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**Tapping Essentials - Every Machinist Needs to Watch This - Haas Automation Tip of the Day**

5 2 Comments

Like Comment

**Norman Elias** Universities should be considered teachers of theory. In my day a good radio amateur had more practical knowlege than I learned even all the way through grad school. Combine those backgrounds and you've got a wizard.

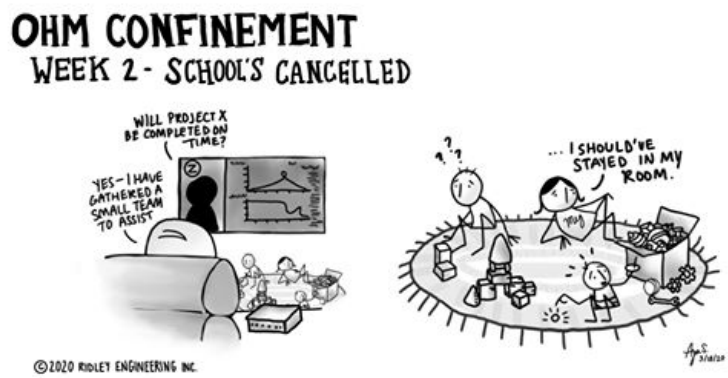
Like · Reply · 1w 1

**Norman Elias** Don't get me wrong though. I'm proud of the undergrad education I got during the days of free tuition at the City College of New York. I can teach up-to-date versions of some of those courses today out of my old textbooks and notes. Magnetics is a good case in point. The subject matter I learned is a sound basis for understanding our current discussions of proximity effects, for example.

Like · Reply · 1w · Edited

Write a comment...

**Ray Ridley**
Admin · March 18 at 10:47 PM




You, Markus F.L. and 26 others 8 Comments

Like Comment

various local, state and national governments.

Are you required to stay home?

Are you working from home or simply on leave?

How is this impacting schedules and business?

Are the increasing isolation requirements impacting your income?

Like · Reply · 2w · Edited

**Ray Ridley** Our state of CA is completely shutdown, with everyone except essentially working from home.

Many have already lost jobs.

This is going to move quickly and the effects both healthwise, and economically are going to be more profound than most people realize. I think there is still a lot of denial going on at all levels.

Ridley Engineering is taking a big hit since a good part of our business depends on training at our facility. April and June workshops are cancelled. Almost all of our attendees have opted to move later in the year rather than taking a refund - we certainly appreciate that. 😎

Like · Reply · 2w

**Ray Ridley** Does anyone else have anything to add? It's a difficult topic to face up to, but communication can help all of us.

Cisco in San Jose has extended the work at home until the end of April, that was before the state mandate. Just about all of our consulting clients are at home in various states of functionality.

I feel really bad for those in Italy and Spain who are hit so hard. This is very personal to me as my daughter is a doctor in Toulouse and she will be on the front lines.

Like · Reply · 1w

**Bruno Torremans** Here in Belgium, we are not yet in a complete lockdown, but a lot of the shops are closed. Only essential shops stay open : mainly for food and pharmacies. People have to stay as much as possible at home and avoid contact with other people. A separation between the different ages is encouraged. Older people are far more at risk then the younger. Factories aren't closed yet, but home-working is the recommendation (not yet for me). It will be difficult weeks/months all over the world.

Like · Reply · 1w

**Colin Tuck** Good ol Godzone ( New Zealand ) is basically in lock down for 4 weeks now, schools closed, only essential travel etc ... stay at home.

Like · Reply · 1w

**David Edwards** Hello Ray Ridley,

I just bought your software (retirement price). A little support for you in these hard times.

Like · Reply · 1w · Edited

**Ray Ridley** David Edwards just got your order. Much appreciated!

Like · Reply · 1w

**David Edwards** Ray Ridley, what happens now? Should I expect to receive a product key and download link via email? No hurry, just wondering.

Like · Reply · 1w

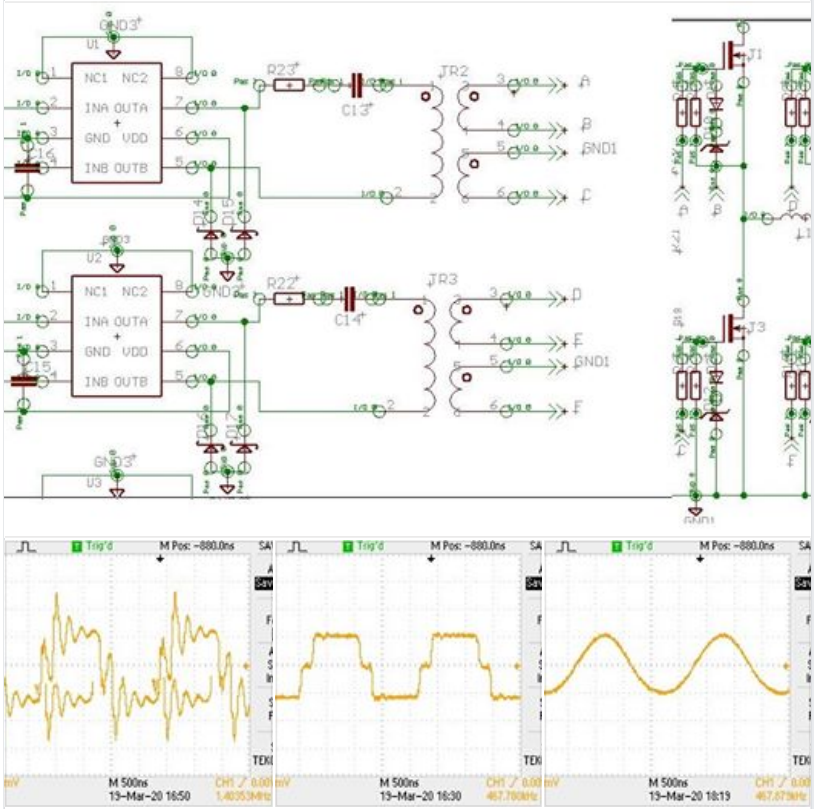
Write a reply...

**Mikail Ünal**
Write a comment...
**Visual Storyteller** · March 19 at 4:32 AM

Figure 1 - Available Schematic.
Figure 2 - The signal's of the Secondary's of the gate drive transformer. ( without the mosfet )
Figure 3 - The signal When I put a 500R resistor between the secondary's. ( without the mosfet )
Figure 4 - The signal of the secondary when i add the mosfet.

Where is the mistake , where am i doing wrong?

Thank you in advance!







9 30 Comments

Like Comment

**Jeremy Lister** C13,C14 value?
Like · Reply · 2w

**Mikail Ünal** 1uF
Like · Reply · 2w

**Ishrat Jamal** Mikail Ünal pulse transformer design and measurement details? Ex. Inductance.
Put c13 and c 14 close to 100nF. This cap is just to avoid DC component going to primary of the pulse transformers.
Like · Reply · 2w

**Alex Berestov** Leakage inductance.
Like · Reply · 2w

**Mikail Ünal** So what should be the average value to drive of the leakage?
or does it have a numerical value?
Like · Reply · 2w

way to couple windings better without compromising isolation. That usually means smaller distance between pri and sec and more or less regular winding.
b) Measure it with LRC meter.
c) Fr=1/sqrt(L*C). So if you know gate capacitance you can figure out Ls. But you need to find resonance frequency.

Like · Reply · 2w · Edited

**Yuri de Klerk** R22, R23 value?

Like · Reply · 2w

**Mikail Ünal** Yuri de Klerk 3Ohm's

Like · Reply · 2w

**Ray Ridley** there are a lot of missing component values.

back to back zeners are the norm - you have a diode and a zener.

Like · Reply · 2w

**Ray Ridley** transformer design is key. You can't just grab any transformer off the shelf.

half the schottky clamps are missing on the drive pins.

Where did this design schematic come from?

Like · Reply · 2w

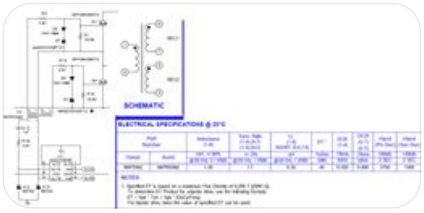
**Mikail Ünal** Ray Ridley i did this take from ucc28950's datasheet also there are too many design's with this circuitry but it's true that i've take it from the grab:)

Like · Reply · 2w

**Riccardo Tinivella** Did you try with a capacitive load also? Cgs+Cgd with miller effect loads the drivers capacitive

Like · Reply · 2w

**James Keith** May be this can help you. I found this from TI's reference board schematic ( 600 W PSFB design )




Like · Reply · 2w · Edited

**Mikail Ünal** Thank you sır , do you know what the LL , Hipot means?

Like · Reply · 2w · Edited

**Roswell Bob LaFrank** I have used binocular cores well into MHz region

Like · Reply · 2w · Edited

**Roswell Bob LaFrank** There is no mistake. These waveforms are exactly what you should expect given the loads that you are driving. You have a resonant gate drive circuit. The reactance of the transformer is playing with the capacitance of the mosfet to give you a nice sinewave. You should be looking at a lower inductance transformer design if it bothers you. I am basically repeating what Alex Berestov said with two words.🙂

Like · Reply · 2w · Edited

**Bob Gudgel** I was thinking that it was resonant also. I normally add capacitive coupling to the secondary and then diodes/zeners at the G-S of the FET

Like · Reply · 2w

Like · Reply · 2w · Edited

**Mikail Ünal** Also today , adding a 100R resistance load on the drain of the mosfet with giving 30V between Drain and source i saw that there 0.1A was going but at the second test there was nothing i dont know i think that i need to design a pulse transformer..

Like · Reply · 2w

Write a reply...

**Ray Ridley** You have gone quiet, Mikail Ünal. Any follow up? Always nice to find the resolution of these issues for everyone.

Like · Reply · 2w

**Mikail Ünal** Sır i was to busy today cause if this board .I was in the morning today and tried to test it.(testing only the drive circuit and 1 mosfet not with the other components)
I added 100R resistor to Mosfet's drain and source and gave 30V voltage. the current was flowing with 0.1A, but it only happened for a while, and that D-S voltage was just fine.
It was not logical to apply a different method since I also drew my circuit board, so I was bored a lot, I still couldn't understand why it wasn't going to happen, I will either wrap a transformer myself or drive it with a different method ?? Time will show..

Like · Reply · 2w

**Ray Ridley** As with all transformers, we start here:

1) sweep the open-circuit impedance (magnetizing and capacitance)

2) sweep the short-circuit impedance (leakage)

This is basic transformer knowledge that they have been doing for 100 years. Don't forget to test your transformers this way.

**Like** · Reply · 2w

**Yuri de Klerk** The switching frequency is very high: 467kHz. You really need to know what you 're doing here (or someone). What is the leakage inductance of the gate transformer?
What is the gate capacitance of the Mosfet's (what Mosfet?)
Did you buy these gate transformers ? For what switching frequency is it specified?

Like · Reply · 2w · Edited

**Mikail Ünal** Yuri de Klerk thank you for giving this advise, do you have a reference design or a example for gate drive transformers?

Like · Reply · 2w

**Ray Ridley** Yuri de Klerk at this frequency it may well have to be custom designed.

Like anything, if you know what you are doing it's easy. (Come to a workshop).

Check Renco for OTS options.

Like · Reply · 2w

**Yuri de Klerk** Best is to follow Dr. Ridley's advice. Also James Keith 's 56P3362 from Vitec seems not bad. But depending on the size of Mosfet's you might need additional circuitry to drive them.

Like · Reply · 2w

Write a reply...

What is needed is very low leakage L and low Z drivers at the edge frequencies ...

If you have gate drive power to burn you can put 470E across all the gate drive windings to damp the ckt ...

Like · Reply · 2w · Edited

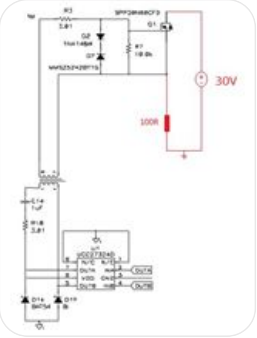
**Roswell Bob LaFrank** Binocular cores are very nice low-leakage coupling, but I think somebody already mentioned.

Like · Reply · 2w

**Mikail Ünal** thank you Roswell Bob LaFrank I will consider this suggestion's.
If this is the signal that is expected to occur, what do you think I had problem driving the one mosfet?
yesterday i've tried this circuit below. but there was no current..

ok I definitely understood that I should drive with a transformer with lower leakage inductance, no doubt in it. I just didn't know it was such an effective thing.

thank you again.




Like · Reply · 2w · Edited

**Roswell Bob LaFrank** Actually where you are switching at a ring core would work nicely. I don't recall the isolation voltage requirement, but if you can wind closly in a trifilar manner I think you

**Colorado Mike Doherty**
March 19 at 8:51 PM

With the rash of domestic shutdowns, does anybody have a source of quick-turn, low volume PCB's that is still up and running? Thank you in advance.

1 | 10 Comments

Like | Comment

**Ken Wyatt** Try Chris Schroeder at slingshotassembly.com in Denver. We just connected on LinkedIn today and he's looking for pcb work. Tell him Ken sent you.

SLINGSHOTASSEMBLY.COM
Home - Slingshot Assembly Quick Turn PCB Assembly Experts: SlingShot…

Like · Reply · 2w

**Colorado Mike Doherty** Thanks! I'm up here outside Fort Collins.

Like · Reply · 2w

**Veda Prakash** Ken Wyatt thanks. We were looking for a quick turnaround PCB vendor as well.

Like · Reply · 2w

**Ken Wyatt** Veda Prakash sorry, thought his shop did both.

Like · Reply · 2w

Like · Reply · 2w

**Veda Prakash** Ken Wyatt we contacted them, looks like they do both. Sorry if I implied otherwise in my previous message. Thanks again.

Like · Reply · 2w

Write a reply...

**Andrew Ferencz** pcbway.com

PCBWAY.COM
China PCB Prototype & Fabrication Manufacturer - PCB Prototype the…

Like · Reply · 2w

**Lucas Sturnfield** Jlcpcb.com - out of china, but still running and shipping

JLCPCB.COM
PCB Prototype & PCB Fabrication Manufacturer - JLCPCB

1

Like · Reply · 2w

**Christopher Compton** Lucas Sturnfield the best..

Like · Reply · 2w

Write a reply...

**Kyle Miller** Pcbway.com and JLCPCB.com are both up. I had stuff delivered this week

PCBWAY.COM
China PCB Prototype & Fabrication Manufacturer - PCB Prototype the…

Like · Reply · 2w

Write a comment...

**Charlie Elliott**
**Conversation Starter** · October 13, 2017

1kW PSFB ZVT converter 97.5% efficiency at full load - achievable or "research project"? (Duplication of post on LI)

We have been asked to consider redesigning a design we did 2-3 years ago for a 1kW PSFB ZVT converter to improve it's efficiency. The input voltage range is 120V DC off-load which droops to around 80V worst case at full load. The output voltage is fixed at 400V DC. We are achieving 95-96% efficiency from 75% -100% load. To get there we have used SiC output diodes to reduce secondary diode snubbing. The target is to increase efficiency by 1-1.5% which looks like a big ask with the existing topology. I would welcome any insight this group may have as to whether they agree. Should we be considering an alternative topology to achieve our goal and if so what that would be

12 101 Comments

Like Comment

Existing system is full bridge output diodes with 200V 20mOhm TO220 Fets on the inputs, ETD59 transformer using the leakage as the "resonant" inductance and sendust output choke. 30kHz operation for a combination of reasons but this could change if required. I am quite space constrained. LLC has of course been suggested!!

Like · Reply · 2y

**Casper Hjort Wilson** GaN FETs?

Like · Reply · 2y

**Charlie Elliott** I could do but the losses in the input FETs are pretty low already and there are conventional Si parts now available with 12mOhm RDSon so ....

Like · Reply · 2y

**Casper Hjort Wilson** Lower switching losses..?

Like · Reply · 2y

**Charlie Elliott** Switching losses are already quite low due to the PSFB ZVT but yet it would probably help a bit and especially so at lower loads when we do start seeing switching losses.

Like · Reply · 2y

Write a reply...

**Colin Tuck** Well, where are the losses currently? Tx? o/p diodes still? housekeeping circuitry and assoc psu? this info is paramount to intelligent loss reduction...

Like · Reply · 2y

Hide 16 Replies

**Charlie Elliott** Despite using SiC output diodes, we still have appreciable snubbing losses - around 8W. The SiC diodes themselves almost doubled the conduction losses vs the original Si diodes but it was an overall improvement due to significant drop in snubbing. Losses in the 4 SiC diodes are around 10W. The transformer is also going to get a good revisit as I suspect that there is more AC loss in the windings that there should be. We are using foil for the primary at the moment resulting in more "layers" than I would like. There is a bit of history there as the customer spec has changed many times. Originally this was full power at 40V design.

Like · Reply · 2y

**Colin Tuck** Oh kay, you need slower transitions on the switching edges to reduce the hit on the diodes, thus caps across the fets ~ 10nF or bigger, and suitably sized series L on the Ph shift full bridge, with perhaps a gap in the Tx to increase energy storage for the transitions here too...

Like · Reply · 2y

**Colin Tuck** Fet turn off, as seen at the gate should be 12V to 0v in <40nS to get mostly lossless turn off...

Like · Reply · 2y

**Colin Tuck** IN PhSFB the pri current is always in the Tx so the Cu has to be sized for this...

Like · Reply · 2y

overcome by having a 1:20 tap on the o/p choke, the B-rect goes to the tap, a diode goes from the LHS (close to tap) to gnd (anode to gnd) and the RHS of the choke goes to the filter cap, this way when the Tx is shorted by the bridge the o/p current flows only in the o/p choke and one diode only (the added one) the rectifying diodes are slightly reversed biased, aiding (reducing) switching losses for the next power pulse...

Like · Reply · 2y

**Colin Tuck** I'm pretty sure Colonel MClyman invented this very useful technique ...

Like · Reply · 2y

**Charlie Elliott** Colin Tuck - Agreed we should look at slowing the transitions again. In the past we have tested with added caps and additional resonant L but then turn off losses were killing us. However that was when we were down at 40V so certainly worth looking at again.

Like · Reply · 2y · Edited

**Charlie Elliott** Colin Tuck - The tapped output inductor idea sounds interesting. Certainly not looked at that before. I hope it isn't patented!!

Like · Reply · 2y

**Cameron Stewart** I would recommend replacing the copper foil with LITZ wire.

Like · Reply · 2y

**Charlie Elliott** Cameron Stewart - Yep already high on the list😉

Like · Reply · 2y

**Colin Tuck** Not sure if it was ever patented - I suspect not - been in public domain for >30 years I think ...

Like · Reply · 2y

**Lotfi Bgh** how much core losses do you have?

Like · Reply · 2y · Edited

**Yurii Shynkarenko** Colin Tuck I am agreed with Colin Tuck. Increasing diameter or sq.mm of the primary in twice will reduce copper losses. There is an additional current of a freewheeling period when the primary is shorted and heating. It is the main disadvantage of PSFB topology.

Like · Reply · 2y

**Charlie Elliott** Yurii Shynkarenko - Changing from foil to litz on the primary will probably reduce losses overall due to reduction in AC component despite the poorer fill factor. However straight increasing the size of the wire on primary without looking at secondary as well isn;t a good idea I am sure you will agree. My transformer is already quite full.

Like · Reply · 2y

**Charlie Elliott** Lotfi Bgh - Calculations say core loss is about 5W at 100 deg. C taking into account the first few harmonics of flux.

Like · Reply · 2y

**Lotfi Bgh** If you don't mind increasing your core size, you can consider reducing the current ripple ratio. This way, you decrease the magnetic field swing and the core loss and also the coil AC loss. You will get higher DC loss though but maybe lower than the actual overall inductor loss.

Like · Reply · 2y

Write a reply...

Like · Reply · 2y

**Magnus Rosén** Hmm ... indeed a great task. Efficiency from 95% to 97.5% mean to slash the losses by half. From 50W to 25W.
Agree that its wise to start invedtigste the options where losses are pretty large. Tx, Rec and houskeeping
(Sorry for not bringing any improvement idea for the time moment)

Like · Reply · 2y

**Erhan Demirok** you may consider to use synchronous rectification at the secondary with center-tapped xtr

Like · Reply · 2y

**Dave Lafferty** Can you use an active snubber to return some of the power back to the rails?

Like · Reply · 2y

**Charlie Elliott** ☕ Ray has already suggested that and I agree that it is a good idea to look at.

Like · Reply · 2y

**Stephen Berry** Nonlinear Coss with voltage can cause commutation problems in the PSFB. Consider other MOSFET options.
Definitely dump the foil transformer primary it's capacitance and ac resistance will cause problems.
Why did you use sendust for the output choke?

Like · Reply · 2y

**Charlie Elliott** ☕ Re sendust, for packaging reasons we needed to use height but not PCB area which pushed me towards a toroid. Sendust met the cost and size requirements very nicely. There are lower loss solutions out there of course and it may be I need to revsit the output choke but it is a little way down the list.

Like · Reply · 2y

**Cameron Stewart** My thinking parallels Colin Tuck's in that you need to make a "power loss budget" for the entire converter.

That means coming up with accurate power dissipation numbers for your various switching and conduction losses for all your components (easier said than done) and then looking at what can be improved -spreadsheet wise - to meet your goal.

As far as LLC, another alternative is straight series resonant under phase shift full bridge control.

Like · Reply · 2y

**Charlie Elliott** ☕ Hi Cameron, thanks for the reply. Series resonant under phase shift control is something I have never considered. Presumably it still requires an output inductor or am I missing something?

Like · Reply · 2y

transformer and rectifiers directly drive the output capacitors with sinewave resonant current.

To be honest, I haven't done series resonant under phase shift control yet. When I have time, I want to build a Spice simulation to explore the concept.

The series resonant inductor runs HOT due to core loss from high AC flux. The primary peak currents are also much higher. Getting current limit and voltage regulation to work properly is a control problem not to be taken lightly. Unlike you, my approach implementation would use analog control rather than digital.

With a 200V winding and a voltage doubler on the output directly driving the capacitors, the diode snubbing problem would be eliminated. A full wave rectifier bridge using a 400V winding is also feasible.

Changing power stage topologies means a brand new development curve for both power and control. It's better to slightly tweak a design that already works when you can. A new power stage topology is something to consider when you have finally run out of maneuvering room with the existing approach.

Like · Reply · 2y · Edited

**Cameron Stewart** LLC has cost reduction advantages because you can use a half bridge rather than a full bridge. Again, the inductor is on the primary, delivering sinewave resonant current direct to the output capacitors from the transformer and rectifiers.

There are plenty of analog control chip solutions already in place. I don't know how well established digital control is with LLC. It sounds like a potential development headache without proven code already in hand. You are also at the upper end of power level or beyond for LLC at 1kW.

Like · Reply · 2y · Edited

**Charlie Elliott** ☕ Cameron Stewart - Re series resonant FB with phase shift and no output inductor, I just remembered that we inherited a 25kW system with that topology to try and fix a little while ago. The company who were developing it were struggling in many areas. My initial concern as to how well it could be controlled was sadly proved true. Even combining limited variable frequency modulation with phase shift control we could not achieve the required output voltage and load range required for the application (EV DC fast charge). As a result the project was canned. Never got the opportunity to investigate whether they just had the turns ratio and LC values / frequency wrong.

Like · Reply · 2y · Edited

**Charlie Elliott** ☕ Cameron - digital control for LLC doesn't worry me. Already have that developed and in many ways allows the kind of flexibility in control required to cover everything. You do have to make sure you have sufficient timing resolution of course especially on higher power systems or else 1 bit change can get scary!! Going for LLC will be a last resort as far as I am concerned as it will be a start from scratch. We will go after the low hanging fruit with PSFB with the existing PCB and control first and see where that takes us.

Like · Reply · 2y

**Cameron Stewart** With series resonant topologies: You need to get a working simulation first as proof of concept before you build hardware.

Turns ratio and input voltage range are critical with the series resonant topology. If the input voltage range varies by more than +/-10% it is prudent to use a pre-regulator in front, thereby impacting efficiency to achieve proper control.

Like · Reply · 2y

about as high as I have ever designed for.

Like · Reply · 2y

**Colin Tuck** Phase shift series resonant is in fact quite useful, we once did a 14kW, 3.5kV input to 350VDC (40A) using this, 85kHz, worked first time and made several units for the Navy, had to be very compact, hence very low switching losses and no snubbers anywhere...

Like · Reply · 2y

**Cameron Stewart** Colin Tuck: A very impressive accomplishment on your part.

Like · Reply · 2y

**Cameron Stewart** If I had to do it today, I would use recirculating clamp diodes for instantaneous peak current limiting and average current mode control for the control loop.

Just a guess on my part until I construct a simulation model.

Like · Reply · 2y

Write a reply...

**Alex Berestov** Series LC not mentioning LLC will deteriorate all other specs. However, filter starting with a capacitor and not the inductor will provide ZVS/ZCS at the rectifiers' diodes. That said the next logical step would be DAB. It's probably as complex as active non-dissipative snubbers with power recovery. But this means that you have to redesign the whole thing from ground up.
Vicor's approach is even more complex: ZVS preregulator plus unregulated self-oscillating series LC with synchronization (some kind of PLL). Two stage conversion is not that uncommon and is widely used in AC-DC converters, especially at higher input voltage (660 three phase).

Like · Reply · 2y

**Colin Tuck** With say 200- 250nS transitions times, 50kHz should be an easy freq to operate at and not hit the diodes too hard, a Tx with layered litz should get the Tx losses down to under 4W total without too much difficulty - we get 4W for our 1.5kW PSFB at 48V out (385VDC in) in an ETD44 at 125kHz ( 3C96 ). Getting good low loss 1206 caps across the fets is the key, along with very strong pull down on the gate drive to eliminate turn off losses...

Like · Reply · 2y

**Yurii Shynkarenko** Hi Colin,
"4W losses for an ETD44 at 125kHz ( 3C96 )" - It`s mean that a TX temperature is raised up to 80-90C degree if there is no fan. Am I right? What TX temperature did you get without a fan at full load?

Like · Reply · 2y · Edited

**Colin Tuck** We never measured the Tx temp without the fan running - sorry.

Like · Reply · 2y

**Charlie Elliott** Thanks everyone for you helpful comments and in particular Colin Tuck for the useful real-world reference points. As I was already aware and several of you have pointed out, ditching the foil in the transformer is probably priority 1. I will also consider a lift in frequency but need to look at the control as it is digital and I am concerned about timing resolution.

Like · Reply · 2y

**Charlie Elliott** If I were to consider a resonant design, one concern I have is the cost and reliability of the capacitance required given the power and voltage. Rough calculations suggest the cap would carry around 20A. Would anybody have any recommendations for parts to consider?

Like · Reply · 2y

expressly designed for this application.

Like · Reply · 2y

**Colin Tuck** Don't give up on phase shift just yet...! We design a lot of resonant converters, and yes the pri side caps need to carry large currents in your design, but a new lower leakage, lower loss Tx and slower transitions, should bump up your efficiency without massive engineering input...

Like · Reply · 2y

**Charlie Elliott** I have certainly not given up on the PSFB. I would have to be very confident that an alternative topology would get us where we need to be before going down that road.

Like · Reply · 2y

**Nigel Springett** For high efficiency, optimise the trafo for low ac losses and good coupling, and use an extra inductor for the commutation.

Like · Reply · 2y

**Charlie Elliott** Nigel Springett - you raise and interesting point. Will having an external inductor always give higher efficiency? Is there a difference as far as the secondary diode snubbing between the two cases?

Like · Reply · 2y

**Nigel Springett** using extra inductor allows the traof to be optimised for low losses, this usually means interleaved windings and low leakage inductance.

Like · Reply · 2y

**Cameron Stewart** Consider using a current doubler to reduce copper losses and snubbing losses.

Like · Reply · 2y

**Colin Tuck** A current doubler also doubles the voltage seen by the diodes - so at 400VDC out - perhaps not so good...?

Like · Reply · 2y

**Cameron Stewart** No worse than a center tap configuration. Full wave bridge has the lowest voltage stress.

Like · Reply · 2y

**Colin Tuck** Indeed 400V a lot easier for diodes to deal with than 800V+ and lower RFI to heatsink too...

Like · Reply · 2y · Edited

**Charlie Elliott** Current design is FB diode rectifier due to 400V DC out and the 50% swing on input volts dictating turns ratio.

Like · Reply · 2y

Write a reply...

**Ray Ridley** It depends on how well the eternal inductor is built!

Like · Reply · 2y

**Charlie Elliott** Was "eternal" a deliberate slip or Freudian?

Like · Reply · 2y

**Colin Tuck** perhaps referring to one built by Michael Faraday...

Like · Reply · 2y

- litz, high performing ferrites, etc, given they managed to design so much that worked without our modern tools for measurement - even measuring 50kHz much have been a reach back then... (apologies for the aside)

Like · Reply · 2y

Write a reply...

**Yurii Shynkarenko** Colin Tuck Colin, please, an interesting question still hangs in the air.
The 4W losses in an ETD44 mean that a TX temperature can raise up to 90C degree if the inverter has no the fan, isn`t it?
What TX temperature did you get without a fan at full load of your 1.5kW PSFB base on an ETD44?
The 4W TX losses are good, but still not enough for high reliability. In that case, the fan is the only hope for the reliable work, isn`t it?

Like · Reply · 2y

**Colin Tuck** yes, it was a fan cooled unit as only 1 U high and 4 across a 19" rack ( 1U = 44.45mm, but unit height actually 42.45mm to allow for rack shelving etc) 4 units wide across a rack is a weird number - as three phase supply is difficult to balance this way - but customer is always right so ... sigh ...

Like · Reply · 2y · Edited

**Colin Tuck** @ Yurii, while 4W might seem high to you for an ETD44, if it is in an enclosure with holes in the right places giving convection airflow at full power - hot spot Tx temp can be lower than 90C in a 30C ambient.

Like · Reply · 2y

**Yurii Shynkarenko** Colin Tuck Colin, thank you for the reply.
I know.. a customer is always right ...

Like · Reply · 2y

**Cameron Stewart** The customer is always right ...
.....until it comes to custom power supplies ....

Like · Reply · 2y

**Yurii Shynkarenko** Colin Tuck Colin, Would you give us a link --" useful technique invented Colonel MClyman".
Thank you in advance.

Like · Reply · 2y

**Colin Tuck** you can easily google the name + tapped inductor.

Like · Reply · 2y

**Yurii Shynkarenko** Colin Tuck OK, Colin, Thank you.

Like · Reply · 2y

**Yurii Shynkarenko** Colin, thanks! Colonel MClyman is the genius!
Useful technique invented Colonel MClyman here:
http://citeseerx.ist.psu.edu/viewdoc/download...
Conclusion:
The use of the tapped, output inductor and its benefits have been shown for both the push-pull converter and the single-ended, forward converter. There is very little to add to get exceptional circuit performance. The author incorporates the tapped inductor in all designs, when feasible. The performance of a converter, using the single or push-pull magnetic amplifiers, can also be improved with the tapped inductor.

Like · Reply · 2y · Edited

**Colin Tuck** you may need a snubber or two to limit overvolt spikes on the diodes, the main diodes now have a slightly higher reverse PIV, but certainly a useful ckt. Can be used in just about any choke input filter ...

Like · Reply · 2y

Like · Reply · 2w

**Ray Ridley** This is an oooold post. But i'm curious too.

Like · Reply · 2w

**James Keith** Dr. Ray: Before I posted my question, I searched for PSFB in this forum. This question was really helpful in understanding the PSFB concepts and the challenges.

Like · Reply · 2w

**Col Johns** PSFB can be very efficient at full load, at lower loads the circulating current in the Tx and mosfets drags the eff down, comparable to LLC ( which is also most eff at full load )

Like · Reply · 2w

**Charlie Elliott** FYI we dodged the bullet on this in the end. We ended up putting the effort intro the downstream converter to get the overall efficiency up. In this respect we were sucessful and got a good overall efficiency improvment for a given $$ (both design and part cost). If we were to revisit this then I am pretty sure we would go back to Si output diodes and use an active snubber. That would give the biggest overal gain in efficiency for modest effort. We have tracked the PCB for a plug in card so we can explore different active snubbers if our customer wants to fund the development in the future.

Like · Reply · 2w

Write a reply...

**George William Tyler** Same spec as a design I did in the mid '80s for a sine ups. I used a weinberg converter on the input and 1/2 bridge output, transformer was a 36mm toriod.

Like · Reply · 2w

**Alex Berestov** What's the point of necroing?
Weinberg will not do. Something like sine amplitude could. Still, quite an engineering feat.

Like · Reply · 2w · Edited

**George William Tyler** what is "necroing".?

Like · Reply · 2w

**Col Johns** internet speak for digging up an old thread ... ( refer necrotic )

Like · Reply · 2w

**George William Tyler** Weinberg was good for high currents due to overlapping conduction of the FET switches. Also, as it is current fed, ripple current on the input side is low so easy on capacitors. actually, i just came across the prototype in my junk! can post a picture if you like? Of course, it was not called weinberg then...

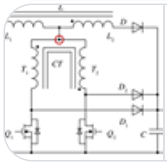
YOUTUBE.COM
Record CEO Quittings & Insider Dumplings to bring one World…

Like · Reply · 2w · Edited

**Col Johns** Overlapping Weinberg has been made to very high powers and very high efficiency - it has many advantages if the designing engineer can understand the operation well.
It is gaining new life in high power fuel cells where the input volts are low but currents are high.

Like · Reply · 2w · Edited

practical bits ) article on the Weinberg - it is VERY instructive:
https://onlinelibrary.wiley.com/doi/full/10.1002/tee.22764



ONLINELIBRARY.WILEY.COM
Research on the optimal design of weinberg converter

Like · Reply · 2w

**Cameron Stewart** Col Johns

I have an overlapping boost Weinberg set up in Spice with zero current switching, a resonant snubber network, peak voltage snubbing, and recirculation of the clamped leakage energy to the output.

Theoretically, it allows the Weinberg to function in 440VAC three phase power factor correction and isolation applications, using 1200V silicon carbide devices, when all three phases are connected line to neutral.

All I need it is to find a job to sell so I can build it. I've done a Weinberg three phase PFC three times before with passive snubbing and up to 92% efficiency in 220 VAC applucations.

The recirculating peak snubbing and zero current switching should improve that by 2% to 4% and also reduce the peak voltage stress on the push-pull mosfets.

It's the peak voltage stress and efficiency loss as a result, that is the Achilles heel of the Weinberg.

I don't know if this approach will help Charlie reach his goal of 97.5% with 120 VDC input voltage, but it might.

Like · Reply · 2w · Edited

**James Keith** Col johns : Can you please give an idea about this converter's power range and input voltage range? I have recently heard about this converter. Is it famous? For example : LLC and PSFB are quite famous and heavily used for 400 V DC bus or 800 V DC bus (where Qrr, Coss of the mosfets can cause problems). How about Weinberg?

Like · Reply · 2w

**Cameron Stewart** I've done 4KW with the three phase Weinberg, or 1300W per phase. Higher powers are theoretically possible.

It's the peak current and voltage stresses that set the maximum power limitation.

Like · Reply · 2w

**Col Johns** James Keith because its a push pull the mosfets see twice the Vin ( + spikes for a poor implementation ) so lower voltage apps are preferred - 1700V SiC allows 800V pk on Vin ..!

Like · Reply · 2w

Write a reply...

**George William Tyler** This is the prototype weinberg.

Love · Reply · 2w

Like · Reply · 2w

**George William Tyler** Col Johns that was 1kW, I made 12V, 24V and 120V versions. The overlapping drive wS a problem, I used cmos logic ics

Like · Reply · 2w

**Ray Ridley** Love it - Ship it!

Like · Reply · 2w

**Colin Tuck** Ray Ridley - spoken like a true sales exec...

Like · Reply · 2w

**George William Tyler** Ray Ridley we did sell a lot. Started out for a true sine ups, then a 48V telecom supply for power ubltilities. Could not make it now to original design as its all through hole, designed before surface mount components. It was really efficient, ran cool.

Like · Reply · 2w · Edited

Write a reply...

**Ray Ridley** to be a true vintage Weinberg, shouldn't it have bipolars instead of MOSFETs?

Like · Reply · 2w

**Col Johns** Oh, c'mon ....

Like · Reply · See Translation · 2w

**Alex Berestov** Preferably germanium, to lower conduction losses. Diffusion type.

Like · Reply · 2w · Edited

**Cameron Stewart** I've had discussions with vintage solid state audio guys on other Facebook forums, almost obssessed with the mystique of germanium transistors.....

Like · Reply · 2w · Edited

**Alex Berestov** This reminds me magnet wire from WWII equipment, preferably of German origin. craze.
In regard to Ge transistors they do switch differently. Modern Si drift type BJT will die immediately if inserted into Permalloy transformer Royer, like one in your old battery powered photo flash lamp.
Cheers!

Like · Reply · 2w

**Ray Ridley** Pretty funny.

Like · Reply · 2w

**Yuri de Klerk** Interesting. I've known this converter as Clark (or Clarke ?) converter studying it in the 90's. Is it different or am I wrong ?

Like · Reply · 2w

**Cameron Stewart** Yuri de Klerk

Weinberg took P.W.Clarke's original patent from 1976 and modified it into a transformer isolated buck-boost converter. This is now the preferred implemention.

The Clarke converter has the catch winding on the input boost choke return energy to the DC INPUT during non-overlap conduction mode.

The Weinberg has the catch winding on the boost choke deliver energy to the OUTPUT during non-overlap mode.

Like · Reply · 2w

Write a comment...

**Michael Delany**
March 20 at 7:24 PM

I'm looking for some suggestions on how to approach a power conversion problem. How would you approach these requirements?

Input Voltage: 90VDC - 150VDC
Output Voltage: 270VDC
Output Power: 2kW
Cooling options: Fan + Liquid-cooling (can design custom enclosure)
Isolated: Yes
Ambient Temperature: 40C

The enclosure is 10" x 6" x 4". I'm still working with the customer on finer detail for this, but what would be everybody's go to solution?

My first thought is a boost converter followed by a full-bridge topology, but I've also run into current-fed full-bridge boost converters which seemed to be used in bidirectional chargers.

Any experience stacking low-voltage output power bricks in series + Input/Output filter on these?

Thanks in advance.

2 5 Comments

Like Comment

**Roswell Bob LaFrank** Full bridge phase shift. Air cooled. No boost converter. Can squeek it into the dimensions no prob with fan considering only 40c. EMI filters will be challenge in the package, but you will be switching at 400kHz or so. No?

Like · Reply · 2w · Edited

**Col Johns** A simple boost converter ( 70kHz ) for non-isolated

200kHz, half bridge resonant for isolated, all ZVS, just conduction losses - planar Tx, no o/p choke just caps....

Like · Reply · 2w

**Michael Delany** Col Johns never done a planar transformer. Are they more or less expensive than a standard one?

Like · Reply · 2w

**Amit Singh** Current fed full bridge boost looks good for this power and voltage

Like · Reply · 2w

**Manu Raj** Are you looking a design for 270V 2kW system??

Like · Reply · 2w

Write a comment...

Hi,

This week we have been battling with GPIO output glitch of our MCU during MCU startup,

the GPIO is used to control pre charge relay that is connected in series with our PFC inductance...resulting in inrush current with boom boom fire...

*Our MCU is TI TMS320F28035

Any suggestion on how to solve it?

2 41 Comments

Like Comment

**John Baillie** What is the exact signal chain? I presume the MCU is driving a transistor or relay driver? Pull-downs/ups and RC filters are your friend here!

Like · Reply · 2w

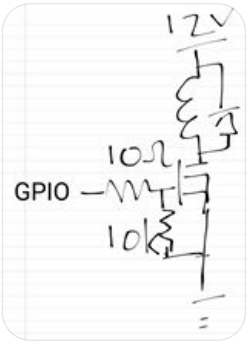
**Arief Noor Rahman** Correct...hand drawn sch below

Like · Reply · 2w

**Yassir Nadir** it will be better if you can show us the circuits from the MCU to the final element...

Like · Reply · 2w

**Arief Noor Rahman**




Like · Reply · 2w

**Yuri de Klerk** I'm not sure about the TMS320 but several controllers have their PWM outputs in a defined state even during starting-up. Maybe GPIO is different and you should move to a PWM ?
I suppose you can invent a circuit which waits for some time until you're sure the controller is initiated, but for sure it can be solved inside the ( a ) controller.

