VICOR

Modular Solutions for Your Power System

COMPONENTS • POWER • EASE-OF-USE • PERFORMAN
INNOVATION • EFFICIENCY • EXPERTISE • CONFIGURA
ME • VOLUME • RELIABILITY • FLEXIBILITY • LONGEVI
MWORK • PROVEN • DENSITY • QUALIFIED • COMPE
SOLUTIONS • INTEGRATION • SUPPORT • OPPORTUNI

Power Supply Design Considerations

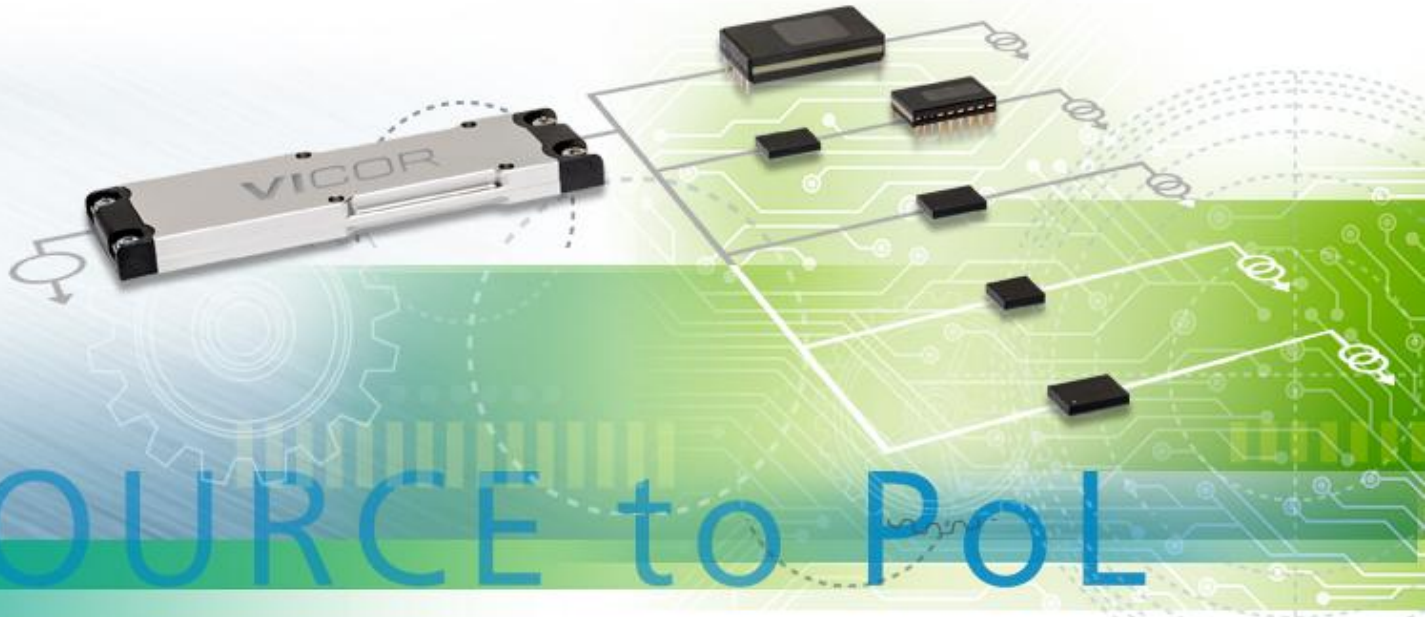
Martin Walker, Vicor on behalf of Arrow

About Vicor

Modular Solutions for Your Power System

Modular system building blocks enable solutions achieving:

- High density and efficiency
- Flexibility, scalability
- Fast time to market, cost effective



