

SX Laser printer repairs  
Linear phase digital filters  
Home theater opportunities  
Debunking some techno-myths  
Government surplus electronics

There've been several media references currently to the *techno-myth*. Techno-myths are simply urban lore with a technical bent. Such as Tesla's new source of unlimited free energy.

The one that he misplaced all of his notes on.

Or a one thousand mile per gallon carburetor that the Detroit conspiracy is suppressing. Which you'd bolt onto your \$25 army surplus jeep. Or that alien commune they secretly stashed at Wright Pat. After impounding their element #117 powered UFO craft in Nevada's Area 51.

Or the lone industry outsider who got his untested and unproven idea, effortlessly patented it, and instantly became filthy rich. While beating the cash-waving Fortune 500 companies away with a stick.

Or most any dowser who's able to collect the \$500,000 prize now being offered. Or all of the Martian happy faces secretly smirking at you.

Techno-myths are also what those Houyhnhnms might politely term *that which is not so*. The myths are easily separated from reality. All you have to do is ask some fundamental and very pointed questions.

For instance: "Are there *several* independent and *personally verifiable* primary sources?" Or "Where is the hard evidence?"

Do any peer-reviewed publications exist?" Or "Is there an unambiguous experiment that will clearly cause the effect to reveal itself?"

Does the claimant possess enough theoretical and math background to even understand the problem? Is this the simplest and the most probable explanation for the observed effect?

As it has for centuries, *Ockham's Razor* still works like a champ.

Was the labwork even done? Or is their labwork "not even wrong?"

I have long been a fan of all these techno-myths. Especially those that involve pseudoscience or any patent scams. Most of these works of fiction are wondrously bizarre reading.

As I've mentioned a time or two

before, a goal around here is to heap all of this stuff on center stage.

Then shine a bright light on it.

And then get you to independently conclude "Yup – That really is a big pile, allright".

I have expanded my pseudoscience section of [www.tinaja.com](http://www.tinaja.com) We've now got new links to everybody from *Saucer Smear* to *Skeptical Enquirer* o *Art Bell* to *KeelyNet*. KeelyNet has made me their resident skeptic.

Whatever that means.

You'll find more on patent myths in my *Case Against Patents* package. Or the [www.tinaja.com](http://www.tinaja.com) patent shelf.

Tellyawhat. Let us make a contest out of this. Simply tell me about any techno-myth I've not heard about yet.

Or a slant on one I have.

There will be a dozen or so of my *Incredible Secret Money Machine II* books going to your better entries. Along with an all expense paid (FOB Thatcher AZ) *tinaja quest* for two going to the best submission of all.

As usual, *written* and *snailmailed* entries only. Be sure to send them to me at my *Synergetics*, rather than to *Electronics Now* editorial.

And hey, no complaints about no email entries. (A) It is my contest, so I'll make any rules I want. (B) I need a hard copy audit trail of the entries.

(C) Snailmail dramatically *increases* your odds of winning. And, of course (D) The purpose of my contest is to encourage creative thought. A single email message ruthlessly demolishes any and all creative thought within a six block radius.

### Linear Phase Digital Filters

After our digital filter coverage in the past few columns, I've had lots of requests for exact details on how you design a "real" digital filter. It turns out to be a lot easier than you'd first suspect. Digital filters simply involve finding some magic numbers called *coefficients*. The coefficients can be found by solving the linear equations we looked at last month.

Simply by shoving all the desired amplitudes and frequencies into these equations. Plain old numbers.

A digital filter acts on a group of numbers. The numbers might be a real time stream of incoming data. Or non real time data already stored in memory. These numbers are *sampled* at some constant rate (or a constant spacing) called the *clock rate*. Each sample first gets multiplied by some magic *coefficient*.

A group of adjusted samples are then added together to create your output. The more samples you select,