Like · Reply · 2w

**Arief Noor Rahman** Hmm...interesting thought, perhaps PWM pin have better startup behavior

Like · Reply · 2w

**John Baillie** Yeah try and solve and the root but always a good idea have an rc filter on the gate of your transistor.

Like · Reply · 2w

**Arief Noor Rahman** We have planned on this approach, we will test it tomorrow...

In the meantime, i am looking for alternative perspective or somebody elses past experience

Like · Reply · 2w

**John Baillie** Arief Noor Rahman just make sure the transistor doesn't stay in the linear region long enough to heat up as the gste voltage increases... you don't need to the speed so the filter can be slow.

Yuval Iz Debug the software startup step by step to see when the glitch happens,
that way you will be able to know whether the problem is a form of software (bug in startup code) or hardware (worse to debug if it is a silicone problem)

Like · Reply · 2w

Write a reply...

**Broox Le** If you are 100% sure the glitch is from the I/o line, is it digital in nature - definitely driving a value you don't want, or analog in nature as in an unexpected spike?

If digital, be 100% sure your initial startup code technique is correct, 1st set desired internal pull-up/downs, set input/output registers, then enable output drivers. Coders often forget to set output register data to a known state before enabling the output driver. Also make sure your power on reset circuit function is intentional & well defined and your MCU power rail rise is monotonic. Make sure your power and ground integrity is solid and that you don't have surges on other I/o line(s) that might be producing a glitch on this one.

Like · Reply · 2w

**Arief Noor Rahman** ☕ ah, that's a very plausible culprit, i will check this and get back to you tomorrow after testing...

Like · Reply · 2w

**Arief Noor Rahman** ☕ Oh...the troubling GPIO pin glitch has digital nature

Like · Reply · 2w

**John DeFiore** I haven't looked at your specific flavor of the TMS320, but in general with this family some of the GPIOs on the part will default to having a pull-up enabled on power up, and some of them default to floating. So if you need it to be high on power up you can select the pull-up

Like · Reply · 2w

**Michael Delany** I posted a similar response without reading your answer first (but I think you're correct). These parts appear to have a very strong pullup unless I misread the datasheet. STM32 for example are around 50-60kohm, so putting a 10k works, but a 100kohm wouldn't. Double checked the datasheet and you're correct.

Like · Reply · 2w

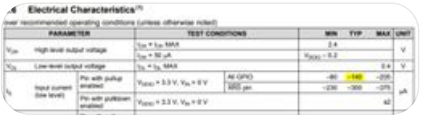
**John DeFiore** version, and if you need it to be low you can select the floating GPIO and add a pull-down resistor. (Or use either but overpower the pull-up.)

Like · Reply · 2w

**Michael Delany** Are you positive the pull down is 10k? The default for this chip is a digital input with pull ups enabled. You might be creating a voltage divider depending on how strong the pull up is. You could try 1kohm and see how that works. Did you measure across the pull down resistor to see if it's creating a divider?

Like · Reply · 2w

**Michael Delany** It looks to me that your pullup is this 140uA which would equate to about 20kohm equivalent resistor. Maybe this is putting 1/3 of VDDIO on the gate of your FET. I still think changing the pulldown resistor to 1kohm is a good test.


Electrical Characteristics

Like · Reply · 2w

Haha · Reply · 2w

**Broox Le** Until you discover some kind of fundamental design limitation.

Like · Reply · 2w

**Broox Le** Crazy story: my first 'real' engineering project out of college was to debug a new industrial motherboard update where the primary change was that they updated the 'Wintel' chipset to the latest rev from the same vendor...and the problem was OS/2 would periodically hang at seemingly random times. I poured over that thing for weeks, had to buy books about PC-AT system architecture because they didn't teach that in college, couldn't find any signal or power integrity issues, kept asking the chipset vendor what things they modified from the previous version and they insisted 'nothing really changed, other customers are having no problems, this is in full production' [and the boss thought this would be an easy project for the new guy] No other test software or operating systems were having a problem. I finally got ahold of a really helpful guy at IBM who offered to do a remote kernel debugging session.....after playing around with it for a while and getting it to hang a few times, he said, "huh, the timer tick interrupt has stopped - that's what triggers the preemptive task switching.' That gave me a direction and I found a flaw in the chipset's interrupt controller implementation such that if two particular interrupts occurred under another particular condition, the controller would latch off the real-time-clock interrupt and stop responding to it - hardware bug in the chipset unfixable by software. EXCEPT, this was an STD bus CPU card of our own design (Pro-Log Corp) and they had a common practice of putting a Xilinx FPGA on board to do some other bus arbitration and external interrupt prioritization; we were able to use the on-board FPGA to implement a digital filter to prevent the particular timing condition that would lock up the chipset's interrupt controller. The FPGA code resided in an on-board serial EEPROM and was changed with a field system BIOS firmware update.

So, we worked around a bad fixed hardware flaw with programmable hardware that was there. 🙂

Like · Reply · 2w

**Ray Ridley** Of course the modern processors don't have any latent little bugs like this.....

Like · Reply · 2w

**Arief Noor Rahman** not exactly, there are always silicon errata...and newer processor sometimes plagued with unknown bug...

so, older device could actually be better since all bugs are well known...

I have one helping a company for their ADC weird measurement, which turned out is caused by somehow the ADC cannot measure from 0~3.3V stated in datasheet, but limited to 0.5~3.3V

thus at that time, the quick fix is just shift the signal, and reduce the signal gain

Like · Reply · 2w

Write a reply...

From memory, as the controller started up, the GPIO went from high impedance to low impedance, both at high rail and low rail, before settling back to high impedance again. In our application, it turned on an entire bank of several hundred LEDs which were only ever supposed to have 10-20 lit at once and so browned out the supply, meaning we could never get out of reset.
Now, whenever there are any pins that absolutely cannot handle glitches during power on then I either filter them aggressively enough that the glitch won't be seen and then add a buffer, or use that filtered pin to control a tri-state buffer.
All of our designs that have pins interacting with power go through a tri-state buffer as standard, now, unless they are things like gate drives with an enable that can be controlled slower.
Edit: I should note, this was 100% reproducible, although magnitudes and timing varied slightly run-to-run and chip-to-chip, definitely low impedance and also happened clearly before any code was running.

Like · Reply · 2w · Edited

**Jonathan Beaver** In this case, if you're only controlling an inrush relay, I assume you can get away with filtering the pin enough that it will take 10-20ms or more to actually change the state of the relay?

Like · Reply · 2w

**Chris Merren** Jonathan Beaver I had similar issues around 12 years ago with similar TI product... It was a "known issue " bug .... The solution was to delay the clock cycles before initiating the code...ie put in a wait.....

Like · Reply · 2w

**Jonathan Beaver** Chris Merren That sounds a bit different to what we found. In our case, it appeared to be an issue with startup but before the code was actually running, although my memory of it isn't completely clear.

Like · Reply · 2w · Edited

**Chris Merren** Jonathan Beaver Oh...OK... I am starting to remember another issue with the TI controller.... Every once in a awhile it got hung up during start-up and would go to full Duty-Cycle without a ramp-up....this led to a unwanted BOOM !!!

Like · Reply · 2w

**Jonathan Beaver** Chris Merren Ours was an issue with just the GPIO pins, from memory. We weren't using it in a SMPS controller, it was just connected to a plain timer for PWM duties.
I can't remember if perhaps it was due to using a enable-high signal with a pull-down or the inverse, but the thing I remember very clearly was a very short period of time when the output went defined-state and low impedance. Potentially, this was as the core was still in reset but the IO rails were up.

Like · Reply · 2w

**Ray Ridley** Chris Merren oops.

Like · Reply · 2w

Write a reply...

**Bob Gudgel** If you temporarily disconnect the GPIO from the gate, do you still see the glitch ?

Like · Reply · 2w

**Ram Mohan** Is that a MOSFET you are using to drive the Relay? Try replacing MOSFET with a simple transistor. Transistors will have lower Input Impedance than MOSFET & will snub the glitch. Also using a pwm pin makes no difference since you only need to turn off or on the Relay. I suggest you to put two Schottky diodes, one tied to vcc & io pin the other tied to gnd & io pin. Changing to Transistor should solve the issue

comment...

Those schottky diode appears like EMI protection

I think you misunderstood the question...in my current understanding, it is a booting issue, not EMI issue

Like · Reply · 2w

**Arief Noor Rahman** ☕ Found the culprit:

From datasheet I found:
4.2 Signal Descriptions
Table 4-1 describes the signals. With the exception of the JTAG pins, the GPIO function is the default at reset, unless otherwise mentioned. The peripheral signals that are listed under them are alternate functions. Some peripheral functions may not be available in all devices. See Table 3-1 for details. Inputs are not 5-V tolerant. All GPIO pins are I/O/Z and have an internal pullup, which can be selectively enabled/disabled on a per-pin basis. This feature only applies to the GPIO pins. The pullups on the PWM pins are not enabled at reset. The pullups on other GPIO pins are enabled upon reset. The AIO pins do not have an internal pullup.

unfortunately, the pin I used is not internally multiplexed with PWM function, thus the GPIO is by default will turn on during booting, before I can set the GPIO to zero.

as a work around, I have decided to place a 1kOhm pull down resistor on GPIO pin to ground, to counter the relatively strong internal pull up...

I will take this in mind for next PCB revision to move the relay control pin to GPIO pin that internally multiplexed to PWM function...

Thanks John DeFiore and Michael Delany for spot on advice...

Like · Reply · 2w · Edited

**John Baillie** Great! Thanks for sharing

Like · Reply · 2w

**Scott Styles** One more thing for your next PCB edit. Consider a flyback zener clamp on the relay coil not a freewheel diode. When you freewheel a relay, the decay of flux in the core is very slow. This means that as the relay is 'flinging open' it is doing so quite 'gently'. If you are relying on the relay to break a decent current it may not open properly. If you choose a flyback zener, you can apply a reverse voltage to the coil and drive the flux down fast. This means that the yoke gets a chance to accelerate and build some momentum before it has to yank the contacts apart.

Like · Reply · 2w

**Arief Noor Rahman** ☕ understood...however, in my case the relay should only turn on and turn off at very low current...is it still necesssary?

of course, in case of protection, it may be different...do you use it for your PFC precharge relay

Like · Reply · 2w

**Scott Styles** we do it as a matter of course on all relays these days.

Like · Reply · 2w

**Michael Delany** Scott Styles the larger the clamp voltage for the zener, the faster the flux decays. What's the highest clamp voltage you use? Do you limit to at most the max coil voltage or do you optimize it based on the FET max Vds?

Like · Reply · 2w

Write a reply...

**Amit Singh** Pull down resistor

Like · Reply · 2w

use 3.3V Vdd, this means a 330mA current at first. TMS320 can supply only a few mAmps. So you should use a simple buffer between GPIO and the MOSFET. A 500mA totempole may work.

Like · Reply · 2w

Write a comment...

**Ram Mohan**
March 20 at 9:36 AM

# Has anyone here have any source or used 1600V, 6A N channel MOSFET?

1 11 Comments

Like Comment

**Oliver Sedlacek** Hmmm, ST do the STW12N170K5 which is close at 5A. Can you parallel a couple of them?

Like · Reply · 2w

**Ram Mohan** Oliver Sedlacek 4A should do the job. Thanks

Like · Reply · 2w

**Roswell Bob LaFrank** or make the 5A part work. Current ratings are somewhat arbitrary. If you keep it cool and don't stray away from good design practice part may be very good for application.

Like · Reply · 2w

**Ram Mohan** Roswell Bob LaFrank Yeah agree. We anticipated this & have built a big aluminium extrusion to keep the MOSFETs & diodes cool.

Like · Reply · 2w

**Roswell Bob LaFrank** Cool. I do thermal analysis if you need.

Like · Reply · 2w

**Broox Le** Do you do true CFD analysis with air flows? If so, what tool(s) do you use?

Like · Reply · 2w

**Roswell Bob LaFrank** I Have been using Sauna for a long time. It is very accurate. Pvt. Msg me if you would like to know more about it.

Like · Reply · 2w

**Col Johns** 2 x 900V fets in series can be made to work very well too - esp for moderate volumes where the pricing would be attractive ...

Like · Reply · 2w · 1

**Roswell Bob LaFrank** You bet. Power Integrations had an app note many years ago about using a fet in series with their smart mosfets. I recall it required a little tweeking to get dialed in, but can be done with smd fets.

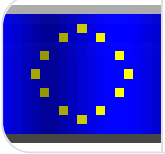
Like · Reply · 2w

**Ram Mohan** Roswell Bob LaFrank They called it "stackFet". The Top MOSFET is gate is biased from +HVDC & the Source is connected to Drain of Topswitch. This is useful upto 30/40W of Output Power. At higher Power levels, the efficiency is poor.

Like · Reply · 2w

Write a reply...

**Ігор Карась** https://eu.mouser.com/.../Transistors/MOSFET/_/N-ax1sf...|0



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Like · Reply · 2w · 1

Write a comment...

**James Keith**
March 2

I was under an impression that half bridge converters are only used upto 1 kW.

Infineon has a design for 3.3 kW (52 V) using half bridge LLC : https://www.infineon.com/dgdl/Infineon-Evaluationboard_EVAL_3K3W_LLC_HB_CFD7-ApplicationNotes-v01_00-EN.pdf?fileId=5546d4626cb27db2016d3a60583725dc

PSFB (3.3 kW , 52 V) : https://www.infineon.com/dgdl/Infineon-Application%20Note%20EVAL_3K3W_BIDI_PSFB%20AN_1809_PL52_1809_081412_Bidirectional_PSFB_3k3W_10-AN-v01_00-EN.pdf?fileId=5546d46267354aa00167404c69bb7b8c

Interleaved LLC ( 3.3 kW, 44V-58V)

https://www.infineon.com/dgdl/Infineon-ApplicationNote_Evaluationboard_3kW_dual_phase_LLC-AN-v01_00-EN.pdf?fileId=5546d462580663ef01582eb629b70118

All of these topologies show more or less the same efficiency (97% - 98 %)

7 · 11 Comments

Like · Comment

**Paul Shepherd** Rules about how much power a given topology can or cannot handle are easily disproven. 🙂 For cost driven offline converters, I've been impressed with how much power a flyback converter can provide.

Like · Reply · 4w

flyback.

A few weeks ago, we built a 400 W prototype for a customer. Took us a week to design and build.

So much for the things we think we know!

Abandon all preconceived notions if you want to move forward in this field.

Like · Reply · 4w

**Stephen Berry** Ray Ridley Bruce Carsten presented a 4.5kW dual interleaved flyback using SiC at PCIM 2017. Mostly for recreation I suspect, but it did work.

Like · Reply · 4w

**Col Johns** Stephen Berry, Bruce's 4.5kW Fyback was for a PFC. We have seen a telecom rectifier 1500W, 3 x flybacks with planars interleaved inside ...

Like · Reply · 4w · Edited

Write a reply...

**Col Johns** Given that you have been able to buy 600V 60A mosfets for nearly a decade, and now have SiC, 3kW in an 1/2 bridge is not too surprising - there are ways to wind an 1/2 bridge transformer that minimise CM transference that cannot be done for a standard transformer too ...

Like · Reply · 4w

**A-ARon Jones** A phase shifted full bridge and interleaved LLC aren't exactly half bridge topologies. The first half bridge LLC uses a very high quality transformer and low conduction loss MOSFETs, plus forced air cooling. 1kW is a good starting point but there are always games to be played to add cost

1

Like · Reply · 4w · Edited

**Manuel Escudero Rodríguez** The LLC demostration board is not an interleaved design, is a single half bridge.

Like · Reply · 2w

Write a reply...

**Milovan Kovacevic** FB vs HB is also a question of EMC performance. FB has this nice property that it does not shove tons of CM current into the transformer if you drive it with 50% duty cycle, and you can also slow down transition edges (of a resonant converter) really nicely with "snubber" capacitors across the switching nodes and trade a little bit of extra conduction loss for a nice drop in EMI signature

1

Like · Reply · 4w

**Milovan Kovacevic** Resonant tank split and symmetric geometry of the transformer are implied

Like · Reply · 4w

**Charlie Elliott** But surely there are no EMC problems with a resonant converter with all those lovely low harmonic sine wave currents !!??😉

Like · Reply · 3w

**Milovan Kovacevic** There is not a single solved problem that high frequency, high voltage, cost / space requirements won't resurface

Like · Reply · 3w

Write a reply...

Write a comment...

**Stuart Wood**
March 18 at 11:26 AM

Question, does the Chan hysteretic model used in many spices, produce real losses in the simulation?

16 Comments

Like Comment

**Bryce Hesterman** It does. The losses aren't frequency dependent, though. What I have done is to model the losses at the converter operating frequency based on published core loss data. I have mostly used the model for cases where I'm trying to understand what would happen if a logic upset caused improper gate signals that could cause saturation.

Like · Reply · 2w

**Stuart Wood** Bryce Hesterman how does the simulator display the power losses? Can you alt- click the inductor with the Chan Model and get the power dissipation?

Like · Reply · 2w

**Norman Elias** My guess would be that it depends on which Spice product you're using.

Like · Reply · 2w

**Stuart Wood** LTSpice.

Like · Reply · 2w

Write a reply...

**Norman Elias** It stannds to reason that hysteresis has to be frequency dependent. There has to be some finite time required to align the rotation of individual atoms/molecules. I found this paper with google https://www.sciencedirect.com/.../abs/pii/S0304885316309775

SCIENCEDIRECT.COM
Mathematical modelling of frequency-dependent hysteresis and energy loss…

Like · Reply · 2w · Edited

**Alfonso Martínez** https://booksc.xyz/dl/60331524/8a9d33

BOOKSC.XYZ
| | download

Like · Reply · 2w

**Ray Ridley** Please, try to post articles that don't require a purchase. it kills conversations. $55.20 for an article is pretty outrageous.

Like · Reply · 2w · Edited

**Alfonso Martínez** I could upload a PDF of the article if I get your permission, Ray Ridley. Nevertheless, if somebody is interested I can send it through private message.

Like · Reply · 2w

**Ray Ridley** We will go with the don't ask don't tell policy I think.

Like · Reply · 2w

winding. The loop was like 30 times wider than normal. Flux density was near saturation. And no, cores did not heat up that much, however magnetostriction was immense. Which was the reason for loop measurement arisen during failure investigation.

Like · Reply · 2w · Edited

**Stuart Wood** If the Chan Model's losses are not frequency dependant how do you know how accurate they are? Are the parameters frequency dependant than? i.e they need to be changed for different operation frequencies? The data sheets don't seem to have Bs, Br etc. Vs frequency.

Like · Reply · 2w

**Bryce Hesterman** Stuart, you are asking great questions. My previous answer wasn't clear. The Chan model traces the same BH path for the same peak flux density regardless of frequency. So, for the same flux density swing, the loss per cycle is independent of frequency. This is different from the Jiles-Atherton model used in other simulators, which is more accurate, but it can produce convergence problems. I have a lot more I could say about this topic, so I will create a presentation to share.

1

Like · Reply · 2w

**Ray Ridley** Bryce Hesterman if it's the same BH path regardless, does that not render the model fairly useless?

Like · Reply · 2w

**Stuart Wood** Bryce Hesterman so what is missing, is that the shape of the B-H curve is changing with frequency. Correct?

Like · Reply · 2w

**Bryce Hesterman** Ray Ridley As I mentioned before, I have found the model useful in some cases where I was investigating saturation effects. If you care about core loss, you need a new model for each frequency. Still, I have found it useful. Mike Engelhardt's prime focus has been to have a simulator that converges well, and he has done a fantastic job at that. The details of the model are described in this patent. http://www.freepatentsonline.com/7502723.html

FREEPATENTSONLINE.COM

Asymmetric minor hysteresis loop model and circuit simulator including the same - Linear…

Like · Reply · 2w

**Ray Ridley** OK, good for saturation. As long as we are clear.

Looks like Mike's model is just for the asymmetric saturation too, nothing about core losses.

Like · Reply · 2w · Edited

Write a reply...

Write a comment...

**Senthil Kumar**
March 17 at 7:21 PM

I am trying to do non isolated buck converter from PFC output to get 170v.
Power is 500W.
This is for pulse load. Non synchronous mode. Switching frequency is 65kHz.
Feasibility of this converter and advice are welcome

9 Comments

**Colin Tuck** Should be fairly straight forward to do, SiC buck diode will make life easier and RFI less ... plenty of chips available for high side gate drive, but as the duty ratio will be in the order of 0 - 50% a GD transformer could be used to good effect too ...

Like · Reply · 2w

**Senthil Kumar** Colin Tuck thanks

Like · Reply · 2w

**Ram Mohan** Though it's non isolated, I would have used a traditional forward Convertor or a Active Clamp forward/flyback design.

Like · Reply · 2w

**Alain Laprade** What is the spec input voltage range?

Like · Reply · 2w

**Colin Tuck** 385 - 420 is usual for PFC o/p

Like · Reply · 2w

**Alain Laprade** Colin Tuck Indeed. Just checking. I'm intrigued as to the power source. Would be moot to pursue the thread if the 170V output is not compatible with the input.

Like · Reply · 2w

**Colin Tuck** Buck controller to an isolated heating element could be one use, I find it not useful to speculate on various people's uses of non isolated power electronics and leave em to it - I had one case in NZ - where I warned the client that it would be illegal and they could be charged with wilful negligence if they proceeded - and left them to their devices ...

Like · Reply · 2w

**Senthil Kumar** Alain Laprade input range is 108vac to 240vac.
I need to know that whether this full non isolated topology will pass EMI, EMC, tests for class A product , IEC61000 ,surge,conducted and radiated emission.

Like · Reply · 2w

**Col Johns** do you mean you need to know before you begin any design work at all..? hahahaha ....

Like · Reply · 2w

Write a reply...

Write a comment...

**Ray Ridley**
Admin · March 18 at 1:02 PM

Firefox puts Facebook in a Cage

For those of you who remain wary of Facebook and its tracking of you, be aware that Firefox has just released a free product to keep you safe.

Now you can be part of this group and no one is watching you.

Enjoy!

https://www.mozilla.org/en-US/firefox/facebookcontainer/


Jay Philippbar, Brian Faley and 18 others — 17 Comments

Like — Comment

**Norman Elias** 🙂
Like · Reply · 2w

**Jonathan Beaver** I've been using that for a few months now and it's great.
Like · Reply · 2w

**Sandeep Kr** Neat!
Like · Reply · 2w

**Alain Laprade** Will give it a spin. Note that after installation, I got logged out of facebook automatically. Have your password handy.
Like · Reply · 2w · Edited

**Peter Comrie** Strange, I've had the Facebook container for months already.
Like · Reply · 2w

**Andrew Ferencz** Ray - I don't have Facebook on my phone (or any of those programs ... instagram, etc.) and I use FBP (look it up). When I went and saw my tracking - I am a ghost. I see no ads. I am zero tracked ...

I wonder if I crossed the Chinese boarder and took my phone - would they believe me?
Like · Reply · 2w

**Tony Salsich** I have been using for a few months as well. Love it.
Like · Reply · 2w

**Alex Berestov** So the Firefox will be selling your data to Facebook or to BigBrother directly.
Like · Reply · 2w

**Edward Ralph** Alex Berestov that's not how Firefox works.
Like · Reply · 2w

**Alex Berestov** It's a joke, period
P.S. Free stuff is a mousetrap.
P.P.S. Ask another Edward.
Like · Reply · 2w

**George William Tyler** I don't believe Ray sent this.
Like · Reply · 2w

Like · Reply · 2w

**George William Tyler** So much hacking these days, this post seemed out of character. I see many posts from friends that are not actually from them,

Like · Reply · 2w · Edited

**Ray Ridley** This was me. Not much spam gets by our group managers.

Like · Reply · 2w

Write a reply...

**Edward Ralph** Been using this for a few days, no complaints here.

Like · Reply · 2w

**Oliver Sedlacek** Just installed it, can't hurt I hope!

1

Like · Reply · 2w

**Bruno Torremans** Using this for months now. Firefox, NoScript and Linux is probably one of the best combinations if you care about privacy.

1

Like · Reply · 2w

Write a comment...

**Ram Mohan**
March 17 at 10:11 PM

A new project requires 600VDC of 3A Output. The Input is 24V or 48V LiFp battery (based on availability, thanks to Covid-19) of sufficient rating. The batteries are charged from our existing 200V to 1000V Solar string DC-DC Converter. Keeping in view of Long term reliability, lower cost & easy maintenance, I'm planning to use 24V/48V to 60V, 3A DC-DC Converters. 10 of them with common Input from Battery but the 60V Outputs connected in series. These 180W modules will be mounted on DIN rails for easy replacement for any failures. Please share your views on this approach. Update: The load is a AC Motor driven through VFD. The batteries + the DC-DC Converters are provided for back-up. The motor operates few seconds every 15minutes & it won't operate beyond 30minutes the whole day.

19 Comments

Like | Comment

**Janamejaya Rox** What is the focus of your work?. What do you need help/advice with?. Any diagram/schematic?. What improvements are you planning to make?.

Like · Reply · 2w

**Manfred Wimmer** I think, this is a bad idea concerning volume, cost, performance and especially reliability.

Like · Reply · 2w

**Ram Mohan** Manfred Wimmer how & where do you think will be the reliability issue?

Like · Reply · 2w

**Manfred Wimmer** The likelihood of failing of a single stage with an appropiate transformer is lower, than that of 10 stages.

Like · Reply · 2w

Like · Reply · 2w

**Ram Mohan** Jim Stone it's a Isolated Push-pull Forward Converter that's being developed. Each Output will only see 60VDC potential difference

Like · Reply · 2w

**Jim Stone** Sure. I'm asking about the frame-to-output insulation & clearance of the 10th module, with output at 540V&600V.

Like · Reply · 2w

**Ram Mohan** Jim Stone The enclosure is Polycarbonate with individual Din rails for each module

Like · Reply · 2w

Write a reply...

**Magnus Rosén** Good aproach. Plenty COTS dc/dc and DIN railed (industrial) are rugged. But Im concerned with humidity load if outdoor.
Also may you add protection diodes on each dc/dc output to protect them from negative input if overload or overcurrent limitation sets in.

Like · Reply · 2w

**Ram Mohan** Magnus Rosén This is a outdoor equipment housed in IP67 enclosure. The load is a AC Motor driven through a VFD. The Batteries are optional if they need to run the motor during the night. Also the maximum operating time of the motor for whole day is around 30minutes. 600VDC with 3A is just peak Current.

Like · Reply · 2w

**Col Johns** make sure the modules are good for 3A continuous ...!

Like · Reply · 2w

**Ram Mohan** Col Johns 3A is the worst case peak Current. Even if it takes 3A load, the total operating duration for the Load is 30minutes a day.

Like · Reply · 2w

**John Baillie** It's difficult to know the limit of how many you can put in series. There is probably caps between the output rails and ground which will limit how high you can go. Also, allowable creepage and clearance distances between the power rails and grounded points will decrease as you increase the output differential voltage.
If you can ground the centre of your output this will help.
Put schottky diodes across each output as others have said. This is mainly protecting the outputs during startup and shutdown where they don't turn on exactly at the same time you will have negative voltages if you don't put them Schottky to be sure that they conduct before any internal body diode. Should be rated for full current and twice the total output voltage

Like · Reply · 2w

**Ram Mohan** John Baillie yes. Sufficient creepage will be provided between each Output & the body. Also the entire system is housed in PC Ip67 enclosure. Will be using Schottky diodes at Input & Output as well.

Like · Reply · 2w

**Roswell Bob LaFrank** Why wouldn't you do it with one converter? 600v out at 3 amp is a fairly easy design. I did a very similar design with a resonant push-pull.

Like · Reply · 2w

**Colin Tuck** pretty sure he wants off the shelf ....

Like · Reply · 2w

Like · Reply · 2w

**Roswell Bob LaFrank** Ram Mohan input voltage was near 24v. 7 LiFePO4 in series.

Like · Reply · 2w

Write a reply...

**Roswell Bob LaFrank** Be aware of fact that vfd may have some bus capacitance requirements due to ripple currents. Some of these ripple currents can be reactive as motor is inductive load. Yours may be less as you are not running off a power line with resultant voltage ripple. Your power supplies may have some other requirements for bus capacitance for stability and there could be problems getting a fair balance. Good luck. Sounds like a fun project.

1

Like · Reply · 2w

Write a comment...

**Scott Styles**
March 15 at 8:35 PM

Esteemed Colleagues

Our supplier of PCBA mount potential transformers PTs has disappeared. Real shame because technically they knew what they are doing.

Can any of you recommend a supplier/manufacturer of PCB mount potential transformers?

Basic spec being Vp = 690V Vs = 100V, 2VA, pri:sec capacitance <23pF, encapsulated. Edit 50/60Hz (forgot that critical point whoops). About size of two boxes of matches give or take.

7 Comments

Like | Comment

**Col Johns** I suppose Marque Magnetics in AKL is out of the question ...?

Like · Reply · 2w

**Scott Styles** you can lead supply chain dept to water but you can't make them drink. They're on the list.

Like · Reply · 2w

**Brian Faley** Pacific Transformer. Pactran.com

PACTRAN.COM
Pacific Transformer | Custom Power Transformer Manufacturer

Like · Reply · 2w

**Chema Molina** We have a list of manufacturers, we can help you to select one.

Like · Reply · 2w

**Chema Molina** Give me your email and I will do it.

Like · Reply · 2w

**Mike West** Would love to help you... But shipping from Texas might cause some pricing issues. We do a lot of potential transformers at Nova

Like · Reply · 2w

**Bob Mirabella** Contact Craig at CET TECHNOLOGY

**Alberto Difrancesco**
March 6 at 3:51 PM

Hi all,

I'm in fight with a well known problem: ground routing. In my current design, I'm developing a 30W offline SMPS.

My question is: how to tie power gnd with signal gnd? The signal gnd comprises the controller, driver and Vaux ones. In previous designs, I kept pwr/sgn grounds separate and tied them underneath the main bypass input capacitor (as a stable ground point) BUT some components seemed to suffer from ground bounce effects (especially the half-bridge driver).

So, I want to change my approach now: some AN recommend to derive the sgn gnd directly from the low-side source and then tie pwr/sgn grounds undertneath the thermal pad of the controller (if present).

What do you think about that? What do you think is the best approach to tie differents gnds guaranteeing stability and avoiding loops?

Bob Gudgel 10 Comments

Like Comment

**David Edwards** How many layers on your board?

With two layers you can treat one as the ground plane and route everything on top only going to the back side to make very short jumpers. Slots in the ground plane act as antennas and interrupt mirror currents from topside traces.

Another approach is to freely route traces on both top and bottom and fill in all areas not used for traces with ground pours. Some layout software will automatically connect overlapping ground islands together with a single via, but you really need many multiple vias spaced every centimeter or two. Filling in all empty spaces with copper keeps the board from warping during soldering.

Like · Reply · 4w

**Alberto Difrancesco** Hi David, the current board is 2 layer. I agree with your first solution but the necessary condition is to have a very stable ground plane. So, in this case, the main effort is to well isolate the power ground defining all the current return paths, and connect it to the main gnd plane in a stable point (underneath the input caps?). Then, I think I will be able to use short jumper for gnd connection.

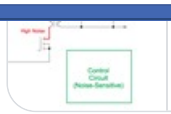
Like · Reply · 3w

**Darrell Hambley** What IC are you using? I had a similar issue with an LT8646. It has a common ground connection to its bottom heatsink pad. All the high-current traces and grounds and thermal vias were laid out around the lower potion of the IC (pins 4-23). The control signals and components were routed around the upper (pins 24-3) portion of the IC. A ground plane on layer 2 was under all control traces and components but, this ground was an isolated island with only one connection to one IC pin. This allowed the control signals to be over a clean ground.

Like · Reply · 4w

**Ray Ridley** check our grounding issues paper in our design center. That might help you. One of the secrets is to not let the power currents pass through the control ground. A consequence of that is avoiding a full pour of ground on the board, counter to the way most layout engineers would go.

http://ridleyengineering.com/.../79-045-forward-converter...



Ridley Engineering | - [045] Forward Converter Design - Part XII PCB…

Like · Reply · 3w

**Alberto Difrancesco** Ray Ridley Thank you, Mr Ridley, very useful paper

Like · Reply · 3w

**Ray Ridley** There is another paper in that series about routing the power currents where you want them to go rather than letting them decide for themselves.

Like · Reply · 3w · Edited

**John Baillie** Two schools of thought on this. If you go with a ground pour it is important to zone your circuits to avoid power current (or anything high di/dt) causing problems.

Like · Reply · 2w

**Ray Ridley** Only two?

Like · Reply · 2w

**John Baillie** Indeed it's more of a spectrum between star-point to ground pour

Like · Reply · 2w

Write a reply...

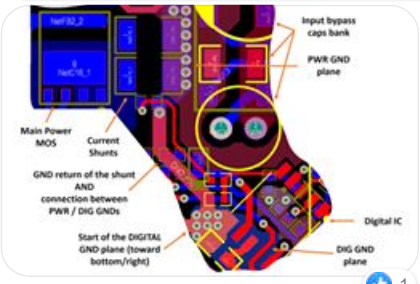
**Alberto Difrancesco** Thank you, gentlemen, for all your advices. Finally, I've decided to follow this approach (see image below):

-The PWR GND is strictly closed between the input bypass capacitors bank and the low-side MOS / current shunt, in such a way that all the high switching currents form a very small loop;

-The DIG GND starts underneath the IC controller and covers the whole signal part. Vias for the DIG GND plane are made near the IC bypass cap (bottom/left of the image);

-Connection between two planes is made through a track (the red squared) starting from the low-side current shunt. The track is large enough to carry both the return currents of gate drive / current shunt BUT meanwhile strict enough to confine all the power switching currents in the PWR GND plane.

What do you think about this?




1

Like · Reply · 2w

Write a comment...

**Nayan Shelat**
March 17 at 5:07 AM

How to load a server power supply for testing it without connecting to actual server.

We are attempting to characterize a newly developed server power supply for conducted emission.

not have an operational server, but intend to load the power supply using some external power supply tester that could facilitate power supply testing or connect resistive load across connector terminals.

Can anyone suggest me suitable source of getting mating connectors for standard ATX power supply connectors so I can mate all output connectors of my server power supplies at one side and connect resistive load on PINS that is meant for PC Board.

You can suggest me any arrangement that I can use to connect resistive load across Molex 20 Pin connector. If you know some power supply tester that I can use to load the server power supply, we can rent it. But tester needs to have compatible mating connections to load the power supply.

Could you please help me on how to load the server power supply through regular connector.

6 Comments

Like Comment

**Peter Malthe Cordtz** You need an electronic load. Probably a load mainframe in case you need several voltages tested at once. Then it's a simple question of finding the mating connector for your supply and making a custom set of wires that connects to your electronic load inputs.

Like · Reply · 2w

**Yuri de Klerk** For conducted emission the extra wiring will influence the emission levels above approx. 10MHz, so the test can only be used as an indication.
For radiated emission it's really not usefull to make use of an electronic load.
Best would be to put the power supply in a server-case and put all the load-resistors in this case too. Even if you have a scrap server you can use the PCB as a fixture to mount all the load-resistors.

Like · Reply · 2w

**Nayan Shelat** Peter Malthe Cordtz: i need some advice on how to interface electronic load. The output is available from my PSU from several standard Molex and AMP connector. Now, i need suggestion on how to connect them to either electronic load or resistive load. I need to connect from MOLEX connector to load. For that purpose I am looking for suitable interface. I am looking for mating connection that has open wire at other end or suitable pin that inserts in to connector and i can solder wires. Or i need a mating connector that mates with PSU connector and has open pins to solder wires. Any suggesting on this area.

Like · Reply · 2w

**Peter Malthe Cordtz** I missed the part about conducted emissions. You need to be careful about using anything other than resistive loads in that case.

Anyway, I don't under tand the question. Why don't you just buy the connectors you need?

Like · Reply · 2w

Write a reply...

**Col Johns** Surely this sort of thing:-

"Can anyone suggest me suitable source of getting mating connectors for standard ATX power supply connectors so I can mate all output connectors of my server power supplies at one side and connect resistive load on PINS that is meant for PC Board."

is not what we are here for ... ?

Like · Reply · 2w · Edited

**Yuri de Klerk** Col Johns I couldn't have guessed it's really about the connectors, haha.

Write a reply...

Write a comment...

**Phil Lane** shared a link.
March 13 at 4:25 PM

The assertion is that "C0G exhibits no change in capacitance with respect to time and voltage". Really? Especially the part about voltage.

CONTENT.KEMET.COM
**content.kemet.com**

You and 5 others | 13 Comments

Like | Comment

**Bob White** Pretty much true. See the data sheets for details. C0G/NP0 are Class 1 dielectrics and are stable with voltage and temperature. They are also much lower dielectric constant than the Class 2 dielectrics. This means that for a given capacitance and voltage a C0G/NP0 capacitor will be larger than a capacitor made with a Class dielectric (e.g. X7R).

Like · Reply · 3w

**Col Johns** We use G0G and NPO for resonant caps in some power supplies - just for this reason.

Like · Reply · 3w

**Jonathan Beaver** Yep. As above, we've used huge banks of them for resonant tuning networks in the 100s of KVA range. No issues that would indicate even a slight shift in capacitance.
For AC usage, care does need to be taken over the voltage rating, but depending on your frequency you may have self heating issues before getting there, anyway.

Like · Reply · 3w

**Jonathan Beaver** Interestingly, I was somewhat nervous starting out using the large format class 1 parts (TDK C5750 series) with all sorts of dire warnings that I had heard about large MLCCs.
I'm now of the opinion that those are almost entirely confined to Class 2 dielectric, because even after deliberately trying to break the Class 1s to get a 'feel' for how brittle they were, I never actually managed. We had plenty of arrays that were run way above recommended temperatures, were dropped, mounted in ways that stressed the boards and we never saw any shift in value with stress/strain etc.

Like · Reply · 3w

**Alex Berestov** For multi kW range there are "real" capacitors like that
https://www.celem.com/Conduction_cooled_capacitors
or that
http://www.vishay.com/docs/22081/ps20ps30ps40ps55c1.pdf
or other doorknob types.

CELEM.COM
Cooled Conduction Capacitors

Like · Reply · 3w

still sitting in boxes downstairs.
They're extremely expensive per KVA (edit: at least at our fixed frequency of 85kHz), much lower Q than the ceramics and extremely awkward when you need to be able to adjust values.

Like · Reply · 3w · Edited

**Alex Berestov** Those are pretty much standard in induction heating. Used to witness bank destruction, made of hundreds of caps: one cap dies, current is up for the rest. Sounds like machine gun.
In regard to price: 0.33 uF 1kV NP0 is around $100 and is rated around 20A RMS. Not to mention current sharing and so on.
And yes I've seen 2...3 thousand PP film caps where 2 or 3 big ones could suffice.

Like · Reply · 3w · Edited

**Jonathan Beaver** Alex Berestov Well my area isn't induction heating. it's wireless power. In induction heating, there are generally simpler resonant networks and less importance to being tuned onto a specific frequency. For wireless power we typically end up using multiple banks, often split, and it's generally easier to adjust the fitment of a bank of smaller units to bring it to the primary frequency than it is to adjust the magnetics, which are VERY carefully optimised.
For those units, I suspect you're thinking of something like the Porcelain ATC caps, not regular NP0s. Those aren't particularly useful for us, either, and are targeted at much higher frequencies (RF region).
The TDK units we're dealing with are 630Vdc or 1000Vdc rated (used at 220Vrms or 350Vrms respectively) and are normally in the 10-100nF range for less than 1USD each. Overall cost is 10% of the Celem solution for the same total production kVAR quantities, including board and assembly costs.
Current sharing is something to be aware of when designing the array, but that's where the art is. I've never had too many issues with it in most circumstances, even up to banks that are in the 10 series/20 parallel kind of component ranges. Biggest array was something like 300 KVA just for the parallel resonant part of the array, never mind the partial series compensation or other parts of the tuning network.