Vicor's Product Portfolio

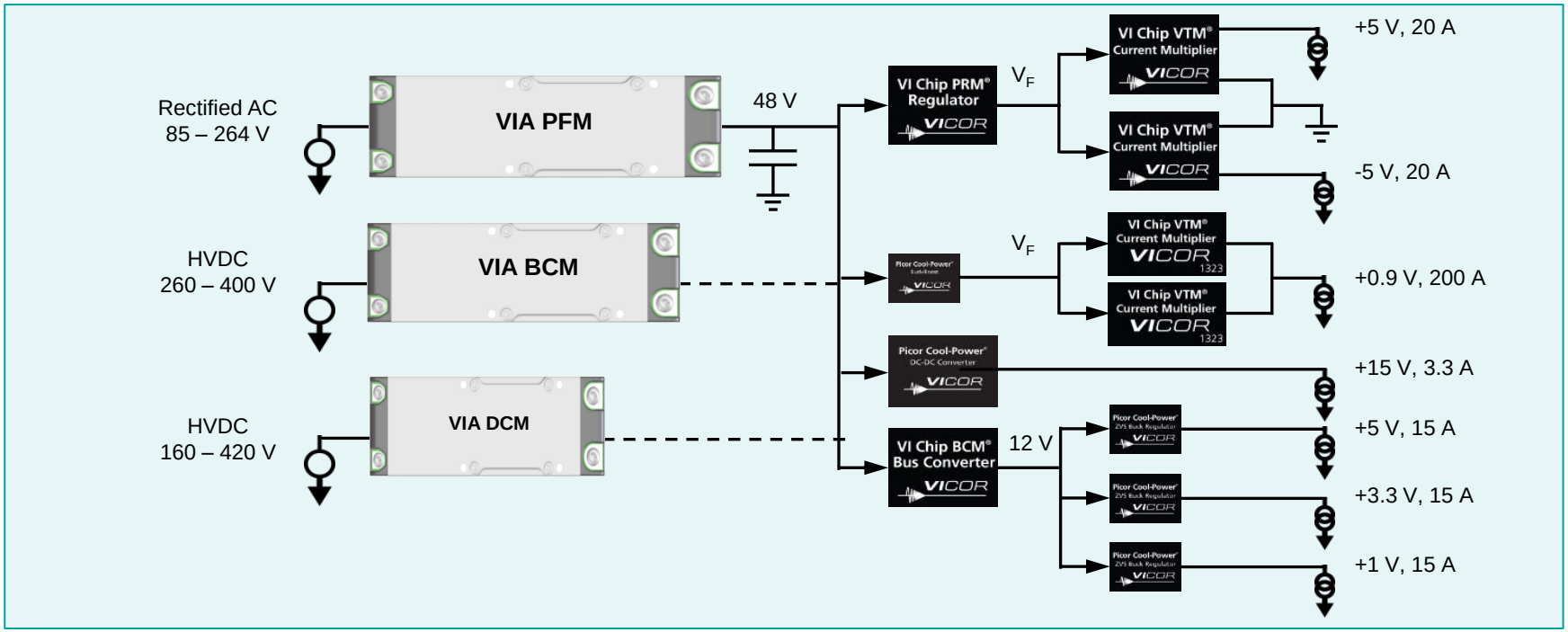
An Optimized Approach to Power Design

Optimized, modular system building blocks

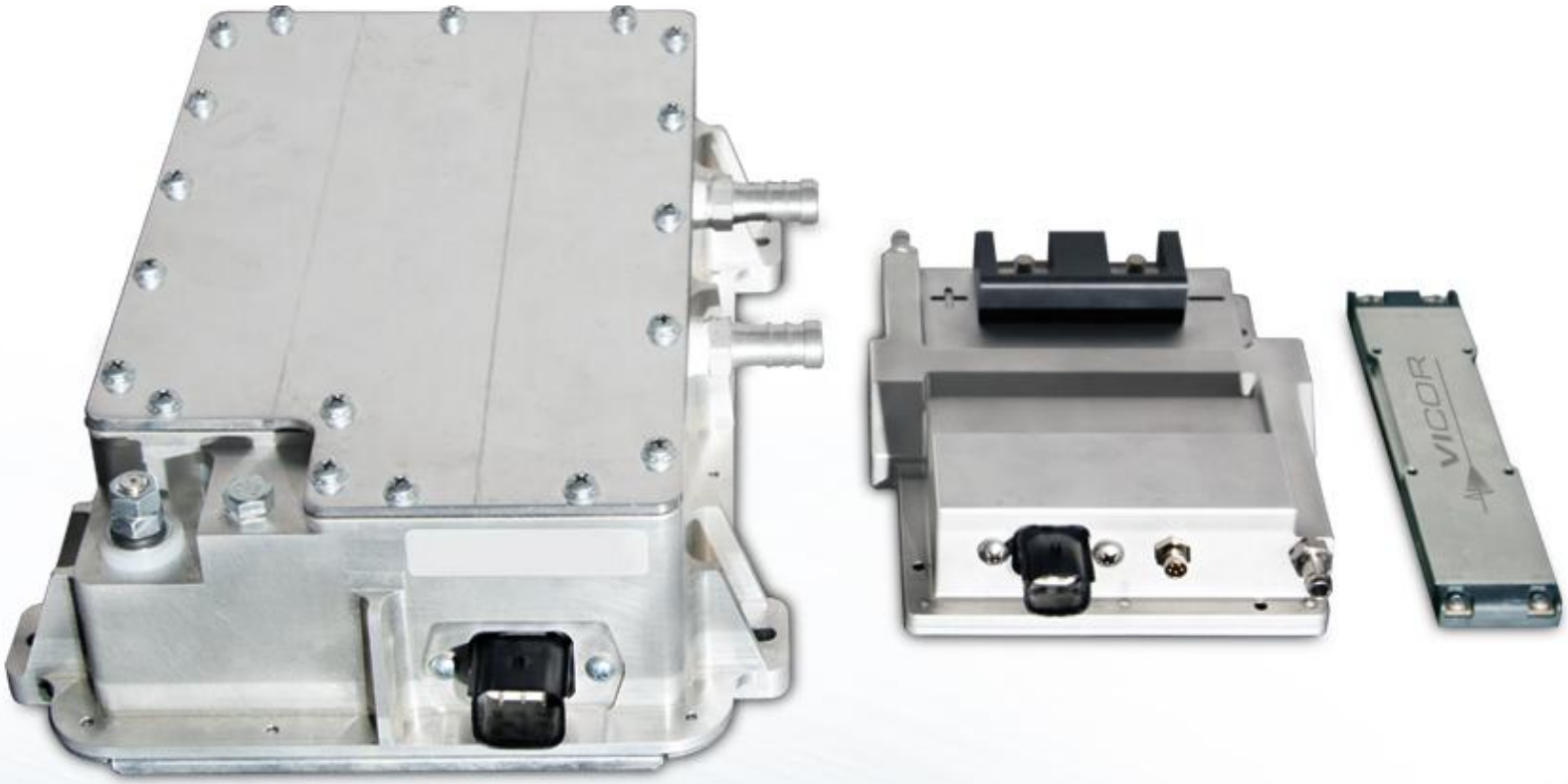
- Isolated, non-isolated
- AC-input, DC-input
- Regulated, Fixed-Ratio
- Low voltage, high voltage, extra-high voltage

An IC approach to higher power system integration

- Integrated power modules from 25 W to over 1,000 W
- Input operating voltages from 8 V to over 420 V (per module) with 700V being released this year



Example of 1.8 kW DC-DC Converter Technology Progression



Vicor in the News….

FEATURE ▸ POWER ELECTRONICS

Intermediate power busses: Who needs them?

By eliminating the intermediate 12V stage and converting from 48V direct-to-processor, has the potential to significantly improve

For Immediate Release

Vicor Modules Support the Data Center Infrastructure Highlighted by Google Compute Summit

Factorized Power Architecture Modules Enable Efficient 48V Direct-to-PoL (CPU, GPU, ASIC … olutions

Andover, MA – Mar
(Point-of-Load) power
memory to be powered
distribution loss. Evider
modules are being intro
promote 48V server and
commented: "By develo
standard, Google is now

Efficient, dense, cost-effe
applications, such as auto
particularly 48V, which re
smaller storage capacitors
from a 48V bus into the lo
GPUs. As a result, CPU pow
current carried by a 48V bu
be as much as 16 times the
fraction of the space, Vicor's
featuring high conversion ef

…f 48V
…GPUs,
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…better than 12V le…
…system designers to implement green distributed syste…
…power density and low distribution loss.

News & Analysis

Google, Intel Prep 48V Servers

12V rails not going away soon

NO RATINGS
LOGIN TO RATE

Rick Merritt
1/21/2016 00:01 AM EST
4 comments

Like 11 Tweet Share 443 G+1 10

SANTA CLARA, Calif. — Google is calling for 48-volt motherboards to cut wasted power in data center servers, a concept Intel already has prototyped seeking industry feedback. The news emerged from representatives of the companies and their power component vendors in a panel at DesignCon here.