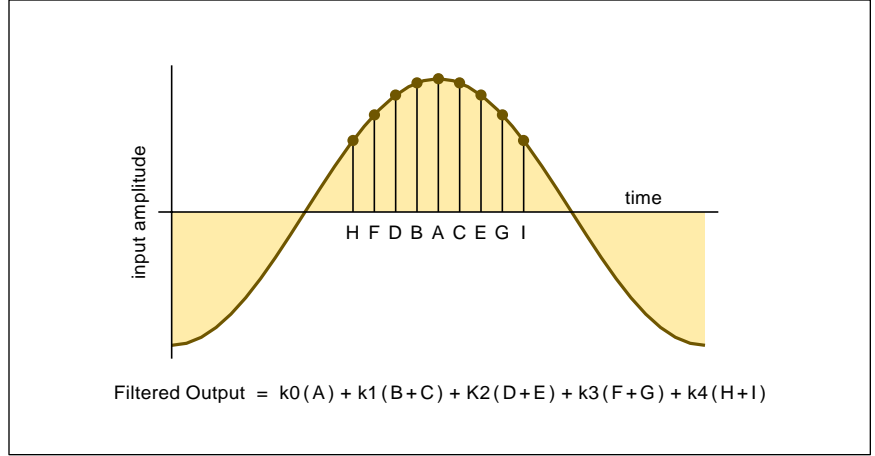


Fig. 1 – A LINEAR PHASE DIGITAL FILTER gets created by taking some chosen number of evenly spaced samples. The samples are then added into pairs and multiplied by carefully chosen coefficients. Finally, all of the paired and scaled values are summed into a single output result.

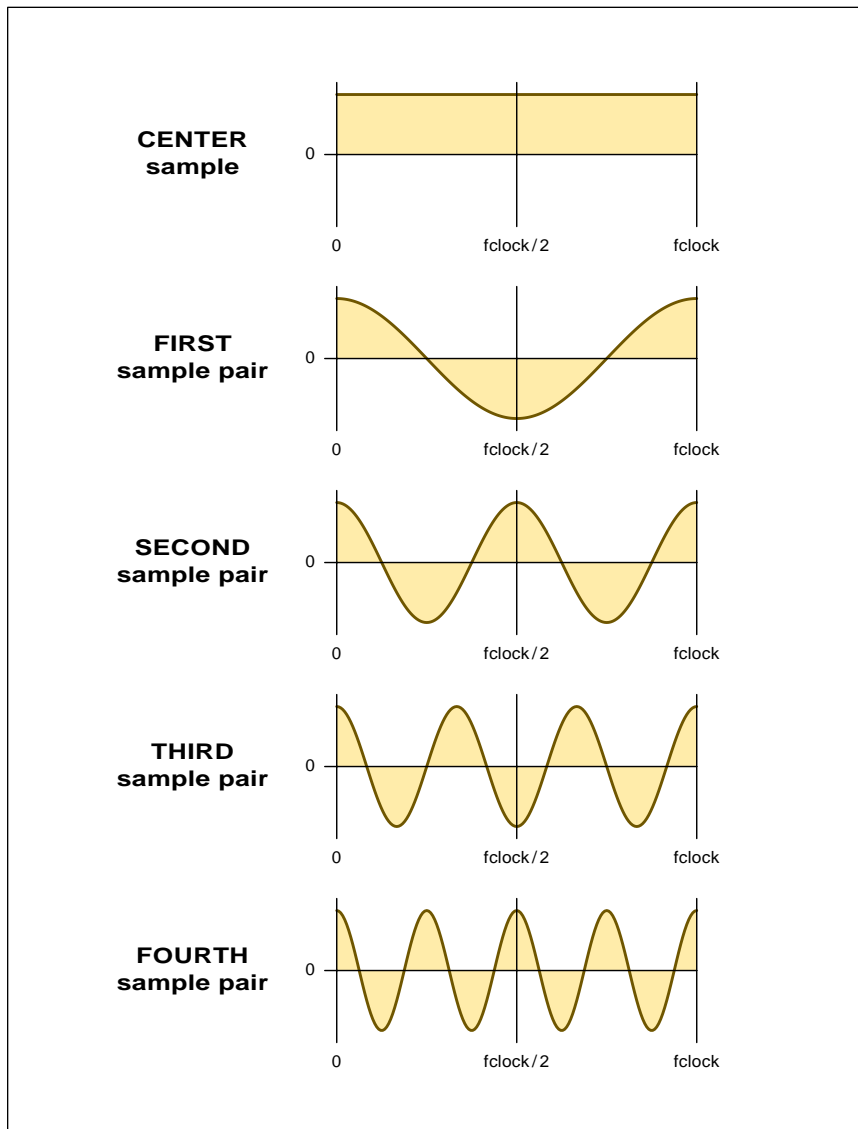


Fig. 2 – EACH FILTER TAP PAIR is independent and responds differently as your frequency changes. Each pair can be scaled to any size or to either polarity by multiplying by a chosen coefficient. Thus, any two of the scaled pairs can force any two frequencies to have any two selected amplitudes. Any  $n$  pairs can force  $n$  frequencies to have  $n$  selected amplitudes.

the better will be your end result. But the more complex your system.