Like · Reply · 3w · Edited

Write a reply...

**Nathan Ellis** Thanks for the input; I had been wondering the same.

Like · Reply · 3w

**Alex Berestov** Yet another way to "... fuel efficiency". While most designers squeeze fraction of a % in efficiency, there come people wasting hundred times of that just for "convenience" polluting surroundings on the way. "

Like · Reply · 3w

**Phil Lane** The massive Murata datasheet has a link to "specifications and test method" on Page 108, for GRM series caps (presumably COG) - that doesn't work. Using more expensive Kemet, because the Murata datasheet is so poor.
https://www.murata.com/.../capacitor/mlcc/c02e.ashx...

Like · Reply · 3w

**Alex Berestov** The need of fine tuning is well understood, however inductors are easier 'cause you basically make magnetics "yourself". Here are caps that may work on par with power film ones, which are BTW self healing. They are capable of 10+A rms through the cap. @ $5 1000pcs they are nor cheaper but what do I know.
https://content.kemet.com/datas.../KEM_C1039_KC-LINK_C0G.pdf

Like · Reply · 2w · Edited

Like · Reply · 2w

Write a reply...

Write a comment...

**Bryce Hesterman** shared a link.
March 5 at 3:19 PM

I'm starting a new thread on ac resistance of windings as a continuation of what I replied to on Stuart Wood's post.

Here are the references:

This reference explains mutual impedances including mutual resistances. This is the key to understanding ac resistances of windings.

J. H. Spreen, "Electrical terminal representation of conductor loss in transformers," in IEEE

Transactions on Power Electronics, vol. 5, no. 4, pp. 424-429, Oct. 1990.

https://ieeexplore.ieee.org/document/60685

This reference shows one way to model transformers that uses mutual impedances. They even show how to include capacitive effects.

E. E. Mombello and K Moller, "New power transformer model for the calculation of electromagnetic

resonant transient phenomena including frequency-dependent losses"

IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 15, NO. 1, JANUARY 2000, pp. 167-174.

https://ieeexplore.ieee.org/document/847246

Here is a link to a zip file that shows how to model ac resistances for a two-winding transformer based on Mombello's method. The zip file includes a Mathcad file, a pdf of the Mathcad file and LTspice files that demonstrate how to do a circuit model that includes mutual resistances. There are LTspice files that show the open-circuit and leakage (short-circuit) impedances of the primary and secondary windings, and they match the measured data very closely. There is no way that L-R networks on the primary and secondary windings can match both open-circuit and short-circuit ac resistances. The Mombello method is general. It works for any number of windings, integrated magnetics, flyback and multiple-output flyback transformers. http://www.verimod.com/…/Mutual_Impedance_Transformer_Model…

IEEEXPLORE.IEEE.ORG
**Electrical terminal representation of conductor loss in transformers - IEEE Journals & Magazine**
The formulation of a general, complete electrical terminal representation of…

You, Norman Elias and 9 others — 51 Comments

Like | Comment

**Bryce Hesterman** David Edwards mentioned my magnetics coupling presentation. Here are links to the slides and a video.
http://www.verimod.com/.../Magnetic_Coupling_IEEE_Seattle...
https://www.youtube.com/watch?v=-gd9_xW5enY

Like · Reply · 4w · Edited

**Robert L Rauck** This is great stuff. Thanks for the links!!

Like · Reply · 4w

**Norman Elias** I've been ramping up to speed on this with help from Bryce. Anyone interested in trying his implementation of a two-winding Mombello model can run it right now on SystemVision (free access on the cloud). Go to https://www.systemvision.com/.../bryce-hestermans-mutual....

Bryce Hesterman's Mutual Impedance Transformer Model | SystemVision®…

Like · Reply · 4w

**Norman Elias** RidleyWorks uses L-R networks on the windings to approximate Dowell's mathematical solution to the frequency dependences. Mombello introduced an equivalent circuit suggested by the electromag physics. You can fit the model parameters to measurements or to a mathematical formulation such as Dowell's. Has anyone tried simply writing Dowell's formula (or any good alternative) into a transformer model, e.g., in Verilog-AMS or VHDL-AMS?

Like · Reply · 4w

**Ray Ridley** Lots of ways to do all this. What is unique to ours:

It takes about 2 minutes to define the winding structure. Then three mouse clicks to load the entire model into LTspice ready to run.

The other methods here will teach you much theory, but take many hours to implement practically.

We are all about speed of development, and time to market. We incorporate advance analysis along the way with zero pain to the user.

If you want to dig into and understand Dowell's, go for it. If you just want a fast and accurate model to simulate the proximity loss, you can do that instead.

Its kind of like using a FET in your power supply. You can apply a gate drive signal and turn it on and off at will. Or you can go dig into Schroedinger's wave equation applied to semiconductor physics first for a few weeks, then come back and turn it on and off the same way. It's all good. 🙂

Like · Reply · 4w

**Norman Elias** Good point Ray. I, for one, prefer collaboration to confrontation. Your goal is not, and should not be, to provide the most accurate model possible. Bryce seems to have some good ideas. If we put our thoughts together, who knows, maybe we can produce a model that will fit your objectives for RidleyWorks. It's not a matter of who's right or who's wrong. It's a matter of what can we accomplish using our best ideas. This forum is a great place to explore those possibilities.

RidleyWorks is a great tool. I'd love to find a way to contribute to it. Bryce is promoting some new ideas. I'd love to see where that takes us.

Like · Reply · 4w

**Ray Ridley** Norman Elias all we ask of people's models is they come in excel

Mathematical function in there are extensive.

In the end a good tool is judged by how well it presents data and that is where excel excels. 😎

Like · Reply · 4w

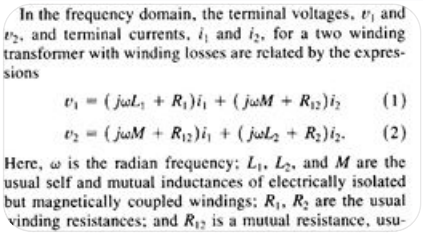
**Bryce Hesterman** My hope is that someday what I am working on can be put into a form suitable to include in RidleyWorks. The Dowell-based approaches with LR networks can have great utility in the limited cases where Dowell's assumptions hold. For more general cases, such as any transformer driving multiple loads or transformers with large magnetizing currents, or parallel-connected windings, a more rigorous approach is required, but any approach that is general requires understanding some subtleties of linear circuit theory including mutual resistance to accurately model the proximity effects. In Mathcad, I have worked out how to write .inc files for implementing the Mombello model in spice. Porting the model exctraction to Excel is difficult, but Norm Elias is helping me. The bottom line is that understanding the limitations of any modeling approach is important.

Like · Reply · 4w

however, it would be helpful if you could explain what it is and what the coupling mechanism is. I am guessing it is just proximity effect induced currents in nearby conductors.

Like · Reply · 4w · Edited

**Bryce Hesterman** . In general, for any linear multi-port network there are self-impedances and mutual impedances between each pair of ports. This applies to any circuit, including transformers. It is as fundamental as KCL and KVL. In general, mutual impedances can have any complex value. When magnetic coupling is to be modeled, we all know about mutual inductance. When interwinding capacitances are being modeled self and mutual capacitances are considered. For whatever reason, people have largely forgotten about mutual resistance, but it is an essential concept for understanding the proximity effect. Here is the basic idea in equation form.



In the frequency domain, the terminal voltages, $v_1$ and $v_2$, and terminal currents, $i_1$ and $i_2$, for a two winding transformer with winding losses are related by the expressions

$$v_1 = (j\omega L_1 + R_1)i_1 + (j\omega M + R_{12})i_2 \quad (1)$$

$$v_2 = (j\omega M + R_{12})i_1 + (j\omega L_2 + R_2)i_2. \quad (2)$$

Here, $\omega$ is the radian frequency; $L_1$, $L_2$, and $M$ are the usual self and mutual inductances of electrically isolated but magnetically coupled windings; $R_1$, $R_2$ are the usual winding resistances; and $R_{12}$ is a mutual resistance, usu-

Like · Reply · 4w

**Riccardo Tinivella** Bryce Hesterman thank a lot for your stuff it's amazing 🙂, is an extension of Cantilever method proposed by Maksimovic?
https://ecee.colorado.edu/~rwe/references/PESC98.pdf.
If you need an extension in python/matlab I can support you no problem.
Up to now I have wrote some script to fit simple spice model from measurements, I'm planning to improve it also 🙂
https://www.linkedin.com/.../spice-model-extraction.../

Like · Reply · 4w · Edited

**Don Marabell** Riccardo Tinivella Bryce also did a nice presentation at denverpels.org(2007)

DENVERPELS.ORG
IEEE Power Electronics Society - Denver Chapter Home Page

Like · Reply · 4w

**Bob Gudgel** It doesn't look like the Denver chapter has had any meetings for several years now ? No interest ?

Like · Reply · 2w

**Stuart Wood** For impedance curve fitting, I found a python program called Zfit_v2.0 it's easy to add new circuits to it and was able to fit a 3000 point data set to a 5 order LR network in about 20 seconds.

Like · Reply · 4w

**Riccardo Tinivella** Thanks for the tip! is this link?
https://exality.com/fitting-equivalent-circuits-to.../

EXALITY.COM
Fitting Equivalent Circuits to Impedance Data | Exality…

Like · Reply · 4w

**Stuart Wood** Riccardo Tinivella yes, it's easy to modify, and in the public domain.

Like · Reply · 4w · Edited

Like · Reply · 4w

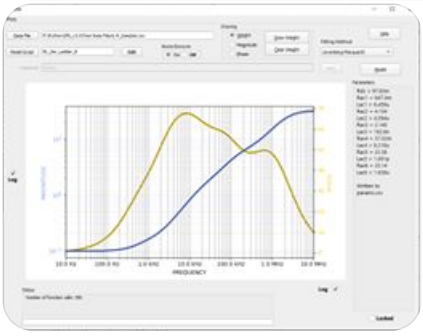
**Ray Ridley** 20 seconds to match? Did you mean to say 20 ms?

Like · Reply · 4w

**Nicola Rosano** Ray Ridley it's struggling.

Like · Reply · 4w

**Stuart Wood** Ray Ridley No I meant 20 seconds, worst case.I have no problem with it taking 20 second as long as it comes up with a good match. This took less than 2 seconds



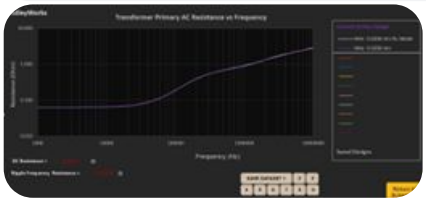
Like · Reply · 4w

**Ray Ridley** Look, there are closed form solutions to the problem that are instantaneous. We have ours in our software, Nicola Rosano has his.

However, I understand, people like to engineer their own solutions. That curve you are showing is not a good match. The algorithm, as Nicola Rosano has said, is struggling.

Like · Reply · 4w

**Ray Ridley** This is the kind of match you should be seeing.



Like · Reply · 4w

**Ray Ridley** Nicola Rosano has gone one better with a 7th order network to reduce the error from around 7 % or so to 1 %.

He is a quintessential engineer. 😎

Being in the lab all the time, I'm happy with 10%, but I am impressed. We just didn't want to hit LTspice with 21 new state variables instead of 15. That seemed an unkind thing to do.

Like · Reply · 4w

**Riccardo Tinivella** Nicola Rosano sorry to haven't read all comments or post of the group, nut I haven't seen the free tool you posted. Can you reshare it?

Like · Reply · 4w · Edited

**Nicola Rosano** Ray Ridley thanks Ray appreciated

Like · Reply · 4w

**Stuart Wood** Ray Ridley the curve on yellow and blue is the data taken from one of the LR networks you posted in a paper. The thin black lines are the solution that ZFit found to match the blue and yellow lines.

Write a reply...

**David Edwards** . Hello Bryce Hesterman,

Could you please provide a concise description of "mutual resistance" that explains the mutual part, the coupling mechanism (magnetic?) and why this concept is more useful and elucidating than traditional alternatives.

All the papers you linked are inaccessible, even with my IEEE power electronics membership. What society need one join to access the Transactions on Power Delivery?

Like · Reply · 4w

**Ray Ridley** Ah the IEEE. Join a society and find that the paper you want is hidden behind a paywall.

I really wish they would get with the times. So much opportunity for them.

Like · Reply · 4w

**Norman Elias** Frustrates the hell out of me. Even as a Life Member, I've paid my dues over the years. I don't want to fork over exhorbitant fees to access papers like these. IEEE is a common link among all of us. The internet opens the door for all kinds of interaction among us. IEEE could expand Collaberatech into a virtual image of itself, one that hosts conferences online where we can exchange peer-reviewed publications freely, one that can link us to experts in all fields of electrical engineering, one that...the sky's the limit. And their cost for doing this should be minimal - pay it with advertising from companies just like they can collect fees today for booth space at a physical conference.

There may always be a need for physical presence at conferences but there are only so many that anyone can afford the time and money to attend. A virtual IEEE can open that interaction into almost a daily opportunity and reduce the vast array of conferences to a manageable number that doesn't have to continuouly extend deadlines in order to capture enough papers for future survival.

Like · Reply · 4w · Edited

**Stuart Wood** It's anyone willing to post a measured data set for the impedance of a winding with the secondary shorted. It would be nice to use real data to model.

Like · Reply · 4w

**Ray Ridley** Stuart Wood give that a shot tomorrow if we remember.

Like · Reply · 4w

**Stuart Wood** Ray Ridley that would be greatly appreciated!

Like · Reply · 3w

**Ray Ridley** Sorry Stuart Wood, we've had our hands full with office closures, APEC nonsense, and health issues. We have a paper with the data in it, but no time to go dig it out....

Like · Reply · 2w · Edited

**Stuart Wood** Ray Ridley when ever you have the time it would be appreciated. I just want to prove that the curve fitting program will handle data taken from a real component.

Like · Reply · 2w

Write a reply...

with primary shorted. Look at the PDF in the zip file. http://www.verimod.com/.../Mutual_Impedance_Transformer... Keep in mind that no RL network can model both open-circuit and short circuit impedances unless a coupled network is set up to model the mutual resistances.

Like · Reply · 4w

2

Hide 16 Replies

**Ray Ridley** Bryce Hesterman not sure what you are trying to say here. Is this a suggestion that the models we are using are not useful?

Pretty bold claim about Dowell and his work if so.

Like · Reply · 4w

**David Edwards** . Hello Ray Ridley and Bryce Hesterman,

I think Bryce is intimating that you cannot model all transformer loss with a single network. This, of course, is neither a problem nor an issue nor against your expectations, which presumably are that one must create one LR network for winding loss (in series with current) and another RL network for core loss (in parallel with voltage).

I think that (non-physical) mutual resistance may be a useful concept when one is modeling a transformer with linear algebra. However, when visualizing (and modeling) what is actually going on physically regarding transformer loss, mutual resistance is a misleading concept in my opinion (but perhaps I don't fully understand it).

Take all of the above with a grain of salt.

Like · Reply · 4w · Edited

**Bryce Hesterman** Ray Ridley What I have been trying to say is that Dowell's work applies to a special case in magnetics, and magnetics that don't fall within the parameters of that special case can't accurately be modeled with Dowell's method. His paper is very clear about what is required to be in this special case. (1) The magnetizing inductance is so high that magnetizing currents are negligible. This rules out magnetics with gapped cores or low permeability cores. (2) The H-field is parallel to the winding layers. This rules out magnetics with windings that produce distorted fields. For example, a one layer primary with full-width and a one-layer secondary with half of the layer full. If the secondary of that example keeps the same number of turn, but is spiral wound to fill the full width of the primary, then Dowell's method is reasonable. (3) The MMF has to have defined patterns of where the MMF is essentially zero. This rules out transformers with parallel-connected windings, and transformers with independent loads on seperate windings. What you need to make Dowell's method work with multiple windings is (a) that all primary windings are connected in series, and all secondary windings are connected in series, with no currents flowing out of the junctions of the series-connected windings, or (b) the loads on two series-connected windings with a current flowing out of the junction are identical in magnitude such as a center-tapped rectifier, but you have to think carefully how to apply Dowell's method in that case. It all boils down to understanding the MMF diagram. Now, suppose you apply Dowell's method in cases that doesn't comply with Dowell's assumptions. The result will most likely be the the losses will be under-predicted, but that is far better that having not tried to predict proximity losses at all.

Like · Reply · 4w

real as Ohm's law. I plan to write up something to better explain mutual resistance, but this will take some time. Here are some examples that may help in the meantime. Suppose you have a primary winding and a secondary winding and a high reluctance core. If you measure the ac resistance of each winding, they will both be fairly high. If you short the secondary and measure the primary resistance, the ac resistance is way down because the secondary current creates a field that decreases the H-field in the primary. Dowell's method works well for predicting the effective resistances of both windings. Now suppose you have a primary winding and two secondary windings with independent loads. The effective ac resisitances of each of the windings will depend on the current distribution between the two secondaries because the field cancellation depends on all three currents. Dowell's method doesn't apply here because the proximity effect depends on the ratio of the secondary currents. Mutual resistance is the mathematical way to account for the losses in this case. You can implement SPICE models that are set up to model mutual resistance, such as the ones in my link.
http://www.verimod.com/.../Mutual_Impedance_Transformer...
One of the benefits of using this type of model is that the leakage inductance effects on diode turn-off ringing are greatly reduced compared to two windings with a coupling coefficient, and are much closer to reality. Thus, by adding a few components, you can actually greatly speed up simulations. Another benefit is that you can model windings that are connected in parallel and see how the currents are distributed and what the ac losses are. I think my next step will be to create a Mathcad file and SPICE models for a three-winding case. The SPICE models will show how the ac resistances of the three windings changing with the ratio of the secondary currents, just as occurs in a real transformer.

Like · Reply · 4w

**Ray Ridley** Of course Dowell's is not perfect. Perhaps that means that everyone should go back to the 1890s and just deal with dc resistances?

Like · Reply · 4w

**Bryce Hesterman** Ray Ridley Please read my final comment of my last reply to you. The bottom line is that if you miss-apply Dowell's method, you will be far better off that not having used it at all, even if the results aren't quite right.

Like · Reply · 4w

**Ray Ridley** That is why we don't misapply it. 😎

Same could be said of Ohm's Law - if you misapply it, better off that you don't use it?

Like · Reply · 4w

**Ray Ridley** I don't really see how using Dowell's can get you in trouble. Worst case if overestimates the loss?

Like · Reply · 4w

Once I had hardware in hand, I would take various impedance analyzer measurements and tweak the model to match, taking symmetries and asymmetries of winding structure into account (for allocating leakage and interwinding capacitance).

As a thought experiment, imagine a simple 1:1 two winding transformer with a shield between the windings. The shield will have no transformed current, but will have proximity currents at higher frequencies. This case may require adjustment of your models.

PS to Bryce Hesterman: the Facebook user interface is annoying, but you can start new lines with ctrl-enter. Just touching enter immediately posts your message. If you are not done, then to edit the message, you must click the ellipsis (three dots) that appear when you hover the mouse pointer over the center of the right edge of your message.

Like · Reply · 4w · Edited

**Ray Ridley** If you are not sure about these little things, Google as always is your friend.

Like · Reply · 4w

**Ray Ridley** We are trying to move the world away from dc resistance to starting to use the results of Dowell's. It is a big step.

One of the barriers to this is that researchers are always talking about how they have something better than Dowell's. Regular engineers see that and they are confused. So they stick with dc resistance.

Get with the program here and help the process of moving the industry forwards.

DC Resistance - Good, better than using zero.

AC Resistance from Dowell's - Much better, can show 10x loss (for example)

Other esoteric methods - better again (maybe) you can see there is still argument about all that. It's what academics do.

Like · Reply · 4w · Edited

**Norman Elias** David EdwardsYou may also use alt-enter.

That's what I just used to skip to a new line.

I typed ctl-enter to skip the above lines. Some GUI's will skip lines if you type shft-enter,

I just used that successfully here. I don't recall having so much success with these prior to tonight. Maybe FB has improved it's GUI.

Like · Reply · 4w

**Norman Elias** Ray Ridley I agree with your message. The engineers need to use the tools they have with confidence and with discretion. As you've said consistently, engineers need to limit their reliance on simulation and conentrate on their laboratory prototypes.

Let those of us who work on the design aids spend time arguing over the best methods. When we are in agreement we can install our best choices in our tools. That's how BJT models advanced from Ebers-Moll to Gummel-Poon and that's how we can move on from Dowell to the next improvement and the next one after that.

I'm sure you'll swap-out the Dowell's model when you're convinced that there's something better that your customers should use. Nobody with any sense would keep replacing the model every time someone claimed to have something better.

Like · Reply · 4w

I think I am beginning to see the light. . .

Imagine a transformer with windings all with the same wire size, with one primary (two layers) and two secondaries (one layer each) one wound on top of the other. Now consider current distribution at a frequency such that the skin depth is a fraction of the wire diameter. This condition falls on the far right of Dowell's curves, but it is still important for realistic damping of ringing.

The MMF curve in the z-axis across the winding build is easy to draw and it is easy to calculate the reflected proximity currents in each winding by inspection. The proximity currents in each winding depend in part on the currents in the other windings. Proximity effects are not symmetrical between the two secondaries. This can be seen by examining the currents when only each secondary in turn is conducting current (as you have previously noted). To easily see this would probably require a simple diagram of MMF and current across the winding for the two cases.

After some more introspection I may draw up an LTspice schematic that is physically based to illustrate this situation. Of course, none of this is new information to you, but I wanted to let you know that I have at least partially absorbed the idea you are touting.

I still take issue with the term mutual resistance as being highly misleading (bad marketing for selling your idea) as it evokes coupling parallels to mutual inductance (which will close many minds before they have given the idea a chance). Perhaps a better term would be "shared resistance." Maybe someone will suggest something even better.

Like · Reply · 4w

**Bryce Hesterman** David Edwards I'm glad that it is starting to make sense for you. Slogging your way through Spreen's paper should make the three winding transformer examples more clear. There is a historical body of literature going back to the 1940s that uses mutual resistance, which is just a subset of mutual impedance. I don't think it would be helpful to create new terminology. My goal is to help motivate people to think of transformers in terms of linear algebra because it opens the way to gaining considerable insight that is available in no other way. Thinking in terms of fields provides another kind of insight. Thanks for the Facebook tips. I don't know how to do the same things on my phone.

Like · Reply · 3w

**Norman Elias** If you just think back to the mesh analysis problems you solved in your undergrad circuit analysis course you'll see that there's generally nothing magical about mutual resistance. It's just a resistance that appears simultaneously in adjacent loops. In the equivalent circuit for a two windiing transformer the mutual impedance will have a real part even if you just model core loss.

Additional losses such as skin effect or proximity can only be modeled by adding more resistance to the circuit model. The closer your model topology comes to the physics of the device the more accuracy you'll get from your simulations. Proximity effects mean adding mutual impedance between adjacent turns of the windings. The Mombello paper introduces a model that comes down to increasing the real part of the mutual impedance between the main primary and secondary of the lumped element model. It's one step better than an R-L ladder added to individual windings.

**Like** · Reply · 3w · Edited

Write a reply...

Write a comment...

**Ray Ridley**
Admin · January 21, 2019

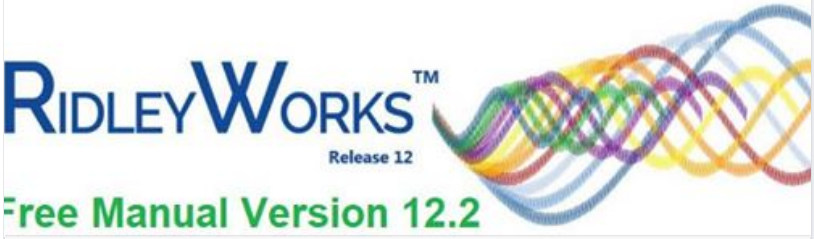
Power Supply Design - New RidleyWorks Manual

You can now download our latest RidleyWorks software manual for free. Take a look at this - you won't find anything that even comes close in terms of designing, modeling, analyzing and simulating your power supply for you. You can simulate instantly any power level, and it selects all the power components for you, including the magnetics.

Unlike IC vendor software, you don't have to choose a part before you can do any design.

Trade off topologies and control choices faster and in more depth than you ever though possible.

http://software.ridleyengineering.com/…/RidleyWorksManual.p…




13 26 Comments

Like Comment

**Scott Styles** ..ANY power level.... Really?
Like · Reply · 1y

**Ray Ridley** Thanks for noticing that Scott Styles - name your power level!
Like · Reply · 1y

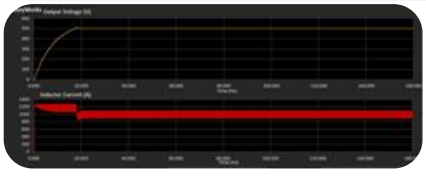
**Graham Ward** Go on Scott, tell him what power levels you're more accustomed to engineering...
Like · Reply · 1y

**Scott Styles** not a boast or brag Graham, but Ray I guess it does go to raise another question which is 'what size stuff are people on here working on/with? (our stuff is typically a few MVA made of few hundred kVA chunks)
Like · Reply · 1y

**Ray Ridley** That's great Scott Styles, nice to have you aboard!
Like · Reply · 1y

**Ray Ridley** Power is power - we all face the same issues it just comes in different sizes, and at different frequencies. Now some of more of you big boys are here, we can have some meaningful discussions about the different ways of doing things, and the challenges we all face.

Can we simulate your systems? Sure, here is a 500 kW buck converter simulation, switching at 5 kHz.



Like · Reply · 1y

above 20 kHz. And at the low end, they are working on converters of less than 1 W. So they are already covering 5 decades of power, you are adding two more.

There are quite a few of you working at your power levels, you are not alone here.

Like · Reply · 1y

**Ray Ridley** Let me ask you the question, Scott Styles - what is your switching frequency for a couple of hundred kW? It would be useful data for me.

Like · Reply · 1y

**Scott Styles** Ray Ridley 4kHz typical for systems with nominal DC link of 750V. This has been arrived at due to combined constraints of multi source IGBT selection, practical reactor design and digital control issues. Same-same as VSD's really....

Like · Reply · 1y

**Ray Ridley** OK thanks, Scott Styles - and that's for a nominal 250 kW type block?

Like · Reply · 1y

**Scott Styles** Ray Ridley pm'ed you

Like · Reply · 1y

**Richard Payne** Will Sic replace igbt for higher frequently?

Like · Reply · 1y

Write a reply...

**Bob Gudgel** Copyright ©1991-2018 Ridley Engineering, Incorporated
Happy New Year !

Like · Reply · 1y · Edited

**Norman Elias** There's a time and a place for everything. You might try something like this. Start with RidleyWorks before you select a semiconductor part. This tool is not selling a chip. Use trusted semiconductor sites to help select a chip for the application you identified. Then build and test hardware in the lab.

Like · Reply · 1y

**Ray Ridley** Exactly Norman Elias, thanks for noting that. All of the other design programs need you to pick a controller first - crazy! Do the big picture design first, then pick your controller from the thousands that are out there. The industry in general has this very backwards.

Like · Reply · 1y

**Ray Ridley** But hey, the software is free - what do you expect at that price?

Like · Reply · 1y

there before you've made that choice. Use their tool to help design the power supply and then test the result in the lab. There are limits to the simulations and to the models of the controller chips. Those models that I've written are tested for startup, steady state, line transients and load transients at a few input voltages and load currents. Hazard conditions and recovery modes are rarely

Trust the simulation models but verify the predictions in the lab with the real thing. Please excuse me for commercializing a little but simulation modeling is my specialty. I'm glad for a chance to share some advice publicly. I'm even happier to offer services that justify a fee - Have computer, will model (hardware, not fashions 😉..

Like · Reply · 1y

Write a reply...

**Barry Zitting** Hi Ray - which file do we download to update our files to the latest (paid-for) installation?

Like · Reply · 1y

**Ray Ridley** Which version do you have Barry Zitting?

Like · Reply · 1y

**Ray Ridley** We are on Release 1220 right now.

Like · Reply · 1y

**Barry Zitting** I last updated to 11.06. Is the key still good?

Like · Reply · 1y

**Ray Ridley** Good to 2021. Will email the download info to you.

Like · Reply · 1y · Edited

Write a reply...

**Stuart Wood** Ray Ridley, will you be updating the free version of the buck converter? It appears to not want to work with Office365 64bit version.

Like · Reply · 2w

**Ray Ridley** Maybe time to get the real version?

We will be doing this, but dealing with a huge amount of issues including health concerns, APEC nonsense, moving to new office space, and so on.

Like · Reply · 2w

**Ray Ridley** Seriously group members - help Ridley Engineering survive these difficult times we are entering by buying some software from us. 😎

Like · Reply · 2w

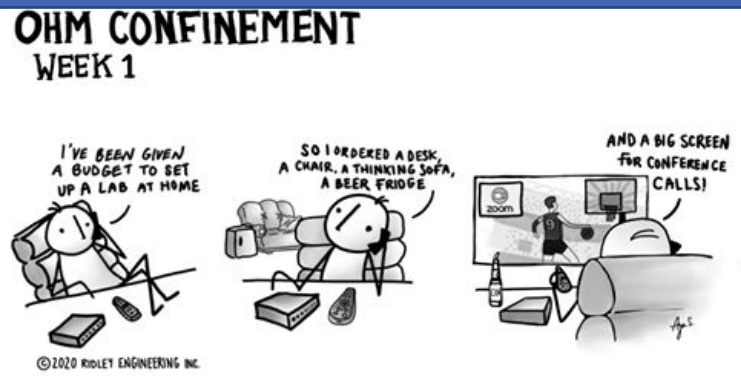
**Stuart Wood** Ray Ridley I keep trying...

Like · Reply · 2w

Write a reply...

Write a comment...

**Ray Ridley**
Admin · March 11 at 2:46 PM




You, Phil Lane and 55 others — 17 Comments

Like — Comment

**John Beecroft** We are many! Just gotta remember to wear a shirt when on a teleconference.

Wow · Reply · 3w

**Ray Ridley** And don't stand up.

Haha · Reply · 3w

**Scott Styles** google 'the oatmeal working from home' 🙂

Like · Reply · 3w

**David Sands** No mention of this little beast that I saw in the latest Ridley Newsletter? Seems like this with a power supply would be all a home lab needs...


Like · Reply · 3w

**Ray Ridley** mmmm..... I wonder what that box on our character's desk might be.....?

Like · Reply · 3w

**Norman Elias** Maybe a router.

Like · Reply · 3w

**David Sands** Ray Ridley Expensive beer coaster? 😂

Like · Reply · 3w

**Ray Ridley** David Sands it does EVERYTHING.

Like · Reply · 3w

**David Sands** Ray Ridley Sure looks like it. If only I hadn't just purchased a Keysight scope 🙂

Any examples of where a 4 channel FRA comes in handy? Used the AP300 at my previous workplace but mostly for checking current mode bandwidth on buck converters...

Like · Reply · 3w

changing any hardware.

It's very convenient when debugging a loop.

Like · Reply · 3w

**David Edwards** ☕. Hello Ray Ridley,

With all those inputs I suppose the new RidleyBox can measure just about everything on a transformer (unlike a simple impedance analyzer - although some have a second set of inputs just for transformers).

Like · Reply · 3w

**Ray Ridley** We set one up with 2 impedance test stations configured. Have to be careful though - they do talk to each other and load the source differently.

But yes - you could measure a 4 winding transformer very nicely with just a change of SW settings.

So much can be done playing in the lab. However, until we get the world used to measuring transformer impedances.....

Like · Reply · 3w

Write a reply...

**Alex Berestov** With all do respect. It's as good as a Swiss knife is. On the other hand tailored to the task loop analyzer - priceless.

Like · Reply · 3w

**Thomas Mathews** The difference between the amount of equipment you need for a real electronics lab and what somebody in accounting thinks is frightening.

Like · Reply · 3w

**Ray Ridley** A nail in a piece of wood comes to mind.....

Like · Reply · 3w

**David Edwards** ☕ Hey, Ray, on Mr. Stick's beer we can read "COR". That wouldn't be a CORONA beer, would it? Of course it would!

2

Haha · Reply · 3w

**Ray Ridley** Amazing how quickly this went out of date - no conference games to watch within a day of posting.

Stay tuned for week 2.....

1

Like · Reply · 2w

Write a comment...

**Clive Harvey**
☕ Conversation Starter · March 6 at 6:19 AM

Hello all, next question.

So I'm working through a datasheet for a boundary mode flyback.

I'm at the compensation network and there's no imperial method, just an iterative approach.

I've not yet looked about measuring designs phase margins on ltspice, can anyone point me too any documents that give an approach?

Like Comment

**Ray Ridley** It's a dcm Flyback. Slight shift in gain that's all.

In our software take the converter to just in DCM and you get the right functions.

I believe basso May have done the expressions.

Like · Reply · 4w

**Clive Harvey** Ray Ridley your SW seems to rely on a fixed frequency?

Where the frequency varies in boundary mode, as I understand it.

Also, as this is isolated and primary side voltage sensing, does this effect the values for the compensation network?

Seems like the snubber choice has an effect.

I think also any filter added too the current shunt also would.

Like · Reply · 4w

**Ray Ridley** The change to variable frequency is just a slight gain shift that I referred to.

The problem with all DCM flybacks is that the measurement don't match too well with the theory. The ringing in DCM affects things in ways that no one has ever analyzed.

Agonizing over the correct gain is the least of your problems 😎

Like · Reply · 4w

**Paul Shepherd** When I worked on a DCM flyback, I found that all of the different diodes (primary-clamp and secondary-rectifier) had major effects on the ringing behavior, and that "standard" parts from different suppliers did not behave the same. Unfortunately this tells me that simulation won't accurately predict these behaviors.

Like · Reply · 4w

**Clive Harvey** Paul Shepherd so best to just build one and tune it?

Like · Reply · 4w

**Ray Ridley** Clive Harvey absolutely. You will always have to do that. Hardware is never perfect and revision on the bench is the best way.

Confirm with theory when you find the time.

Like · Reply · 4w

**Clive Harvey** Ray Ridley my normal approach is ball park with sims and then fine tune with reality,

I'm wounding if in this case it's just tune.

Like · Reply · 4w

Write a reply...

**Ray Ridley** Build the spice circuit with a feedback loop. Measure the switching circuit as our software does. Get psim if you want to speeed it up.

Have to decide whether you want to write a PhD or just ship some rugged product.

Like · Reply · 4w

done have the time to go into every detail.

We just need good confidence in the values being reasonable.

When you say measure as your SW does, how do I see its method?

Like · Reply · 4w

**Ray Ridley** The LTspice code is right on the schematic.

Like · Reply · 3w

**Clive Harvey** Ray Ridley I still haven't been able to get the LTSpice to export?

Like · Reply · 3w

**Ray Ridley** Clive Harvey ssend is the file

Like · Reply · 3w

Write a reply...

**Yuri de Klerk** IWatt uses internal compensation and some sophisticated primary voltage sensing at the 'knee' of the reflected pulse. I used IW1760B for an 80W design. Never got into control details however. Did you consider such part ? I think others make similar parts with internal compensation.

Like · Reply · 4w · Edited

**Col Johns** Clive Harvey - yup snubbers do have an effect on boundary mode point - but as they add loss they should add damping to the power stage to make it easier to compensate - unless you particularly need stellar load step performance - BCM & QR flybacks are very easy to compensate ...

Like · Reply · 3w

**Clive Harvey** So one issue i have been having in simulation is the output voltage had massive ripple and loss of noise.

The same design running in DCM around 200mV @2kv, vs boundary mode at >20V @2Kv

Upping the output capacitance 10x still had little improvement.

Like · Reply · 3w

Hide 23 Replies

**Ray Ridley** Clive Harvey can you account for the increase?

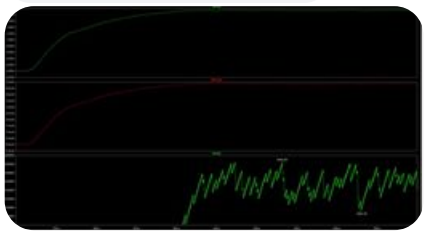
Like · Reply · 3w

**Clive Harvey** Ray Ridley I'm just doing some sims and screen shots now to show.

But this is something to do with the control loop and at very low frequency,

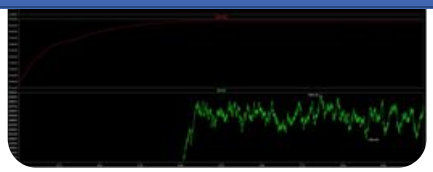
Like · Reply · 3w

**Clive Harvey** 75n output cap



Like · Reply · 3w · Edited

**Clive Harvey** 750n output cap



Like · Reply · 3w

**Clive Harvey** as we can see the peak to peak at 75n is around 9V an at 750n is around 30V.

Like · Reply · 3w

**Col Johns** the control is being affected by something - RFI ..? - yes - most likely ...

Like · Reply · 2w

**Clive Harvey** Col Johns what do you mean by RFI?

Like · Reply · 2w

**Col Johns** radio frequency interference caused by the power ckt getting into the control ckt - we deal with this A LOT on equipment sent to our lab, which is a "nearly working" design ...

Like · Reply · 2w

**Clive Harvey** Col Johns this is an LTSpice simulation though?

Like · Reply · 2w

**Col Johns** In that case there is some LTSpice produced ringing ( usually at higher pulse width ) affecting the voltage seen by the f/b loop coupled with too high a gain some where in the control ckt...
i.e. o/p diode ringing - is the graph shown at light load ...?

Like · Reply · 2w · Edited

**Col Johns** Is it a current mode control of the peak pri side switch?

Like · Reply · 2w

**Clive Harvey** Col Johns this is my concern, Ive tried a few boundary mode controllers and all have some sort of low frequency control issue like this in simulation.

Is this just LTSpice being annoying?

This is a automotive qualified part, I struggle to believe it would have issues like this in real life?

The design process isn't complicated enough for me to have somehow got the values that wrong.

Like · Reply · 2w

**Col Johns** Most likely LTSpice playing up yes - without seeing the ckt and the voltages at the various nodes - definite statements are hard to make. In spice though - lots of snubbers are a good idea to make it behave stably ...

Like · Reply · 2w

**Clive Harvey** Col Johns I posted a screen shot of the circuit. What I have there is the test fixture with tweaked values.

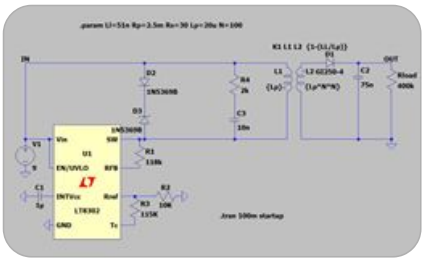
Like · Reply · 2w

**Col Johns** Sorry I have not seen that screen shot ...

Like · Reply · 2w

**Clive Harvey** It doesn't seem too have uploaded, I'll attach it.

Clive Harvey



Like · Reply · 2w

**Col Johns** If the PIV is exceeded on the o/p diode it will break down in spice just as per the real world - and cause issues - a wee bit of filtering RC on the FB pin seems sensible too.

Like · Reply · 2w · Edited

**Clive Harvey** Col Johns ok, I'll take a look at that, it's a 4.5kv diode, I'll try upping it.

Like · Reply · 2w

**Col Johns** For that particular diode - the Trr is 2uS, so I wouldn't run it faster than 5kHz in the real world ... look at the currents in the diode and the Tx pri...
also with a 1:100 turns ratio you only have 20V of flyback volts on the pri side - this means the diode will see 900V at turn on - for 9V vin plus 2kV of Vout plus any spikes ... !

Like · Reply · 2w · Edited

**Clive Harvey** Col Johns the real world diode I'm using is the 2x series R5000F but now I look for it, the datasheet doesn't give a Trr, I wonder if I've given myself an issue here?