Google Cloud Platform Blog

Product updates, customer stories, and tips and tricks on Google Cloud Platform

Google joins Open Compute Project to drive standards in IT infrastructure

March 9, 2016

Urs Hölzle, senior VP of technical infrastructure at Google, speaking at Open Compute Summit 2016

DATA CENTER DESIGN, FACEBOOK, GOOGLE, OPEN COMPUTE, POWER, RACKS AND ENCLOSURES

Google Contributes 48V DC Data Center Rack to Open Compute

How to access Vicor's technology without being a power expert?

- **Challenge:**
  - Thousands of products
  - Dozens of product lines
  - Many terms and three letter acronyms
  - Constantly expanding product offerings

- **Quickly assess system-level performance from product datasheets?**

- **Vicor's Application Engineers are knowledgeable but there are a limited number of them.**

Introducing…

Power System Designer – What is it?

- **A tool to enable a user to quickly design an optimal high level block diagram of a complete solution using Vicor products**

- **Tool:**
  - By definition, a tool makes a task easier
  - The quality of the result depends on the user's ability and the tool's capability
- **Quickly Design:**
  - Takes the place of sifting through datasheets of dozens of Vicor products
  - Does not require expert knowledge of Vicor's topologies, architectures, or many TLA's
  - Performs hundreds of calculations, pulls thousands of data points, draws a complete block diagram, *all in a matter of seconds*.

Power System Designer – What does it do?

- **High Level**
  - Basic Conversion functions (regulated vs. fixed ratio; isolated vs. non-isolated)
  - Specialized functions beyond the scope of the current tool
- **Block Diagram**
  - Utilizes Vicor *PowerBench*™ Whiteboard
  - Whiteboard is fully editable to enable further enhancement/optimization
- **Complete Solution**
  - Multiple outputs
  - Front End *and* point of load
  - Factorized Power *and* direct DC-DC components
- **Vicor Components**
  - Will recommend Vicor's best fit solution

VICOR PowerBench™

The Vicor PowerBench is a workspace of tools and references allowing engineers to select, architect and implement power systems using Vicor's products.

Power System Designer

Find a product using parametric search or start your Power System Design.

Search > Design >

Whiteboard

Architect your power system through analysis of topology and efficiency.

Simulators

Precision modeling of electrical and thermal behavior of Vicor's products.

Configurators

Tailor products to meet your specific needs.

Calculators

Guidance for determining accessory components for your power design.

Application Notes

Instructional and recommended operational information for Vicor Products

White Papers

Information and analysis for advanced power system design.

Video Resources

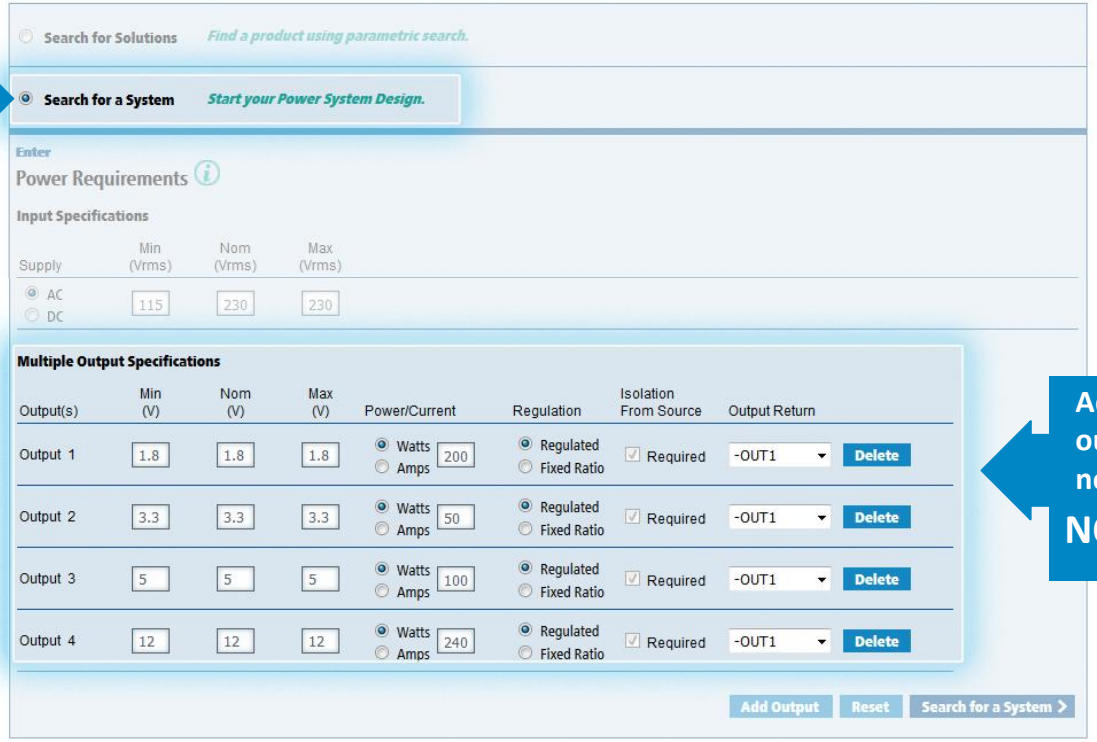
Video based online educational materials.

Webinars > Videos >

http://sapps.vicorpower.com/SolutionSelector/web/init.do

PowerBench™ – Power System Designer

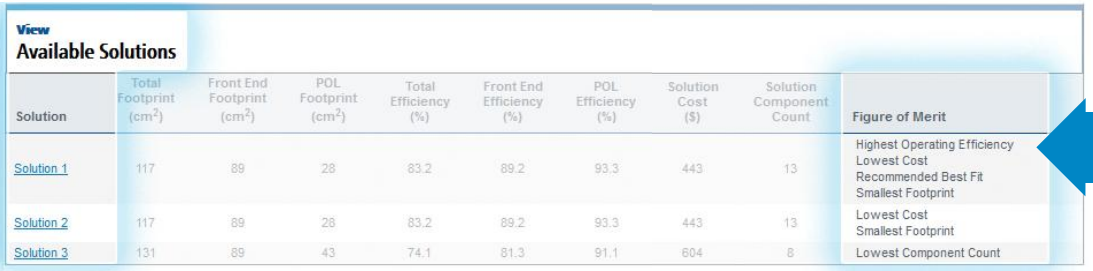
For systems requiring **multiple-output chains,** users can now quickly develop an optimal, high-level block diagram.



