Some RFID resources
PostScript trig functions
Hydrogen scams and fiascos
Steplocked Magic Sinewaves
Are VMSK/2 & AAPSK bogus?

Fig. 1 – POPULAR RFID SCHEMES vary in their transmit and response frequencies and methods.

The hydrogen storage problem is the crucial gotcha. If you really want to do something useful, solve it.

It turns out that electrolysis is such a poor way to produce hydrogen that it is never used commercially for bulk energy apps. In particular, stainless steel is an atrocious electrode choice.

Why so? Because of the hydrogen overvoltage of iron and its passivated surface. Instead of using electrolysis, methane reforming is the standard industrial process today.

But the methane really has to want to reform.

A final point is that solar electric to electrolysis to hydrogen is clearly a monumentally stupid bet today.

Solar electricity is far too valuable to waste on electrolysis. It is also a much "better" energy way higher up on the exergy chain, since you can do more things with it far more easily and far more efficiently.

The inefficiencies and costs of all these systems today mean they are net energy sinks which are simply destroying gasoline.

With the possible partial exception of a few rare and remote gas wells, no terrestrial non-nuclear means is known to produce hydrogen which does not use up considerably more energy than the hydrogen could store as an energy carrier or transport media.

Your best starting point on all this is where it has been for the last few centuries: Faraday's notebooks. You can easily find these as Britannica Great Books #45. Faraday (along with myself and every other even remotely credible researcher since) felt that...

The web is full of outright scams to produce hydrogen by violating fundamental physical laws. To me, these all look like investment stock plays aimed at the cluelessely gullible. Plain and simple.

Although I'm sure their supporters strongly feel otherwise.

One claims that fractional energy states exist lower than those allowed by quantum mechanics. Another arcs carbon underwater in violation of thermodynamic irreversibility.

Another injects microwaves into an engine cylinder. A fourth claims miracle electrolysis efficiencies. By way of a thoroughly discredited pulse or high voltage technique.

A Canadian penny stock is starting to look just like a Canadian penny stock. Another exploits a high profile circuit of his tent show populist "not even wrong" hystronics. An idiotic decades-old scam still hypees hugely inefficient "overunity" motors.

Trolling newsgroup posts continue to be made by ripped-off and clueless investors in terminal denial of their having been done in by a deceased Ohio "water car" swindler.

An apparent Phillipine water car fiasco has now been recycling itself for three decades. And a final scam championed by a rock musician has his minions still selling $15 plans for a ridiculous dynamic brake.

Uh, let's review: There's no known way to store hydrogen today which is safe enough, dense enough, or cheap enough for personal vehicle use.

Except for hydrocarbon fuels.

If pressurized to 80 PSI, a 12 foot diameter spherical vessel would be needed for useful vehicle range. Such a tank would have something around 700 tons of force on it. The minimum recommended DOT orange book day time no-wind evacuation distance is 2640 feet for such a hazmat situation. As in hazmat.dot.gov/gydebook.htm And your best recommended tool is a powerful pair of binoculars.

Sadly, all known hydrogen storage methods are worse or not here yet.
(1) The net energy that is required to dissociate hydrogen is independent of method.

(2) One electron has to be added for each hydrogen atom.

(3) Approximately two electron volts of energy are needed.

All these rules are non-negotiable. Observations to the contrary are—experimental error. Your question is never whether the errors occurred. It is always finding exactly which errors were made in what manner. Finding the source of these errors can end up challenging and educational.

If you feel these rules are in error, please show me which centerfold of *Science* magazine you have appeared in and which aisle of Wal-Mart I can find your product on.

Yes, modest amounts of hydrogen injection can very much improve the behavior of a gasoline engine. But if and when the process proves feasible, the hydrogen will likely be gotten by fuel modification or by exhaust gas driven reformation. Or another way that makes more thermodynamic and economic sense than electrolysis.

More on hydrogen resources at my www.tinaja.com/h2gas01.html and in my file BASHPSEU.PDF

Waiting for the RFID Cows to Come Home

There’s bunches of new interest in an emerging field known as RFID, or Radio Frequency Identification.

RFID literally can watch your cows come home and make sure each one gets into her own stall. Or keep track of library books. Or stop shoplifting.

Or assign parking spaces.

Or give Percival Pussival exclusive use of his private cat door. Or find stolen cars or missing dogs. Or label friendly military targets. Or hazmat in transit. Or buy groceries. Or pay bus fares or bridge tolls. Or keep tabs on wandering boxcars.

RFID consist of at least two units. The base unit is the transmitter or the sensor. The moving unit is a tag, an implant, or a transponder. Most tags are passive in that they do not need any internal batteries.

Depending on the system used, the base unit typically sends out some RF energy that is intercepted by the tag.
The tag first may “steal” some of this energy, change it to dc and capacitor store it for its own use. The tag then responds, either altering its rf profile or returning new energy.