Like · Reply · 2w

**Christopher Richardson** Hi Clive Harvey, if you have a contact at Analog Devices, ask them for information about performing Bode plot analysis in LTspice. I worked as a Linear Tech-dedicated FAE at Arrow for a few years, and I helped update the section of the LTspice seminar dealing with this. It takes a long time because the software has to run a sim for each frequency point, but it can be done. Hope that helps!

Like · Reply · 2w

**Clive Harvey** Christopher Richardson would this be to plot the control loop response to a single in the feedback path?

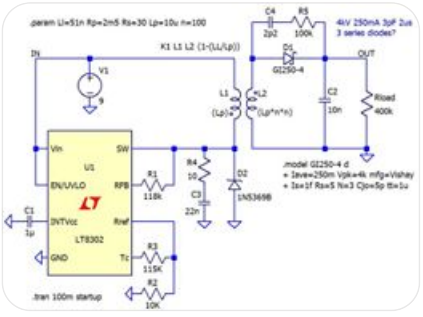
With this particular controller I'm not sure how easy that would be too do.

Like · Reply · 2w

Write a reply...

**David Edwards** . Hello Clive Harvey,

Perhaps your transformer inductance is too high. Also you need RC snubbers across the switches (IC SW and output diode), not across the transformer.



Like · Reply · 2w

**Matic Uršič** shared a post.
March 15 at 8:27 AM


23,010,943 Views

**David Guetta**
March 13 at 10:20 AM

Like Page

Don't forget to clean up the amplifier guys 🤣🤣🤣

You and 25 others — 14 Comments

Like | Comment

**Soumya Chatterjee** I wonder will it be able to run again.. Some CRC expert please give light
Like · Reply · 3w

**Jesus Elias Valdez Resendiz** Yes, it will. Just need to be very dry
Like · Reply · 3w

**Jared Bevis** I'm guessing may have been involved in a flood. Water is used in final cleaning process for pcbs... Just make sure to bake it out and may actually work.
Like · Reply · 3w

**Milovan Kovacevic** Not any water. Distilled water.
As low amount of impurities as possible, otherwise they will stay on the board and with some help of humidity in the air cause failures in the future.
Like · Reply · 2w

**Paul Shepherd** Maybe its got a conformal coat? 🤒
Like · Reply · 3w

85°C and after some hours in the owen , direct ino a vacum chamber. the water boils off and the unit will work again. My firs job in my career was in a workshop for mostly servo amplifiers and industrial motor and control systems. we had to wash of conductive dirt and cooling water oil remains from the electronics...

Like · Reply · 3w

**Ratna Joshi** Conformal coating and heating after washing may work

Like · Reply · 3w · Edited

**Sharif Kidwai** Effective flux removal 😆

Like · Reply · 3w

**Broox Le** Yeah, just slip it in the oven on low for a few hours after. Water & wetting agent washing is still used as part of many PCB post-soldering assembly processes.

Like · Reply · 3w · Edited

**Shubhangi Tewari** Arvind Sivakumar thoughts?

Like · Reply · 3w

**Mike West** we had a problem at a place that I worked in the late 90s. We were getting pot core power transformers (I never have cared for pot cores in power applications) back from a customer (mil-world) that were literally fragmented to pieces. I was the low guy on the experience chart and came out of the commercial world...so I wasn't allowed much input until I asked the customer what their process was. They went from board stuffing/soldering, to washing (in a re-purposed dishwasher) to thermal cycling. I asked which way their thermal cycle went...then suggested that they might consider reversing the journey to go to the high side first. It seems that I was the only one who knew that the history of pot cores started out as 4 pieces...2 rings and 2 flats...and then some bright guy at Bell Labs figured out how to press them in 2 piece sets as you see them today. Micro-cracks are the norm in the sintering process and the water was forced into the cracks during wash cycle...and didn't work and play well with others on the -55°C temperature excursion.

Like · Reply · 2w

**Dan Cousin** Cleanup before selling on Ebay.

**Like** · Reply · 2w

**Doddapaneni Venkata Nagesh Babu** Similar was truly happened 20 years back in my old company

Like · Reply · 2w

**Gaurav Kajavadara** Apurva Randeria

Like · Reply · 2w

Write a comment...

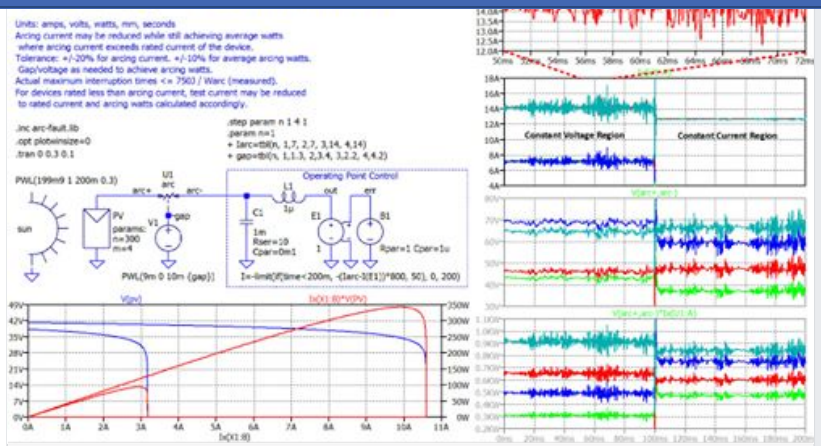
**David Edwards**

Conversation Starter · March 14 at 10:45 PM

⚡ Arc-Fault Anomaly ⚡

The attached figure shows a simulated array of 5x4 60-cell PV panels. On the bottom left is the PV curve for one panel at both full sun and 0.3 sun. This curve matches a "square" output panel with a very steep constant current section of the curve. On the right side is a plot of the array under full sun running the four standard arc-fault test sequences. At the middle of the plot insolation drops to 0.3 sun and the controller voltage drops to 50 volts. This forces the array well into its current source region.

Notice how the arc-fault current signal practically disappears when operating in the constant current region of the PV array, yet the array differential voltage signal remains strong. Partially shaded panels can produce arc-faults that are undetectable with standard methods. Arc fault detectors should include both current and voltage inputs (the voltage inputs could be coupled with safety Y-capacitors).




You and 8 others 11 Comments

Like Comment

**David Edwards** This anomaly is not just theoretical. I have verified this detector "blind spot" in the lab with our PV array and an actual arc-fault.

The arc model uses a physics based negative incremental resistance arc model. Arc voltage and current are both affected by gap length. The model varies gap length chaotically about the nominal.

Like · Reply · 3w

**David Edwards** Many group members have designed or worked with photovoltaic power conversion systems. Many of these are prone to unmitigated arc-faults because they create high voltage dc with a current source characteristic when shorted. PV panels are powered by the sun so they are difficult to "turn off." For these and other reasons arc-fault physics, detection and safe interruption is of interest to many power conversion engineers.

UL 1699B is the controlling standard in the USA for arc-fault detection and interruption, but the field is in its infancy and the standards, test methods and mitigation requirements are continually evolving.


2

Like · Reply · 3w

**Sanchit Mishra** I had a question. Partial shading can be a fast phenomenon (milliseconds) while arc testing is significantly slower detection (seconds). Doesn't that eliminate this ?

I always thought the worst case "non detection" was panel to panel arcs which goes undetected as you don't measure all the inter-panel currents or voltages, thus have no information about what is going on. Didn't assume partial shading caused any major issues due to the difference in time spans of shading vs detection.

Like · Reply · 3w

make some arcing much harder to detect. Many cases of partial shading can be long duration (bird droppings, leaves, etc.).

Most arc-fault detectors only target series arcs inline with the main power path. Parallel arcs to grounded metal are another phenomenon altogether and may be undetectable by some series arc-fault detectors.

PV system safety evolved from when panel voltage was just above the battery (12V or 24V) and charging was controlled with a relay switch. Significant arcing was not possible in those low voltage systems and shock hazards were low, so the only safety measure was a one amp ground fault detector.

Like · Reply · 2w

**Brian Faley** I've worked with three IC manufacturers who were all targeting developing a chip to do the heavy lifting of accurate arc fault detection. Unfortunately, they all abandoned the market, because the standards are ill defined and changing, pretty much blind to parallel arcs, and the liability issues drove them all to abandon the efforts. So David Edwards, what have you come up with to solve the parallel issue? Series is possible, especially if the detector lives on the roof near the panels. It's not as prone to the attenuation issues. In my opinion, any solution requires measuring current and voltage, it's all about the energy, and that means simple solutions aren't going to have the horsepower to do the math.

Like · Reply · 2w

**David Edwards** . Hello Brian Faley,

I don't have a general solution (only a series arc detection solution for a specific product - and the company from which I retired was unwilling to pay to have it tested and certified). Regarding parallel arcs - never worked that problem.

What I do know is that the incremental resistance of a panel can vary (depending on operating point) to where sensing for chaotic current becomes useless in a panel's constant current region. This has been completely overlooked and is why voltage (or perhaps power) sensing is needed at the panel level. All it would require is a differential voltage signal coupled through safety Y-caps summed in with the existing current sense, yet nobody is offering this.

I've developed a very accurate LTspice of an arc (difficult) and an array (easy), so testing out ideas is easy, but there is little motivation to do so.

Like · Reply · 2w

**Brian Faley** I've been through the arc fault certification gauntlet three times, and I have to say I think it's a racket. Each NRTL had their own take on the requirements, and were more than happy for us to spend money teaching them about how to conduct the tests, and everyone required more tests than were in the standard. Biggest gotcha was the arc fault board we purchased from the company that bought my former company was only tested to radiated emissions at 5kV per meter when the test of the inverter required 15kV per meter. That was fun.

Like · Reply · 2w

**Bob Gudgel** You BET that NRTL's are a racket ! The Mafia as someone near to me analogizes.
As for parallel arcs, a few years ago now, we (MidNite Solar) worked on that more or less successfully. For the simple case, series arc, you open up the system and parallel arcs, you short.

Another engineer and I went to Sandia Labs where they wanted to test the system which worked well in that scenario. Inside the array parallel arcs as well.

https://energy.sandia.gov/.../SAND2013-5916...

Like · Reply · 2w

seen some customers though with what they thought was a false trip but when we asked them to investigate, they found a bad connection which caused the trips.

One thing that causes real false trips come from the inverters and/or controllers that are controlling the PV array. Switching noise ! Ugh !

That is part of the art of making these work well. That is where a background in the audio industry and DSP came in handy

Like · Reply · 2w · Edited

**Brian Faley** Every major fleet operator of inverters I've known has disabled the arc fault detectors because of false tripping. Knowing the whole system helps, between the h- bridge grid tied inverters with their massive common mode noise, and the change controllers and battery inverters stomping all over the spectrum makes it very difficult to make anything work properly. There is great art making it work right. Even when your boss won't pay for you to do the right thing.

Like · Reply · 2w

**Bob Gudgel** And one particular GT inverter manufacturer from Austria has internal arc-fault. We were trying to work with them for rapid shut-down (something now required for US and Canadian PV systems as Brian and others here know about), that we could NOT get to detect a REAL PV arc. The company said that they were designed to work for the UL 1699B test.
That may be because their test uses (used ?) steel wool to start the arcing. Turns out that the material, copper, aluminum, steel makes different arc current noise and that may have been (or not) the problem. Most solar PV I know of uses real copper wire.

Like · Reply · 2w · Edited

Write a reply...

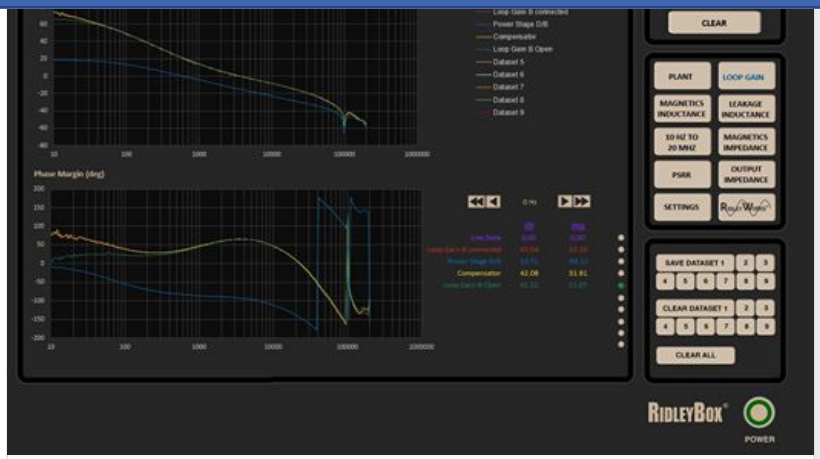
Write a comment...

**Ray Ridley**
Admin · March 13 at 7:26 PM

RidleyBox Fun

We are having more fun than should be legal with our new test equipment. Sweeping the frequency response of a power supply remotely from the comfort of home. We can change connections to measure the power stage, compensator, and overall loop remotely - that's where the 4 channels come in.

You can even control it with an iPhone.😎




Jay Philippbar, Brian Faley and 32 others 22 Comments

Like Comment

**Ray Ridley** I wish I had this capability when just starting out on my career. The next generation are going to be spoiled.

We asked conference attendees what they wanted most on a new analyzer and the young ones all really wanted to be able to run tests remotely.

The next generation of analyzers is all about ease of use and the software.

And yes, you can do all this with the AP310 as well. (Not the 4 channels though).

Like · Reply · 3w

**Broox Le** Sounds handy for software defined digital controllers where the control designer could be remotely working on the digital code tweaks and retesting the responses.

Like · Reply · 3w

**Ray Ridley** Its pretty timely for this age of working remotely in one way or another.

Like · Reply · 3w

**Alex Berestov** So one have to buy i device to have an operational unit

Like · Reply · 3w

**Paul Shepherd** Alex Berestov I don't think it's required, but wireless connections do generate less conducted noise!

Like · Reply · 3w

**Ray Ridley** Its an option, not a requirement.

Like · Reply · 3w

**Alex Berestov** Just kidding. I would love to get such a box.

Like · Reply · 3w

Write a reply...

**Paul Shepherd** Very exciting! Is there an official release date? Data sheet/manual reveal date?

Like · Reply · 3w

**Hamza Malik** I thought we couldn't market stuff in this group 🤔

Like · Reply · 3w

**Hamza Malik** Although i must say, this is something really useful

Ray Ridley It's our group, Hamza Malik.
Like · Reply · 3w

**Chris Roth** Ridley box available soon? I might have some budget from last year to spend 🙂
Like · Reply · 3w

**Ray Ridley** Projected ship date May 1.
Like · Reply · 3w

**Ray Ridley** Material is starting to appear on our website, much more to come. http://ridleyengineering.com/.../ridleybox-intro-2.html

RIDLEYENGINEERING.COM
Ridley Engineering | - Intro

Like · Reply · 3w

**Cameron Stewart** The older I get, the more I want to keep things simple. So perhaps I'm simply showing my age:

Why is it important to test a power supply control loop "remotely"? What's the advantage?

And how remotely? Across the other end of the lab? From home while the supply is at work?

I don't mean to diss the Ridley Box. But please: Someone enlighten me.

I remember when the remote control craze took over consumer electronics 40 years ago. I didn't get it then either.....

Like · Reply · 3w · Edited

**Ray Ridley** Cameron Stewart example: life and thermal tests running overnight at your office.

Lots of other ways to use this including customer support from us.

It's an option though. If you don't like it don't use it 😎

Like · Reply · 3w

**Cameron Stewart** Ray Ridley

Life and thermal tests running overnight: OK. I've done my time babysitting those kinds of tests.

Customer support: OK, I get that too.

Perhaps it's changing demographic preferences that I'm trying to understand. The "Young Engineers" you've mentioned: What's their motivation?

Like · Reply · 3w · Edited

**Ray Ridley** Cameron Stewart no idea. We just asked them last year at apec what features they really wanted.

iPhone control was high on the list for several of them

I can't help you with the inner thoughts of the young though if that is what you are asking 😎

Like · Reply · 3w

Well to be honest:

I spend far more time on the Internet with my smartphone than on my desktop or laptop.

I unplugged by TV ten years ago. Don't watch it.

I use my smartphone to keep up with the news, E-mail, social media, and for watching videos.

Perhaps I understand "the inner thought of the young" better than my old school thinking will allow me to .....

Like · Reply · 3w

Write a reply...

**Ray Mayer** But does it get HBO?

1

Like · Reply · 3w

**Ray Ridley** Netflix. Better.

1

Like · Reply · 3w

**Ray Mayer**

Like · Reply · 3w

Write a reply...

**Adam As**

March 12 at 7:57 AM

Write a comment...

Hello,

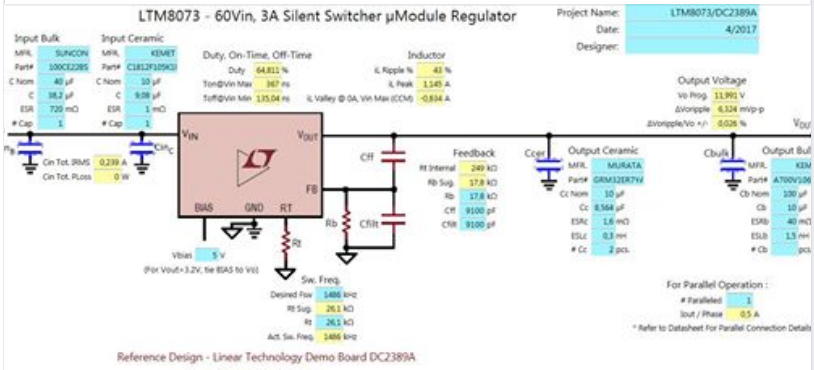
I'm designing a 12V/2A out, 20Vin buck converter. I used Analog Devices LTM8053 uModule for simplicity. In design I'm using the LTPowerCAD to facilitate work. When it comes to loop gain adjustment the program is insensitive for changing the capacity of electrolytic bulk cap.

Changing the ceramic capacity value I can see direct changes in loop gain plot, however while changing the bulk capacitance the plot is not changing.

Is this a program isue or it's true that for the loop gain only the nearest MLCC capacitance matters?

Another question - if from simulation I get the optimal for phase margin is to have 100uF capacity at output, then can I divide it in a way to have in paralell 10uF MLCC and 100uF Electrolytic? I blieve yes - because Capcaitance will be as required and ESR will be of MLCC while they are paralell connected.

Thank you for the advices

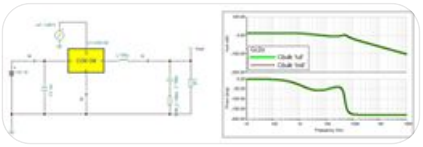


Like Comment

**Pablo Roberto Oliva** you have to specify de # of pcs, is the last row

Like · Reply · 3w

**Nicola Rosano** It is correct. If you're looking at the control to output transfer function, the input is virtually grounded' Then the Bulk cap is shorted (not visible). That cap by the way has huge impact on the input filter, as it alters Zin. If you use Vorperian approach you see easily.



Like · Reply · 3w · Edited

**Alain Laprade** I disagree. The bulk cap is always visible in a control-output transfer function, irrespective of whether it is voltage mode or current mode.

Like · Reply · 3w · Edited

**Ray Ridley** Confusion over which cap is called the "bulk" cap, I think.

Like · Reply · 3w

**Alain Laprade** "Another question" unclear to me. You may want to clarify. A parallel combination of ceramic/electrolytic is of course desirable. As to the influence of the bulk, the 40 mOhm ESR may be dominant (left hand plane zero). The bulk ESR will help with your phase margin, but do be cautious as to simulate the min/max values from temperature dependence to avoid surprises in the field.

Like · Reply · 3w

**Ray Ridley** Sounds like you just volunteered to look into this, Alain Laprade.

Like · Reply · 3w

**Alain Laprade** Ray Ridley Doooh!

Like · Reply · See Translation · 3w · Edited

**Ray Ridley** Lets be clear here. I think he is referring to the output cap Cbulk on the schematic. That should absolutely affect the transfer functions.

He is no talking about the input bulk cap. That will have no effect on the schematic shown since it is shorted by a voltage source.

In the real world, it will change things since there will be inductance between the input source and the cap, ie an input filter and Nicola Rosano has quite correctly pointed out.

Like · Reply · 3w

**Nicola Rosano** Honestly I have never called Cout (or Cfilter) = Cbulk. My fault if Alain Laprade was referring to that one. Obviously if Cout changes all transfer functions change: control 2 output, line 2 output and Zout and less intuitive Zin as well.

Like · Reply · 3w · Edited

**Adam As** Yeah, I ment the output electrolytic saying 'bulk'

Like · Reply · 3w

Can someone please go check out that it indeed has this problem, and get back to the group?

I can't do everything here - If you haven't actively participated in the group yet, its a good chance to step up and be a player. 😀

Do something good for the community here - it will come back to you manyfold.

Like · Reply · 3w · Edited

**Adam As** If someone had time, here is the link to the software from AD: https://www.analog.com/en/design-center/ltpowercad.html. Then one just need to select LTM8073.

ANALOG.COM
LTpowerCAD | Analog Devices

Like · Reply · 3w

**Alain Laprade** Hmmm. Problem statement should be restated. Well in that case, if Adam is referring to the input bulk capacitor, it can become visible in the control-output plot IF it is sized incorrectly and results in a condition where negative impedance oscillation (resonance between the EMI output impedance and the DC/DC supply's input impedance) rears its ugly head. IF the input bulk capacitor damping is selected correctly, a 100 uF or a 10000 uF won't be visible in the transfer function.

Like · Reply · 3w

**Ray Ridley** I guess I know how to kill a conversation in its tracks. 😲

1

Like · Reply · 3w

**Alain Laprade** Are we related?

Like · Reply · 3w

**Ray Ridley** Alain Laprade yes we are engineers. One of the needed innate skills.

Like · Reply · 3w

Write a reply...

**Christopher Richardson**
Write a comment...
March 12 at 4:57 AM

Transient protection: trust the forward voltage of a zener, or put a schottky in parallel?

Hi All - I'm looking for your general experience with protecting a low voltage pin (input to an ADC or low voltage buffer amp) against voltage transients, both negative and positive. Can I trust the forward voltage of a zener diode to clamp the negative transients? Or should I add a schottky in parallel? I have the space and budget for the schottky, but I want to know if it's worthwhile.

Thanks,

chris

1 17 Comments

Like Comment

**Andrew Ferencz** your question can't be answered without more information - how much energy in that transient? ESD, line disturbance .. where does the transient come from?

Like · Reply · 3w

withstand voltages are in -0.3V range. You can check from datasheet.

Like · Reply · 3w

**Stuart Wood** I prefer clamping schottky diodes to the rails like Akif Hakkı Polat said.

Like · Reply · 3w · Edited

**Oliver Sedlacek** Speed matters. Zeners are very reliable to the extent that they are trusted by authorities to form intrinsically safe barriers, but they are a bit slow for some applications.

Like · Reply · 3w

**Stuart Wood** Low voltage Zener diodes have very large junction capacitance that can interfere with signal integrity.

Like · Reply · 3w

**Kadir Yilmaz** Forget zener use two Schottky diode . One from ground to sense , the other from sense to ic supply voltage

Like · Reply · 3w · Edited

**Broox Le** For an analog input line, I prefer schottky clamps to the rails; I only use zeners or tvs when I don't have a rail voltage to clamp to or to prevent overvoltage on the rail.

Like · Reply · 3w

**Arief Noor Rahman** ☕ Agree...

Like · Reply · 3w

**Richard Payne** Broox Le yep

Like · Reply · 3w

**Brian Faley** Schottky diodes are fine for some signals, but beware the high leakage current at elevated temperatures on sensitive signals, and stay within the pulse current ratings. Also, the practice of using the power supply rails as a clamp-to voltage assumes the rail has the capacity to absorb the transient. Many LDO regulators don't like being back fed and lack reverse current protection diodes leading to a big voltage spike. Know your power supply. All depends on the amount of energy.

Like · Reply · 3w

**Nathan Ellis** Brian Faley good point. Would think you could mitigate this by just adding more decoupling capacitance to catch excess energy while keeping voltage low.

Like · Reply · 3w

**Brian Faley** Completely depends upon the amount of energy. This is a pretty classic problem where the solution has to address the problem statement. Prescriptive solutions are a dime a dozen. Be sure you know the side effects.

Like · Reply · 3w

**Charlie Elliott** ☕ Bat54s and RC for noise filter + swapmping S+H internal cap + helps with ESD and BCI etc.

Like · Reply · 3w

**Charlie Elliott** ☕ But as others have said, watch out for high temp leakage if high impedance node. Can be mitigated by using much higher voltage part than you need to some degree.

Like · Reply · 3w

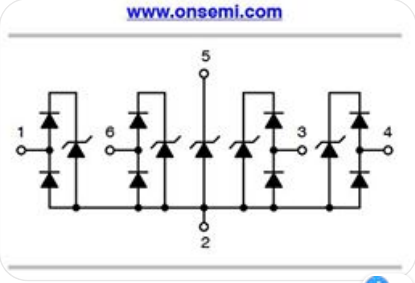
aborbed? What is the amplitude and duration? How much energy before the clamp fails? are you putting in a series impedance to help with the peak energy issues?

Transorbs and TVS parts can be big and bulky. A simple small zener might look good on a schematic but its not much use if it gets zapped by the first pulse that comes along.

Look at a good production power supply. There you will find good, well researched data with years of experience behind the design decisions.

Like · Reply · 3w

**Alex Berestov** A little bit of both. For instance: NUP4114. Cheers




2

Like · Reply · 3w · Edited

**Christopher Richardson** Wow, what a mix of emotions! First, as usual, all of your suggestions and ideas are both excellent and helpful. I hadn't even considered a second schottky to +VCC, I don't think I ever saw this done, or if I did, I didn't realize what it was for. On the other hand - I'm a bit embarrassed for not thinking of it. This forum is wonderful. To answer the questions, this input is the tap of a resistor divider for an electronic load, and I myself connect the DUT

**Atish Tailor**
March 10 at 2:50 PM

Dear experts,

I am doing some research in trying to understand the DC-DC converter used inside a Tesla powerwall.
I have made a bit of a guess as to what the basic internal blocks are.

On the HV side, the voltage variation is 350-550VDC.
On the LV side it charges a 48V nominal battery. This is a 5kW bidirectional converter.

This can't be a buck or boost variant converter as the conversion ratio is 13. This must be a topology with a transformer.

It is possible this could be 2 sets of Hbridges with a transformer in the middle as this would support Bidirectional DC power flow.
It could also be a half bridge on the LV side and a full bridge on the HV side as shown in second immage (save 2 mosfets).

Are there any other ideas as to the topology that could be a good idea provide upper 90% efficiency?

Maybe someone knows what's inside the Powerwall?

Many thanks for your comments in advance.

Write a comment...

11 34 Comments

Like Comment

**Davide Bagnara** it should be a ZVS at primary side and just an "active" rectifier at the secondary side... but we can wait some more expert feedbacks...

Like · Reply · 3w

**Atish Tailor** Your right it must be series resonant. Could this be achieved in a half bridge or would this have too big of an impact to the transformer which must already be large..

Like · Reply · 3w · Edited

**Riccardo Tinivella** At the beginning they were reusing the same.obc inside of car to keep the cost down. Is it liquid cooled?

Like · Reply · 3w

**Atish Tailor** Please clarify what obc is? Yes I believe its still liqued cooled.

Like · Reply · 3w

**Riccardo Tinivella** Atish Tailor obc is on board charger, from the input range can.be an Llc. Why output is 48 v?

Like · Reply · 3w

**Atish Tailor** LV side is 48V because that is the battery voltage

Like · Reply · 3w

Write a reply...

**Atish Tailor** I believe this could be series resonant to achieve zvs. Control scheme can be PSFB

Like · Reply · 3w

**Alex Berestov** There is no need for a "series" or "parallel" resonance to achieve ZVS. You need a current source i.e. inductor with enough energy to (dis)charge leg's capacitance.

Like · Reply · 3w

**Atish Tailor** I spent many years with SR but I never spent any time without the C in the circuit and only keeping the L. Can you kindly point me to a good reference document for this?

Like · Reply · 3w

**Brian Faley** Those who may know can't tell you. Buy one and see. Guessing is a waste of time. There are so many ways to achieve this bidirectional objective.

Like · Reply · 3w · Edited

guessing can put options on the table and lead to the right solution. It's all part of the learning we do every day and we are all init together.

Like · Reply · 3w

**Brian Faley** I think they initially adopted the 48V nominal battery voltage to duck under US NEC2014 household installation codes for battery systems, and because they were planning on the HVDC being connected to a standard transformerless grid tied PV Inverter it necessitated galvanic isolation on the battery side - to do otherwise would have been prohibitively costly because of all the cells requiring reinforced insulation between the cell and heat exchanger. They chose to implement a deadbanded droop control method of power transfer to make it compatible with PV inverters - surplus PV gets stored, and then used when the voltage falls low enough to trigger a discharge. The battery pack was adopted initially from a car - including the liquid cooling which requires an auxiliary isolated power supply for the circulation pump and battery heater, and internal electronics. Their gen 2 contains an inverter as well. Two huge things drive the power electronic choices: 1) COST, 2) Efficiency. All of these things are not guesses - they are observations from tear-downs, user documentation, and close study of regulatory requirements. I'd be surprised if the DC/DC converter efficiency is lower than 96%.

Like · Reply · 3w · Edited

**Atish Tailor** I cant understand why isolation would be a requirement? They could have made the enclosure out of plastic and said it's doubly insulated and no userservicable parts inside..

In the above case if the user was to use in a DC transformerless system, why are the solar panels allowed to be non isolated and the powerwall suddenly needs isolation?

You are correct we can estimate (or guess as I call it) the DC-DC is at 96% because overall its spec sais its 92%.
This implies its 96% for charging and 96% for discharging plus some auxiliary power consumption brings it to 92.

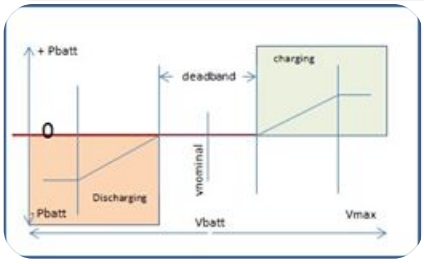
I there appears to be no teardown immages and videos.

Like · Reply · 3w

**Atish Tailor** Also what is deadbanded droop control? Kindly?

Like · Reply · 3w

**Brian Faley** See graph - for deadband droop control. It's widely used in DC microgrids. A variation is used for Freq/Watt protocols in AC grid distributed energy resources - DER.




Like · Reply · 3w

**Atish Tailor** Oh yes the dead band. This is controlled using 2 pins one that controls the direction and the other controls the power. The decision is made based on the measure of a ct at the incoming grid feed and optionally a timer based system. I hope iv not left or overlooked anything.

Like · Reply · 3w

Write a reply...

battery conversion.

I ended up mating a Weinberg Push-Pull converter on the low voltage battery side with a full bridge on the high voltage side.

The high voltage side required IGBT's so the internal body diodes could also be used as rectifiers.

The low voltage battery side required MOSFETs bypassed with schottky diodes as rectifiers.

There were two control circuits. An external transfer control determined which control circuit operated and which way power would flow.

Nothing ZVS or ZCS here and no synchronous rectification. The concept was to keep it simple with ordinary hard switching.

The design concept never made it passed the initial proposal stage so I never got to build actual hardware to make it work.

Maybe someday .....

Like · Reply · 3w · Edited

**Atish Tailor** Interesting concept to keep it simple. It would have been interesting to think what sort of efficiency this could be got upto..

Like · Reply · 3w

**Cameron Stewart** Atish Tailor

92% is quite feasible.

Like · Reply · 3w

**Atish Tailor** 92% charging and 92% discharging takes it down to about 84% overall thats the trouble.. if it was 84% and getting rid of lots of power components it would be ok maybe.. but if @84% it only makes the designers life easier, it's a hard one to sell in this day and age..

Like · Reply · 3w

**Cameron Stewart** Atish Tailor

So you need another 3% efficiency each way: 95% charging / 95% discharging for a total of 90%.

You probably need to either:

A) Run a computer simulation to get a better estimate of losses.

B) Build actual hardware and test.

Once you get something working, then you can take the next step: Optimization.

Maybe that means adding the synchronous rectifiers, and regenerative snubbers on the push-pull Weinberg, or migrating toward ZVS resonant on the full bridge side, or substuting Silicon Carbide Mosfets for the IGBT's.

And maybe it means doing all of the above.

My 92% number is simply an estimate of the minimum baseline performance you can get without optimization.

You need to start out simple and get something working first. Then work incrementally on the efficiency problem.

Like · Reply · 3w

**Atish Tailor** Some very nice advice there Cameron Stewart much appreciated. You remind me of a really humble gem that trained me and taught me what I know today.. Thank you.

Like · Reply · 3w · Edited

Write a reply...

isolation but greatly improved power densities (can then trade off volume for efficiency as desired)

Like · Reply · 3w

**Atish Tailor** This has also been on my todo list but I'm not sure if I will realistically get the chance to give it the time it deserves..

Like · Reply · 3w

**Alex Berestov** What a waste of resources and labour. First you build a city surrounded by the mountains so no fresh air comes in. Then you populate it with wealthy people so everyone gets big vehicle just to get around. Everybody starts to suffocate. Here comes the savior and orders to buy "clean at spot" ones and other unsustainable "greeny" stuff at the public expense.
Sadder than that are houses lost to the fires. Burnt to the ground each year and apparently built again at the very same place(s).

Like · Reply · 3w · Edited

**Atish Tailor** We never get to hear such stories in the uk.. but we have a grid demand problem at peak times and such a device solves that (no I don't have the option of suggesting to upgrade the grid. Be better to get people to pay for their own energy upgrade rather than government upgrading it)

Of course, I don't make the rules of economy, I just think of them and follow them

Like · Reply · 3w · Edited

**Alex Berestov** It's like making iron in a bloomery on your back yard.
Most grids do have rush hour generation capabilities times cheaper than power wall which needs WWW to operate.

Like · Reply · 3w · Edited

**Atish Tailor** The generators are not well distributed and loads are quite localised and they don't want to build new coal fired I believe hence this allows a distributed approach.. agreed it be better not doing a sticky tape fix.

Like · Reply · 3w

Write a reply...

**Alex Borisevich** first of all, everyone advertises a peak efficiency. so high 90% maybe only one operating point. average efficiency can be achieved by software simply by trying to run converter all the time around the optimal operating point.
then yes, please study DAB, there are ZVS conditions for both bridges in terms of operating points. also you can parallel devices in order to minimize conduction losses

1

Like · Reply · 3w · Edited

**Atish Tailor** So tesla say 91.8% at 3.3kW round trip. Ok they didn't give the full conditions and what would be great is if they did a power sweep vs eff and a DC V sweep against eff at 3.3kW also.. wishfull thinking as consumers don't seem to be demanding with such information

Only the nerds like us would find that fascinating

Like · Reply · 3w · Edited

Write a reply...

**Biswajit Bose** Honestly surprised CLLC DAB didn't come up as an option yet

Like · Reply · 3w

beginning. But what is the benefit of using 2 extra switches on the LV side?
And for CLLC, I did initially suggest series resonant however there is an extra C with your proposal on the LV side. Again this would be an expensive C. Remember the current on the LV side goes up to about 115A DC to do 5kW.

In fact the opposite seems better- To not have any C and just have an L in series with TXFR on the HV side

Like · Reply · 3w

**Biswajit Bose** You want bidirectionality. And as efficient a system as possible to keep thermal management expenses low and system backup high. You are constrained by space. So you would possibly prefer soft switching on as many stages as possible in both operation modes. You can absolutely go SR, but note the input voltage range width. So most probably you would prefer a multiresonant system (think L+L+C). If you are operating between the resonances, you get to enjoy ZCS on the secondary switches too. But yes, you do have to tolerate the extra switch conduction loss. The justification of the extra switches on the secondary, AND the extra capacitor on the secondary, is to give you a bidirectionally symmetric system. The extra that you spend on the secondary C will be more than compensated by the flexibility it will provide in terms of the bidirectional tank design, tight control over the tank parameters in large scale production, and if you really want to milk the resonant topology, perhaps you might think of WBG FETs, with moderately high switching frequency, with reduced size of passives. Though 5kW is pretty low, at these power levels and higher, your primary cost components tend to be the cooling system parts and the magnetics. A wee Sec cap wont really dent the system BOM cost.

Like · Reply · 3w

**Biswajit Bose** But yes, all these are without actually calculating anything, so a pinch of salt perhaps to go with what i wrote from my mobile...

Like · Reply · 3w

Write a reply...

Write a comment...

**Sai Prasad**
March 9 at 4:26 AM

Hello Everyone. This is a great community where I was able to find lots of answers to my doubts. I'm currently facing a challenge with buck converter, and battery. A typical self-made charging circuit.

How can we protect our dc dc converters from reverse current?

I know that reverse voltage (polarity) protection can be achieved using a MOSFET connect in the ground path or live path just before the battery to prevent reverse current flow when connected in reverse polarity.

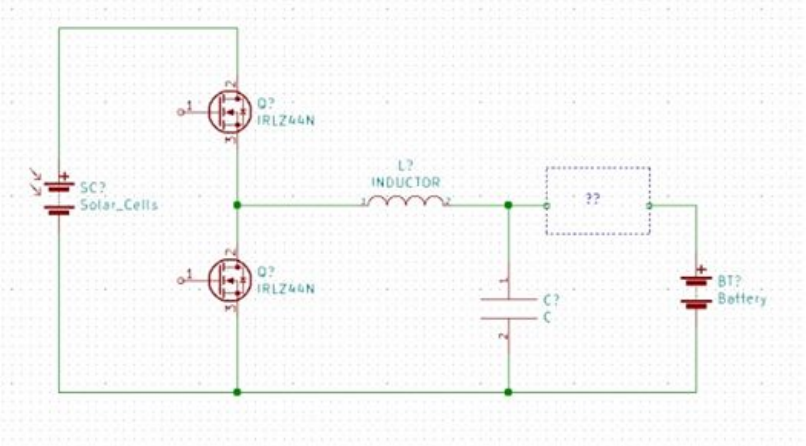
current flowing from battery to the converter. The situation becomes worse when we connect a sync buck when the lower MOSFET conducts and blows itself. How can we prevent that from happening. Some of you may say connecting diode is a solution but it reduces the efficiency even if it is a schottky diode because load current is more than 20A which approximates to around 14W loss across diode and is enough to blow diode off because of thermal runaway and 14W loss is unacceptable in the application.

Please help me getting a concrete solution.

P.S. To make situation even more complicated, the source is a solar panel which means the input voltage is not at all constant and during evenings, above problems occur.

UPDATE -

Below is the schematic for reference.




5 74 Comments

Like Comment

**Janamejaya Rox** Have you done any simulation at all?. Schematic or block diagram would be helpful. Very difficult to visualise the problem without it.

Like · Reply · 3w

**Sai Prasad** I tried on real hardware and faced the above issue. I've updated the post with a schematic

Like · Reply · 3w

**Yassir Nadir** Have you tried back to back FET for reverse current protection?

Like · Reply · 3w

**Sai Prasad** That does not work as the fet would already be on. You cannot control the flow of current with that. The back to back FET is used to block current that flows through the body diode of the FET, as far as i know. In my case, The reverse current shouldn't flow.

Like · Reply · 3w

**Bob Gudgel** Back to back FETs is one way to prevent reverse voltage. So is a relay in the battery positive to the inductor. Those two methods are exactly what the industry uses for this in PV to battery MPPT chargers

Like · Reply · 3w · Edited

**Jared Bevis** This is usually accomplished through the use of an ideal diode circuit at the output of the power supply. There are many inexpensive controllers out there for this purpose.

Like · Reply · 3w · Edited

**Bob White** This^^^

Ram Mohan This seems to be a typical MPPT Charge Controller Circuit with Synchronous Buck Converter. A additional Reverse Blocking diode or Mosfet in series to Solar Panel (SPV) is required to prevent SPV Reverse. The Freewheeling Mosfet is more efficient than the Diode. If the timing signal for Top & Bottom Mosfet is proper, then there will be no issues of Cross-conduction. Used this Circuit for upto 3KW MPPT Conversion. For higher Efficiency dual interleaved is recommended.

