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The Power Behind Performance

Designing High Performance Power Systems

Fast, low risk, method for designing a complete AC-DC system

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Sean Wu– Applications Engineer
Vicor Coporation

The importance of time

- Power Systems take fixed time to design; that time can be split among multiple resources (taking less time but requiring more money) or consolidated to a single resource (taking longer)
- Reducing time for free increases risk (e.g. cutting corners)
- Increasing risk leads to lost time if risks do not resolve favorably

1981 年矗立在深圳蛇口工业区的巨幅标语

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Power Systems are complex

- Complicated sources and sophisticated loads yield significant power system complexity
- Many design steps require significant time
  - System design
  - Design verification
  - System verification
  - Safety approvals

Examples of Power System considerations

- **Input Source requirements**
  - Operating Range
    - Power requirements over line
  - Voltage Surge/Dropout
    - Clamp vs. survive
    - Shut down vs. Ride through
  - EMI Filtering
  - Fusing/Protection
- **Battery backup required?**
- **Negative Impedance (downstream regulators)**
- **Capacitive or pulsed power loading?**
- **Peak versus average power required**
- **Telemetry**
  - Requirements
  - Protocol
- **Loads**
  - Single voltage setpoint or trimmable?
  - Isolated or non-isolated
  - Negative voltage needed?
  - Regulated voltage or regulated current
  - Transient requirements
    - Response time
    - Maximum undershoot/overshoot
  - Load protection requirements
  - Steady state vs. peak power/current requirements
  - Output voltage ripple and noise
  - Startup and sequencing
- **Thermals**
  - Conduction or fan cooling?
  - Maximum ambient temperature
  - Efficiency; Maximum power dissipation
- **Agency Approvals/Standards**
- **…**

Risk is undesirable

- **Cutting corners or skipping steps is unacceptable**
- **Designing a complex system with minimal risk without adding more time is difficult**

All system considerations and requirements are met	**Need more time** to design
System will meet performance targets	**Need more time** to analyze
The system will work	**Need more time** to qualify

Conventional approach to lowering power system design risk

- **Break it into two parts:**
  - Front end (power supply)
  - Point of load (POL)
- **Reduces complexity by dividing considerations**
- **Saves time by introducing parallel processing**

- **Input Source requirements**
- **Battery backup required?**
- **Negative Impedance (downstream regulators)**
- **Capacitive or pulsed power loading?**
- **Peak versus average power required**
- **Telemetry**
- **Loads**
- **Thermals**
- **Agency Approvals/Standards**
- **…**

Front End	Point of Load
Input Source requirements	Loads
Battery backup required?	Telemetry
Negative Impedance (downstream regulators)	Thermals
Capacitive or pulsed power loading?	Agency Approvals/Standards
Peak versus average power required	
Telemetry	
Thermals	
Agency Approvals/Standards	

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But…

- Increases resources required to design the system
- The partitioning of the system becomes a barrier
  - Different manufacturers
  - Different designers
- Adds complexity by introducing a new point of interface
- Still does not reduce the time needed to get safety approvals
- Duplicates some considerations
- Still must pay to reduce risk

Interface between partitions must be engineered

Front End

- Input Source requirements
- Battery backup required?
- Negative Impedance (downstream regulators)
- Capacitive or pulsed power loading?
- Peak versus average power required
- Telemetry
- Thermals
- Agency Approvals/Standards

Point of Load

- Loads
- Telemetry
- Thermals
- Agency Approvals/Standards

Duplicated design considerations

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What's needed

- **Save time without increasing risk or paying more**
  - Typical system prototype time is 6 weeks
  - Typical system design time is 6-9 months (2-3 months for safety approvals alone)
- **Reduce complexity without adding redundancy**
- **Be able to design a power system with fewer (not more) resources**

Making the power system design process a win-win and not a tradeoff

Power Component Design Methodology (PCDM)

A proven approach for timely, low resource, low risk, high performance power systems design

The components
(or products)
for complete
system design

The tools
for being able
to quickly and
effortlessly apply
them

The support
for being able to
insure success - now

Power Component Design Methodology – How does it work?

- Power system is divided into two parts: front end and point of load
- Front end and point of load functions are implemented using power components – modular power converters specifically optimized for a power conversion function
- These components are engineered to interface with each other; yielding infinite flexibility in designing the system

