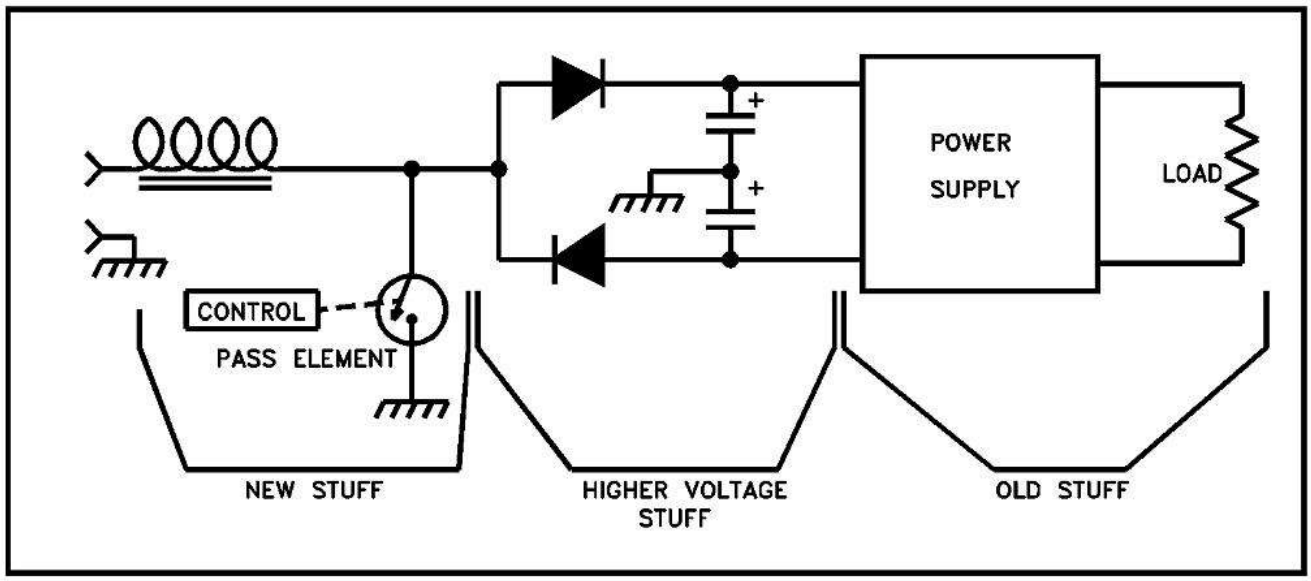
RAKO STUDIOS

Crusty McJowl on power-factor correction

A guest article from the noted curmudgeon shows how simple electrical engineering can be.



A propeller-head to English translation.

by Crusty McJowl

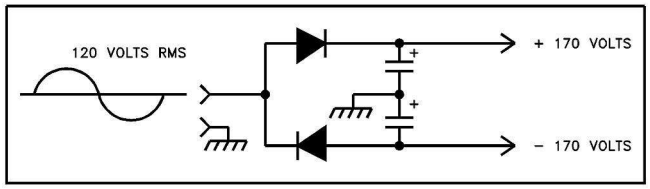
Land sakes o' goshin'. What's all this brouhaha over power-factor correction? The way these young whipper-snappers talk the whole sun is risen and setting over this gigantic issue of power factor correction (PFC). Us crotchety old-timers know that the hardest part of power supply design is getting all the holes to line up. Well, with all the jaw jackin' and pontificating going on, I thought I'd set down a few lines and more importantly, a few pictures to give you young 'uns the inside dope. Might help out you MBA types too.

Now right off the top, don't believe that power-factor correction can make your power supply more reliable. There is no way you can add parts to a design and have it be more reliable. If power-factor correction can lower the stress on some components then those components must be under-designed.

Another thing them kids will tell you is all the good reasons to redesign your power supplies using power-factor correction. That's 'cuz they're itching to design something. Used to be that way myself. Now I know better. Don't fix it if it ain't broke. There are only three reasons to utilize PFC:

1. You need an honest 15 Amperes from a wall outlet.
2. The government makes you.
3. Your customer makes you.

With that understood, Let's look at what the hell this power-factor correction is all about. Looky here at this circuit:



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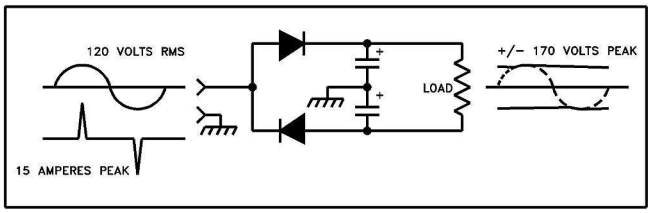
During the first cycle of input voltage the current rushes all lickety split begoshen to fill up the top and then the bottom capacitor. After that the whole mess just sits there. Remember there isn't any load hooked up. The capacitors are charged to the tippy top voltages of the input ac voltage. In this great country of ours it's about 170 volts on the top and -170 volts on the bottom.