Like · Reply · 3w

Hide 18 Replies

**Sai Prasad** Thanks Ram for your comment. I already have implemented the Protection at the SPV side. The problem is at the load side.

Like · Reply · 3w

**Ram Mohan** Sorry but i could not understand the Load side issue you are having. Please elaborate?

Like · Reply · 3w

**Sai Prasad** The issue is when the panel power drops, the voltage couldnot be maintained at the load end, so the battery starts to have higher voltage than the converter output due to which, reverse current starts flowing from battery to buck converter itself. That causes the lower side mosfet to short battery terminals and blows itself off.

Like · Reply · 3w

**Ram Mohan** Sai Prasad have you tried building the circuit or done simulation? The lower Mosfet is turned "ON" only for freewheeling the Inductor Current during off time. The Battery Current irrespective of the Voltage will not flow in "reverse" due to the Inductor.

Like · Reply · 3w

**Sai Prasad** Ram Mohan I have tested on the hardware. The lower mosfet keeps blowing up

Like · Reply · 3w

**Ram Mohan** Sai Prasad You need to give more Inputs. What is the Mosfet rating & Gate Driver configuration? How are you generating the PWM? Have you implemented PID algorythm? Please post more details so that it helps every one to solve or learn.

Like · Reply · 3w

**Ram Mohan** Also post how the Gate drive wave forms of Top & Bottom Mosfet looks like

Like · Reply · 3w

**Sai Prasad** The MOSFET is IRF3205 N Channel type, gate driver is IRS2110S (smd). I have implemented the controller using Atmel Atmega32.

Like · Reply · 3w

**Ram Mohan** Sai Prasad The Gate Waveform for Top & Bottom should be some thing like this.

Like · Reply · 3w · Edited

Like · Reply · 3w

**Sai Prasad** There is a dead time programmed as well

Like · Reply · 3w

**Sai Prasad** I've not implemented PI controller but it's kind of bang bang controller

Like · Reply · 3w · Edited

**Ram Mohan** Sai Prasad Not sure about your reason of selecting Gate drive IRS2110 as this is meant for 500V applications. This part is most suitable for 60KHz offline HB or FB or Double Ended designs. The Top Mosfet may not be getting enough bootstrap Voltage (Vs). I would recommend a 100V Part some thing like LM25101 unlike the IR legacy part.

Like · Reply · 3w

**Sai Prasad** Thank you Ram for the suggestion going to change my design accordingly. The reason for selecting irs2110 is, it is more like a jelly bean component with a decent cost and availability is almost everywhere

Like · Reply · 3w

**Ram Mohan** Sai Prasad Most of the IR parts available off the shelf with traders in India are cheap Chinese duplicates. I always use mouser.com or digikey.com for designs.

Like · Reply · 3w · Edited

**Sai Prasad** I don't think the problem is with the driver because it works when there is enough solar power

Like · Reply · 3w

**Ram Mohan** Sai Prasad why don't you stop the mppt once the Solar Input Voltage is lower than Battery Voltage? I usually switch off gate pulses to both MOSFETs once the SPV Voltage is lower than Battery Voltage.

Like · Reply · 3w

**Col Johns** You need to change your control so that the bottom fet is kept off for pwm < 5% and for reverse current - you need to sense this - or for when your "panel power" drops away ...

Like · Reply · 3w

Write a reply...

**Yuri de Klerk** You will need a controller which is able to detect negative current, or very low positive current. The low-side Mosfet should be switched off just before the inductor current gets negative. For TI parts this is called 'source-only' . If you make a controller yourself (digitally), you need a circuit to detect the negative current and switch off both Mosfet's until the next clock-cycle AND current is NOT negative anymore.

Like · Reply · 3w · Edited

**Atish Tailor** It would be simpler to to have a voltage detector and if the sc V is > BT V, you start generating your gate drives. Slow ramp as at some point the V at the sc may drop again. Maybe you can get this to work in burst mode

Like · Reply · 3w

**Mukul Chourasia** as Atish Tailor told it will be better to sense the source and load voltage and accordingly decide the gate pulses.

Like · Reply · 3w

**Sai Prasad** Atish Tailor Mukul Chourasia I was trying to do that but within that short period of time, MOSFET blows off

Like · Reply · 3w

V. Can you have a large C at the sc?

Like · Reply · 3w

**Mukul Chourasia** one thing can be done, put one schottky diode in parallel with bottom mosfet. when ur difference become too less means just going to have reverse current flow. you have to switch off the bottom mosfet and rely on schottky.
once a major difference appear switch back to bottom mosfet.

Like · Reply · 3w

**Sai Prasad** Mukul Chourasia That's a good idea but wont it be wasting power while normal running ?

Like · Reply · 3w

**Sai Prasad** Atish Tailor Can you help me with the system response ? The controller was programmed and not an analog designed. Some resources would be really great

Like · Reply · 3w

**Mukul Chourasia** Sai Prasad to avoid power concern, your RDS ON has to sufficiently low so that it won't allow schottky to operate or very less amount of current get divert to diode.

Like · Reply · 3w

**Sai Prasad** Mukul Chourasia The Rdson of the mosfet is 8milliohm as per the datasheet. I guess that would be enough to prevent alternative conduction. Is it?

Like · Reply · 3w

**Mukul Chourasia** you can verify in simulation.
do consider RDSON at 100 deg celsius at Vgs u r driving.

Like · Reply · 3w

**Sai Prasad** Mukul Chourasia Ok Thank you. Can you help me with understanding SOA of a mosfet please? I always get confused while selecting a mosfet practically

Like · Reply · 3w

Write a reply...

**Nicola Rosano** Place a Mos in there.

Like · Reply · 3w

**Ray Ridley** Is this a home/school/work project?

Like · Reply · 3w

**Sai Prasad** This is a project

Like · Reply · 3w

**Ray Ridley** I can see it is a project. But is it for school?

Like · Reply · 3w

**Sai Prasad** No, its related to work. Sorry my previous answer wasn't clear

Like · Reply · 3w · Edited

Write a reply...

applied to the solar cells, they can enter "stall" mode, and their output will be severely limited until that overload is removed and the cell can reset. This is what an MPPT controller does (no, it is not meant "track" or tilt the solar cell, it is mean to prevent start-up overload, and then to "track" the most efficient load point the cell(s) can handle). In this version, if you cannot integrate proper MPPT control, at least place a diode in series with the solar cells making their output one way, and place a capacitor across the solar cells after that, to allow voltage to build before the choppers switch on.

Like · Reply · 3w

**Ray Ridley** You need to sense the current and control it. You might not be able to do that with the solution you have chosen, so you have to add circuitry to do that.

Like · Reply · 3w

Hide 14 Replies

**Sai Prasad** I've actually shown only the concerned part. I included current sensor and all the auxiliary circuit needed for the operation.

Like · Reply · 3w

**Sai Prasad** The circuit is oversimplified in the screenshot

Like · Reply · 3w

**Ray Ridley** Well if you have all the current and voltage information should be easy to control as needed when things move in the wrong direction.

Like · Reply · 3w

**Sai Prasad** True. But within the time of action things are going wrong. The controller implemented is more of a bang bang type. So I was thinking of a solution where the current would flow in one direction like a diode (but not diode) implemented using MOSFETs. I don't know if that exist.

Like · Reply · 3w

**Sai Prasad** I'm a rookie in control system world

Like · Reply · 3w

**Ray Ridley** I might suggest changing your controller. That is not where these designs should start. You have to define the functions and protections you need first, then find the controller that gives you what you need.

Like · Reply · 3w

**Sai Prasad** It was done like that only but I think something is wrong, the response time is slow. I think I should brush up my skills on control system. I did went through some articles from Ridley design Blog. Can you please suggest some resources on practical control system design & analysis and sensing? That would be of a great help. I really need to dive in deep.

Like · Reply · 3w

**Ray Ridley** Sure. Plan on coming to our workshop. We will get you trained.

Like · Reply · 3w

**Sai Prasad** Does it happen in India?

Like · Reply · 3w

**Ray Ridley** If you would like to have an in-house course, we can do that.

Like · Reply · 3w

**Ray Ridley** Otherwise plane fares are cheap to CA I understand.

Like · Reply · 3w

**Ray Ridley** go to our website. www.ridleyengineering.com

RIDLEYENGINEERING.COM
Ridley Engineering | - Solutions for Switching Power Supplies

Like · Reply · 3w

**Ray Ridley** In-house means that we hold the course at your company.

Like · Reply · 3w

Write a reply...

**N D T Rao** https://ieeexplore.ieee.org/document/4631374

IEEEXPLORE.IEEE.ORG
Modeling and Control of PV Charger System With SEPIC Converter - IEEE…

Like · Reply · 3w

**N D T Rao** Try reading this paper u will get good idea about pv battery charging system.

Like · Reply · 3w

**Riccardo Tinivella** Is this what you need?
https://www.analog.com/.../technic.../data-sheets/4367fb.pdf
Dcdc in automotive must be protected by reverse polarity and they use mos back to back with floating driving voltage like charge pump or transformer supply

Like · Reply · 3w

**Col Johns** You need to change your control so that the bottom fet is kept off for pwm < 5% and for reverse current - you need to sense this - or for when your "panel power" drops away ...

Like · Reply · 3w

**Kadir Yilmaz** Connect one mosfet series to the top buck MOSFETs

Like · Reply · 3w

**Kadir Yilmaz** Drain of mosfet will be connected to drain of buck mosfet

Like · Reply · 3w

**Kadir Yilmaz** Then utilize gate control pulses of the top buck mosfet such a way that create dc gate biasing to the added mosfet . You are done

Like · Reply · 3w · Edited

**Kadir Yilmaz** Technically you are creating ac switch as a part of buck top mosfet

1

Like · Reply · 3w

**Kadir Yilmaz** But you must have logic that when output voltage bigger than input buck controller Must Stop

1

Like · Reply · 3w

**Col Johns** it can't easily stop due to the diode in the top fet ...!

Like · Reply · 3w

Like · Reply · 3w

**Kadir Yilmaz** Sai Prasad not at all
If it is non isolated even simpler

Like · Reply · 3w

**Kadir Yilmaz** If you have control pulse for top mosfet the same signal will be utilized without using another driver just hold circuitry consist of one diode one cap and 2 resistor that is it

Like · Reply · 3w

**Kadir Yilmaz** I could post the sch when I come back from my vacation

Like · Reply · 3w

**Sai Prasad** Kadir Yilmaz That would be really great. thanks for the help!

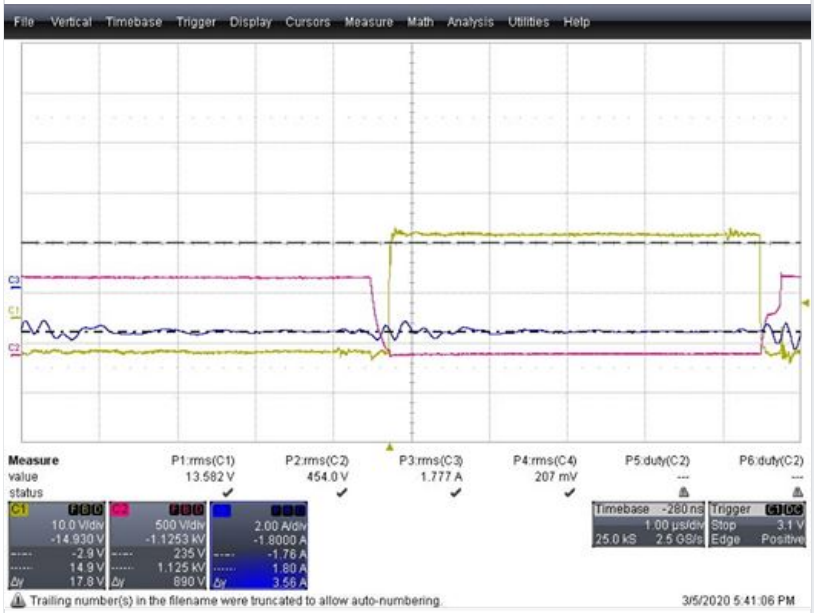
Like · Reply · 3w

Write a reply...

Write a comment...

**Lotfi Bgh**
March 9 at 8:32 AM

Hi everyone,
I have a problem with a PSFB. It is 800V at input and 825V output. The screen capture below shows the ZV switching on the lagging leg at the nominal load (1450 W, yellow is Vgs, red is Vds and blue is load current ... inverted) but my feedback loop is saturating at full-load (1.8 kW) because of the high value of the resonant inductor (here Lr=145uH!!). The reason for that is the transformer's high parasitic capacitance value (here 500pF). What are your suggestions to bring that cap value lower so I can switch at ZV with a lower Lr.
Thank you




56 Comments

Like Comment

Like · Reply · 3w

Hide 21 Replies

**Lotfi Bgh** Ray Ridley you mean by increasing the distance between the two windings?

Like · Reply · 3w

**Alain Laprade** Lotfi Bgh Interwinding capacitance. Is your inductor winding multilayer or single layer?

Like · Reply · 3w · Edited

**Lotfi Bgh** Alain Laprade multilayered, but I am afraid there is not much I can do with transformer at the moment since there is not much room left to make any change or dimension increase ...

Like · Reply · 3w

**Yuri de Klerk** Lotfi Bgh Are you sure the parasitic capacitance is 500pF ? (How was it measured?)
Did you use clamping diodes ? The clamping diodes can be placed such that ZVS gets bad.
Is the series cap value high enough? If too low, the energy of the resonant inductor gets eaten by the cap before the transition has even started.

Like · Reply · 3w

**Ray Ridley** Yuri de Klerk series cap? How about a schematic Lotfi Bgh?

Like · Reply · 3w

**Lotfi Bgh** Yuri de Klerk I don't see how the clamping diodes can affect the ZVS, if you can give more details on that, thanks. There is a 4uF DC blocking cap, I should probably increase that.

Like · Reply · 3w

**Ray Ridley** Schematic, please.

Like · Reply · 3w

**Ray Ridley** Why do you even have a coupling cap?

Like · Reply · 3w

**Lotfi Bgh** Ray Ridley to a avoid transformer saturation due to umbalcing when voltage mode is used. Some papers evoke this DC blocking cap

Like · Reply · 3w

**Ray Ridley** Make Cc = ∞

Save you some board space 😎

Like · Reply · 3w

**Lotfi Bgh** Ray Ridley would removing the output filter inductor reduce the overall parasitic cap? Ripple will increase but there is still room to add more caps at the output

Like · Reply · 3w

**Ray Ridley** Lotfi Bgh That means they gave up on controlling it properly. It is a big part to put back in again, and comes with its own set of issues.

The transformer needs revising in my view. It doesn't necessarily have to get bigger.

Without that, we have a classic and very common situation in power - please fix the circuit, but don't change anything. 😎

Like · Reply · 3w

transformer.
2. I am not looking for solutions than do not include any change, I am just seeking for different solutions.

Like · Reply · 3w · Edited

**Ray Ridley** You use current mode to balance the transformer. Standard technique.

This solution to this problem must start with the transfomer examination in my professional opinion. That is where we always start. Most problems originate there.

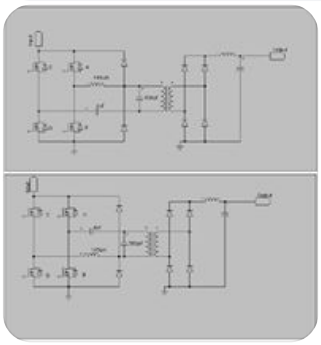
You begin by measuring the open and short circuit impedances. that will tell you much information.

Then you measure the primary to secondary capacitance.

Plan on current mode control with sense transformers.

Like · Reply · 3w

**Yuri de Klerk** Lotfi Bgh There are two possible locations to put the shim inductor with the diodes. As I can recall putting it near the CD leg takes away some transition energy, especially with high transformer capacitance. Putting it near the AB leg however can result in hot clamping diodes.



Like · Reply · 3w

**Alain Laprade** Lotfi Bgh Ah, you had stated 'resonant inductor'. I interpreted that statement as it being a separate element from the transformer. As mentioned by Ray, you might have no choice but to revise it.

Like · Reply · 3w

**Lotfi Bgh** Thank you Dr. Ray Ridley. It looks like I still have a lot of work to get it done!!

Like · Reply · 3w

**Lotfi Bgh** Yuri de Klerk thanks a lot. I haven't tried this yet. I will give it a try.

Like · Reply · 3w

**Ray Ridley** Here is something to think about. IBM were in preproduction (1000s) and started encountering a failure rate of about 2% during light load tests.

Power supplies are a LOT of fun. Why we sign up to this is a mystery.

Just ship the app note demo board and pray! Move on to your next job quickly in case it gets returned.

Like · Reply · 3w

**Yuri de Klerk** Ray Ridley is right.For 500pF to (dis)charge from 800V with 145uH you'll need 1.5 Amps (about 1200 Watts?) So 500pF is way too high for making it work a little proper. 145uH at 100kHz is 91 Ohms. Or is your switching frequency 10 times lower?

Like · Reply · 3w

Like · Reply · 3w · Edited

Write a reply...

**Ray Ridley** Lots of advice here. Lotfi Bgh is discovering the delight of the PSFB that many of us have been through. It's a lovely app note and a great research paper.

Getting it to rugged and reliable production is something else entirely.

Keep at it Lotfi Bgh, you will get there if you persevere, but the path will be neither short nor easy.

Just for reference, IBM took 7 years to get their power system (including the PSFB all the way to flawless production. Not all that, obviously, was on just the bridge. Very complex system.

Like · Reply · 3w

**Nicola Rosano** You need to rewind the magnetics

Like · Reply · 3w

**Charlie Elliott** We went through similar pain with PSFB when we first started using it in terms of high self capacitance. Took some head scratching and several iterations to improve it sufficiently to perform well. As Ray Ridley says, absolutely no need for blocking cap if you use proper sensing and control.

Like · Reply · 3w

**Riccardo Tinivella** Why dont you try to integrate partially the inductance in the transformer, this separates primary and secondary to store magnetic energy. Is this 500p the pri2sec capacitance right? A possible reference is here https://ieeexplore.ieee.org/document/7104347 , as you can see rac get worse maybe but it's normal no free lunch as always 😊

IEEEXPLORE.IEEE.ORG

Design considerations for high-efficiency leakage transformers - IEEE…

Like · Reply · 3w

**Lotfi Bgh** Riccardo Tinivella thanks Riccardo, a very good ref. Yes, it is pri2sec.

Like · Reply · 3w

**Ray Ridley** When you arrive at the Mountain Top of knowledge after a long and arduous journey, you will meet the gurus of power electronics. You can ask them "What is the secret to life and success in this field?"

And they will answer in one voice:

"Magnetics"

Listen well.

Like · Reply · 3w · Edited

**Lotfi Bgh** Ray Ridley Eventhough the answer is given in your comment, I still have have to climb the mountain. Otherwise I won't realize what the answer is really about.

Like · Reply · 3w

**Lotfi Bgh** Eventhough the answer is given in your comment, I still have have to climb the mountain. Otherwise I won't realize what the answer is really about.

Like · Reply · 3w

**Ray Ridley** that's true. Realize, though, that it is the magnetics mountain that needs climbing. The rest is just details. 😎

Venkat Karthik Are you using an extra resonant inductor or just the leakage of the transformer? What is the Coss of the SiC mosfets?

Like · Reply · 3w

**Lotfi Bgh** Venkat Karthik thanks for the comment. It is discrete and I see what you mean, I will try some additional caps across the lagging leg mosfets.

Like · Reply · 3w

**Ray Ridley** How is that schematic coming along? By giving that, you give a little something back to those that are helping and watching. Doesn't have to be complete.

Like · Reply · 3w

**Lotfi Bgh** Ray Ridley I am grateful to this group and I will see if sharing the schematic is something possible.

Like · Reply · 3w

**Ray Ridley** You've already given the scematic in words. Just put it into pictures. FETS, coupling cap, Lr, transformer, diodes output cap, output L.

Nothing confidential. Just the overall scheme which is public knowledge. They we don't all have to guess about and external inductor, series cap, etc.

Make it easy for people to answer your questions. Much better results that way.

Like · Reply · 3w

**Col Johns** For this sort of app where you have 500pF of C on the pri wdg ( and the sec too? or is it 500pF combined for pri and sec - as they are fairly closely coupled? ) it is necessary to have lots of commutating energy and extra C across the mosfets to give you slower transition times - say 250nS at least - unless you are going to rewind the Tx to try and get a lot lower C there )
If you do this you will need energy from a commutating choke - these can be additional to the main ckt - we have done this fix to other peoples designs ( luckily there was space ) - it also greatly reduces RFI and switching losses if done right - EMC was what we were originally called in for ... - but then had to fix the power ckt ... and the gate drive ...

Like · Reply · 3w

**Lotfi Bgh** Col Johns thank you for the comment. Yes, it is pri and sec combined. Adding some caps across the mosfet is supposed to decrease the equivalent parasitic capacitance and I have some margin on the deadtime so I'll give it a try. Yes, it also helps with EMI, even with lower loads. It is always better to have quasi-resonant switching than hard switching.

Like · Reply · 3w

**Snehal Bagawade** Hi Lotfi Bgh
In a PSFB why are you adding 145uH series inductor on primary? It may have increased your problems with diodes more. What is the value of filter inductance on the output?

Like · Reply · 3w

**Lotfi Bgh** Hi Snehal Bagawade snubber is doing its job and diodes can take high voltage. But the plan is not to use a 145uH because it is too high. I was expecting something between 15uH and 30uH.

Like · Reply · 3w

**Snehal Bagawade** My point is that you don't really need an inductor in the primary side. Why do you have it there?

Like · Reply · 3w

**Col Johns** an inductor is common for phase shift full bridge PSFB ...

Like · Reply · 3w

Like · Reply · 3w

**Col Johns** ZVS & ZVT are the same thing ...

Like · Reply · 3w

**Snehal Bagawade** Col Johns would you not get enough from transformer leakage? Specially for a transformer designed to work with this high voltage and 100khz?

Like · Reply · 3w

**Lotfi Bgh** Snehal Bagawade it is not that simple. It depends of the load at which you want to do your zvs...

Like · Reply · 3w

Write a reply...

**Ray Ridley** That schematic sure would come in handy at this point as we now start talking about snubbers.....

We might have to make a rule soon - no schematic, then no discussion.

Like · Reply · 3w

**Adhistira Madhyasta Naradhipa** Hi Lotfi Bgh, I think the simplest way to reduce your series inductance (Lk) value is by sacrificing the ZVS operation at light-load. Required Lk for ZVS from 50% load is smaller than Lk for ZVS from 10% load.

Other than that I think you can look again at your transformer design to reduce the parasitic capacitance. I also got the same problem when designing PSFB-CD with PCB winding transformer. There is a trade-off between Rac of the winding and Cparasitic.

What is your target ZVS range?

1

Like · Reply · 3w · Edited

**Lotfi Bgh** Adhistira Madhyasta Naradhipa thanks, your comment makes sense. I am targeting 100% at 1450 Watts. ZVS for lighter loads is not important.

Like · Reply · 3w · Edited

**Arief Noor Rahman** Well...you should specify at what %load do you want to achieve ZVS...

Of course, you can always choose for ZVS from 95%load

Like · Reply · 3w

**Lotfi Bgh** Arief Noor Rahman it is in my post

Like · Reply · 3w

Write a reply...

**Lotfi Bgh** Thanks to everyone for the comments and suggestions. End of discussion.

Like · Reply · 3w

**Ray Ridley** Lotfi Bgh well not quite. We'd all like to know what you are going to do next and follow the progress as you implement the changes.

The learning should go both ways.

Like · Reply · 3w

**Lotfi Bgh** Ray Ridley all right, I will keep the group updated.

Like · Reply · 3w

what didn't will quickly find that no one wants to answer their questions any more.

Like · Reply · 3w

**Charlie Elliott** Ray Ridley - Absolutely agreed. BTW have a look at the vishay paper referenced in my electrolytic cap below zero post.

Like · Reply · 3w

Write a reply...

Write a comment...

**Charlie Elliott**
**Conversation Starter** · March 6 at 8:56 AM

## Aluminimum Electrolytic ESR vs Freq at Temps Below 0 deg. C

Anybody know at what temp the ESR of a typical "-40 to +105C" rated aluminium electrolytic starts to increase considerably? I have found data at 20C and at -40C (showing approx x4 at 100 Hz) but nothing in between. I am sure this data used to be published but so far not found anything.

5 27 Comments

Like Comment

**Grzegorz Sobiegraj** Since this effect is caused by freezing of the eletrolyte, it depends on its chemics. So each manufacturer will have different results. In fact, this is probably so uncontrollable and difficult to measure that they just give you some worst-case values at possible border conditions.

Like · Reply · 4w

**Charlie Elliott** Yes abolsutely agreed. You can get some parts specifically designed with lower freezing point but you pay for it either with ££ and / or with higher ESR / lower ripple rating at higher temps!!

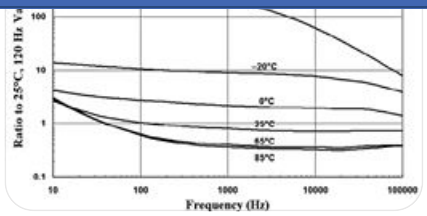
Like · Reply · 4w

**Cameron Stewart** I would suggest that you wire up some electrolytics in a temperature chamber and make your own ESR versus temperature measurements.

You are unlikely to find much of this kind of data anywhere. However, I did a quick search and found this on the Internet

Like · Reply · 4w

**Cameron Stewart**




Like · Reply · 4w

**Charlie Elliott** Cameron Stewart - You must be better at digging than me. Which m/f is that for?

Like · Reply · 4w

**Cameron Stewart** Charlie Elliott

This graph was pulled off a paper found on ResearchGate. The manufacturer is anonymous.

Like · Reply · 4w

**Cameron Stewart** Most of the change occurs between -20C and -40C. In my past experience this temperature range is where an otherwise stable power supply will begin to oscillate or otherwise misbehave.

Like · Reply · 4w

**Alain Laprade** Make sure you distinguish between solid and liquid Aluminum electrolytic capacitors. Solid types offer better performance. Alternatively, consider Aluminum-Polymer capacitors if the voltage rating is within your needs. Expect to pay more on a per unit basis, but you won't need as many in parallel to compensate for the -40C degradation that liquid aluminum electrolytics have.

Like · Reply · 4w · Edited

**Charlie Elliott** Alain Laprade - Thanks for the useful comment. For the sorts of thing I am particularly interested in (400V+ and 470uF+) I dont beleive solid electrolytics or hybrid polymers are an option.
Our biggest concern in the application we are looking at (cold soak to -30C and then needs full power immediately available) is the potential reliability implications. Loss will be much higher which will of course heat up the caps but could this thermal shock cause some kind of premature failure?

Like · Reply · 4w · Edited

**Alain Laprade** Charlie Elliott If information isn't available from the datasheet or the manufacturer's reliability information (normally available, but as separate information from the datasheet), I would consult their applications staff for guidance on the failure mode of concern. You do not define your thermal shock operating concern. Others may chime in with different information, but I've never heard of a -30C capacitor thermal shock failure (hot temperature, yes it can happen but that isn't your question). From my own experience, I would be focusing on stability and EMI concerns from the high ESR at -30C. For an input filter, this can reduce the effectiveness of an EMI filter, and also introduce vulnerability to negative impedance oscillation interaction with the downstream DC/whatever converter at low input voltage. If this is an output filter (mentioned by Cameron Stewart above), then the stability of the feedback loop at cold may be of concern as the modulator plot response (control to output) may have a mid-frequency gain increase which voids the intended bandwidth.

Like · Reply · 4w

**Charlie Elliott** Alain Laprade - In this case I only need to worry about the EMC implications as this is an input filter on a motor drive. I have sent e-mail to a couple of applications engineers last week. I will let everybody know if they come back with anything of interest. I have a horrible feeling I will be told to test it!!

Like · Reply · 4w

**Magnus Rosén** Consider metallized polypropylen capacitor. Have used Vishay MKP1848C in a couple of products. Very stable and rugged in for an example sub zero environment. Btw also incredible rugged in high temp that would cause electrolytic to vent.
Downside: V•C versus volume. But in your case could it be equal.
Costwise is equal or better.
Also consider a hybrid design. I have not done that - yet, but it should give a potential fusion of booth elyt and film advantages.

Like · Reply · 4w

**Charlie Elliott** Magnus Rosén - We use film for DC link caps whenever we can. Unfortunately in this case the holdup requirement needs raw energy storage as opposed to ripple current handling. There is simply not enough volume available to fit in film.

Like · Reply · 4w

**Magnus Rosén** Charlie Elliott Hybrid MPC+AlElyt?
MPC=stable ESR
AlElyt=bulk capacitance
Choke//Diode for current steering

Like · Reply · 4w

**Cameron Stewart** Consider the Cornell Dublier MLS and MLS series of electrolytic capacitors.

They offer cold temperature operation down to -55C.

Like · Reply · 4w · Edited

**David Edwards** I believe these parts use a toxic, carcinogenic electrolyte that you don't want to breathe if the part ever vents. However, it would seem that electrolyte leakage is not generally a problem in a welded steel case. For the high voltage parts the degradation of 25C ESR at -55C is only 2 to 1. That is extremely good for a liquid electrolyte - must be some really nasty stuff.

Like · Reply · 4w · Edited

**Charlie Elliott** Cameron Stewart Are those the ones in the welded metal rectangular can?

Like · Reply · 4w

**Cameron Stewart** YEP. Epoxy end sealed as well.

The aluminum foil is pre-anodized before wrapping with the electrolyte added. Consequently, you can store them for years without use and not worry about the need to reform the dielectric when you first apply power.

I did an avionics supply a few years back with a cold temperature and long term storage requirement. Conventional electrolytics were ruled out as a result.

This produced a trade study between stacked film, organic polymer, wet slug tantalum, and the Cornell Dublier Flat Pack capacitors.

The Cornell Dublier option won out, hands down.

These are not cheap capacitors. And as for electrolyte toxicity if vented, the material safety data sheet will spell all this out. I've never seen one vent, even when the production people installed them backwards.

Everything in engineering is a design trade-off. You take the bad with the good and choose your poison accordingly.

Like · Reply · 4w · Edited

Write a reply...

**Phil Lane** If the ESR was high enough the cap would warm itself up.?

Like · Reply · 4w

True. The surrounding power supply component heat also helps warm the capacitors up.

But there is a waiting time - typically 5 to 15 minutes - for the capacitor to warm up, an acceptable performance to be restored. In the meantime the power supply is oscillating or producing excessive output ripple.

That kind of behavior usually isn't acceptable to customers. They expect proper performance immediately after initial turn-on.

Like · Reply · 4w

**Charlie Elliott** My main concern in this case is potential reliability issue due to the thermal shock of putting high ripple current through the parts with ESR increased. We are already operating x 2 the rated ripple (specified at 105C) as our max temp is low. I have asked the question of three m/fs but so far no answer.
Anybody in the group actually carried out such a reliability test? (Cold soak to well below -10C and then hitting system with full rated power.) This would need to be done many times to get any kind of meaningful data. Our customer is asking for 10 year life on the system and this thermal shick will happen at the start of day. Say temp could be below -10C for 90 days a year then that is 900 such events in the life of the product. Certainly one to "keep you awake at night".

Like · Reply · 3w

**Cameron Stewart** Charlie Elliott

You will be hard pressed to find a better electrolytic than the Cornell Dublier MLS flatpack for your application.

Like · Reply · 3w

**Charlie Elliott** Cameron Stewart - Looks like they only go to 250V so I would need 4 in series for my 800V DC bus 😠

Like · Reply · 3w

**Cameron Stewart** Charlie Elliott

300V units are available as a special order.

Like · Reply · 3w

Write a reply...

**Charlie Elliott** My old contact at Vishay came through for me (was about to say came up trumps but dont like that expression any more 🙂 ). The following has some useful generic data http://www.vishay.com/docs/49663/49663_pl0359.pdf . He was also able to generate specific data and give me measured data for some specific parts.
He wasnt too concerned about the thermal shock aspect but he is right that the voltage ripple is a real concern. I had not appreciated that as well as the significant increase in ESR the capacitance will also be way lower at high frequency.

1

Like · Reply · 3w

**Colin Tuck** That is a good find ...!

Like · Reply · 3w

**Charlie Elliott** It is and somewhat sobering!!

Like · Reply · 3w

Write a reply...

Write a comment...

**Alex Berestov**
March 10 at 6:47 AM

# Is it at all reasonable to use "standard" controller like 2825 for a 20+kW converter?

1 4 Comments

Like Comment

**Col Johns** You can if you can get away with it - we have used the UC3879 to 16kW @ 80kHz

Like · Reply · 3w

**Ray Ridley** 2825 is actually a very rugged "old" controller. That means it is designed "old-school". When the Vmax says 40 V (or whatever it is) it will keep working far above that. Parts were tougher then.

it's bipolar rather than FET based, so it is more noise immune.

Go for it. There are sexier parts perhaps, but this can often be the shortest path to success.

Like · Reply · 3w

**Alex Berestov** Thanks for the encouragement. I used to use custom made controller either analog or DSP on higher power designs. For this particular one specs are very relaxed so I wondered: Why not?

Like · Reply · 3w · Edited

**Charlie Elliott** KISS is still very applicable.

1

Like · Reply · 3w

Write a comment...

**Fırat Deveci**
March 10 at 12:44 AM

Hello All,

I'm working on very wide input MPPT chargers and I was curious about your approach.

Vin: 200V to 1000V (DC from PV Panels)

Vout: 30V 20A with CC/CV (2 or 3 stage lead-acid chargers)

Isolation is not necessary

Which power topology would you choose if you design this?

P.S. My approach is using Non-Isolated Boost Converter + Half/Full Bridge Converters.

4 54 Comments

Like Comment

Like · Reply · 3w · Edited

Hide 12 Replies

Fırat Deveci In the field, users generally use solar panel between 600-700V. They don't use these panels for battery chargers, because for 600V voltage level, they have to use around 20 solar panels in series. If every sonal panel power is around 250W, total power will come 10kW. They are generally used for solar water pump in agriculture area.

Like · Reply · 3w · Edited

Edward Ralph That didn't answer the question. I've fitted solar and can't see why you'd want such a wide voltage range. Current changes a lot voltage not so much, relative to pout.

Like · Reply · 3w

Fırat Deveci Edward Ralph They want like this, i dont know why, I am designer not a customer, maybe they want to fit more or less series panels and want one converter to use.

Like · Reply · 3w · Edited

Edward Ralph Ahh ok. I was going to say it doesn't sound like an engineers spec!

Like · Reply · 3w

Scott Styles it is always good to challenge requirements. I see this a lot. someone with a statement of what they want you to do, but unfortunately not enough understanding to really know what they need. I guess if you're in a contract design role it is easier to detach yourself from this, but when you have to live with things long term...

Like · Reply · 3w

Scott Styles driven past heaps of these on 4wd trips but never had the opportunity to stop and take a look. i think there's a market here. https://www.trademe.co.nz/.../listing-2569633342.htm...

TRADEME.CO.NZ

Epump Solar Water Pump

Like · Reply · 3w

George William Tyler Fırat Deveci watch out for this, if customer wants silly things it is better not to do it!

Like · Reply · 3w

Fırat Deveci George William Tyler I know they will use it around 600-800V input ranges. But in the morning or before sunset, PV voltages comes 300-500V and motor drivers dont run the motors. In this situation, they want to use this level to charge batteries especially in the morning.

Like · Reply · 3w

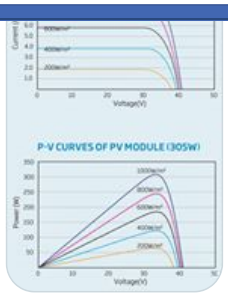
Kadir Yilmaz first that is not true

Like · Reply · 3w

Edward Ralph Fırat Deveci if the voltage is low, no current will flow anyway.

Like · Reply · 3w

Edward Ralph This is what mean, panel voltage doesn't vary much due to sun irradiance.




Like · Reply · 3w

Fırat Deveci Edward Ralph you are absolutely right, this is only my thought. I dont know about customer how to use this converter. This is the spect I have to handle.

Like · Reply · 3w

Write a reply...

**George William Tyler** Firstly, I would probably make it isolated anyway, as to get from 1000v to 20v would be better handled by a transformer than a buck etc. Maybe a boost first with this doing the mppt function? Maybe better to have a buck from 1000 to 200 then DC to DC isolated 200 to 30.

Like · Reply · 3w · Edited

Fırat Deveci George William Tyler I want to boost voltage to 800V to make current very small. After that i will use transformer to make it 30V.

Like · Reply · 3w

**Petrica Barbieru** May try buck only with MPPT conditional by load level.

Like · Reply · 3w

Fırat Deveci Petrica Barbieru if i use buck, duty will be very very small.

Like · Reply · 3w

**Petrica Barbieru** Yes, indeed. It's strange why they use 20-30V battery stack when need to feed an inverter for motor pumps. Maybe in 10-12 battery stage can use buck and increase overall efficiency by reducing cable / input inverter currents.

Like · Reply · 3w

Fırat Deveci Petrica Barbieru They generally use PV directly connected to MPPT motor driver. So they are using 600-800Vdc. They are using batteries because of they run TV or something else at night. Batteries are not for motors. This is my idea, maybe customer uses it to completely different area.

Like · Reply · 3w · Edited

**Petrica Barbieru** Fırat Deveci a... ok. In this case I think will be much better to add isolation even they don't requested... as topology, I'll try LLC with high gain range (1-5) below fr.

Like · Reply · 3w

Fırat Deveci Petrica Barbieru I will use transformer. If switches fails, they will not damage batteries. But for LLC input range is very wide I think, I have to calculate.

Like · Reply · 3w · Edited

**Petrica Barbieru** Yes, it's very wide input range but may be covered by small Lm/Lr ratio. Need Lr to be separate... can't be leakage only, being high value (at least for "normal" sw freq).

George William Tyler Charger will draw max current when battery is flat, voltage there will be 22V, And be able to reach 32V for equallisation

Like · Reply · 3w

Write a reply...

**Ram Mohan** Having successfully developed & produced similar Converter specs but at 200W, I recommend double ended Forward Convertor. Use a MCU that has digital Slope compensation for implementing MPPT algorithm + the Forward Convertor. If you are using the existing Solar String supply connected to MPPT+VFD pump controller, you can skip the MPPT & use standard asic for Forward Convertor.

Like · Reply · 3w

Fırat Deveci Ram Mohan I think to use forward converter too but for size of transformer size, maybe better to use half bridges or full. It will be digital controlled.

Like · Reply · 3w

**Col Johns** to make this small we would run 2x 600v H bridges in series, and transformer down to your 30v ... 70kHz ... actually 2x half bridges for 600 watt

Like · Reply · 3w · Edited

**Kadir Yilmaz** Solar voltage in the morning will still be almost open panel under no load. That why we are doing MPPT . Different is very low current capability

Like · Reply · 3w

**Kadir Yilmaz** Use serially connected two switch forward Control this by utilizing phase shift control concept

Like · Reply · 3w

Fırat Deveci Kadir Yilmaz That's cool idea. I will make simulations for that 👍

Like · Reply · 3w

**Kadir Yilmaz** Therefore you may use 650 v rated MOSFET on primary side

Like · Reply · 3w

**Kadir Yilmaz** Since you have 1000 max mosfet on primary side will see max 500 V

Like · Reply · 3w

**Magnus Rosén** Two transistor fly-back from 200-1000V to 30V CV/CC
One stage
Simple MPPT
Plenty of COTS xfrmr
Easy to OEM xfrmr
Optional isolation
Use SiC MosFET switch
Split transformer, for an example 6x100W, but still one switch. Or interleaved 2 or 3 phases.

Like · Reply · 3w

Fırat Deveci Magnus Rosén What about reflected voltage level? 1200V fet will be not enough.