Add as many outputs as needed.

NO LIMIT!

Direct access to Whiteboard diagram from the Available Solutions link.



Identifies optimal chain ranked on same five merits.

System Design Considerations

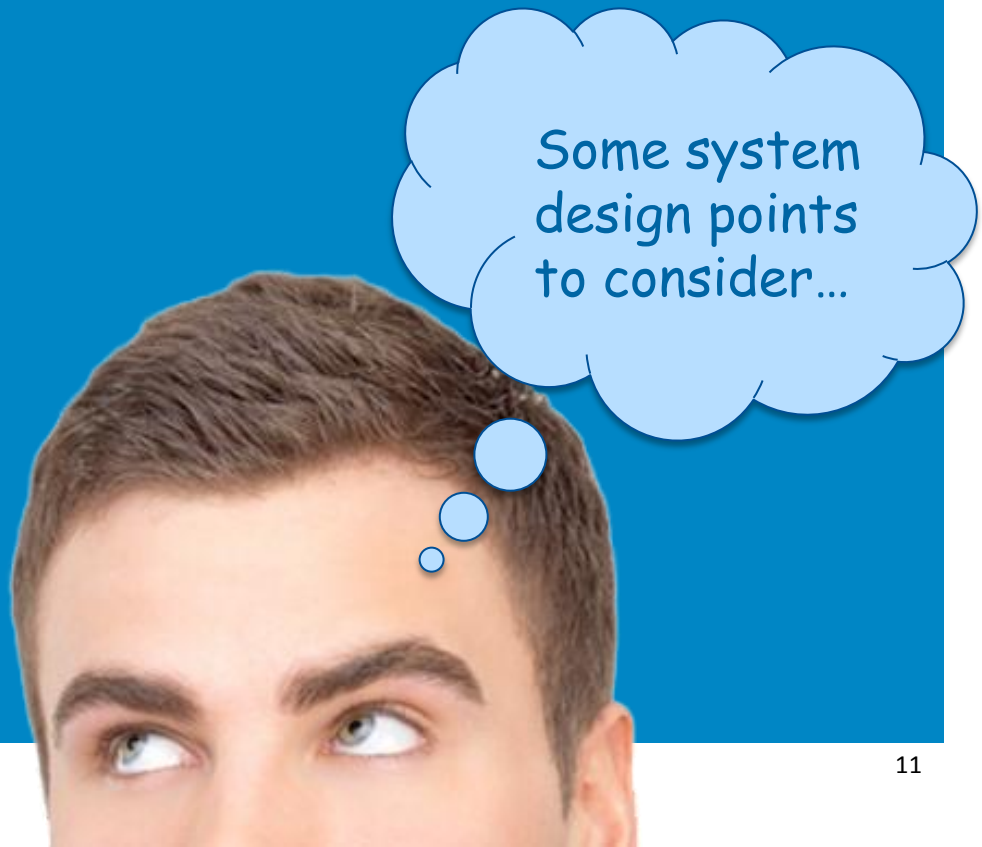
What's the best intermediate bus voltage?
48 V vs. 24 V vs. 12 V

Where do I place the components?

Do I still really need isolation?
If below 60 V, is it for…
Safety? Or analog/digital noise?

Priority ranking…
Efficiency? Cost? Size?

How can I cool it?