OK, let's say you hook up a load. It pulls a couple of volts worth of current out of the caps. Now here comes that next plus and minus cycle of input voltage. Well, sakes alive, if the caps are only down a couple of volts nothing happens until the input voltage reaches 168 or -168 volts. Then a passel of current flows into the cap during the small time the voltage is greater than 168 volts. (It's a passel of current as opposed to the whole mess o' current that flowed during the first "inrush" cycle. Professional engineers should be quantitative you know.) Now, look at what you got:



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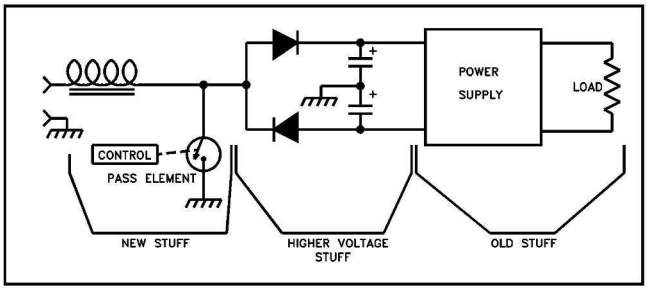
Little bumps of current that flow only when the input voltage is right at the top or bottom. Them young 'uns will try to impress the boss by calling these current bumps "haversigns" or "higher order harmonics". Us old timers know what they really are: *Little bumps of current.* Them little bumps are what trips the circuit breaker when the peak current is 15 amperes but the average current ain't even melting the insulation. Them little bumps are what makes your electric meter spin faster then it should. Them little bumps radiating away are why my 200 dollar portable phone doesn't work when I'm on the shop floor.

Power factor correction takes out the little bumps. The common, but not exclusive method, is as shown below:



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The pass element could be a tube, relay, transistor FET, IGBT or Maxwell's Demon. The new stuff bumps the voltage to +/- 300 volts. This way the new stuff can be drawing current almost all the time. When you get it goin' the control circuit will buzz the pass element input just right so that the input current is a sign wave just like the input voltage. No little bumps of current. The kids used to call it good karma. Now I guess it would be politically incorrect. Whatever the saying, she'll hang in there pretty good.

A word about component selection:

Important.

Really important. As any Russian schoolchild knows, the inductor specification is critical. If you're pulling 15 amperes you should figure on a half-pounder. Next year you can trim it down. Change a few arbitrarily-chosen passive components at the same time. Throw some

jargon at the boss like "state of the art current-feedback topology," or "multi-pole finite-zero all-pass compensation network". This should nail down that merit raise. You'll already be riding high from the raise from this year's shipment of product. The pass element package is based on your bosses shirt:

- Pattern shirt: use TO-3
- Oxford shirt: use a multi-chip module
- Suit & Tie: use TO-220
- 3-piece suit: use surface mount

OK, now that the pass element package is nailed down you can figure out the flavor. First, wander aimlessly about the building. Locate the most attractive person of the opposite sex. Ask them for an organization chart. They probably won't have one, but it might help your social life. When you finally do track down an organization chart look at the money side of the company. If the bean-counters are called:

- Bookkeepers: use MOSFETs
- Accountants: use IGBTs
- Comptroller: use Transistors
- Office of Financial Planning and Resources: use MOSFETS

At this point the rest is all simply hooking up the wires. Now I can just hear all the propeller-heads kicking up a fuss and scrapping about. They'll be saying: "What a dork! He didn't even mention the control topology!" Or: "I can't believe he glossed over the switching losses!" Well, maybe so. Maybe so. Then again, the folks over at Linear Tech probably got a chip for it by now. And I'm sure the kids will be writing in telling me all the important stuff I missed. I get the lowdown without even trying. Once again, youthful exuberance is no match for experienced treachery.
Crusty McJowl, Empirical Heuristics, 3-18-92