Like · Reply · 3w

have to observe some limitations of turns ratio and duty cycle range. And it's slightly moore complex gate drive for top switch. Vds 1200V may be sufficient. If solar array overvoltage (transient/surge/etc) are limited to 1000V+200V.
Your original idea with front buck stage PPT control from 1000-200V to 200V followed by f/b, fwd, llc, h/b or psfb stage is also good. As W Tyler suggests.
The problem is when planning breakfast, there is too many ways too cook an egg 🍳🥚🍽
And this forum has many master chefs with their favourite recipe haha.
BTW - doing this equipment without proper insulation between input solar array and output accessible couplers is noot feeling good. Does it?

Like · Reply · 3w · Edited

Fırat Deveci Magnus Rosén Oh sorry i didnt see 2-T flyback. You are absolutely right 👍

Like · Reply · 3w

**Magnus Rosén** If the 2T is perfect, tDelay, tR/tF the switch transistor may have Vds rating (Vfb+Vin)/2. But in practice hard to achieve. Drawback is EMC when isolation transformer conversion from high Vin. That's why step down to 200V may be overall better, even if 2 conversion stages.

Like · Reply · 3w

Fırat Deveci Magnus Rosén What do you think about boost the voltage and then using half/full bridges. I want to make it boost because for 600W output power, input switches rms current will be 1-1.5A. In this case i can use IGBT at 1200V and they are very cheap.

Like · Reply · 3w

Write a reply...

**Yuri de Klerk** Many possibilities off course, but which one's better?
I've got one:
Buck converter in the negative solar path to 200V. So no high-side driver required. Second stage can be any topology easy to make, even with LLC IC with integrated high side driver.
Maybe single stage can reach higher efficiency but 1000V high side driver is harder to make and wide range input with galvanic isolation will bite efficiency goal.
So now I just see I actually second George William Tyler

Like · Reply · 3w · Edited

**Col Johns** If the input is never going over 1kV then an LLC half bridge with 1200V fets will work just fine too say 50k - 100kHz to keep the Tx simpler ...

Like · Reply · 3w

**David Seal** Early-load "generation stall" prevention under partial cell illumination is the main reason for MPPT, though it does also ensure that the peak efficiency is maintained while partial illumination climbs to full. This also means that to prevent over-loading the input side under start-up, the output power must be adjusted gradually upwards as well, by matching the exact output voltage and current available to charge the battery. So not only do you have to allow for a wide input range, you must also maintain a precise output control as well, based upon the input conditions.

Like · Reply · 3w

**Col Johns** For pwm or freq control - this is pretty easy - just adjust pwm ( or freq ) to arrive at max power in, this will automatically adjust Vo / Io, have to limit the power when Vmax ( or I max ) is reached on the batt - we did this in analog for a very high volume, low cost design ( no uP ).

Like · Reply · 3w · Edited

lengths, installation, regulatory and national electrical code issues. There is a reason there are so few, great PV charge controllers on the market. It's not for lack of trying. The road is paved with good intentions.

Like · Reply · 3w · Edited

3

**Col Johns** @ Brian Faley - assuming there is only one peak power point at a given time ( there may be some sub peaks ) if a controller arrives at the true peak quickly - then 80% of the issues are solved ...? correct ..?

Like · Reply · 3w

**Brian Faley** Depends on how big the sweep is. I've seen tons of roof top systems with two large peaks get confused several times a day from sharp line shadows from plumbing pipes, overhead wires, or partial shade from roof dormers, or tree leaves. Very few roof tops don't experience some issues. Some happen suddenly, others gradually. How much power can you afford to leave off the table? How critical is the load? Sweep. Unless you're totally full sun all day, it's going to happen, until the sun starts to set and shading begins. (Or rises and stays off the real peak all day! )

Like · Reply · 3w · Edited

**Col Johns** Chaos theory and analog design ... ! Step one - create a chaotic system at the PPPoint...
Partial shading is a real power killer though ...

Like · Reply · 3w · Edited

**Bob Gudgel** Typically, the higher input voltage of 1000 VDC or 1500 VDC are going to be commercial solar farms and they will typically not have any shading. Solar/PV on homes, at least here in the US, are typically not higher than 600V open circuit. Until recently, those 600 Voc (more like 550 Voc) have not had batteries so much (in the US) Now, self consumption is starting to happen in the US so batteries will be more and more common.

Did you know that with the Tesla Power Wall system that they will not run for very long without an internet connection ? So much for using them for off-grid systems

Like · Reply · 3w · Edited

**Brian Faley** Col Johns Partial shading is the reason SolarEdge and Enphase dominate residential grid tied solar systems. Module Level Power Electronics (MLPE) at the solar panel is the sure way to avoid the loss of power from more than just the shaded panels.

Like · Reply · 3w

**Bob Gudgel** Module level MPPT doesn't work quite as well as a chain saw though at reducing shading from trees 🙂

Like · Reply · 3w

**Brian Faley** MLPE is quite good at preventing one or a few modules from shutting down the whole array. But like Bob Gudgel observed, sometimes you have to cut the trees back.

Like · Reply · 3w

**Bob Gudgel** Yes, MLPE can help for partial shading BUT if the WHOLE module is shaded, then it doesn't do any better than the bypass diode(s) built into the module(s)

Like · Reply · 3w

backup mode. I think that is what the CEO (founder?) told me in Munich at Intersolar about 6 years ago when I talked to him about their system there for self-consumption. I think he may have passed away recently ?
The system there was, I think, a 380V or 400V bus and the module level control kept the voltage from rising much higher than that

Like · Reply · 3w

**David Edwards** ☕. Hello Bob Gudgel,

Yes, with a relatively fixed input voltage then the main inverter is a much easier and lower cost design. They have a very good system. It can shut down panels to within a diode drop via their communication network (rapid shutdown and fireman safety).

They may have integrated arc-fault detection (not completely sure). Detecting arc-fault at the panel level offers the possibility to detect chaotic voltage across the panel, which, when combined with current allows easy detection no matter where the operating point on the PV curve (it is much harder to detect chaotic current in the constant current section of the PV curve, but the voltage signal gets much larger in that section).

**Like** · Reply · 3w · Edited

**Bob Gudgel** I am guessing that NO arc-fault detection/protection are in the modules... That would cost an arm and a leg where only a leg would do. i.e. only necessary at this point at the string level.
AND they only have to pass the UL test. One inverter manufacturer, Fronius, has arc fault built into their inverter and it does NOT detect real arcs as we have seen here. It only detected the UL arc 🙂

**Laplacian Mutasa**
March 12 at 2:49 AM

Write a reply...

Hello everyone,

I want to buy a Fluke Scope meter (Fluke 124/5) for use in my Power Electronics work.Has anyone used this range of Instruments ? For basic waveform observations and troubleshooting?

Write a comment...

1 Comment

Like | Comment

**Ratna Joshi** I had used fluke 190-204 and MDA 550. Both are good. If you are looking for power electronics. Is your applications involve 3 phase system go for these models otherwise 124B/S is good.

Like · Reply · 3w

1

Write a comment...

**Zerouali Nabil**
March 12 at 3:28 AM

Hello guys
I have some questions regarding filters..
I'm building a VSD and i'm stuck with the input filters, i found maby topologies and couldn't decide which one to use and couldn't find the sizing formulas
Can you please help me knowing that the VSD is a 2.2kW three phase drive with an input frequency of 50Hz Vinput=400v

1

Like Comment

Write a comment...

**Mohamad Mortada**
March 7 at 4:25 AM

Hello all,

For a 3 phase transformer, delta-star configuration, can someone tell me the reason why we earth ground the neutral point of the star? Since the output is isolated from the main input, then in théorie there is no risk of electrocution when touching any one (only one at a time) of the output phases even if our body is in contact with the earth ground.
Thanks

2 18 Comments

Like Comment

**Charlie Elliott** Qu: If you leave it floating, what sets the potential wrt earth?
Ans: Nothing!! That can be a safety issue in it's own right
Dont forget that a mains transformer has appreciable capacitance to earth so when you say it is floating...

Like · Reply · 4w

**Mohamad Mortada** Thanks Charlie for your explanation. Ok, so enough life threatening current ( higher than 5 mA) can circulate through stray capacitances between primary and secondary through earth.

Like · Reply · 4w

**Charlie Elliott** Mohamad Mortada I dont think there is any guarantee as to what the magnitude of the capactively coupled current will be but for sure it has the potential to kill.

Like · Reply · 4w

**Samuel Carvalho** To provide a conduction path for zero sequence currents (coming from load imbalance, harmonics, etc)

Like · Reply · 4w

**Charlie Elliott** Samuel Carvalho - I dont think you read the question carefully!!

Like · Reply · 4w

**Samuel Carvalho** Charlie Elliott indeed.

Like · Reply · 4w

**Samuel Carvalho** In that case, in a residential power setting that kind of connection can be used to sense residual currents. A differential residual relay can be installed to sense it and interrupt power to save somebody in case of an electric shock.

Like · Reply · 4w

Write a reply...

**Cameron Stewart** Oddly enough, the most dangerous thing in a power supply lab are the grounded electrical outlets on a lab bench.

I've never been a believer in "safety grounding". The cure has always seemed worse than the disease.

Like · Reply · 4w

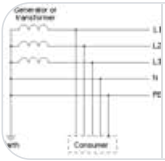
purpose was for lightning arrestors ?

Like · Reply · 3w · Edited

**Col Johns** If you don't earth the o/p some where - all the cables can float up to some high voltage and the insulation to earth will be tested ...! Oh - I see Charlie already said this ...

Like · Reply · 4w · Edited

**Robert Turner** Woah, careful careful! It is not as simple as a few anecdotes. Ready up about the different earthing systems in use around the world TT, TN, IT etc: https://en.wikipedia.org/wiki/Earthing_system https://electrical-engineering-portal.com/erection...



EN.WIKIPEDIA.ORG

Earthing system - Wikipedia

**Like** · Reply · 4w

**Hamish Laird** Ok - if you are actually going to make decisions based on earthing,bonding and safety ignore everything in this thread except the “Whoa”. None of the comments except Robert’s are completely true as earthing bonding and safety systems are different where you are in the planet and what the application is. Seriously!

**Like** · Reply · 4w

**Armando Fabbris** Take in account the first fault to ground not detectable without ground fault device detector

Like · Reply · 4w

**Ray Ridley** Please - everybody - this is a social media help group. While you will get some great advice here, this is not a place to rely on for your safety standards and life/death decisions.

Do the job properly. Get in some professional help for these issues. People do this for a living, use them.

This cannot be done on the cheap.

Like · Reply · 4w

**David Edwards** In the USA at least the National Electric Code and the permit and inspection system should block any unsafe large transformer installation and configuration. Should. In theory. Mostly.

2

Like · Reply · 3w

**Jeremy Lister** Just a couple of consequences if mains is at undefined potential to earth, what voltage rating would your Y1 caps have to be and what is the hipot test voltage?

Like · Reply · 3w

**Charlie Elliott** But once you have put Y class caps in you are not floating wrt to earth so ...

Like · Reply · 3w

**Col Johns** presumably there could be a DC offset ... (?) unless the caps are a bit leaky ... (?)

Like · Reply · 3w

Write a reply...

Write a comment...

Hello experts,

I want to make a Lt spice simulation model for a Quasi-resonant flyback with auxiliary winding to detect the valley.
I am planning to use the model for analysis and conceptual stuff.
I am facing some challenges to detect the valley.
My approach was to sense the voltage change on the aux winding when the current becomes zero and add a delay which of approximately 1/4 of the resonant period of Lm and C mosfet and C transformer.
This kind of works but I would like to do it more elegant and with a method which is independent of Lm and the parasitic capacitances.
So I tried to detect the slope in order to trigger when this becomes zero(valley), but with no succes.

Did anyone have any experience with building such a model and point me in the right direction?

4 1 Comment

Like Comment

**Norman Elias** I would look for a way to monitor phase. It might give you more advanced warning.

Like · Reply · 3w

Write a comment...

**Mikail Ünal**
**Visual Storyteller** · March 9 at 4:33 AM

Hi everyone ,

i want to ask question about the winding path of the transformer

what do you think about the winding path in the picture,is this way true?

red - Primary

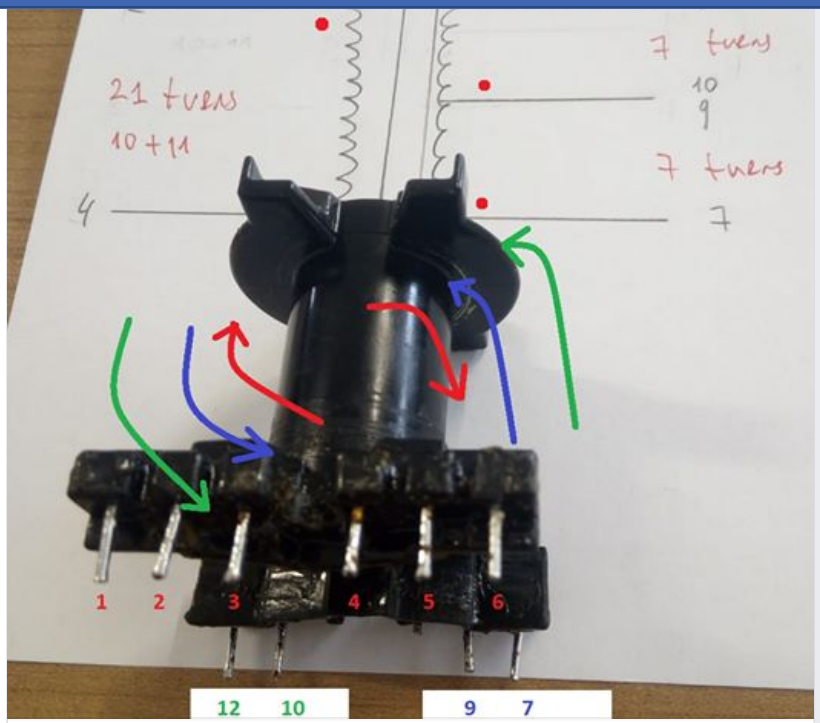
blue - 1.Secondary

green 2.Secondery

İt's a center tapped transformer.

and how the calculate ,that the wire i selected fits in the window?

Thank you everyone!




30 Comments

Like Comment

**Bùi Văn Cương** Last week, I had the same question, and I suggest you watch this video.

Like · Reply · 3w

**Bùi Văn Cương** https://www.youtube.com/watch?v=LuZh1QnegC4

YOUTUBE.COM
#209: Basics of Phase Dots on Transformer Windings

Like · Reply · 3w

**Bùi Văn Cương** https://www.youtube.com/watch?v=otzjJ9ZciW0


YOUTUBE.COM
Dot convention 2

Like · Reply · 3w

**Andrew Ferencz** Simple for winding on a bobbin, I use the dot side for either clockwise or counterclockwise. Even if you have two windings with a common connection (center tapped), each winding starts and ends. And I try to wind so the wires don't cross at the pins.

Like · Reply · 3w

**Ram Mohan** Quite simple. Rotate the Bobbin clock wise & follow the instruction
1. Wind 21Turns clock wise. Start Pin 2 finish Pin 4.
2. Wind 7 turns.clock wise Start Pin 7 finish Pin 9 & 10.
3. Wind 7 Turns clock wise. Start Pin 9 & 10 finish Pin 12
Thats it!!. For calculating the Build, you need to calculate the Ap (Area Product) required for the respective Power levels, Output Current, Frequency, insulation, Topology. Then chose the nearest Core & bobbin that fits

Like · Reply · 3w · Edited

**Mikail Ünal** thank you , and do i need isolation between the 1.secondary and 2.secondary?

Like · Reply · 3w

**Ram Mohan** Mikail Ünal Only if you have to wind the 2nd half center tap winding on top of 1st half center tap.

Like · Reply · 3w

**Mikail Ünal** Ram Mohan can i send a video to you if i do it right or not?

Like · Reply · 3w

**Ram Mohan** You can send it here i guess if the Admins permit so that others can comment or learn!

Like · Reply · 3w

**Mikail Ünal** Ah oke thats better!

Like · Reply · 3w

**Mikail Ünal** This is the winding video ,
Note : i have put isolation between s1&s2
I dont know that this a true winding technique is ,
Im waiting you're comment guys thank you again.

Like · Reply · 3w

**Ray Ridley** that man could use a winding machine in the lab 😎

happy to see you making your own.

Like · Reply · 3w

**Ray Ridley** what is the winding order that you are using?

cant really tell from the choppy video.

Like · Reply · 3w

**Mikail Ünal** Ahah yes sir that's true my opinion is that we need to start from the basic to become a master

The order is 10+10 primary (to minimaze the leakage)

And the Secondary is 7+7 (center taped)

Like · Reply · 3w

**Ray Ridley** OK, how about more details - you have two primary layers, and two secondary layers. that is 4 windings.

What is the order in which you put them on the bobbin?

Also we need to know your topology.

Like · Reply · 3w

10-12 2.secondary

I'm going use this transformer in a phaseshifted full bridge converter wich will work in 100-240vac

My irms current on the primary side is 12A
And on the secondary side is it 18A

I have set the current density almost to 4a/mm2

For the primary winding 18x0.45mm wich has 3mm2 area
Ans for the secondary 28x0.45mm wich has 4.5mm2 area

Like · Reply · 3w

**Mikail Ünal** Also i have calculated the max wire diameter for the transformer that will work in 100kHz and how many power the transformer will carry , my output power is almost 750watts and the transformer can carry more than 1400watts

Output power of the converter 30vdc 25A

Like · Reply · 3w · Edited

**Ram Mohan** Is that a PQ36/30 Bobbin?

Like · Reply · 3w

**Ray Ridley** OK still need more. How do you wind the two layers of primary?

Like · Reply · 3w

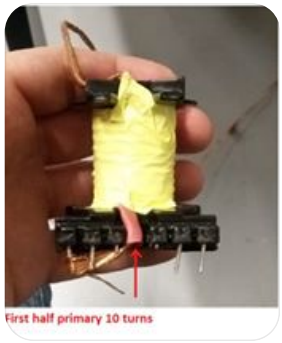
**Ray Ridley** Can we see a primary impedance sweep, open and short circuit?

Like · Reply · 3w

**Ray Ridley** That is three short circuit sweeps, each secondary at a time, then both together.

Like · Reply · 3w

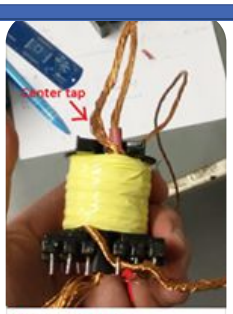
**Mikail Ünal** i have take photos maybe it should be better
İn this picture i have wind the first but half primary with 10 turns




Like · Reply · 3w

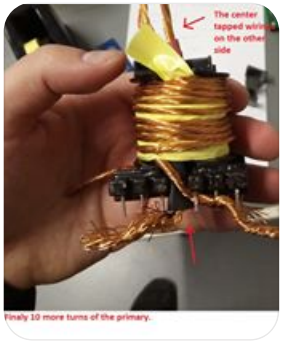
**Mikail Ünal** and in this picture i have wind the 1. secondary i was becarefully with every layer so therefore put isolation everywhere.

Like · Reply · 3w · Edited



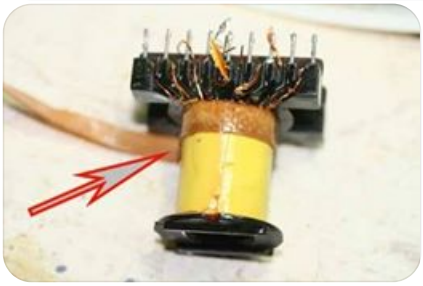

Like · Reply · 3w

**Mikail Ünal** and the last look of the transformer is in the picture what i did is
the winding of the other half primary and also the center wirings are in the air




Like · Reply · 3w · Edited

**Janaki Ram Gopal Pagolu** You have to provide creepage distance between windings, i.e. between primary and secondary to prevent input a.c. supply to appear at the output (by insulation breakdown). This is done by providing margins at top and bottom of the winding. Creepage distance depends on the insulation on wire and tape you use.



Like · Reply · 3w · Edited

**Mikail Ünal** Janaki Ram Gopal Pagolu ah thank you for giving this advise i will isolate it much beter this is a prototype , but what about the winding path and the center tap is it right?

Like · Reply · 3w

**Janaki Ram Gopal Pagolu** Mikail Ünal I always kind of cheat in this step, I wind the transformer in which ever way (CW or CCW) possible and in the end I apply sine voltage from signal generator, compare input output waveform, and swap the terminals if requirement is not met

Like · Reply · 3w · Edited

Write a reply...

**Markus F.L.** for symetrie is better the sek winding Bifilar...

Like · Reply · 3w

Like · Reply · 3w

Write a comment...

**David Isaias Jaimes Reyes**
March 2

Good Afternoon

I have a Problem:

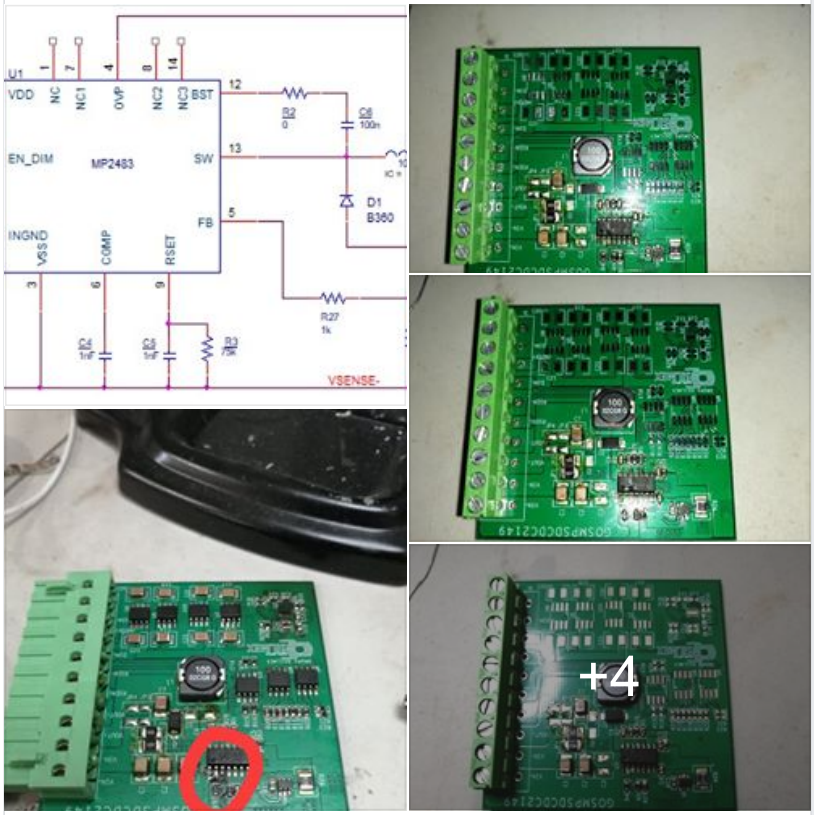
I am, design a Power Supply with a MP2483 with the next features:

Input: 14-30 VDC

Output: 1-14VDC / 0.1-1.5A

The problem that I have is when I connect to the PCB to the VARIABLE POWERSUPPLY Laboratory to 24 V the IC burns between 2 and 3 PIN (VDD and VSS)

What can be the problem?




3 50 Comments

Like Comment

**David Edwards** Are INGND and VSS hard connected together on the PCB?

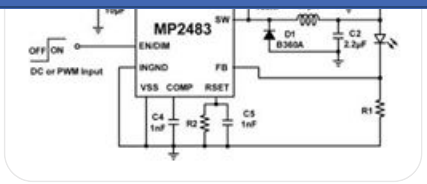
Like · Reply · 4w

Hide 16 Replies

**David Isaias Jaimes Reyes** David Edwards si

Like · Reply · See Translation · 4w

**David Isaias Jaimes Reyes**




Like · Reply · 4w

**David Edwards** Is this the first time you have applied power to this PCB assembly? If so, please check all the IC pin numbers to the PCB. Perhaps there is a layout mistake. Perhaps SW is shorted to ground (D1 is backwards?).

Like · Reply · 4w

**David Isaias Jaimes Reyes** David Edwards yes, is the first time

Like · Reply · 4w

**David Wigton** David Isaias Jaimes Reyes Next time currnet limit the bench supply.

Like · Reply · 4w

**David Isaias Jaimes Reyes** David Wigton is the current?

Like · Reply · 4w

**David Isaias Jaimes Reyes** David Wigton


Like · Reply · 4w

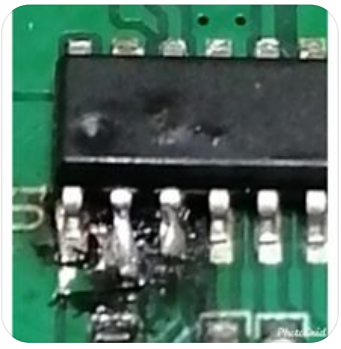
**David Isaias Jaimes Reyes** It is the power supply bench

Like · Reply · 4w

**David Wigton** David Isaias Jaimes Reyes You can limit the current on the supply where it says current. Set it before attaching to your supply. It's hard to tell in the PCB picture what burned, can you get a close up of the damaged area?

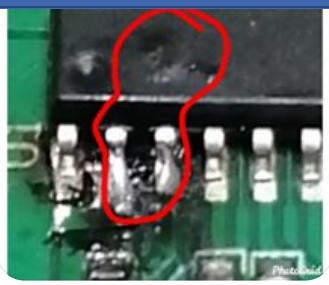
Like · Reply · 4w

**David Isaias Jaimes Reyes**



Like · Reply · 4w

**David Isaias Jaimes Reyes**



Like · Reply · 4w

**David Wigton** The controller was damaged. Was D1 populated? I'd clean up the area and check for PCB damage, replace the controller and populate D1.

Like · Reply · 4w

**David Isaias Jaimes Reyes** David Wigton I soldered a new pcb and have the same Problem

Like · Reply · 4w

**David Wigton** David Isaias Jaimes Reyes With D1 populated?

Like · Reply · 4w

**David Edwards** @ David Isaias Jaimes Reyes,

D1 populated AND pointing the correct direction? With the bench supply connected and in current limit there should NOT be a measurable voltage drop across D1 (sign that it is backwards).

Like · Reply · 4w

**David Isaias Jaimes Reyes** David Edwards I will check again

Like · Reply · 4w

Write a reply...

**David Edwards** @ David Isaias Jaimes Reyes,

In the photo of the PCB assembly, why is D1 removed and why does the PCB look slightly burnt in that area?

Like · Reply · 4w

**David Wigton** D1 does look like it was not populated and it looks like flux, but a better picture would help. It also looks like the controller may be bubbled on pin 3, but that could be picture making it look that way.

Like · Reply · 4w

**David Edwards** One of the first things one learns after leaving university for industry is to do a 100 percent visual check of the PCB as assembled to the schematic/layout. It is a rookie error not to do so.

Like · Reply · 4w

**David Wigton** David Edwards Yeah, I suspect we all have been there.

Like · Reply · 4w

Write a reply...

**Ray Ridley** Repairing modern parts is a tough game. And getting much worse all the time.

I remember having a conversation with a digital guy who wanted to use a TI gate driver that practically needed to be welded to the board. I asked him what he was planning on doing to repair it during the power development. he asked me why he might need to do that?

David Isaias Jaimes Reyes Ray Ridley in this moment I dont know how repair the problem in my pcb. I think that I am a digital guy

Like · Reply · 4w

**David Edwards** @ David Isaias Jaimes Reyes,

Check the PCB assembly between points with a digital voltmeter in diode beep mode (perhaps without the control IC soldered in). Because this is a first-time-power-up, you must verify the assembly to the schematic.

Like · Reply · 4w

**David Isaias Jaimes Reyes** David Edwards okay, I will check

Like · Reply · 4w

**Ray Ridley** David Isaias Jaimes Reyes that's ok, you can be trained. First thing to learn is that power parts will fail. Choose a package technology you can rework. Hot air gun is useful, perhaps someone can recommend a model?

We all have this problem. The last time I took out an LT controller by touching the wrong pin, it had to go to a professional rework lab, we couldn't do it either. Removing the offending part without killing all the others around it is a learned skill.

One of my pet peeves is the use of 0402 resistors on development boards. No good reason why, there is usually plenty of room. It just makes our life difficult to implement changes. I prefer the 0805 or 1206 packages.

Like · Reply · 4w

**Bob Gudgel** Ray, at least you know what you did to hurt it ! What I hate is when my circuits break because of STS.... (Something Touched Something)

Like · Reply · 3w

Write a reply...

**Harshit Soni** Simple - D1 is not soldered which is the buck converter low side switch. Internal high side switch turns on and charges the inductor, and D1 is missing so hv develops across the internal HS switch and blows up the IC - dissipates inductor energy by spark

Like · Reply · 4w

**Bob White** I think more likely if D1 was not populated at the time of failure is that after the first on time, when current has been developed in the output inductor, when the control/top switch turns off the inductor pulls current that flows from Vss through the IC substrate to the SW pin. This is never a good thing.

Like · Reply · 4w

**David Isaias Jaimes Reyes** Harshit Soni yes, you have reason, it is a first test, but LATER I soldered the diode in D2 in a new pcb and I had the same Problem. The picture in this place is because I hadnt the other pcb photo

Like · Reply · 4w

**David Isaias Jaimes Reyes** Bob White what is PUPULATED, I am from México and I understand this term

Like · Reply · 4w

**Mark Dennis** "Populated" normally means "installed", or soldered in place.

Like · Reply · 4w

soldered?

Like · Reply · 4w · Edited

**David Isaias Jaimes Reyes** Harshit Soni yes

Like · Reply · 4w

**Harshit Soni** David Isaias Jaimes Reyes that is strange. In this case it will be difficult to tell without looking at waveforms. e.g. SW node, CS node, Vin node.

Like · Reply · 4w

**David Isaias Jaimes Reyes** Harshit Soni I cant see the waveforms because when I connect the circuit it fail

Like · Reply · 4w

**Harshit Soni** David Isaias Jaimes Reyes well you can always trigger the oscilloscope on power supply voltage and utilize high memory of oscilloscope for such debugging.

Like · Reply · 4w

Write a reply...

**David Isaias Jaimes Reyes** I am going update the pictures

Like · Reply · 4w

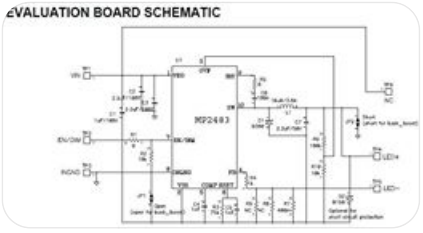
**Farhan Beg** The main reason for the damage is voltage spikes exceeding the input limits excessively. I notice that your bulk cap. C1 and C2 are connected far away from the pin. Try connecting a lower value capacitor right on top of the Pin 2 and Pin 3 which should take care of any inductance in the loop and ensure that it dampens the spikes seen by the pin VDD. The only reason for your burnt IC is excessive voltage. You should be able to measure this voltage by feeding 5V or so to the IC since the IC has an input voltage range of 4.5V to 55 V and I would assume that the spikes seen by the IC dont exceed the hard limits at 5 V or so. Please share the waveforms at an I/P voltage of 5 V.

Like · Reply · 4w

**David Isaias Jaimes Reyes** I am basing in this circuit

Like · Reply · 4w · Edited

**David Isaias Jaimes Reyes**




Like · Reply · 4w

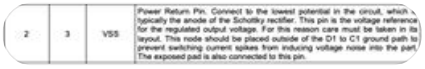
**Farhan Beg** Shouldnt Vss be connected to the ground?

Like · Reply · 4w

**David Isaias Jaimes Reyes** Farhan Beg for buck?

Like · Reply · 4w

**Farhan Beg**




Like · Reply · 4w

**David Isaias Jaimes Reyes** Farhan Beg in my circuit I put a jumper as the evaluation board for conect Vss with Ingnd

Like · Reply · 4w

**David Isaias Jaimes Reyes** Hi my friends. I disconnect the VSS and INGND and now they arent together. I connect the PCB to a BANCH SUPPLY to 20V and it isnt burn, but now I mensuare a voltage between GND and VOUT- of 20V, the same voltage to the input

Like · Reply · 4w

**David Isaias Jaimes Reyes** Excuse me for late, but I was waiting for a new IC

Like · Reply · 4w

**David Isaias Jaimes Reyes** Vss have a voltage, I am meansure the voltage with the GND to the input 17V, and when I mensuare the volarge in VOUT+ I have 17 V, AND GND with VOUT- I have 17V, and the voltage in the SW pin is a DC signal

Like · Reply · 4w

**Jeremy Lister** External supply overshoot or resonant overshoot? Measure input transient at turn on. Stick a power zener on the input.

Like · Reply · 4w · Edited

1

**Jared Bevis** I have had this happen on a battery charging circuit where the inductive kick from the wiring at in rush killed the chip. Different controller chip altogether (TI BQ series), but same internal burn.

Like · Reply · 3w

Write a reply...

Write a comment...

**Ray Ridley**
Admin · February 26

New Group Members

Please make sure that you let new potential members know that they MUST answer the questions to be a part of this group.

This has become a legal requirement in the US now, we cannot accept them if they don't answer. It's not just us - you will see similar questions being asked if you try to download free software and other design information from the big companies.


You and 8 others

7 Comments

Like Comment

**Janamejaya Rox** Yes Ray, we will inform new members to answer the questions.

Like · Reply · 5w · Edited

Like · Reply · 3w

**David Edwards** "What is your favorite color?"

"Blue, no wait, red . . . auuuuu-u-u-u-gh!"

Haha · Reply · 3w

**Ray Ridley**

Like · Reply · 3w

**Ray Ridley** Someone who tried to get into the group but failed.

Like · Reply · 3w

**Phil Lane** Ray Ridley Engineer turned day-trader.

Like · Reply · 3w

**Ray Ridley** Yes, when his spouse discovered what he had been doing all day at home.....

Like · Reply · 3w

Write a reply...

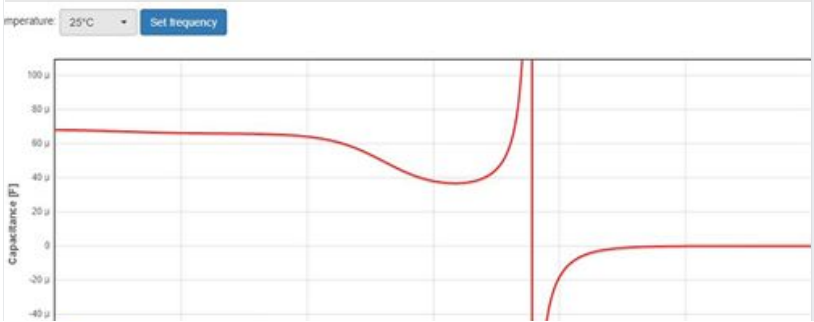
Write a comment...

**Ray Ridley**
Admin · February 27

AVX Capacitor Simulator

There is a new simulator in town - SpiCAT! Not spice, but just a simulator for capacitors.

Intrigued, I dug in a little, and this is the frequency response data that I found. Any comments?

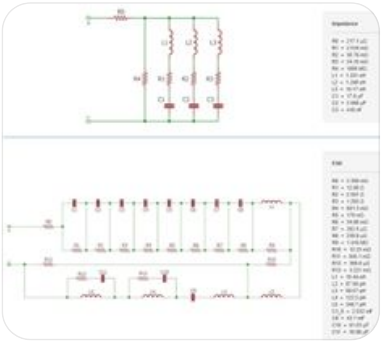



Frequency [Hz]

Jay Philippbar and 18 others 28 Comments

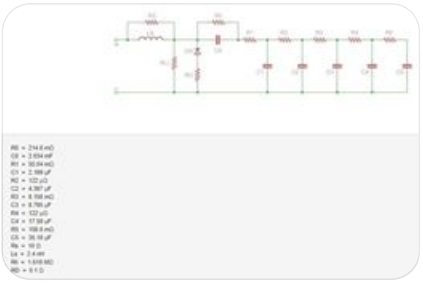
Like Comment

**Ray Ridley** And here is their circuit model for an MLCC - awesome!



Like · Reply · 5w · Edited

**Ray Ridley** circuit model for the tantalum cap in the first diagram.



Like · Reply · 5w

**Thomas Mathews** Is that graph bogus? I can believe that reactance might swing toward the infinite but, hmmm, the capacitance [in uF] does not do that..... right?

Like · Reply · 5w · Edited

**Ray Ridley** Well, does it? Does capacitance go to zero?

Like · Reply · 5w

**Thomas Mathews** No but Xtotal=Xc+Xl can....

Like · Reply · 5w

**Ray Ridley** here is a PhD dissertation in the making. Write the analytical transfer function for a buck converter using one of these capacitors. Any takers?

Better start with SSA to make sure you get a 12+ order matrix to invert.

Like · Reply · 5w

**Ray Ridley** Sorry, make that 18th order. Wonder if Mathcad can invert that symbolically and factor the result?

Like · Reply · 5w

**Michael Thomason** This is why I prefer to use Kemet (K-Sim) and AVX capacitors

Like · Reply · 5w

**Kevin Azul**

👍👍

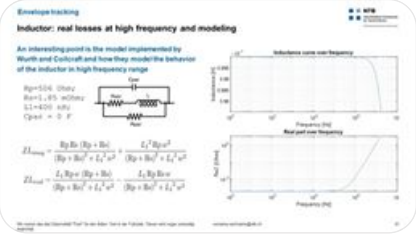
Like · Reply · 5w

but i do like their circuit models, very sophisticated and usable.

Now, if only we can get the magnetics manufacturers to put out a circuit model too. So far they are resisting that strongly. I will keep banging this drum because it is getting ridiculous at this point in our industry.

Like · Reply · 5w

**Riccardo Tinivella** the new spice models of coilcraft and wurth have Rac (only proximity) inside, I check also them by measurements and they are also quite ok (till 5MHz) let's say




Like · Reply · 5w · Edited

**Darrell Hambley** Gotta be suspicious of the person who made that pic. That resistor value would only be accurate at one unique frequency and peak flux level.

Like · Reply · 5w

**Ray Ridley** That model won't work for proximity. Its a fixed series resistor, and the parallel resistor is for some representation of core loss. About as crude a model as you can get.

Straight out of the texts of 1898.

Like · Reply · 5w

**Ray Ridley** Magnetics - dragged kicking and screaming into the 20th century.

Better late than never.

Like · Reply · 5w

**Claude Abraham** I've used it & really like it. It provides useful data.

Like · Reply · 5w

**Thomas Mathews** I still contend that, because it shows negative, as well as zero capacitance, that this graph is bogus. The Y-axis is probably supposed to be j*Ohms not uF. OK, so negative capacitance is not totally impossible but I see no gyrator in this circuit so color me skeptical.

Like · Reply · 5w · Edited

**Ray Ridley** You are quite right. They have a lot of good data and models, but this particular graph is bogus. AVX have a history of this, plotting capacitance vs frequency and having it drop to zero at the resonant point.

they don't do it for their MLC parts, just the tantalum (based on my quick look at their program.)

Good job though for the circuit models. If the cap makers can do it, its time for the magnetics vendors to up their game. We have shown them how to do it, but they don't want to go their yet.

Like · Reply · 5w

**Col Johns** I just can't get over the fact that they are plotting Z not C - yet put C on the axis - where is the real understanding? C does not go to some ultra high value ...

Like · Reply · 5w

asked it to extract an RC model (no L) then it made the equivalent cap go to zero at the resonance. All their MLC parts were plotted this way.

Seems they have learned not to do this any more, but maybe some legacy measurements remain.

Like · Reply · 5w

**Ray Ridley** Doesn't make sense for a cap vendor too say their part goes to zero at some frequency. People get easily confused and won't buy it.

Like · Reply · 5w

**Col Johns** This seems like sales people with no engineering degree - just plot Xc vs freq and put a big red arrow at SRF with an asterix and note at/on the graph - above SRF plot XL ... this is very instructive for high quality electrolytics ...

Like · Reply · 5w

**Claude Abraham** Actually, their interpretation makes sense, but is sloppy. For a series L-C network, impedance can drop to near zero, at resonance. This zero impedance is equivalent to a zero inductance value, or infinite capacitance value.
Likewise, a parallel L-C has a very large impedance at resonance. This can be modeled as an infinite inductance, or a sero capacitance. A capacitor of 0 farad has infinite impedance at any finite frequency.
I agree with the posters above, that their terminology is sloppy.