Figure one shows us a special type of digital filter known as a *constant phase* filter. Constant phase filters can magically search both *forward* and *backward* in time.

All of the signal's harmonics stay in perfect step with each other. Most analog filters instead often introduce unavoidable delays with capacitor or inductor energy storage.

One major advantage of constant phase filters is that these are usually "distortionless". Which is extremely

important in data comm apps. Their disadvantage is that their response shapes are somewhat limited. Also, more time and effort might be needed to get a desired result.

A linear phase filter consists of a single *center* sample. Combined with one or more *pairings* of identically scaled "outrigger" samples. The first sample pair is made one clock earlier and one clock later than "now".

Your second sample pair will end up two clocks earlier and two clocks later than "now". And so on.

As many sample pairs get used as

are needed to do the job. In general, a digital filter begins to pick up power when you use the center and three or more sample pairs.

Your clock sets your sample rate. And thus your *time interval* between samples. At any desired frequency, another name for a time interval is a *phase delay*.

Let's assume a clock frequency of 72 samples per cycle for your lowest ( $f=1$ ) frequency of interest. There's 360 degrees in one frequency cycle. Last time I checked,  $360/72 = 5$ . So there are five degrees of phase shift per sample at the  $f=1$  fundamental.

Since digital filters are linear, we can analyze them by using carefully chosen frequencies and phases.

By a process of *superposition*, the chosen selections should predict the exact final real world filter response. Where lots of frequencies and phases are present all at once.

Because we are linear, we can also apply a *normalization*. You initially assume your fundamental frequency is 1.0. And in our current case, your clock frequency is 72. Later you can adjust your clock to reach the desired frequency response range.

We will also *normalize* our input to one volt. This simplifies the math and is easily scaled later.

Additional details on scaling and normalization are found in my *Active Filter Cookbook*.

### Building a Response

First, let's look at the fundamental. Because any old phase will do for our analysis, let's use cosines. Otherwise known as a ninety degree phase shift. Your center sample simply measures how big your fundamental is.

The first sample pair measures the amplitudes at (in this case) plus and minus *five* degrees of phase.

The second sample pair measures in at plus and minus *ten* degrees of phase shift. The third sample pair hits at plus or minus *fifteen* degrees from the center peak.

Next, look at your ( $f=2$ ) second harmonic. The center sample stays on your peak. But your first sample pair now measures at plus or minus *ten* degrees. Your second sample pair is at *twenty* degrees. Similarly, at your third harmonic, your center sample still stays in the center. But the first

sample pair is at plus or minus *fifteen* degrees from peak.

How do these sample pairs behave as we change frequency? Figure two shows us the amazing results. Your center sample is just your amplitude. Telling us "how big" this frequency is. Thus, the center sample plots as a constant with frequency.

A straight horizontal line.

Your first sample pair plots as a *cosine* in amplitude-frequency space. Why? At rather low frequencies, the samples are all so close together that they are nearly identical.

As you raise frequency, the sample pairs move further and further away from the peak. At one quarter of the clock frequency, both samples will sit on a zero crossing. Giving you a zero result. At one half of the sample frequency, both samples will hit on negative peaks.

And back to zero at three quarters your sample frequency. Finally, back to the full reinforcing at your actual sample frequency. Note that at your clock frequency, your sample phase shift is plus or minus 360 degrees, and they are sitting on the peaks of the next and the previous cycle from where you "now" are.

Hmmm. Your second sample pair is easily shown to be a cosine which will repeat *twice* in the sample space. Your third sample pair will repeat *three* times, and so on.

Taken together in the real world, I believe this neat-o pile of cosines is called a *Chebyshev Polynomial*. A free ISMM II to the first math freak that can set me straight on the correct terminology.

### Finding Coefficients

Let us see what we can do with all these magic cosines. A center sample can be thought of as a "dc level" or zero frequency cosine. We can adjust this amplitude any way we like. We can also make it positive or negative. Thus, with our zero frequency cosine, we can force any *one* frequency to have *one* chosen amplitude.