The coding of the return might act like a bar code. Or give you a serial id number and other data. For instance, a hog implant might also include the core body temperature. While simple tags work one-way only, fancier ones can be written and read. Storing, say, Elsie’s milk production. Or the shock history of a package in transit. Or the GPS position. Or a remaining “smart card” cash balance.

Figure one shows us three popular RFID schemes. Giving you choices in cost, range, and size.

An older RFID scheme transmits at 250 kiloHertz and responds either at 125 kHz or at VHF. The low transmit frequency acts as a fairly efficient air core transformer. Such that tag power can get extracted and stored “crystal set” style. The Holtek HT6730 is one typical VLF-only example. The usual range is six inches or so.

Instead, most newer approaches to RFID make use of...

The Backscatter Method

It sure would be nice if the tag did not have to transmit anything at all. Thus simplifying your tag circuits and very much lowering tag power. That’s just what the newer RFID backscatter methods are all about.

Most resonant circuits have a way of “sucking in” surrounding energy. Ferinstance, if you take a large tuned loop antenna and set it close to any AM radio, your nighttime reception will dramatically improve.

Hams once used “grid dip” meters. Where a tunable oscillator was placed near a tuned circuit. A drop in energy was noted at the resonant frequency.

Similarly, radar works by blowing a target with rf energy. The target then reflects energy back for measurement or display. If the target is resonant, it returns a very strong signal.

Reflected or returned radar energy is called backscatter. You can think of backscatter as “rebroadcasting”.

So, all a backscatter tag has to do is switch a resonant tank into or out of resonance at a coded rate. Or change its resonance frequency. Either takes little energy or fancy circuitry.

Fig. 4 – POSTSCRIPT ASIN and ACOS custom trig procs.

Microchip Technology is really big on 13 MHz backscatter RFID. Their MCRF360 is typical and can be found in their microID line. Up to 50 tags can be interrogated interference free through an anticollision algorithm. Lots of these data sheets and ap notes and tutorial design guides are up at www.microchip.com.

Check them out. Micro’s MicroStamp, DuraTracker or similar systems operate either near 900 MHz or at 2.4418 GHz. Although their micropower tags require battery power, they have a fifty foot range.

And do such neat tricks as let you walk by the back of any 18-wheeler and catalog the entire cargo and the recent travel history of the truck.

I have gathered some useful RFID info together for you as this month’s resource sidebar. More RFID links are up at www.rwprox/WWW.html. Also see the RFID News website.
I call steplocked magic sinewaves. These are quite easy to synthesize and analyze. Steplocking is a brand new multi-billion dollar green energy savings opportunity. The technique also has the amazing property that any chosen number of sequential low harmonics can be forced to zero!

My steplocked magic sinewaves are similar to plain old PWM pulse width modulation, except: (A) all the pulses are locked to the generated sinewave; (B) far fewer pulses than normal are used; and (C) the pulse positions and widths must be carefully chosen.

The fewer pulses are the secret to much higher switching efficiencies.

Figure two shows us one quadrant of several steplocked magic sinewave options. In the "normal" sequence of 2a, six uniformly spaced pulses have their widths precisely adjusted to give the needed energy of a fundamental frequency sinewave.

Once you have your first quadrant, you'll mirror it for your second, then turn your mirrored pair upside down for your third and fourth.

Working in quadrants drops your data storage by four and eliminates all dc terms, all even harmonics, and all odd cosine terms.
More details in **MUSE90.PDF**.

If you send this exact waveform to an integrator or low pass filter (such as the inductance in a motor) and look at all the "error" energy which is not the fundamental, you'll find the first non-zero harmonics are the 23rd and 25th! You could think of these as the residue from a 24th harmonic carrier whose phase cyclically alternates.

The object here is to make all of your energy either fundamental or carrier, leaving nothing for the other low harmonics. Thus forcing them to zero. In this example, "none" means a total harmonic distortion 2-22 that is under 0.0823 percent.

Detailed magic sinewave catalogs and JavaScript calculators are now up at [www.tinaja.com/magsn01.asp](http://www.tinaja.com/magsn01.asp).

Consulting services are offered by way of [don@tinaja.com](mailto:don@tinaja.com)

### The Bad Stuff

Any magic sinewave has to make a compromise between stuff you want (that smooth fundamental) and stuff you don't (all the sharp switching corners). How do steplocked magic sinewaves compare?

As with my other magic sinewaves, steplocking works by forcing all of the harmonics as high in frequency as possible for easy filtering.

On the plus side, harmonics two through a selected maximum are all zero in theory, and end up darn little in practice. The low harmonics even improve with low amplitudes. Design is straightforward, and only modest computer time is needed.

You have a nearly infinite possible sets of amplitudes. Only 26 storage bytes are required per amplitude in our "normal" example. Again, the low number of switching transitions used can end up vastly more efficient than classic PWM techniques.