Like · Reply · 4w

**Stephen Ziel** I've been using these models for as long as they've been around. I don't really look at the curves other than impedance. I think at some point it all boils down to the equivalent impedance of the capacitor across frequency. Other manufacturers are starting to provide their own capacitor models. Murata has a triple resonance near the minimum impedance for their X7R caps, and their ladder network simulates that.

1

Like · Reply · 3w

**David Edwards** . Hello Ray Ridley,

This graph is of capacitance (which has no phase). At resonance it switches to inductive (which is plotted as a negative capacitance). The magnitude just switches polarity, but never really goes through zero. A better plotting program would not plot the vertical line at the polarity change..

Like · Reply · 3w

**Colin Tuck** Surely the graph is of Ztotal not capacitance ... even then it is wrong ...

Like · Reply · 3w · Edited

**David Edwards** Look at the y-axis label. 👀

Like · Reply · 3w

**Colin Tuck** I would but it's wrong - the C doesn't and can't go from + infinity to zero to - infinity over a short freq span ... and then to zero at VHF ... tis quite the piece of crap graph ...

Like · Reply · 3w

impedance of a cap, and tell it the equivalent circuit. It will then fit values to the curve. Great.

Trouble arises when you have an RLC circuit that you try to match with just an RC. AVX made this error long ago, and it

**Col Johns** is looking for recommendations.
March 9 at 6:24 PM

Slightly flexible pcb - can anyone recommend a place that can do 2 Oz copper on 0.2mm kapton ... ?

1 Comment

Like Comment

Write a reply...

Write a comment...

**Brian Faley** Boardsharkpcb.com
2
Like · Reply · 3w

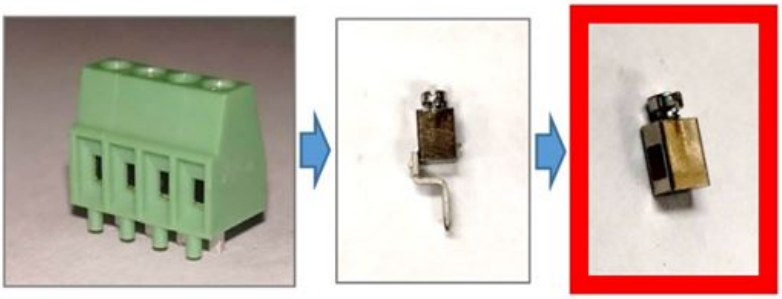
Write a comment...

**Arief Noor Rahman**
Conversation Starter · March 9 at 8:51 AM

Does anybody now the name of the thing in the red box where the screw is connected to?screw block?screw terminal?mating-screw terminal?

and is it correct if I call the dangling leg that we can solder as "solder-able terminal" or "solder-able pin" or "solder-able leg"?

the photo is disassembled 2.54 mm pitch plastic screw terminal to be used for custom low inductance screw terminal



14 Comments

Like Comment

**Paul Shepherd** I've ripped those out for a very high-temp test board before, but no, I don't know what to call it.
Like · Reply · 3w

**Arief Noor Rahman** Haha...we need to be always creative...some applications asked for non conventional approach
Like · Reply · 3w

**Ray Ridley** Widget with a screw in it.....
Like · Reply · 3w

**Broox Le** To be precise, include pictures/drawings with whatever words you choose.
Like · Reply · 3w

**Arief Noor Rahman** Of course, that picture is in my paper draft...
Like · Reply · 3w

I can't tell you how many times these are the weak link and highest failure.

Cost reduce these at your peril - I have some horror stories that I'm not allowed to share, unfortunately.

Like · Reply · 3w

**Lucas Sturnfield** Digikey lists them as a "lug", under rectangular connectors

Like · Reply · 3w

**Ray Ridley** Lug to me would be the bent connector part coming off the side in the middle picture.

Like · Reply · 3w

**Brian Faley** Box terminal?

Like · Reply · 3w

**Darren Hoppins** Box Lug

Like · Reply · 3w

**Norman Elias** Here's one of the images that comes up if you google "lug"

Like · Reply · 3w

**John MacLeod** Cage clamp.

Like · Reply · 3w

**David Edwards** .
Rising clamp 100A terminal block, through-hole mount.

Like · Reply · 3w · Edited

**Arief Noor Rahman** Thanks folks for the suggestion....

As always, great response!

Like · Reply · 3w

Write a comment...

**Simopekka Niskanen** shared a link.
February 14, 2019

Here is something to think of: Totem-pole PFC with GaN-switches, achieves some 99% efficiency. This is from the Future

FUTUREELECTRONICS.COM
**Futureelectronics NorthAmerica Site**

Phil Lane and 2 others — 6 Comments

Like | Comment

**Ray Ridley** Link is not active. Will have to delete.

Ray Ridley 99% is actually right now for the PFC, not in the future.

Like · Reply · 1y

**Ray Ridley** Can you get the right link Simopekka Niskanen?

Like · Reply · 1y

**Simopekka Niskanen** I will re-check, thanks. Ad it is from the Future Electronics 🙂

Like · Reply · 1y

**Simopekka Niskanen**
https://www.futureelectronics.com/.../future-electronics...

FUTUREELECTRONICS.COM
Future Electronics — GaNdalf Development Platform |…

Like · Reply · 3w

Write a reply...

**David Edwards** http://www.my-boardclub.com/.../application_board_page...

MY-BOARDCLUB.COM
Boards on my-boardclub.com

2

Like · Reply · 3w

Write a comment...

**Chan Hao Jie**
March 6 at 6:21 AM

Hi guys. Has anyone did the small signal model for an active clamp forward converter? I am referring to C. Basso article about one, but can't follow through once he talked about the clamping capacitor. Also the model would not work in SPICE as the cap is an open at DC so SPICE could not find an operating point.
Many thanks in advance.

2 14 Comments

Like Comment

**Ray Ridley** Sweep the time domain circuit as described in our software

Like · Reply · 4w

**Chan Hao Jie** I'll try doing a sweep. Thanks for the suggestion

Like · Reply · 3w

1. Correct active (ground), passive (clamp branch) and common (magnetic) terminals
2. Correct voltages mean values (both active to passive and common to passive terminals). I used it.
Further the clamping cap is linear per se and can be placed as it is.

I'm writing a tribute chapter for a SMPS book concerning his elegant approach

Like · Reply · 4w · Edited

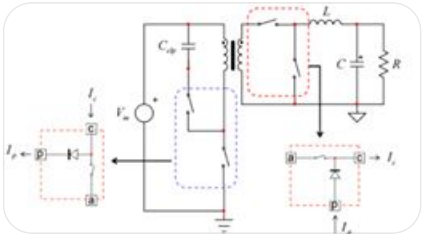
**Steve Den** Voltage Mode or Current Mode?

Like · Reply · 4w

**Nicola Rosano** Steve Den VM, the model is available. Or you can proceed, as I did, from scratch to crosschek with available model.
Once you enclose the 'non linear part', mos + clamp diode couple you can apply Vorperian approach.
1. Identify the three terminal cell (mentioned before)
2. Average active, passive, and common current. Repeat for two voltages (active2passive, passive2common, active2common with Kirchhoff voltage law). You have the large signal model.
3. Partial derivative to get small signal.
Trust me, if you grasped Vorperian approach, it is more hard to explain then try

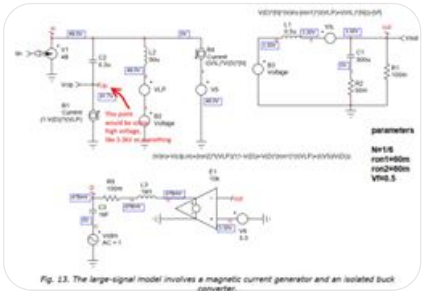
Like · Reply · 4w · Edited

**Nicola Rosano**



Like · Reply · 4w

**Chan Hao Jie** Nicola Rosano Hi Nicola. I tried following his approach, and I had a roadblock.
The image is from "The Small-Signal Model Of An Active-Clamp Forward Converter (Part 2)"
Vclp node is showing high voltage in LTSpice, which makes sense, because it's a cap in series with a current source. I am not sure how to approach this. Looks like his ISpice is working



Like · Reply · 3w

Write a reply...

**Alain Laprade** You might want to consider dropping a note at Christophe's web site asking for guidance.
https://cbasso.pagesperso-orange.fr/


CBASSO.PAGESPERSO-ORANGE.FR
Welcome

Like · Reply · 4w

halfway unfortunately. Maybe I should try again

Like · Reply · 3w

**Alain Laprade** Chan Hao Jie Do so. Its a good web site. IF you cannot reach Chris after a few days, contact me. We are in frequent communication as work colleagues.

Like · Reply · 3w · Edited

**Chan Hao Jie** Alain Laprade I see. Thanks!

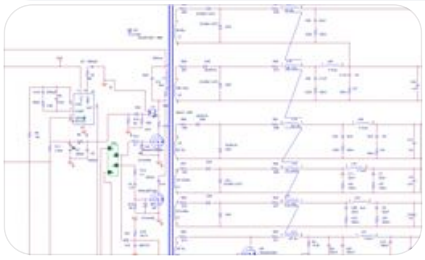
Like · Reply · 3w

**Alain Laprade** Chan Hao Jie I know the answer is out there, I just don't have the bandwidth to dig it up.

Like · Reply · 3w · Edited

Write a reply...

**Chris Merren** This has the active clamping cap and runs smoothly in Cadence



Like · Reply · 4w

**Chan Hao Jie** I suppose this a controller in large signal simulation? My large signal is working I guess, but getting the small signal is tricky for me

Like · Reply · 3w

**Mike West** Write a reply...
March 9 at 7:23 AM

Write a comment...

Just got confirmation that Vishay has pulled out of all shows and shut down travel.

6 2 Comments

Like Comment

**Jeffrey Casady** It doesn't sound like anyone will be there.

Like · Reply · 3w

**Simopekka Niskanen** We at Future Electronics have cancelled everything related to fairs/shows too.

Like · Reply · 3w

Write a comment...

**Charlie Elliott** shared a link.
**Conversation Starter** · March 1

Hybrid Polymer Electrolytics? Any gotcha's?

We are design a 50W non-isolated buck for an automotive application. We need a decent amount of hold up capacitance so MLCCs would be expensive and large. Tants will be quite expensive and straight electrolytics too large to meet lifetime. We are therefore considering a Hybrid Polymer Electrolytic from Panasonic (https://industrial.panasonic.com/cdbs/www-

INDUSTRIAL.PANASONIC.COM
**industrial.panasonic.com**

You and 6 others 15 Comments

Like Comment

**Federico Rodighiero** I used polymer alu cap from kemet as inverter input capacitor. I am very satisfied, they are small and the esr rate is almost comparable to ceramic.

Like · Reply · 4w

**Janaki Ram Gopal Pagolu** and you don't have to derate with DC-bias voltage unlike MLCC

Like · Reply · 4w

**Baird Hendrix** I haven't used one in a product but I have evaluated them for use in an aero product before. I particularly looked at the Panasonic poscaps (which from what I understand were originally Sanyo).

The good :
* Vibration and shock performance is very good, similar to solid tantalum (ie nearly ideal) . No microphonics from what I could see but I wasnt looking very hard.
* Voltage deratings are quite good compared to tantalum mno2 caps (I generally see 80% as the recommended derating, similar to polymer tantalum). Also no dc bias effect like mlccs!
* Can get them in voltages up to about 35v (at least when I looked) , great for decoupling on PoL supplies.
* They don't explode like mno2 tantalum.
* Because they're solid they're good candidates for vacuum or high pressure environments.
* ESR is good, comparable to real aluminum electrolytic or good tantalum (not as good as mlcc though). Note that you may have to operate them at 1 MHz or higher to get the lowest ESR spec.
* Good volumetric density.

The bad :
* Rated hours at high temps pretty low compared to solid tantalum (1000 hrs @ 125c is considered high reliability)
* Leakage is quite high, avoid using in hold-up circuits.
* Low ripple current ratings compared to mlcc.
* Usually single source, though this is improving.

Overall they look a lot like modern polymer tantalum capacitors at a fraction of the cost. Reliability is supposedly quite good within the lifetime spec, and I've seen quite a lot of commercial products using them now (they're especially common for PoL converters for processor core voltages, or what Intel calls VRMs).

Like · Reply · 4w · Edited

**Charlie Elliott** Baird Hendrix - Thanks, that is exactly the useful insight I was after. FYI Panasonic spec 10k hours at 105C on that range. They also have another range giving 4/5k hours at 125C!!

Like · Reply · 4w

**Anil Adapa** They are good, we have been using the same series (from Panasonic) for the past 5 years. Application is a 300-400 kHz half-bridge inverters with 24V dc and power levels for 10-25 W.

Like · Reply · 4w

**Lucas Sturnfield** They are quite good. Nice and space dense. The above commenters put in the bads (single source, price, lower ripple current, etc). I would offer an experience that this series really doesn't like to be overvoltaged and they will pop aggressively (not unique in caps of course, but still an aggressive failure mode)

Like · Reply · 4w

Panasonic.

My experience with Panasonic parts is that they are never characterised very well.

Like · Reply · 4w

**Alex DiDonato** Hybrid is a good choice. The solid electrolytic capacitors can fail short.

Like · Reply · 4w

**Charlie Elliott** Alex DiDonato - Any cap can fail short!! Is there something specific about the solid (not hybrid) types that cause this that you are aware of?

Like · Reply · 4w

**George T. Ottinger** About 20 years ago, we used them to replace tantalums when there was a world wide shortage of tantalum. We did have to re-compensate some loops due to an ESR difference.

The biggest issue was that we would go through our SMT process and send the finished goods to the customer, who would then place the module on his board and go through his reflow process. In the meantime, the polymer's package absorbed moisture and would then "popcorn" in the customer refow. So, check the MSL rating. I imagine they have fixed that in the last 20 years.

Like · Reply · 4w · Edited

**Alain Laprade** Charlie, I always recommend a al-poly/ceramic filter capacitor mix to customers. Choose the ceramic for filtering noise, choose al-poly for the bulk. Beside filter size reduction for bulk filtering, a huge benefit of using al-poly is the stable (over temperature) ESR you are introducing in the filter that benefits the feedback loop phase margin, permitting a wider power supply bandwidth than can be achieved for an equivalent all-ceramic bulk solution. An all-ceramic solution always deteriorates the phase margin (near-zero ESR).

Like · Reply · 4w

**Charlie Elliott** Thanks everybody for your useful insights This group is great for things like this!

2

Like · Reply · 4w · Edited

**Simopekka Niskanen** We started using those around 2000 at Nokia Networks, it was Sanyo then. I think the hybrid is the best choise: low ESR, long life time even at hot, no shortcircuiting, no burning, hihghest reliability. But the best comes with a price 🙂

Like · Reply · 4w

**Charlie Elliott** Were the original Sanyo OSCON part hybrids or straight polymers?

Like · Reply · 4w

**Simopekka Niskanen** Charlie Elliott OsCon was the brand. We did 48DC => 3V3/50A supplies for DX200, digital telco echange. It was then centralized power feed. After that, IPA2800 we went to distributed power feed.

Like · Reply · 3w

Write a reply...

Write a comment...

Admin · March 6 at 5:44 PM

TI's New Design Software - RidleyWorks 0.001

It was mentioned in a thread somewhere here, but I pulled this out. TI have realized what we have known for 30 years - Excel is the perfect platform for design. Presentation of data is unsurpassed, and it is a great multivariable environment.

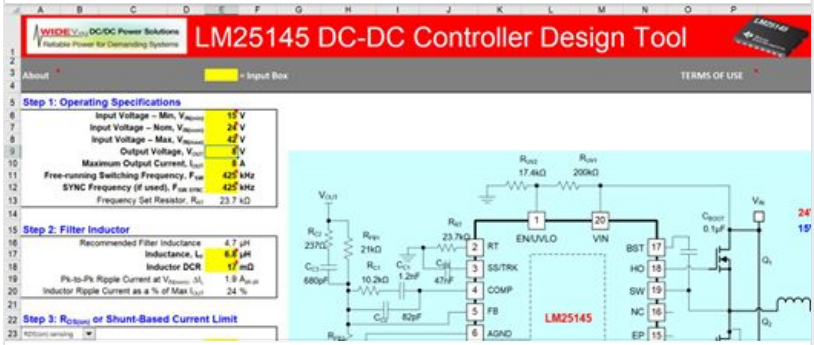
Easy for all to follow and understand since they know Excel, we all have to use it.

Now, their product is where we were in 1991. It designs the controller compensation. They have a lot still to learn about how to make Excel work for you. Data presentation is still spreadsheet-think, cluttered, and too much data at once. We started there too.

I don't think they will ever take our next step - running the large-signal simulation inside the Excel spreadsheet. We do it more efficiently that anyone can simulate a circuit. We could teach them how to do it, but they are not going to ask, we know that.

Incorporation of proximity loss and full magnetics design? Maybe in another 30 years or so.

Regardless, congrats to TI on arriving at the right playing field. Better late than never! We can even see some cute things they have done that we may adopt in RidleyWorks. Nice to have another programmer to lead the way for once on the small details.




You and 27 others 10 Comments

Like Comment

**Amit Kumar** Very inspiring Dr. Ridley !

Like · Reply · 4w

**A-ARon Jones** Depends on the engineer over there, they still believe Webbench is the simulator for the future

Like · Reply · 4w · Edited

**Ray Ridley** I'd put my eggs into the PSIM basket, having learned a lot more about it recently. But having the instant simulator in Excel like we do has huge benefit too. Lets us do things that cant be done elsewhere.

Like · Reply · 4w · Edited

**Venkat Karthik** My guess: LM25145 is National semiconductor's legacy product line, not TI's (although these guys acquired them). I think TI did not want to change that product line and the tools used by National.

Like · Reply · 4w

**Darrell Hambley** Well, that was slightly entertaining for the last 20 minutes. The act of using this spreadsheet however, is not "designing"; rather it is "hacking" or "shot gunning" quickly.
I believe none of these "design it for you" programs are a substitute for an understanding of 'Control Theory 101'.

4

Like · Reply · 4w · Edited

again this decision is out of Dallas, not Santa Clara.

Like · Reply · 3w 1

**Ray Ridley** Norman Elias true. I missed that

Webbennch will be the way for them I'm sure.

Like · Reply · 3w

**Norman Elias** You don't use WebBench to design a power converter. You go there to get one fully designed. If you want to tweak the design before taking it to the bench you're on your own in Spiceland.

Like · Reply · 3w

**Ray Ridley** Norman Elias indeed. I'm sure it works great every time.

Like · Reply · 3w

**Norman Elias** Don't forget. The object of WebBench is to sell chips. It promotes sales by giving you an application for the chip it selects. The object of WebBench is completely orthogonal to your intent. In that sense these tools do not compete with each other.

Like · Reply · 3w

Write a reply...

Write a comment...

**John Knapp** shared a link.
March 8 at 1:50 PM

I may only be telling people what they know already, but the boost converter has been around a long time. OK, it's water, but even so.

http://www.greenandcarter.com/ram_pump_eandt_jan_2014.pdf

More info out there on the web if you're interested.

GREENANDCARTER.COM
**www.greenandcarter.com**

Like Comment

Write a comment...

**Divya Ks** uploaded a file.
March 7 at 9:13 PM

Hi all,

1) In a buck converter, is there any correlation between switching transition time and decoupling capacitor requirement?
As per the TI document attached input decap values are only determined by input ripple current and switching frequency.
2) In the text book "A to Z Switching power supplies_Sanjay Maniktla", it was mentioned the noise has little to do with the basic switching frequency of the converter itself — it is the transition that is responsible for most of the noise, and all its attendant problems. Is the author referring to voltage spikes (noise) due to stray inductance alone?

Thanks in advance

**Cap selection.pdf**
PDF

Like Comment

**Justin Larson** 1) No, switching transition is effectively in the 100's of MHz. Its best supported with a small size capacitor to reduce ESL

2) Even a waveform with no ringing will have a high frequency component, due to the rise time. Look at the Fourier transform of a trapezoid.

Another note, the fundamental switching frequency can be an issue depending on your application, such as <2MHz switching in an automotive application can cause problems in the AM radio band.

Like · Reply · 4w · Edited

**Divya Ks** So would there be 3 sets of capacitors?
1. Bulk capacitors- for load transients
2. Ceramic capacitors- for input ripple
3. Additional lower caps with low ESL for supporting during switching transitions

Like · Reply · 4w

**Justin Larson** Divya Ks That is ideal, and the placement should be in the reverse order (smallest capacitors closest to the power device).

Like · Reply · 4w

**Divya Ks** Justin Larson Thanks

Like · Reply · 4w

Write a reply...

**Phil Lane** The input cap is supposed to carry current at the main switching frequency, plus a few harmonics. Probably need more of a filter to kill the fast switching transitions.

Like · Reply · 4w

**Col Johns** If you have or require very fast switching times - you will need quality caps close to the fets, also damped C on the supplying bus nearby too ...

Like · Reply · 4w

Write a comment...

**David Edwards** uploaded a file.
**Conversation Starter** · March 7 at 12:23 AM

In another thread I was requested to post this small presentation about oscilloscope probe cable extensions for making measurements within a vacuum chamber that I created some years ago. Making scope measurements under these conditions often requires extension cables. Measurement pitfalls are discussed and two clean measurement methods are presented.

**Electrical Measurements Under Vacuum.pdf**
PDF

You, Jay Philippbar and 11 others 3 Comments

Like Comment

**Arief Noor Rahman** Great thanks...

Like · Reply · 4w

**Robert L Rauck** Very useful information.

Like · Reply · 4w


2

Like · Reply · 4w

Write a comment...

**Arief Noor Rahman**

Conversation Starter · March 6 at 4:31 AM

Hi, I am considering about a method to probe high voltage high dV/dt signal (i.e. GaN Vds signal 0~400V) with coax

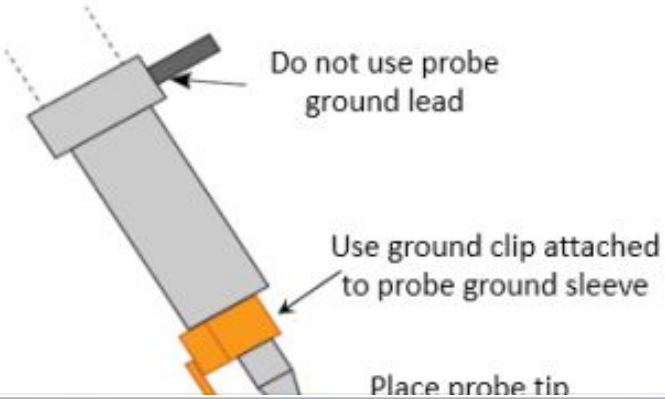
normally, we use a normal passive probe as shown below...

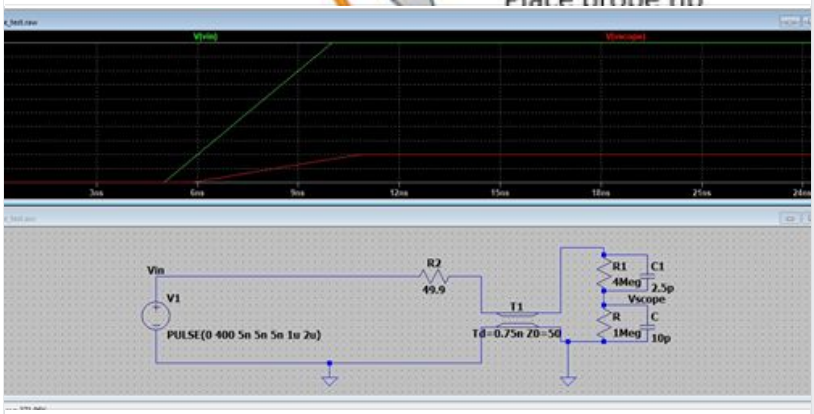
however, as everybody may aware, connecting probe with that approach is not the safest way to do it since the connection often flimsy...

I am thinking about using SMA connector soldered on the board, and to avoid signal reflection when using coaxial cable, I can place a 50ohm resistor before between measurement point and coax terminal in the PCB, then, to reduce the voltage before the voltage before the scope, I can use a small pcb just in front of the scope BNC terminal to place resistive divider to reduce the voltage by 10:1 or 5:1 ratio (LTspice simulation result attach in the photo below)

does anybody has experience on this?any suggestion?

Thanks....




5

32 Comments

Like

Comment

pretty safe, no ground lead (and common-mode noise issues). You are basically making your own probe with resistors on the board. You need to consider the voltage rating of the resistor. 1206 500V rated resistors are pretty inexpensive.

Like · Reply · 4w · Edited

**Arief Noor Rahman** I know I am like trying to make my own probe, but the difference is location of resistive divider that is close to the scope BNC, instead of close to probe tip as normal probe

I got the idea by watching EEVblog video
https://www.youtube.com/watch?v=gpwkiJC5hfU

my problem with that pcb to probe adapter is...it is big, and my space for measurement is very crowded with 3 test points next to each other...

YOUTUBE.COM
EEVblog #1266 - PSU Probing Screw Up!

Like · Reply · 4w · Edited

**Andrew Ferencz** A scope is 'unbalanced' .. and any common-mode current will flow in the ground lead (low impedance) rather than the tip. Thus all CM current flows in the ground and you get a V=Ldi/dt .. which isn't 'real' if you are interested in the differential signal. I don't think an SMA connector is smaller than a 5mm probe tip ..

Like · Reply · 4w

**Arief Noor Rahman** Andrew Ferencz the measurement point itself is referred to ground as well...

the problem is although the probe tip is small, but, the probe body is considerably larger...and if I use pcb to probe adapter it will be much larger than SMA connector...if use as the picture above, the probe can fall easily

Like · Reply · 4w

**Andrew Ferencz** you can route your measurement point to a better location, the key is a good ground plane for the scope, not a skinny trace.

Like · Reply · 4w

**Arief Noor Rahman** Andrew Ferencz could you please elaborate on "good ground plane"?

Like · Reply · 4w

Write a reply...

**Arief Noor Rahman** I just noticed that 50ohm coax has ~1pF/cm capacitance...so, perhaps this approach may increase the capacitive loading compared to 10x probe...

Like · Reply · 4w

**Alex Berestov** Think before you do.
Nobody prohibits you from competing with the scope industry.

Like · Reply · 4w

**Dave Lafferty** I have used that before. Small sma or other small rf connection on the PCB to measure ripple.

Like · Reply · 4w

**Arief Noor Rahman** May I know your freq of interest and the signal amplitude?

Like · Reply · 4w

However the best results come from battery powered/isolated scope(read safety rules first).

Like · Reply · 4w

**Arief Noor Rahman** I did that already...but I am looking to make it more physically stable...now is okay but i want to improve it

Like · Reply · 4w

**Thomas Mathews** A 10X probe simply has a 9 megaOhm resistor in parallel with a variable capacitor. The vari-cap has range that includes a value that is ten times lower than the input capacitance of the scope and coax combined. You could build the 9 MegaOhm and varicap (maybe 0.3pF to 3.0pF type) onto your PC board then connect via coax to your 1M-Ohm scope with an SMB or SMA. To adjust the compensation capacitor, you'll have to figure out how to get a square wave "calibration" signal to the input side of this structure. Make sure the 9 megaOhm resistor you use is up to the 400V signal as most chip resistors are only good for 200V max. If you use chip resistors consider several in series that add up to 9 megaOhm.

Like · Reply · 4w · Edited

**Arief Noor Rahman** Thanks Thomas Mathews

Like · Reply · 4w

**Kristian Kruse** An oscilloscope cable is not a regular coax. As far as I know, it is a lossy line, which helps to minimize standing waves and ringing.
If I remember correct then Dave from EEVBlog has a video about the subject.

Like · Reply · 4w

**Thomas Mathews** Yes, that is probably true but this will work to some bandwidth. If you want flat response to many hundreds of MHz then, as you point out, finer details may need attention....

Like · Reply · 4w

**Kristian Kruse** Thomas
I might be wrong. But isn't the high bandwidth is exactly what you want, when you want to measure the high dV/dt and ringing of a GaN HEMT switching?

Like · Reply · 4w

**Arief Noor Rahman** Yes...you are right Kristian Kruse...scope probe has 300ohm resistance...they must do it because they want to have very long cable and flat freq response

I read somewhere that if cable is shorter...the signal reflection will be less of an issue, thus no need for an lossy transmission line

Thats why I am considering to use only 10~15cm cable

Like · Reply · 4w

**Kristian Kruse** Arief
How high bandwidth are you aiming for?
And how will you verify that the bandwidth and linearity is correct?

Like · Reply · 4w

**Arief Noor Rahman** Kristian Kruse

I dont have any number to shoot for...

I also have no clue on how to verify since i need 1Mohm probe input impedance while most VNA or spectrum analyzer has 50ohm input impedance

I guess, just compare with our passive 500MHz tek probe, if looked similar then call it good enough

Write a reply...

**Daniel Ruiz** I've gotten good results embedding the voltage divider to create a 10x and 100x probes in the PCB, run it through a high-speed amplifier, then out via SMA into the scope in 50ohm impedance mode. Use the vari-cap as mentioned above to compensate you "probe." Alternatively you can use discrete caps to create a capacitor divider in parallel with your voltage divider. You are trying to keep capacitive mismatch between the two resistors from distorting your measurement.

A couple of tricks I use to avoid having to hold the probe with my hand, which you may not have the luxury to include on your board (but others may find useful):
1. add a pair of holes on the PCB with the right spacing to directly insert the probe tip and ground clip (see Figure 5 in this doc: http://www.ti.com/lit/ug/snvu551/snvu551.pdf).
2. add a fuse-holder clip with the right inside diameter to fit the barrel of your scope probe placed in such a way that you can slide in the probe and contact the point of interest witht he probe tip, which keeping a solid and snug ground connection to ground.

Like · Reply · 4w · Edited

**Thomas Mathews** All analog/RF labs should have one of these: https://www.mathews-engineering.com/.../High_Impedance...

MATHEWS-ENGINEERING.COM
High Impedance Buffer Amplifier

Like · Reply · 4w

**David Seal** Nice product, well thought out, reasonable cost.

Like · Reply · 4w

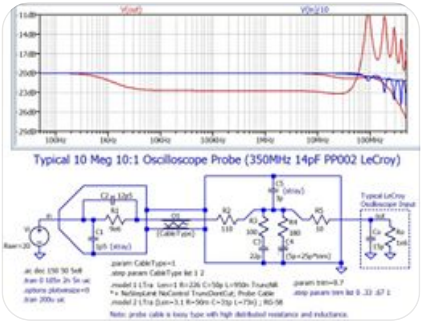
**Arief Noor Rahman** ☕ Nice touch

Like · Reply · 4w

**David Edwards** ☕ Probe cables are very application specific and of unique construction:

* Very low per-foot capacitance for small diameter cable (~16 pF/ft)
* Special spiral wound high resistance center conductor (226 ohms)
* Provides controlled high per-foot resistance (~75 ohm/ft)
* Also provides distributed peaking inductance (~1µH total)

Attached is a schematic and simulation plot of a typical 10x oscilloscope probe. The plot shows the effect of changing probe cable to 50 ohm RG-58.




Like · Reply · 4w

**David Edwards** ☕ The red trace is with the wrong probe cable (RG-58 50 ohm). The matching networks are for the special probe cable and would need to be adjusted to work with the RG-58 cable. However, the real problem is at high frequencies.

Like · Reply · 4w

intervals are due to the round trip time which, for 1 meter and 67% velocity of propagation would be spaced by exactly that amount.

Like · Reply · 4w · Edited

**Thomas Mathews** What is this kind of coax called? Can it be purchased from Digi-Key or the like?

Like · Reply · 4w

**David Edwards** ☕. Hello Thomas Mathews,

I have no idea where to buy such cable. It could well be a custom product as the probes you and I disassembled seem to be quite different in their cable construction.

I reverse engineered a broken LeCroy probe about 13 years ago when I was looking into how best to make measurements in a vacuum chamber. This required cable runs longer than a three meter long oscilloscope probe. I could post the presentation I made if there is any interest.

Like · Reply · 4w

**David Seal** RF Parts in California has the largest selection of Coax that I know of. They will also assemble it to any of their broad range of connectors for you as well.Thomas Mathews , David Edwards

Like · Reply · 4w · Edited

Write a reply...

**Thomas Mathews** I had a broken 100 MHz Tektronix probe so I cut the cable open. As indicated by David Edwards the inner conductor is very fine probably for highest Zo and low pF/ft. I measured the inner conductor to be 40 Ohms/foot with a diameter of 0.0025". On this particular probe there was no spiraling of the inner wire and I don't know if the dielectric material is made of anything unusual.

Like · Reply · 4w · Edited

**Arief Noor Rahman** ☕ David Edwards and Thomas Mathews

thanks for your insight...

I am aware that normal probe is lossy transmission line with 300ohm resistance and inside the probe box, there are a few components there to help flattening the bandwidth...and sometimes they also make a spiral on the compensation box to add inductor there of some sorts...

However, I think the reason why they need to put a lot of extra engineering is because they put the 9Meg in the tip and followed by 1.3~1.5 meters long cable which makes it more difficult to handle signal reflection

Thats why I am thinking about using only 10-15cm RG58 cable between the test point to the scope to make the reflection being less of an issue

And of course I will place 50ohm resistor between testpoint and the RF connector to absorb the reflection as mentioned by the EEVblog video...

David Edwards...please send us the presentation...that will be interesting

Like · Reply · 4w

Write a comment...

**Ahmed Salah**
March 6 at 7:41 PM

Question:

If short circuit happens in the circuit through MLCC ( the ceramic caps ) which supposedly supply the short circuit current
Is it reliable to keep using that cap after the circuit is fixed ?

1 Comment

**Dave Lafferty** Depending on the physical size of the MLCC they can withstand double digit RMS current. A short circuit current value shouldn't damage them unless it's pretty high current.

Like · Reply · 4w

1

Write a comment...

**Adam As**
March 5

Hello,

it's my first post on this group, nice to be here.

I'd like to ask for some hints regarding the simple buck converter design. The schematic is attached.

I've tried to add second stage filter at the output to reduce ripple. Used rule of thumb regarding the filter coil and filter caps ratio from one of the articles from dr Ridley. However I didn't analyse the stability plots during design.

Input is 20V, output 5V, measured and without any load.
After building the circuit I had a problem that L602 (energy storage coil) was overheating, the frequency that should be constatnt on 350kHz was jittering much and there was audiable noise from the coil.

When I short-circuited the L603 everything became normal - lower drawn current, no overheating of the coil observed, no audiable noice, constant frerquency.

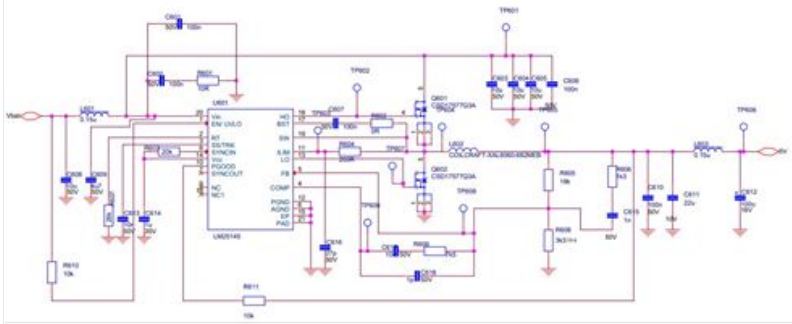
I believe it is because some stability issue and when I short-circuited the L603 I added more output capacitance and shifted the loop crossover frequency. But that is my guess and I'm about to analyse the stability.

The questions are:

1) Are those typical stability issues? When the switching freq is not stable, hear audiable noise from coil - the first thing I should think of and check is stability or maybe sth else?
2) What else can I do to maintain the output filter as it is (not changing the values) - go up with frequency? -play with compensation loop elements? -lower the coil value?
3) When I add 100u input capacitance the audiable noise lowers down - does it indicates I had also input filter problem?
4) When I touched the main IC with my finger the audiable noise was no audiable anymore however the swittching pattern was still not good - does it mean that adding really small capacitance (my finger) to one of the pin (could not distinguish which one) can change so much?
5) Do you think it's possible to model the LM25145 with RidleyWorks software? I was trying but could not find in the datasheet the fundamental control loop parameters so assumed it's not possible, maybe I should ask TI for the parameters...

Thank you very much in advance for any help.

Adam



2 21 Comments

Like Comment

issues. (1) PCB noise/EMI (hint given by your 'finger test' on the main IC), potential stability issue. Do you have the capability of measuring the feedback loop (modulator plot, op amp response, open loop in closed loop form)? I think Ray's software would also be helpful given datasheet parameters (Ray can better comment on that for a 2 stage output filter). TI has a model on their web site. Did you attempt to use it?

Like · Reply · 4w

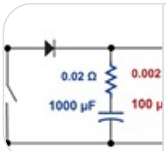
**Casper Hjort Wilson** Try to:
- Increase C609 (input cap)
- Switch output caps C611 and C612. I believe C. Basso has an app note from OnSemi about addition of L-C post-filter impedance on a Flyback. As I remember, the larger C (in uF) should be closest to the Buck choke.

Like · Reply · 4w

**Adam As** Thanks.

Like · Reply · 4w

**Adam As** Regarding the caps order please see:
http://www.ridleyengineering.com/.../86-052-designing-a....
Recomendation for doing it the way I did.




RIDLEYENGINEERING.COM
Ridley Engineering | - [052] Designing a Two-Stage Output…

Like · Reply · 4w

**Casper Hjort Wilson** Also, consider a RC snubber across lower FET. Check ringing on oscilloscope.

Like · Reply · 4w

**Michael Thomason** The output filter is not dampened. Also the input filter has the dampening cap smaller than the input bulk. Can you capture and post input and output waveforms? Filter output imp vs converter input? Bode plot?

Like · Reply · 4w · Edited

**Yuri de Klerk** I wondered if the output cap is e-cap or not. For damping an e-cap with esr > 0.1 Ohm could be helpfull.
About the input filter I agree with Michael Thomason: The dampening cap should be a larger value than input bulk.

Like · Reply · 4w

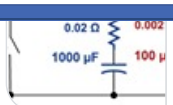
**Adam As** regarding input filter is it a rule of thumb to have biggest cap near the input (having the pi filter at input)? I checked Middelbrook criteria with this configuration and it was ok.

Like · Reply · 4w

**Christophe Poupart** LM25145 is a voltage mode control. Contrary to current mode control, L602 can't be neglated and introduce one pole power frequencyresponse. So, with voltage mode control, it's very difficult to defined a good stability corrector. With a second LC filter, your buck could be unstable.
Why Adding second LC filter ?
To reduce ripple output voltage, you have to follow the datasheet to estimate the LC output filter and estimate the voltage loop corrector.
Low esr capacitor could help you.
Without network analyser, Loadstep test will help you to evaluate stability margin.

Like · Reply · 4w

**Adam As** Hi, thanks. This article shows quite big advantage of using second LC filter, and remarks that it is not influencing the gain loop. However now I noticed that it could be only the truth with current-mode...
http://www.ridleyengineering.com/.../86-052-designing-a...




Ridley Engineering | - [052] Designing a Two-Stage Output…

Like · Reply · 4w

**Claude Abraham** I am a freelance contractor now. If you need a pro to help you, I've designed nearly 100 power converters. No minimum hours. If you only need me for a few hours, that is fine. I can help you.

Like · Reply · 4w

**Nikhil Joshi** Check placement of loop compensation components ,see if it's ground and IC's ground is common and should have minimum track length possible.

Like · Reply · 4w

**Jimbo Hissem** Did you follow the datasheet application information? You need to find the correct output L and C to get the ripple you want, adding a second filter is unnecessary.