Similarly, by using our one-cycle cosine, we are able to force any *one* frequency to *one* chosen amplitude. But all these waveshapes are totally independent of each other. Thus, we can use the dc level and the one cycle cosine *together* to let us force any

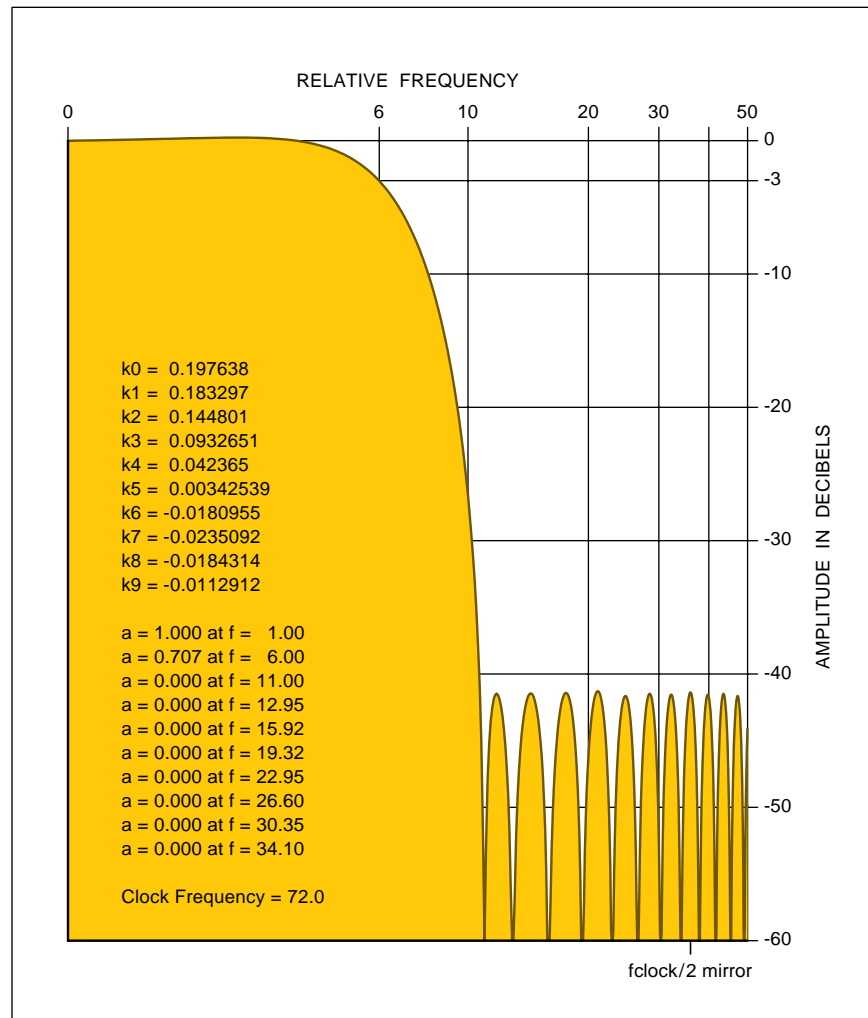


Fig. 3 – FREQUENCY RESPONSE of a typical 19 tap linear phase low pass filter. Ten desired amplitudes and frequencies are sent to LINEAREQ.PS. Which then calculates the coefficients and plots the results.

*two* frequencies to *two* amplitudes. By using plain old algebra, we get two equations in two unknowns.

Add another cosine to the pile, and you'll have three equations and three unknowns. We can now force three frequencies to match the amplitudes we are looking for.

By going to more and more cosine terms, you can force more and more frequencies to meet your goals.

For instance, figure three shows us a specific example. This is a sharp cutoff lowpass filter having a cutoff frequency of six. Using 10 terms for a total of 19 taps.

Note that one center tap and nine outrigger pair taps should sum to ten variables. And also to nineteen taps. You solve a 10x10 linear equation to arrive at the correct coefficients for

the needed nineteen samples.

More on solving linear equations in MUSE106.PDF on [www.tinaja.com](http://www.tinaja.com)

The desired amplitude at  $f=1$  was set to 1.00. At our wanted  $f=6$  cutoff frequency, we set a 0.707 amplitude.

Equal to three decibels down.

Those remaining eight terms were forced to zero at higher frequencies. The initial try bounced around a lot, so the frequencies were adjusted to give the uniform humps shown.

More design details appear in file LINEAREQ.PS on [www.tinaja.com](http://www.tinaja.com)

You easily design your own digital filters just by punching frequencies and amplitudes into this routine.

