendale AZ 85301
(602) 934-9387

Microchip Technology
2355 W Chandler Blvd
Chandler AZ 85224
(602) 786-7200

MWK Industries
1440 S State College Blvd 3B
Anaheim CA 92806
(800) 356-7714

Parallax
3805 Atherton Rd #102
Rocklin CA 95765
(916) 624-8333

Rex Supply
3715 Harrisburg Blvd
Houston TX 77003
(800) 369-0669

Stemgas Publishing
PO Box 328
Lancaster PA 17608
(717) 392-0733

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073

Tapestry
431 Griggs Street N
St Paul MN 55104
(800) 876-3776

from solar energy to injection molds. *Rex Supply* also prints a fat catalog chock full of machine shop stuff.

Stemgas Publishing has magazines and reprints of interest to collectors of antique gas or steam engines.

The Boy Mechanic III is the latest reissue from *Lindsay Publications*. A thick 1919 reprint full of wondrously essential projects. Such as full details on building your own cement kiln.

From *Tapestry*, a complete line of fancier ink jet media. Glossies, clear, cling, golds, silvers.

Ace Plastic has a wide variety of unusual plastic shapes. Tubing, rod, squares, rounds, balls, cubes, rings, diamonds, wedges, and more. From *Castcraft*, a new flyer on casting and moldmaking.

Contract Professional is a brand new magazine for independent tech consultants. Also see the *Synergetics Consultant's Network* you'll find on *www.tinaja.com*For most individuals and smaller scale startups most of the time, any involvement whatsoever with patents is *absolutely certain* to end up as a total net loss of time, energy, money, and sanity. Find out why in my *Case Against Patents* package. Along with tested and proven alternatives which do deliver in the real world. As Per my nearby *Synergetics* ad. I have also still got some great surplus buys on Tek 1230 and Fluke 9010 logic analyzers.

Most of the mentioned resources appear in our *Names & Numbers* or *AC Phase Control* sidebars. Be sure to check here before calling our no charge US helpline or visiting my *www.tinaja.com* web site.

Let's hear from you. ✦