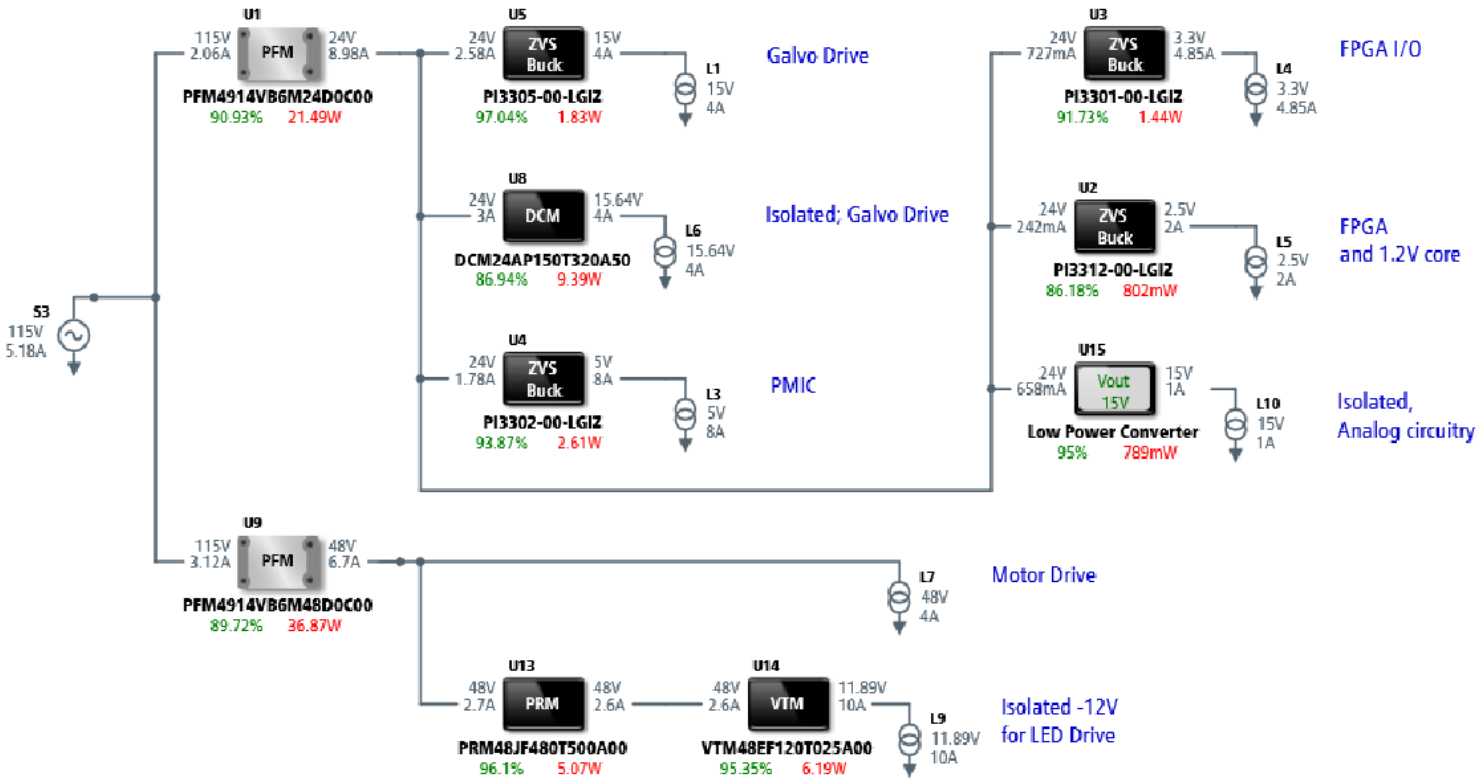


Where do I start?

Need to design power for an AC-DC system that includes:

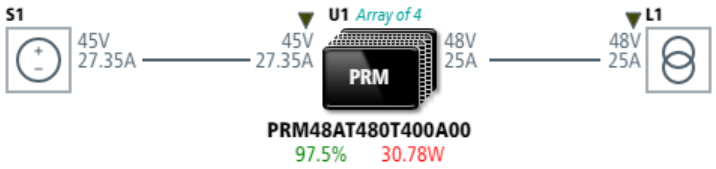
1) Galvo Drives *(+/-15 V)*
2) Motor Drives *(48 V)*
3) Constant Currents for LEDs *(-12 V)*
4) Core voltage for FPGA/ASIC *(2.5 V / 1.8 V)*
5) I/O *(3.3 V)*
6) PMIC *(5 V)*
7) Isolated rails for low power analog circuitry *(+/15 V)*

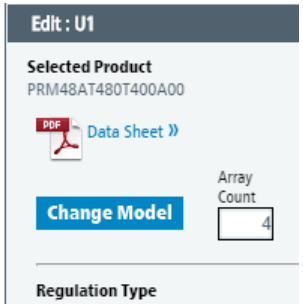
… Just simply enter the voltage/current requirements for each rail in to Power System Designer. Then choose optimal solution based on merit ranking.



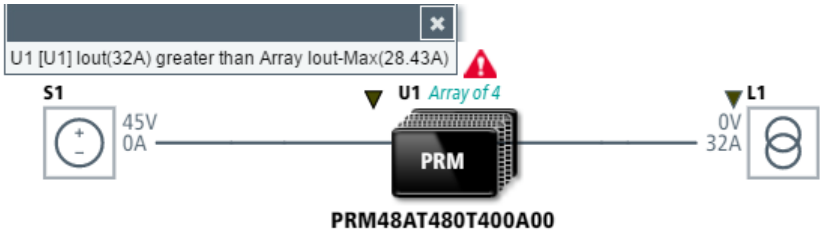
PSD Features: Parallel Arrays

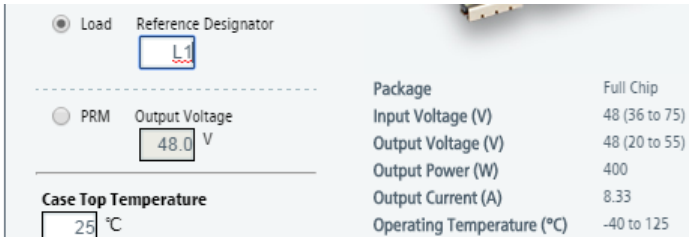
- PSD automatically parallels components if greater power or output current is needed:



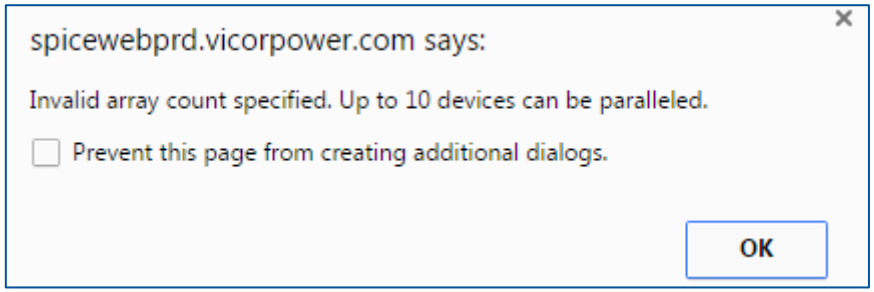


- PSD knows the derating due to sharing accuracies:



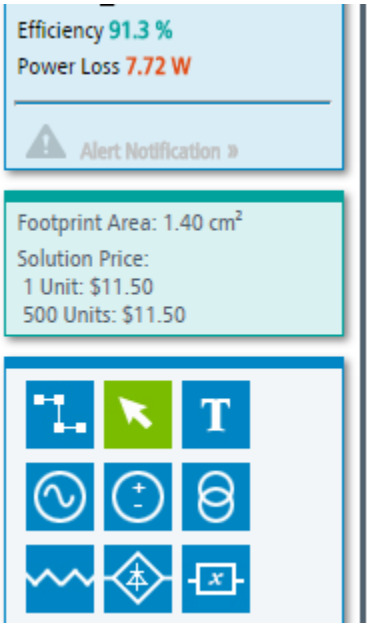


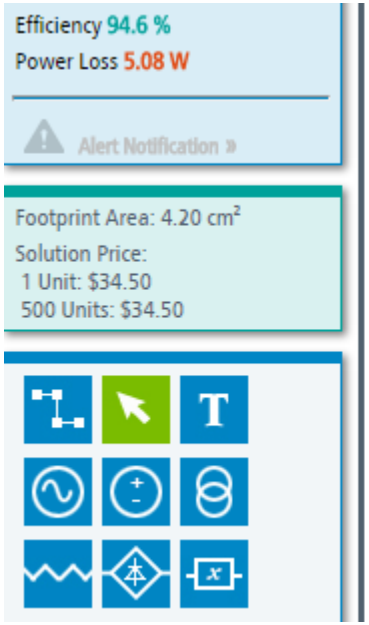
- PSD knows the array limits:



PSD Features: Does it include other manufacturer's parts?