On the debit side, all the steplock delay values do have to be amazingly precise to force weak low harmonics. Something like 1 part in 30,000 error can make a difference. Which means that you'll need timing accuracies of a few microseconds at 60 Hertz. And that you may want to separate setting your frequency and amplitude. With use of a phase locked clock.

Even though there is a zero third harmonic, this "normal" waveform is not yet three phase friendly. Ideally, you want to only drive the terminals on an unmodified three phase motor. Without splitting out your windings or using six drivers.

To be three phase friendly, you'll have to obey this strange rule: **Any three waveform sample triads spaced by 120 degrees must individually sum to precisely zero.**

Our "normal" magic sinewave can sneakily be made three phase friendly by splitting and adjusting its narrow pulses as shown in figure 2b. A delta friendly example is in figure three.

Another steplock restriction is that the technique works best with power electronic frequencies of 50 to 400 Hertz. Clock frequencies may get way out of hand for faster use.

Steplocking does have the big time gotcha common with all PWM: Your first two uncontrolled odd harmonics will be very strong. Possibly as strong as your fundamental.

Filtered by simple integration, they remain around 3 percent amplitude and 0.09 percent power.

Which is a typical design tradeoff: overspecify one goal (such as forcing lots of zero low harmonics) and other problems are sure to crop up.

If you can add a second lowpass filter pole, your remaining distortion could be greatly reduced. Load inertia will sometimes provide this service free of charge.

Yet another steplocking restriction is that it only works over a somewhat limited frequency or speed range. 5:1 or so without mods.

But higher sequences or tracking filters can easily be added.
**Synthesis Secrets**

Adding magic sinewave pulses can zero out more odd harmonics. But at the cost of more efficiency-robbing switch transitions. Conversely, less pulses can be used to raise efficiency. The number of adjustable steplock quadrant edges sets the number of low odd harmonics you can force to zero. By using six pulses and twelve edges, for instance, you can force your fundamental to a desired amplitude and the 11 harmonics 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, and 23 to zero.

Delta friendly gets trickier, because certain pulse edges have to track each other. In our figure 3 example, there are fourteen edges, but only seven are independently adjustable. The seven non-adjustable edges force all the odd triad harmonics (3, 9, 15, 21, etc...) to zero. The seven adjustable edges let you control the fundamental and the six remaining low odd harmonics of 5, 7, 11, 13, 17, and 19. Thus zeroing out everything through the 22nd.

Note that all even harmonics (plus the dc and cosine terms) will already be zero when using this potent new steplock scheme. Further design help on step-locked magic sinewaves is at www.tinaja.com/magsn01.asp

**Oddball PostScript Math**

One of the beauties of the general purpose PostScript language is that you can define anything at any time, building on what you already have. For my steplocked magic sinewave math research, I needed an acos or arccosine function. One that input a cosine of an angle returns the angle itself. PostScript only comes fairly close with its atan operator.

So, as our PostScript utilities for this month, I have shown you some simple transforms that get you from the existing atan operator to the asin or acos of your choice.

Basically, you redefine the names on a trig triangle and work your way around as needed. Per figure four.

**New Tech Lit**

There's apparently a new group of wireless data encoding schemes that seems to promise surprisingly narrow bandwidths. Such as five times a 57K modem's abilities on any plain old voice grade phone line.

Or a hundred CD quality programs in a typical FM radio channel. It is called VMsk/2, short for one-half very minimum phase-shift keying.


Web sites are www.vmsk.org and at www.castileen.com/alpha/vmsk1.html

Because the Shannon bandwidth limit is set by thermodynamics, at least some insiders strongly feel the scheme is nothing but bad labwork.

Click here for an analysis.

Zero cost online access to Ulrich's Periodicals Dictionary seems to have been frustratingly difficult recently. One useful free alternative is Pub List at www.publist.com. Thankfully, the superb Oxbridge service has returned to the web at www.mediafinder.com.

From Texas Instruments, a new Analog and Mixed Signal Designer's Guide. Some very small ac line power supply parts that can fit inside the power plug are available as the LR8 from Supertex and the 830 series from Bit Technologies. Yes, the latter even includes full safety isolation.

Unusual wax products are sold by the Kindt-Collins folks.

An amazing variety of low cost video cameras is sold by Supercircuits. Some as cheap as $29, others that are built into ties, caps, or glasses. A free networking ATM Pocket Reference can be gotten through G. N. Nettest.

I'm not big on business books, but Thomas Friedman's The Lexus and the Olive Tree seems to be worth a read. It thoroughly analyzes the one world impact of the Internet revolution. You can find it on my book access page on my Guru's Lair website.

For all the fundamentals of digital integrated circuits, be sure to study copies of my TTL Cookbok and CMOS Cookbook. You can find both these at www.tinaja.com/amlink01.asp.

And a final reminder about our cash-and-carry InfoPack consulting at www.tinaja.com/info01.asp.

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