### Some Options

Remember that there is a "mirror" on any digital filter at *one half* the

A FEW HOME THEATER RESOURCES

**Advanced Imaging**

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Melville NY 11747  
(516) 845-2700

**Audio Video Interiors**

21700 Oxnart Street #1600  
Woodland Hills CA 91367  
(818) 593-3900

**B&H Video**

119 W 17th St  
New York NY 10011  
(800) 932-1977

**CableVision**

825 7th Ave  
New York NY 10019  
(212) 887-8400

**CD-ROM Professional**

462 Danbury Rd  
Wilton CT 06897  
(203) 761-1466

**CD-ROM Today**

23-00 Route 208  
FairLawn NJ 07410  
(201) 703-9500

**Digital Imaging**

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Torrance CA 90501  
(310) 212-5802

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2160 Heathercliff Rd #200  
Malibu CA 90265  
(301) 589-3100

**Information Display**

201 Varick St  
New York NY 10014  
(212) 620-3371

**Journal AES**

60 E 42nd St Rm 2520  
New York City NY 10165  
(212) 661-2355

**New Media**

901 Mariner's Is Blvd #365  
San Mateo CA 94404  
(415) 573-5170

**PC Graphics & Video**

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Santa Ana CA 92707  
(714) 513-8400

**Presentations**

233410 Civic Cntr Wy #E-10  
Malibu CA 90265  
(310) 456-2283

**Pro Audio Review**

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Falls Church VA 22041  
(703) 998-7600

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222 Rosewood Drive  
Danvers MA 01923  
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Shelby NC 28150  
(704) 482-9673

sample frequency. Thus, the figure three response starts going back up around a frequency of 62. And gets back to unity at the 72 clock.

This is why you *must* prefilter all digital filters to *prevent significant energy beyond half the clock*.

When you force some frequencies to provide the amplitudes you desire, others may end up wildly wrong. For instance, a linear phase filter seems to want to "bounce" in the stopband. Force the smooth stopband response and it won't end up as good.

If your response misbehaves, try shifting your set frequencies around some. If that fails, you could go to additional taps. Experiment.

Figure four shows a *symmetrical* approach to digital filters. Instead of the center sample we used before, all samples are paired.

Symmetrical filters have somewhat improved shapes for a given number of samples. But your output result is "centered" between input samples. A feature that caused problems for my magic sinewave research.

You can also unpair your samples. Each can independently contribute to your response shape. You will get lots more shape options. But you will lose the "distortionless" property of linear phase filters.

Another play for you is to go two dimensional with your digital filters. For video enhancement and such.

**Home Theater Resources**

This is sort of like a 1902 book on aviation, but a preliminary listing of

home theater resources shows up as this month's sidebar. The new home theater field is now about to explode. Offering lots of unique opportunities to more savvy tech folk.

There is absolutely no reason why home video displays can not shortly *exceed* those of theaters. For quality, brightness, and resolution.

Those new DVD disks and players should start to hit the retailers just about the time you read this. They are the first media that are obviously able to offer full theater quality. And can be more than flexible enough to adapt to even better future display or compression formats.

If you search the web, you'll find over 200,000 listings on *Alta Vista* alone for *home + theater*.

Such as the new *Secrets of Home Theater and High Fidelity* ezine at [www.sdinfor.com/about.index.html](http://www.sdinfor.com/about.index.html) Do let me know if there are some additional home theater resources we should have listed here. A free ISMM II for your input.

**NEED HELP?**

Phone or write all your US Tech Musings questions to:

Don Lancaster  
Synergetics  
Box 809-EN  
Thatcher, AZ, 85552  
(520) 428-4073

US email: [don@tinaja.com](mailto:don@tinaja.com)  
Web page: [www.tinaja.com](http://www.tinaja.com)

**New Tech Lit**

Government surplus electronics has gotten a lot easier to deal with. There's now walk-in fed run "retail" stores in certain areas. New online listings are available. And plastic is now acceptable as payment. To get started, call (800) GOVT BUY for a free catalog. Or visit their website at [www.drms.dla.mil](http://www.drms.dla.mil)

From *Linear Technology* a new CD full of data sheets and ap notes.

From *National Semiconductor*, a new *sidewinder* plug and play chip known as the PC87308VUL. This one includes a floppy disk controller, a keyboard interface, a real time clock, a pair of UART's, infrared support, and a fast two-way parallel port.

For some strange reason, it comes in a 160 pin package. Apparently they are saving the cow milking option for chip revision 2.0.

From *C&H Sales*, a new catalog on surplus motors, pneumatics, steppers, transformers, and for similar "heavy iron". All appear great for robotics or homebrew flutterwumpers.

*Lindsay Publishing* is continuing their re-release of "new" older books. Some 1904 *Amateur Work* reprints, a 1921 book on *Graduating, Etching, & Engraving*, and a hard bound 1910 *Elements of Machine Work*.