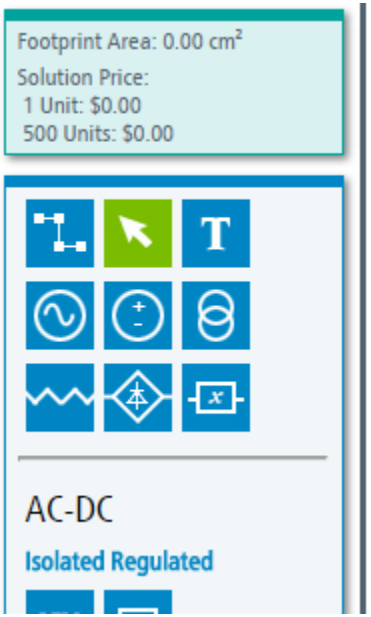
›**No, but the create functional block can allow you to do this:**

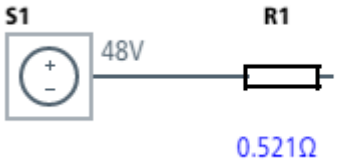


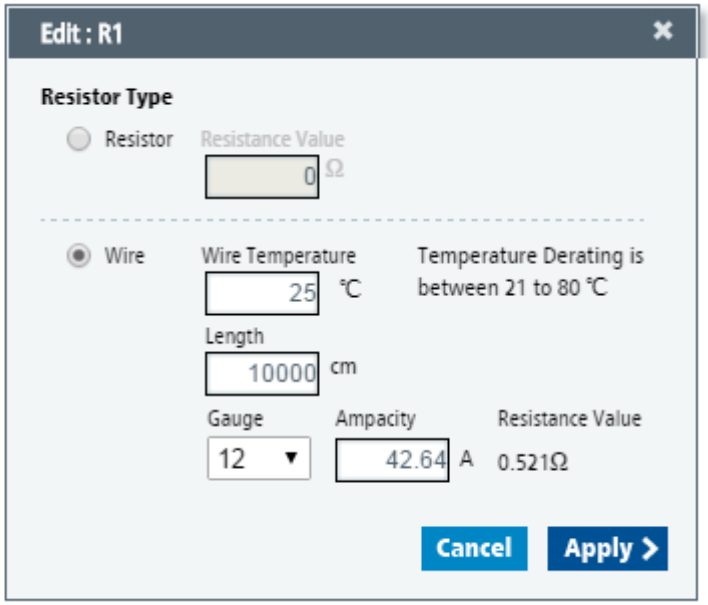


PSD Features: Can I model distribution losses in my cables?

› Do I need to look at tables of ohms per metre for different cables?







› Gives resistance value and current handling capability for different wire gauges

Worked Example – 90 Second Challenge

Application is an LED display screen mounted on vehicles

- **Input:** 12 V battery
- **Output:** 5V to drive panel
- **Load:** 28A
- **Environment:** 5 metres of AWG 18 cable between source and display

What is the best solution?

1. What solution does Power System Designer give you?
2. What are the losses in the cable?
3. With cable loss, would there be an advantage to using a two-chip solution (i.e. use one chip to boost from 12V to 48V and another to buck 48V to 5V?
4. What two chips could we use?
5. Which is the most efficient solution?

1) What solution does Power System Designer give?

Power System Designer™ VICOR PowerBench™ Vicor Website | All PowerBench Tools | Provide Feeback

Reference

Your Entered Power Requirements

Input Supply	Min (Vdc)	Nom (Vdc)	Max (Vdc)
DC	12.0	12.0	12.0

Output(s)	Min (V)	Nom (V)	Max (V)	Power/Current	Regulation	Isolation From Source	Output Return
Output 1	5.0	5.0	5.0	28.0 A	Regulated	N	-OUT1

Solution	Total Footprint (cm^2)	Front End Footprint (cm^2)	POL Footprint (cm^2)	Total Efficiency (%)	Front End Efficiency (%)	POL Efficiency (%)	Solution Price 1 Unit	Solution Price 500 Units	Solution Component Count	Figure of Merit
Solution 1	3	0	3	95.7	0.0	95.7	$15.00	$15.00	2	Highest Efficiency Lowest Component Count Lowest Price Recommended Best Fit Smallest Footprint

View

Solution 1 : Total System

Click image to enlarge

Analyze >

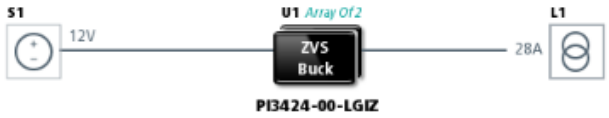
Display

Outputs

Output 1 (L1)

Analyze

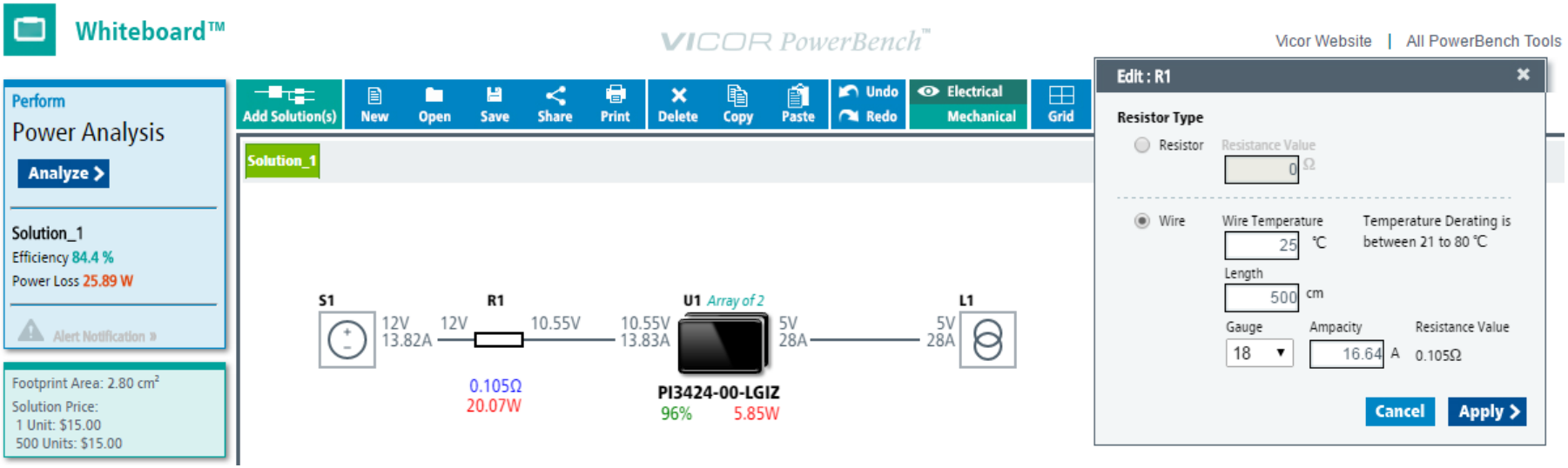
Output 1 (L1)



	Part Number	Quantity	Online Simulation	
	PI3424-00-LGIZ	2	--	

2) Model the losses in the cable

› We can model the losses in Whiteboard:



› At 12V there are losses of 20.07W of losses in the cable with total losses of 25.89W.