Like · Reply · 4w

**Adam As** I thaught that second filter solve the ripple problem and I do not need too much care about L and C values. I mean not much care - of course I checked this with Webench Designer from TI and was ok. But I could not simulate the second filter and just put large cap at output(so as there was no second inductor)

Like · Reply · 4w

**Jimbo Hissem** Adam As You need to design the L and C to meet your requirements, and then adjust the compensation accordingly. There is no reason to add second filter and it's only causing you problems.

Like · Reply · 4w

**Frank Warnes** You didn't move your feedback connection to after the second filter did you as this would really screw up your compensation

Like · Reply · 4w

**Adam As** this could be the clue... however I thought feedback connection point before filter does not influence the gain loop

Like · Reply · 4w

**Christophe Poupart** To help you, you can go on TI web site and use the Webench Designer (near technical documents)
http://www.ti.com/product/LM25145
You will find schematic, layout and simulation tool. You could simulate Bode, startup...

Like · Reply · 4w

**Ray Ridley** Oh my, they put it inside Excel - i wonder where they got this idea? 🙂

Like · Reply · 4w

**Ray Ridley** Its like RidleyWorks from 30 years ago, that is where we started too. Just a bode plot or two.

In two years we had waveforms added. Full simulations.

Glad to see TI catching up. 😎

Like · Reply · 4w

**Ray Ridley** Next thing, TI will be starting to sell magnetics - oh, wait, they just started doing that too!

It's an interesting world for engineers right now. Nothing is what you thought it was.

Like · Reply · 4w

**Norman Elias** shared a post.
March 6 at 10:08 AM

Are we missing the forest for the trees? Is there an obvious answer that we're all ignoring?

Take a look at this post..

https://www.facebook.com/groups/ridleyengineering/permalink/2579417012296105/

...and to this one...

https://www.facebook.com/groups/ridleyengineering/permalink/2580455782192228/

Every model discussed expresses the frequency-dependent losses in terms of an equivalent circuit. Some start with tables of measurements, others with formulas derived from the physics (namely Dowell's). This by itself introduces some error. But then we compound that error by force-fittting to a circuit topology.

Wouldn't it be better to just build our equations or our table of measurements explicitly into the model? I mean we don't, for example, model a diode as a network of resistors with voltage dependent switches that approximate the exponential i-v characteristic. We hard-code the terminal characteristic into a model that executes during the simulation.

We can do that with Dowell's equation too! More and more of our simulators support the Verilog, VHDL, SystemC,... standards. Why aren't we using them?

> **Stuart Wood** ▶ **Power Supply Design Center**
> March 4
>
> I'm trying to understand how you would measure the AC resistance of a winding (primary or secondary) and then produce the RL network that would represent it.
>
> Two question: Assuming a simple two winding transformer.
>
> 1) if you short the secondar and then measure the primary impedance using an swept impedance analyzer or FRA, and then model this, won't it include the leakage inductance too?
>
> 2) how would you separate the reflected secondary AC impedance?

4 Comments

Like | Comment

**Riccardo Tinivella** You are right, semiconductor companies model transistors with mathematical equations for many years now. Look inside Coolmos lib for example.
One of the main problem is not this, but the fact that Spice solver is an evolution of Newton-Raphson method, in other words it needs to invert the MNA matrix every time step. This is strongly dependent from the condition number of the matrix and can become really bad if the equations you use to describe your components do strange things.
I have spent a lot of time to improve the convergence of CoolMos models and it's not a fun experience, just because LTspice was not able to manage DIV/0 (Simetrix at least shows an error message).
Anyhow I love LTspice ❤️, without it I were still there with Orcad 9.2 🙂

1

Like · Reply · 4w · Edited

that I write have provisions for DIV/0 built into the model but that doesn't resolve the N-R failures. For those I find myself playing with the expressions, e.g., for a resistor I can choose any of the following assignment statements...
V == I*R;
or
I == V/R;
or
V - I*R == 0.0;
I can also try re-orderiing the placement of these assignments in the lines of code.

It's a lot of playing with the mechanics of the model but it shouldn't prevent me from trying.

Thanks for your comment.

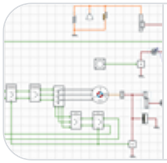
Like · Reply · 4w · Edited

**Riccardo Tinivella** Norman Elias thanks, may I ask you what do you use as simulator?

Like · Reply · 4w

**Norman Elias** My favorite right now is SystemVision. Free access on the cloud at www.systemvision.com. If you register you can try a simulation of the transformer model Bryce Hesterman shared with me at https://www.systemvision.com/.../bryce-hestermans-mutual.... I have a ton of other stuff their as well.

I'm also an old hand at Spice dating back to Larry Nagel's original version from UC Berkeley and more recently from ICAPs, Pspice, LTspice. And for the wealthy, I've done a lot of good work with Saber.



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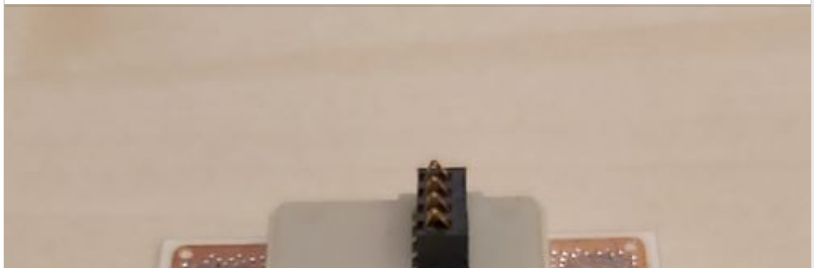
Write a reply...

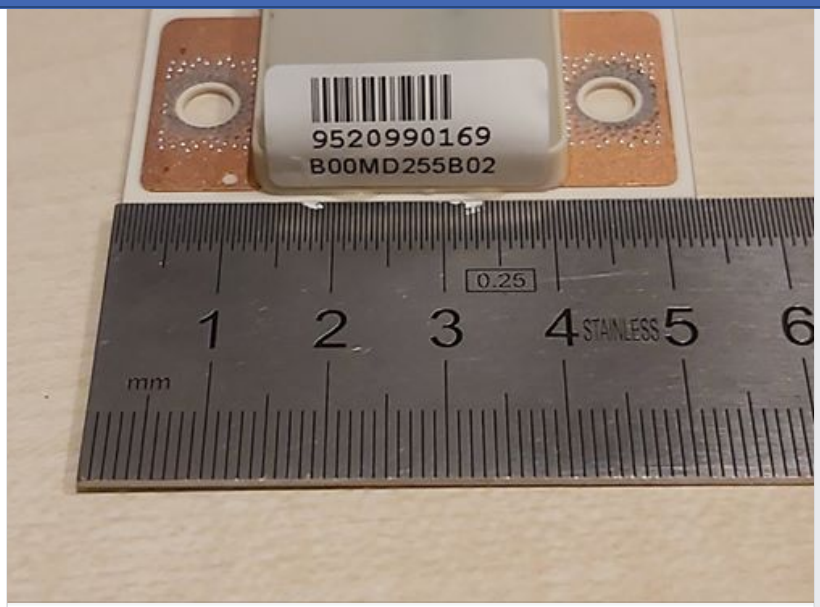
Write a comment...

**Emre Oğuz**
March 5

Hello,

We are currently using high current, low voltage (600A-1000A/100-150V) half bridge mosfet modules, in those 62mm packages for golf car motor drivers. But I saw the attached module in one of the motor drivers in a repair service. It has a smaller footprint comparing to those 62mm packages. I think it is a custom design module for a specific customer. Do you know which companies produce mosfet modules with high current and low voltage range like this one?






3 18 Comments

Like Comment

**Gà Tuấn** Hust Phùng-Tuấn
Like · Reply · 4w

**Gà Tuấn** I think we are too backward, sirr
Like · Reply · 4w

**Phùng-Tuấn Hust** Gà Tuấn ừ công nhựn
Like · Reply · See Translation · 4w

**Michele Bergo** SME group
Like · Reply · 4w

**Emre Oğuz** Gà Tuấn It is not about being backward, it is about the quantity and economic potential. If we had a potential over 100K units every year, the MOSFET company would find us. Unfortunately, as a startup company, we have to work with standard components from trusted suppliers, because our demands are much lower.
Like · Reply · 4w

Write a reply...

**Michele Bergo** https://sme-group.com

SME-GROUP.COM
AC Controllers and Motors Manufacturer | SME Group
Like · Reply · 4w

**Emre Oğuz** Yes, most likely the module comes from a SME driver. But I am not interested in motor driver itself. I am searching for a packaging company which produce small footprint MOSFET modules like this one.
Like · Reply · 4w

**Michele Bergo** they are producing the modules themselves
Like · Reply · 4w

Like · Reply · 4w

Write a reply...

**Ratna Joshi** Looks like pcb mounted mosfet with good copper trace

Like · Reply · 4w

**Emre Oğuz** There are MOSFET dies inside the plastic case in the form a half bridge.

Like · Reply · 4w · Edited

**Charlie Elliott** Is the cream colour backing ceramic or perhaps FR2 ?

Like · Reply · 4w

**Emre Oğuz** It is ceramic, I guess.

Like · Reply · 4w

**Alex Berestov** Most likely alumina. AlN has to be protected from the elements like Nd magnet.

Like · Reply · 4w

**Michele Bergo** Alumina

Like · Reply · 4w

**Michele Bergo** with infineon/ir mosfet inside

Like · Reply · 4w

**Charlie Elliott** Ok so this is in effect a DBC module without a baseplate and a plastic lid with probably gel covered die underneath.If so boy would you have to be careful when doing the bolts up to make sure you dont crack it!!

Like · Reply · 4w

**Michele Bergo** Charlie Elliott exactly!

Like · Reply · 4w

Write a reply...

Write a comment...

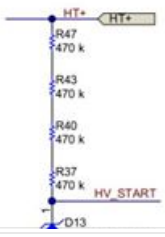
**Xavier Pacheco Paulino**
March 1

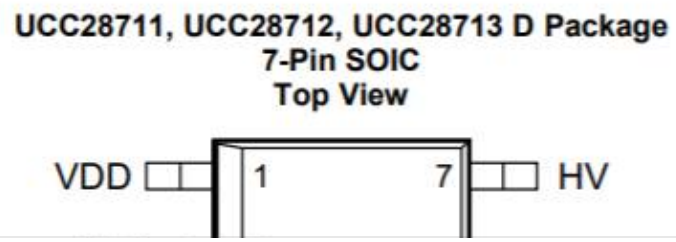
Hello,

Has anyone used controller UCC28711? I'm a little bit skeptical on the startup time, since I need quick startup for my application (60-70 ms). I've seen this resistor-diode setup connected to the HV pin (for high voltage inputs). Thoughts?

**HV Startup**

The UCC28710 device has an internal 700-V start-up switch. Because the dc bus can be as high as 1200 V dc, an external Zener voltage regulator is used to limit the voltage at the HV pin to about 550 V dc. The typical startup current is approximately 300 µA, which provides fast charging of the VDD capacitor. The internal HV start-up device is active until VDD exceeds the turnon UVLO threshold of 21 V at which time the HV start-up device is turned off. In the off state, the leakage current is very low to minimize standby losses of the controller. When VDD falls below the 8.1-V UVLO turn-off threshold, the HV start-up device is turned on.






1 18 Comments

Like Comment

**Bob White** In what document did you find "Fig 16 HV Startup Circuit"?

Like · Reply · 4w

**Xavier Pacheco Paulino** In this app note: http://www.ti.com/lit/ug/tidu412b/tidu412b.pdf

Like · Reply · 4w

**Bob White** Wow, a quick look and I immediately found a very, very wrong statement - Figure 3 and the last paragraph of page 4. TI data sheets and app notes often have little mistakes but not usually this bad.

Like · Reply · 4w

**Xavier Pacheco Paulino** Bob White What's the wrong statement?

Like · Reply · 4w

**Bob White** Xavier Pacheco Paulino Do you really get 1800 V rating with 900 V MOSFETs arranged in cascode as shown? Tell me why not.

Like · Reply · 4w

**Xavier Pacheco Paulino** Well, we don't want to hit the max VDS. They didn't apply a derating factor.

Like · Reply · 4w

**Bob White** Xavier Pacheco Paulino Not even close. Try again.

Like · Reply · 4w

**Bob White** OK, I need to call it a night so here is the answer (sort of).

All voltage referenced to the primary common/return.

Suppose there was 1000 V on the drain of Q2 and that Q2 and Q1 split the voltage equally (a bad assumption but we will go with it for now).

What is the voltage on the drain of Q1?

What is the voltage on the source of Q2?

What is the voltage on the gate of Q2?

What is the gate to source voltage of Q2?

Is there a problem here?

Like · Reply · 4w

Write a reply...

**Col Johns** Bob White ZD2/D13 is 550V per fig 16 - this is how the cascode works ... Fig6 shows the G-S zener ( 15v) to protect the top fet ... sharing resistors a good idea though ...

Like · Reply · 4w · Edited

drawn incorrectly... must throw a lot of people off.

Like · Reply · 4w

**Nathan Ellis** Darrell Hambley Agreed; You need the additional Vgs zener across M2 so its source doesn't drop ~500V below its gate when M1 turns on.
Turn-off will still be problematic though; the resistor adjoining both zener cathodes proximal to the gate of M2 (Fig.6) will want to be small to allow M2 to turn off quickly as its source shoots up and reaches 500V (Cgs charge needs to bleed off into left-of-center 500V zener reference). However, a small resistor here implies HUGE quiescent current draw when M1&M2 are on.
Could actually probably solve this by using a larger resistor here (for low quiescent draw when ON) and putting an additional diode in parallel with that resistor with its cathode pointing to the left (Allows Cgs2 to dump out its charge as Vg2 goes higher than 500V).

Cascoding is a neat trick, but I would be very careful here.

Like · Reply · 4w

**Col Johns** Nathan Ellis - the current is not huge, I think, as limited by the upper resistors ( ~2Meg) ... the gate R is typ 10 ohm...

Like · Reply · 4w · Edited

**Nathan Ellis** Col Johns Aha, I see; so the 500V zener doesn't hold a constant 500V across it because the Vgs-zener out-weighs it when M1 is on 👍 In that case it seems as if you wouldn't theoretically need the resistor at all? (Other than to add some damping)

Would think you'd want to do some capacitor feed-through analysis to ensure M2 turns on fast-enough with M1: If you assume zero parasitic capacitance (other than Cgs2), M2 turns on with an RC time constant of ~(2Mohm)*(Cgs2) slooooowwww... And if it turns on at much slower rate than M1 then it will have the full 1000V across it for a short time. The (Cdg2+Czener)-Cgs2 capacitor divider might have it pop on nicely though.

Edit: That's also a lot of CV^2f loss across the 500V zener, but perhaps tolerable for high power throughput.

I still think this would be very finicky to dial in: seems all like a balancing act with low tolerance to component variation. Thoughts?

I bet there are more robust (albeit more expensive) alternatives.
I'm also not sure if there's really any advantage to doing this; the device physicists already build devices with "pseudo-cascode" i.e. drain extending or NMOS+J-FET. Is this just motivated by a high-voltage device availability issue?
(I haven't seen any derivations showing that a 50/50 voltage split cascode is more efficient than a 10/90 split).

Like · Reply · 4w · Edited

**Col Johns** This ckt has in fact been employed quite widely by power integrations devotees - often the 550V zener is split into two with a 33pF cap across each to provide a bit more oomph at turn on, depending on Cgs these caps might be recharged when the lower device turns off ... the volt split is not exact and for very low Vin the lower device does all the work ...
Given that 2 x 600 or 2 x 800V fets are quite cheap compared to 1200 / 1600 volt device - the approach is attractive for low cost metering power supplies for 3 phase ... Nathan Ellis

Like · Reply · 4w · Edited

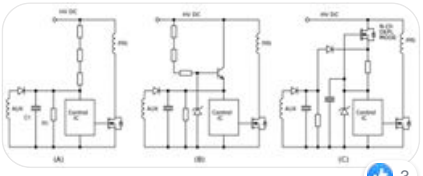
**Nathan Ellis** Col Johns Cheers Col, thanks for the insights.

Like · Reply · 4w

Write a reply...

Like · Reply · 4w

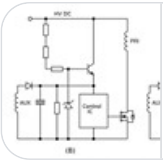
**Paul Lee** Have a look at the UnitedSiC website for a well written article on startup schemes.



3

Like · Reply · 4w

**Paul Lee** Bob, it's a little hidden with a snappy title targeted at flybacks but works for forwards as well. It explains an interesting way to provide startup power when using a cascode of SiC JFET and Si MOSFET.
https://unitedsic.com/standby-for-a-breakthrough-in.../



UNITEDSIC.COM
‘Standby’ for a breakthrough in Flyback converter losses - United…

Like · Reply · 4w

Write a reply...

Write a comment...

**Stuart Wood**
March 4

I'm trying to understand how you would measure the AC resistance of a winding (primary or secondary) and then produce the RL network that would represent it.

Two question: Assuming a simple two winding transformer.

1) if you short the secondar and then measure the primary impedance using an swept impedance analyzer or FRA, and then model this, won't it include the leakage inductance too?

2) how would you separate the reflected secondary AC impedance?

You and 2 others 40 Comments

Like Comment

**Grzegorz Sobiegraj** If you short the secondary, you are reflecting the "zero" impedance to the primary. So you will measure only the leakage which is not coupled.

Like · Reply · 4w

**Stuart Wood** Grzegorz Sobiegraj won't you still have the windings impedance?

Like · Reply · 4w

two magically connected inductors - those inductors are modelling the effects of creating magnetic field in the core. If current flows through primary, it creates the magnetic field in the core, which is causing a current flow in the secondary. But this current flow generates the exact opposite field in the same core that cancels the effect of first inductor. If I'm wrong here please correct me - I tried quite hard to understand some basic physics about it...

Like · Reply · 4w

**Stuart Wood** If you short the secondary winding to measure the impedance of the primary. The impedance of the secondary winding and that of the short are reflected back into the primary. So if the secondary has a DC resistance of 1 ohm you will still reflect that back into the primary.

Like · Reply · 4w · Edited

Write a reply...

**Ray Ridley** You separate out the Real and imaginary. That gives the total Rac of both the primary and secondary.

Like · Reply · 4w

**Ray Ridley** A combination of modeling and measurement techniques are used to arrive at the model. Measuring Rac is tough, but it can be done with enough skill.

Like · Reply · 4w

**Stuart Wood** Ray Ridley don't you promote measuring it withe AP310 and then it will calculate the mode?

Like · Reply · 4w

**Ray Ridley** We do that. We don't really promote it yet, most users don't have the measurement skills to get it right.

Like · Reply · 4w

**Stuart Wood** Worst case you take a couple of measurements at diferent frequency ranges and combine the data to get a full sweep, right?

Like · Reply · 4w

**Ray Ridley** Correct. And you include some theoretical predictions to fill in the gaps of measurement.

The ability to wind a whole series of transformers really speeds up the process.

Like · Reply · 4w

Write a reply...

**Stuart Wood** But isn't the imaginary equivalent to the leakage?

Like · Reply · 4w

**Ray Ridley** Yes, imaginary is the leakage. That is useful too.

Like · Reply · 4w

**Stuart Wood** So why not combine the two into one RL network that reflects the impedance measured?

Like · Reply · 4w · Edited

**Ray Ridley** ? i think there is a typo there?

do you mean one?

For a flyback, this won't work. For a forward it can.

Like · Reply · 4w

braking out the leakage inductance into its own circuit element

Like · Reply · 4w

**Ray Ridley** We have all sorts of techniques for doing this. For example - build a transformer with two identical primaries instead of a secondary.

Then as a good approximation, you will measure 2x the ac resistance.

Then do the same with two secondaries. Not as easy if the turns count is low, which is why it is good to have analysis to back up the measurements, and vice versa.

Like · Reply · 4w

**David Edwards** You can see the ac resistance of just one winding by removing the core then measuring the winding.

Also, with the core intact and the other winding shorted AND if your impedance analyzer goes low enough in frequency, at low frequencies you should see the ac resistance of just the winding under measurement, then, as the test frequency increases, at some point you should see a step in ac resistance as magnetic coupling puts the two windings in series.

Like · Reply · 4w

**Ray Ridley** This is another technique that we often use. You have to be careful though, the windings will talk to each other and affect what the ac resistance actually is.

Like · Reply · 4w

**Ray Ridley** You almost have to use that technique for inductors.

Like · Reply · 4w

**Stuart Wood** I just was looking at paper for measuring the AC resitance of inductors using a second winding. I'll try and post it tomorrow.

**Like** · Reply · 4w

**Stuart Wood** Https://ieeexplore.ieee.org/document/8291492

IEEEXPLORE.IEEE.ORG

A New Method for Measuring Winding AC Resistance of…

Like · Reply · 4w

**Ray Ridley** Yep that is another technique we use. Put a hard short in the inductor in the right place, we use foil for this. The model is easy, so you can extract that part afterwards.

Like · Reply · 4w

the Utah State University Power Electronics Laboratory, I am able to share what I have learned. The key to understanding this is learning how to measure and model mutual impedances. Power electronics engineers are typically familiar with mutual inductances, but few are familiar with mutual resistances. Consider what happens when you measure the series resistance and inductance of a transformer winding with all windings open. Both the inductance and resistance are high. If you short a winding and measure the inductance at another winding, both the inductance and the resistance are reduced considerably. From a circuit theory point of view, the reason is that there is both a mutual inductance and a mutual resistance which nearly cancel the open circuit inductances and resistances of the measured and shorted windings. From a magnetic point of view, the current in the shorted winding largely cancels the field produced by the measured winding and this reduces the losses. Dowell figured out how to quantify that effect and others have figured out how to create LR networks to represent it. However, this approach only works when there are one or more primary windings connected in series and one or more secondary windings connected in series, and the magnetizing current is small. The Dowell analysis depends on equal and opposite amp-turns, so it can't model the open-load ac resistance. Now suppose there are windings connected in parallel, or multiple secondary windings with independent loads. For those cases, the MMF diagram is indeterminate and another approach has to be used because the ac resistances depend on the current distributions, which can't be known in advance. About 20 years ago, I found that this issue had been thoroughly studied by a few authors in the utility industry, and I learned how to apply their techniques to the the magnetics used in power electronics. Here are two key papers: (1) Electrical terminal representation of conductor loss in transformers. (This discussed mutual impedances. The author was not in the utility industry.) https://ieeexplore-ieee-org.dist.lib.usu.edu/document/60685 (2) New power transformer model for the calculation of electromagnetic resonant transient phenomena including frequency-dependent losses. (This model shows how model mutual impedances in a circuit simulator.) https://ieeexplore-ieee-org.dist.lib.usu.edu/document/847246 My work has been done in Mathcad, but I'm getting assistance translating it to Excel, and I hope to get it translated into Matlab scripts soon as well. I would be glad to correspond with anyone who wants to learn more about this topic.

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library2.usu.edu

Like · Reply · 4w

**Alex Berestov** What's the point of posting URL requiring USU login?

Like · Reply · 4w

**Ray Ridley** Can you please repost without the login Bryce Hesterman?

Like · Reply · 4w

**David Edwards** . Hello Bryce Hesterman,

Everyone should read your groundbreaking work on the realizability of multiple coupling factors for a set of windings. It's importance was recognized by Mike Engelhardt and is used by LTspice to determine whether to issue error messages for unrealizably coupled windings.

Kudos aside, I can't help but believe that mutual resistance is naught but an unnecessary and misleading mathematical artifice. Models typically attempt to duplicate the behavior of a system with constant value lumped elements, but carrying this too far can be misleading.

For example, one would like to model transformer winding ESR as a constant. However, when other loss mechanisms (such as core loss) are inadvertently added into the ESR measurement (or model), it causes the overly simplistic ESR model to rise in value with frequency. The same can be true for eddy currents induced in other windings or nearby conductors.

Since mutual resistance does not really exist (as far as I know) it should not be used to explain transformer loss. Just my two cents.

Like · Reply · 4w

when even the experts cannot agree.

And at the same time magnetics are absurdly simple. Anyone can learn to design and make them in just a few hours as we show in our workshops.

It's a wonderful paradox.

Like · Reply · 4w

**Ray Ridley** Not sure what you mean by ESR being constant. Obviously it rises with frequency.

Probably just a different way of looking at the same thing.

Like · Reply · 4w

**David Edwards** @ Ray Ridley,

Many engineers tend to speak and write precisely, even pedantically, but it is surprising how difficult it is to avoid miscommunication.

My point is that engineers tend to like models built from invariant lumped elements. If measurement shows that the lumped element (for example, ESR) is not constant over all frequencies) then the model must be extended by appropriately adding more lumped elements.

This becomes problematic with systems that contain diffusion-like elements, such as skin effect, which really needs a half pole representation. Unfortunately, no half-pole lumped element exists, so one must resort to an approximation with RC or LR networks.

Like · Reply · 4w

Write a reply...

**David Edwards** Remember when Slobodan 'Cuk was touting the ripple reduction properties of his converter topology and he explained its workings using the mathematical artifice of negative inductance?

Of course, there is no such thing as a real negative inductance. It is a consequence of choosing a nonphysical, but mathematically valid solution to an under-determined problem with an infinite number of possible solutions. Dr. 'Cuk used each winding's inductance (without adjusting for turns ratio) and mutual inductance to come up with mathematically forced negative values for leakage inductance. With a solution that first adjusted for turns ratios, all inductances would remain positive.

I always thought Dr. 'Cuk's explanation was a "smoke and mirrors" attempt to impress the unwary with the supposed uniquely mystical ripple-cancellation properties of the 'Cuk converter. I was not impressed, but the controversy Dr. 'Cuk stirred up back then sure was a lot of fun. He was the Mohamed Ali of power electronics (for those of you who remember both 'Cuk and Ali).

I suspect "mutual resistance", like negative inductance, is simply a mathematical artifice of a particular solution to an under-determined problem. It simply obscures rather than elucidates the underlying physical process. Other valid solutions with normal lumped elements that are much more closely tied to the underlying physical process should be possible. Note: this is just a gut-feel opinion - I could be completely wrong.

Like · Reply · 4w · Edited

**Ray Ridley** I remember looking at a converter in those days where the voltage on the winding was one polarity, and the current ripple was the wrong way. It was like cuks negative inductance. It can't exist on its own, has to be coupled to another winding of course.

The waveforms were quite clear though - this was a negative inductance from a two-terminal point of view.

Like · Reply · 4w

inductance was the right direction and the sum of all the ampere turns was still equal to the magnetizing current.

Like · Reply · 4w

**Ray Ridley** Of course. But it LOOKED like a negative inductance.

Like · Reply · 4w

**Col Johns** having looked at it closely too ( some time ago ) the ripple inversion was an interesting thing - on the coupled Cuk converter - the biggest disappointment for me was that there is not a true 100% cancellation of ripple. Although quite small the ripple flipped from slightly positive to inverted - ...

1

Like · Reply · 4w

**David Edwards** My studies into the matter indicate that the fully coupled 'Cuk converter has ripple reduction about equal to a buck converter with input filter. This is assuming equal amounts of optimized energy storage.

One slight-of-hand trick (in my opinion) Dr. 'Cuk used to tout his topology was to use very large electrolytics for the flying capacitors so their voltage was almost constant. Then he would use a caliper setup to adjust the gap in the magnetics so that the ripple would go from positive to near zero to negative. It was like magic <sarc>. He would justify the large capacitance by the need for an adequate ripple current rating, overlooking its effect on ripple reduction.

Then, in his next paper, he would tout the dynamic response of the 'Cuk converter, but in this case the capacitors would be small value film types with RC dampers in parallel. (The C in the damper would be a small electrolytic about 3x to 5x the value of the main capacitor.)

The dynamic response was optimized - the ripple reduction - not so much.

Like · Reply · 4w

**Col Johns** Ah yes it may be that very near zero ripple is possible as the flying cap value tends to very large - that would make some sense ...

Like · Reply · 4w

Write a reply...

**Ray Ridley** Yes, Vorperian proved that with his switch model with ripple extension. Amazing work, but far above the heads of most engineers and students. I still don't quite get it, but I can marvel over the results.

He is close to me. When there is advanced circuit analysis to be done, I call him and watch him do it in 1/100 the time it would take me.

1

Like · Reply · 4w

**David Edwards** The averaged switch model concept is very simple. All such converters contain a switching cell that is surrounded by low pass filter elements. The switching cell presents one side with a chopped voltage source and the other side with a chopped current source. Average those chopped sources (V=d*V_C and I=d*I_L) and the averaged system becomes continuous (which SPICE is very happy to solve).

Things get more complicated if the capacitor and inductor surrounding the switch are less than ideal. For example, capacitor ESR can add or subtract extra voltage to the capacitor. The ripple extended models take this into account.

Like · Reply · 4w

back in to the control port and combine that with coupled inductors, it gets very, very interesting.

Like · Reply · 4w

**Ray Ridley** I think that you are referring to a different concept to Vorpérian's ripple extension. I will try to dig that article up.

Like · Reply · 4w

Write a reply...

Write a comment...

**Robert Turner**
March 3

Hi all,

For 5-30kW grid-connected 3-phase converter, has anyone got experience in the end-cost tradeoffs between conventional Si IGBT (~10kHz) + standard inductors, versus SiC (~50kHz) + much smaller inductors? SiC switches will be certainly more costly, but the inductors get a significant size/cost reduction. Has any benchmarked this tradeoff recently or are we still waiting for the SiC costs to come down further? Thanks

4 15 Comments

Like Comment

**Colin Tuck** EMC will require more attention for the 50kHz SiC approach ...

Like · Reply · 4w

**Robert Turner** Good point. Additional testing and any additional parts to combat EMC should also be considered in BOM

Like · Reply · 4w

**Arief Noor Rahman** For SiC below 10kW, perhaps you can use up to 50kHz...but above that, you may consider reducing your Fsw....

I think the big cost reduction come from smaller inductor, and smaller heatsink

Like · Reply · 4w

**Charlie Elliott** Dont forget about the half way house - IGBT + SiC Schottky Diode.

Like · Reply · 4w

provided by the SiC.

Like · Reply · 4w

**Robert Turner** Although by increasing the switching freq to around 50kHz the switch losses are going to go up and likely equaled by reduced inductor losses

Like · Reply · 4w

**Hamish Laird** Typically cost goes up as switching speed goes up for grid-tied. If you use a reasonably asymmetric LCL then the total core volume for the high ripple inductor will be quite low so long as the capacitor lifetime for the switching ripple is OK. Saturation levels for the line frequency currents in the inductors and low-frequency ripple life for the DC side caps in AC imbalance are the dark horse constraints.

Like · Reply · 4w

**Robert Turner** That's inline with my conclusion that I would end up trading cost vs size, ceteris paribus. DC caps ripple due to imbalance is part of the design as the converter will primarily be delivering asymmetric currents

Like · Reply · 4w

**Hamish Laird** Robert Turner 👍

Like · Reply · 4w

**Scott Styles** if you increase switching frequency then presumably the size of the AC filter capacitors can go down... so then at what point do these capacitors become small enough that you stop worrying about them resonating with the grid? (have I missed a trick?)

if you need bulk DC caps for the power system frequency ripple, you can likely re-use this same capacitance for the snubbing/swithing freq ripple too if Fsw isn't too high...

not doing this on work time are you? 😛

Like · Reply · 4w

**Robert Turner** Ha if only we had spare time during the day

Like · Reply · 4w

**Hamish Laird** Robert Turner LVRT + grid code + fault current contribution too!

Like · Reply · 4w

Write a reply...

**Col Johns** Just going to SiC at 20kHz, with plenty snubbing - gives you the low on drop of SiC - without extreme EMC penalty ....

1

Like · Reply · 4w

**Robert Turner** Gets it out of the audible range too. Might have to have a detailed look to see if SiC (or likely hybrid) can be cost justified at that point

Like · Reply · 4w

Write a reply...

**François Boige** You can evaluate the differents solutions with this tool. Ask for a free trial. https://www.powerdesign.tech/live-demo/

POWERDESIGN.TECH

Live demo - PowerForge

Like · Reply · 4w

**Karim Illoul**
March 2

Hi,
How to choose the frequency of a high frequency transformer(HF),knowing that:
Model: EC42/43-43
Vin= 12V
Vout=0-220-380 18V
P= 500W
Iin= 45A
Iout=3A
Thank you very much.

1 29 Comments

Like Comment

**Janamejaya Rox** Would it make sense to choose a value and backtrack to check if the transformer is not saturated?.
Like · Reply · 4w

**Karim Illoul** Janamejaya Rox of course yes, but we don't have the Bmax to calculate the characteristics and dimensions of this transformer! Thanks
Like · Reply · 4w

**Janamejaya Rox** Ok, understood.
Like · Reply · 4w

**Sesha Sai Kumar** Karim Illoul , choosing the right frequency for the transformer is no doubt primly a trade of decision between your semiconductor losses and overall compactness of magnetics and filters. You should run a detailed sweep analysis to know your optimal frequency value. So it's one way topology dependent also. Hope it helps. Also..there's upper limit for magnetics by itself in terms of core losses and thermal rise. You must consider all of these.
Like · Reply · 4w · Edited

**Karim Illoul** Sesha Sai Kumar thank you very much!
Like · Reply · 4w

**Ray Ridley** Oh dear. Sometimes I think I write articles in vain.

When it comes to magnetics there is just no engineering knowledge.
Like · Reply · 4w

**Hicham Boutouche** Dr Ray Ridley can you please share with us your article?
Like · Reply · 4w

**Roswell Bob LaFrank** It is fairly cookbook these days.
Like · Reply · 4w

**Ray Ridley** Everything is easy once you know how.....
Like · Reply · 4w

Write a reply...

There is no "right" frequency for a magnetic. It is a multifaceted problem, everyone will have a different answer depending on their goals.

Just choose a frequency, design it, test it, and adjust if you need to.

Like · Reply · 4w

**Karim Illoul** Ray Ridley thanks !

Like · Reply · 4w

**Ray Ridley** http://ridleyengineering.com/.../281-106-custom...

RIDLEYENGINEERING.COM

Ridley Engineering | - [106] Custom Transformers – ONE Design Equation

Like · Reply · 4w

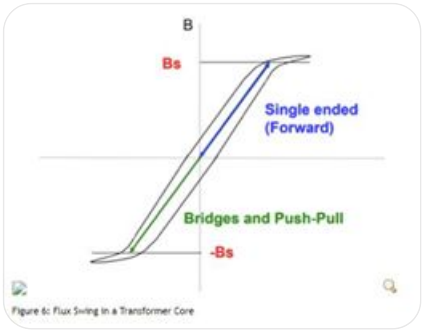
**Hicham Boutouche** thnak you very much Dr Ray Ridley i read your article it's very good,so if understood for flyback and forward converte we take Bmax <= 0.3 T and for push pull,half or full bridge we take Bmax<=0.6 T

Like · Reply · 4w

**Hicham Boutouche**

Like · Reply · 4w

**Hicham Boutouche**




Like · Reply · 4w

Write a reply...

**Col Johns** If we take the core area as 185mm^2 then dB/dt = V/(N.Ae) gives one a turns.freq product, in this case 2.N.F = V/(Ae.dB) where delta B is that B traversed in half a period.
So for 12V, 185mm^2 and B = 0.2T ( -100mT to +100mT ) we see that N.F = 162 162.0 thus 100kHz gives 1.62 turns and so on...
One must then calc what turns will fit on the core which give an acceptable temp rise ( pri & sec ) about 5 watts max depending on cooling for the EC42 ...
good luck ...

1

Like · Reply · 4w · Edited

**Karim Illoul** Col Johns please why we chose B=0.2 T?

Like · Reply · 4w

**Col Johns** +/- 100mT swing is a sensible maximum for core losses for 100kHz for good quality ferrite...

Like · Reply · 4w

**Hicham Boutouche** Thanks Col Johns can you share it with us a document or something like that who speaks about this ideaa

**Hicham Boutouche** Col Johns but in the case when the switching frequency is 50 kHz does not this affect the value of bmax

Like · Reply · 4w

**Col Johns** It does ...

Like · Reply · 4w

**Hicham Boutouche** Col Johns so what we should do in this case

Like · Reply · 4w

**Col Johns** read a whole heap more about core losses at various driven frequencies ...

Like · Reply · 4w

Write a reply...

**John Leek** Core type?

Like · Reply · 4w

**Col Johns** it would appear to be -43 material ....

Like · Reply · 4w

**Karim Illoul**

Like · Reply · 4w

**Karim Illoul** John Leek

Like · Reply · 4w

**Col Johns** none of that explicitly identifies the core material ...

Like · Reply · 4w

**John Leek** Yep

Like · Reply · 4w

Write a reply...

Write a comment...

**Darrell Hambley**
March 4

Creep from gravity?

I am proposing using an existing board for a new project mounted vertically (due to the enclosure situation). There are large (25mm dia x 40mm ht) capacitors held onto the board with epoxy plus their own solder on 2 pins and some edge-mounted toroids 25mm tall. These older boards, normally mounted horizontally, have been through vibration with peaks in excess of 11 G's in all axis. The engineering manager has a "gut feeling" about long term creep due to gravity which may eventually pull the parts off the board. I've never heard of a creep issue but maybe someone has. Any thoughts?

1 10 Comments

Like Comment

**Paul Shepherd** 11G's is a great version of HALT testing. I assume the Engineering Manager isn't an ME? Testing to failure might get their buy-in.
Like · Reply · 4w

**Peter Comrie** Ordinary glass creeps but only a really tiny bit over decades so glass fibre may too but this would be over a much longer time frame than any life expectancy of any electronic equipment. Significant creep would only happen at very high stresses and temperatures where glass would start to flow - way beyond where electronic components (or solder) would behave normally.
Like · Reply · 4w

**Charlie Elliott** You have to be careful with increased bleedout of heatsink compound if used at high temp and vertical.
Like · Reply · 4w

**Colin Tuck** If there are soldered and epoxied - there should be no issue - what is lifetime of product - 7 years? ( life of electro ) - they should be fine ...
Like · Reply · 4w

**Colin Tuck** metal creep is more of an issue in metal turbine blades - I have never heard of it in power electronics ...
Like · Reply · 4w

**Darrell Hambley** I'm looking for any odd documented case where, yes, large parts can start to move downward on a vertical board. Again, I've never heard of this. I have seen many consumer products with vertical boards (old TVs etc) that are still intact 25 years later. These have the same continuous 1G of vertical stress that my parts will have. My worry is that actual data and facts don't hold a candle to "gut feeling".
Like · Reply · 4w · Edited

**Jonathan Beaver** Ask him to define a test that would simulate that failure mode. Perhaps some number of hours at some multiple of regular gravity (centrifuge or just weights tied to it)?
Coming at it from a different approach might help clarify the situation in their head.
Like · Reply · 4w

**Colin Tuck** Standard FRG-4 pcb can change shape if bent and heated - but the stresses required are usually above the norm ...
1
Like · Reply · 4w

(you guys here) have never heard of this kind of creep. The response was rather curt: "The lab technician said he wouldn't trust that board mounted vertically so you're wrong".

Like · Reply · 4w

**Colin Tuck** hahaha - ask that Tech where he has seen such creep ...!

Like · Reply · 4w

Write a reply...

Write a comment...

**Ray Ridley**
Admin · March 4

Build a Custom Prototype in 4 Hours

In our hands-on workshops, part of the training is learning how to speed up your design processes. We show how to prototype a power supply in an afternoon. That includes designing, testing, and winding the magnetics, the heart of the converter. We remove the mystery from this process, and also teach cutting edge concepts for all to apply.

Over 4000 engineers worldwide have learned these methods from us, and the last 2 years we have implemented our fast prototyping boards. These are now being used on design projects to help our customer make sure their first PCB iteration is going to work. It is a huge time saver.

In addition to magnetics and topologies, our attendees leave armed with the knowledge and experience to handle the design and implementation of control loops on the bench. A combination of simulation, CAD, and experimentation gets you highly productive in the workplace. Next workshop is April 20-23, and there are limited spaces left.

10 6 Comments

Like Comment

**Ray Ridley** The point of this is that you want to ensure that your first PCB design is going to work. That means solving the problems that arise when you put the switches, diodes (or SR), transformer, gate drive, and current sensing together.

We test these interactions as early as possible - you don't want to change magnetics size after the layout is done and the real board is built.

Like · Reply · 4w