From *Don Thompson*, a new book on easy laser printer module repairs. Especially the popular Canon SX and LX engines. And the revised *Battery Reference Handbook* retailed by the *Butterworth-Heinemann* folks.



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313 Washington Street  
Newton, MA 02158  
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**C&H Sales**  
PO Box 5356  
Pasadena CA 91107  
(800) 325-9465

**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

**National Semiconductor**  
2900 Semiconductor Rd  
Santa Clara CA 95052  
(800) 272-9959

**Saucer Smear**  
James W. Moseley, J.S.  
Box 1709  
Key West FL 33041

**Skeptical Inquirer**  
PO Box 703  
Buffalo NY 14226  
(716) 636-1425

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

**Don Thompson**  
6 Morgan #112  
Irvine, CA 92718  
(714) 855-3838

For the fundamentals of your own homebrew self-publishing, check into my *Book-on-demand* publishing kit. Per my nearby *Synergetics* ad. Also just picked up a few newer surplus items. Including several more mint *Tektronix* 1230 logic analyzers. Give me a call for full details.

A reminder that nearly all of the mentioned resources do appear in the *Names & Numbers* or *Home Theater* sidebars. Always be certain to check here first. Then visit my web site at [www.tinaja.com](http://www.tinaja.com) I also offer a no fee US technical helpline per the *Need Help* box. Plus US email support. ♦

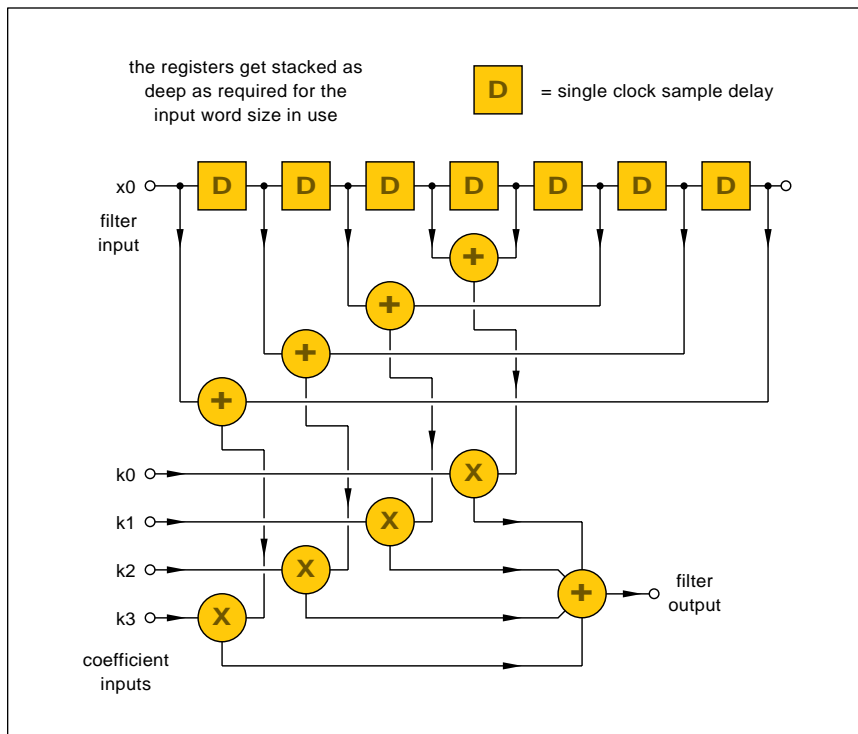


Fig. 4 – SYMMETRIC DIGITAL FILTER OPTION uses tap pairs. Response shape can end up better. But the output falls between the input samples.

**new from DON LANCASTER**

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Hardware Hacker II, III or IV .....	\$24.50
Micro Cookbook I .....	\$19.50
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PostScript Show and Tell .....	\$29.50
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PostScript Reference II .....	\$34.50
PostScript Tutorial/Cookbook .....	\$22.50
PostScript by Example .....	\$32.50
Understanding PS Programming .....	\$29.50
PostScript: A Visual Approach .....	\$22.50
PostScript Program Design .....	\$24.50
Thinking in PostScript .....	\$22.50
LaserWriter Reference .....	\$19.50
Type 1 Font Format .....	\$16.50
Acrobat Reference .....	\$24.50
Whole works (all PostScript) .....	\$380.00
Synergetics Surplus Catalog .....	FREE
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