3) Would there be an advantage moving to 48V distribution?

› We can use Power System Designer to look for a 48V to 5V solution:

Reference

Your Entered Power Requirements

Input Supply	Min (Vdc)	Nom (Vdc)	Max (Vdc)
DC	48.0	48.0	48.0

Output(s)	Min (V)	Nom (V)	Max (V)	Power/Current	Regulation	Isolation From Source	Output Return
Output 1	5.0	5.0	5.0	28.0 A	Regulated	N	-OUT1

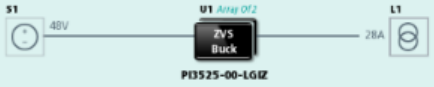
Solution	Total Footprint (cm^2)	Front End Footprint (cm^2)	POL Footprint (cm^2)	Total Efficiency (%)	Front End Efficiency (%)	POL Efficiency (%)	Solution Price 1 Unit	Solution Price 500 Units	Solution Component Count	Figure of Merit
Solution 1	3	0	3	93.2	0.0	93.2	$33.00	$33.00	2	Highest Efficiency Lowest Price Recommended Best Fit Smallest Footprint
Solution 2	9	0	9	89.6	0.0	89.6	$167.00	$115.00	1	Lowest Component Count

View

Solution 1 : Total System

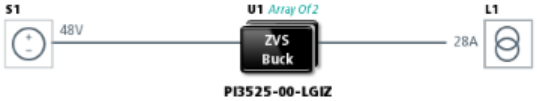
Click image to enlarge

Analyze ›



Analyze

Output 1 (L1)



› Solution 1 offers the PI3525

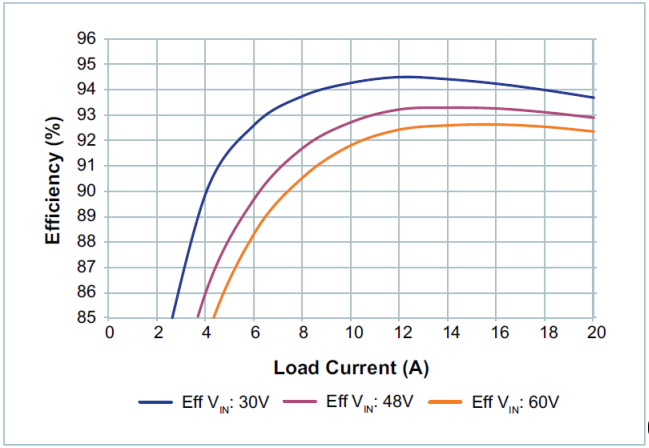
48V Cool-Power ZVS Buck – PI3525 (5Vout, 20A)

Features:

- Higher current version of PI354x
- 2x power in just 40% more area
- Wide input voltage range 30V-60V
- Constant voltage or constant current
- Parallel with single wire current share

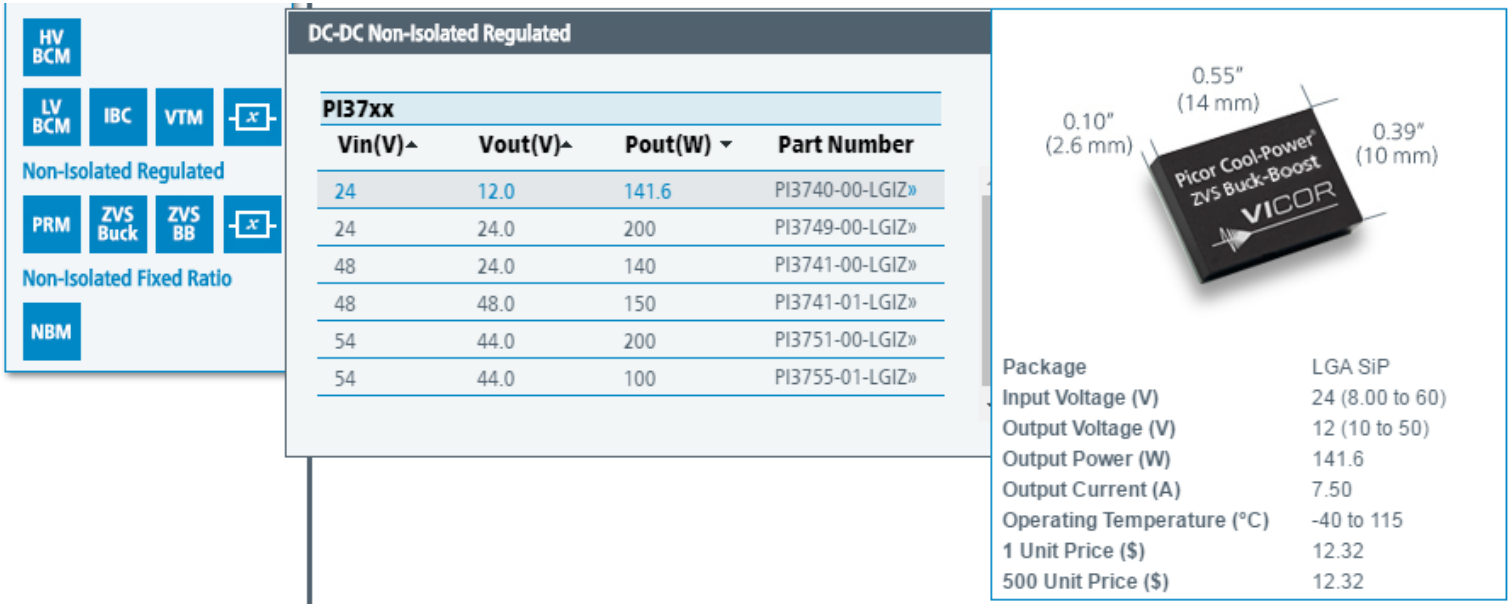
Benefits:

- Migration path to higher power
- Allows more compact designs
- Ideal for Industrial applications
- Battery charging or LED driving
- Easy to scale up system power



4) What about Boosting to 48V?

›**The PI3740 Buck-Boost regulator can provide a 12V to 48V Boost:**



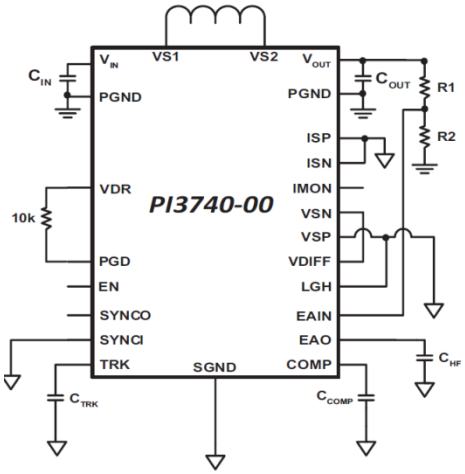
Wide Input/output Cool-Power ZVS Buck-Boost – PI3740

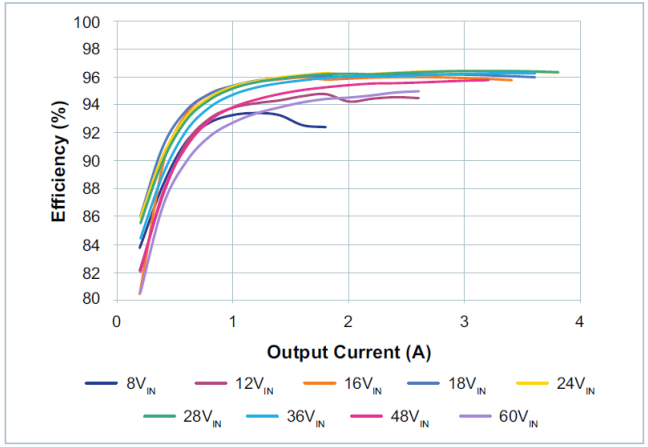
Features:

- Wide 8-60Vin to wide 10-50Vout
- Up to 96% efficiency
- 50–140W continuous output power
- Parallel with single wire current share
- Minimal external components

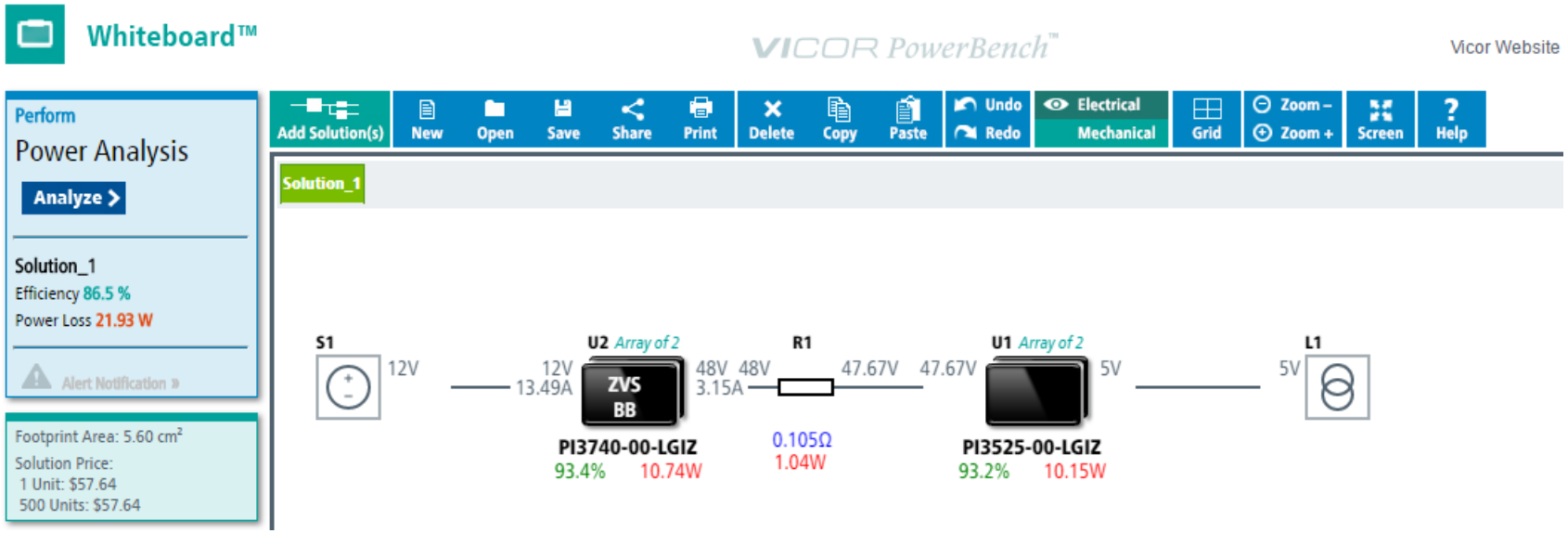
Benefits:

- Ideal for Industrial applications
- Cooler units; greater reliability
- Brick performance in an IC package
- Easy to scale up system power
- No compensation calculations!





5) Modelling efficiencies



- At 48V, the losses in the cable drop to just 1.04W and the total losses of the PI3740 + PI3525 are 21.93W vs. 25.89W with the PI3424
- This makes the two-regulator solution more efficient
- Benefit increases the longer the cable

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Feedback »

HOT 100 EDN 2016

90 - Take the 90 Second Challenge!

START YOUR DESIGN >

Start
Designing A Power System

Imagine designing
a power system in 90 seconds.
Take the 90 second challenge today!

Start >

Learn
How It Works (tutorial)

Watch how fast an engineer can design
a full AC to PoL power system
with Vicor's Power System Designer

Learn >

Watch
How to Build Your Next Power Design in Half the Time

Designing with and without
the Power System Designer Tool

Watch >

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Thank You