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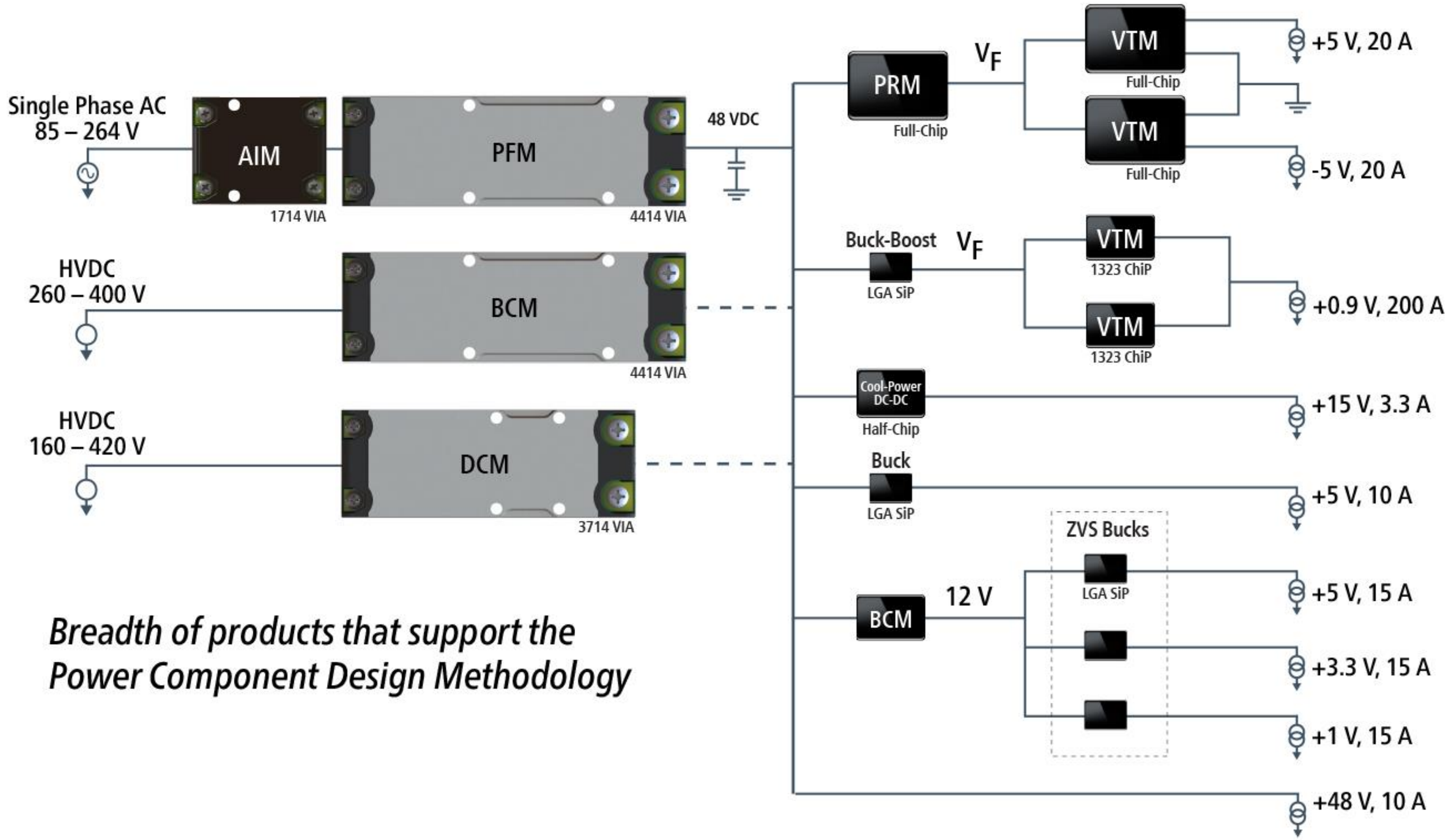
Power Component Methodology Summary

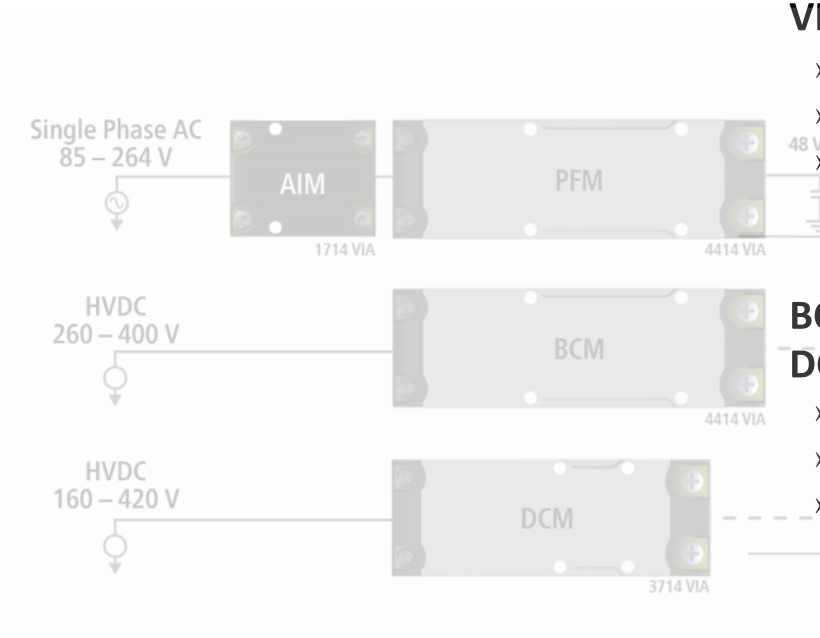
Front End
Vicor Power Systems

Point of Load
Vicor Power Components



Breadth of products that support the Power Component Design Methodology

Vicor Power Systems: Front-End Modules



VIA PFM AC Front End

- 85 to 264 $V_{AC\text{-}IN}$
- V_{OUT} = 48 V
- Power = 400 W

BCM Isolated Fixed Ratio DC-DC Converters

- 400, 380, 350, 270, 48 V_{IN} nominal
- V_{OUT} = 3 to 50 V
- Power = Up to 1.75 kW per module

DCM Isolated DC-DC Converters

- 300 V and 28 V_{IN} nominal
- V_{OUT} = 48, 28, 24, 13.8, 12 and 5 V
- Power = Up to 600 W per module

Vicor Power Components: Point-of-Load Solutions

Cool-Power ZVS Buck Regulators

- Best-in-class density and efficiency
- 12 V, 24 V and 48 V_{IN} nominal buck regulators
- LGA and ChiP packaged

Cool-Power ZVS Buck-Boost Regulators

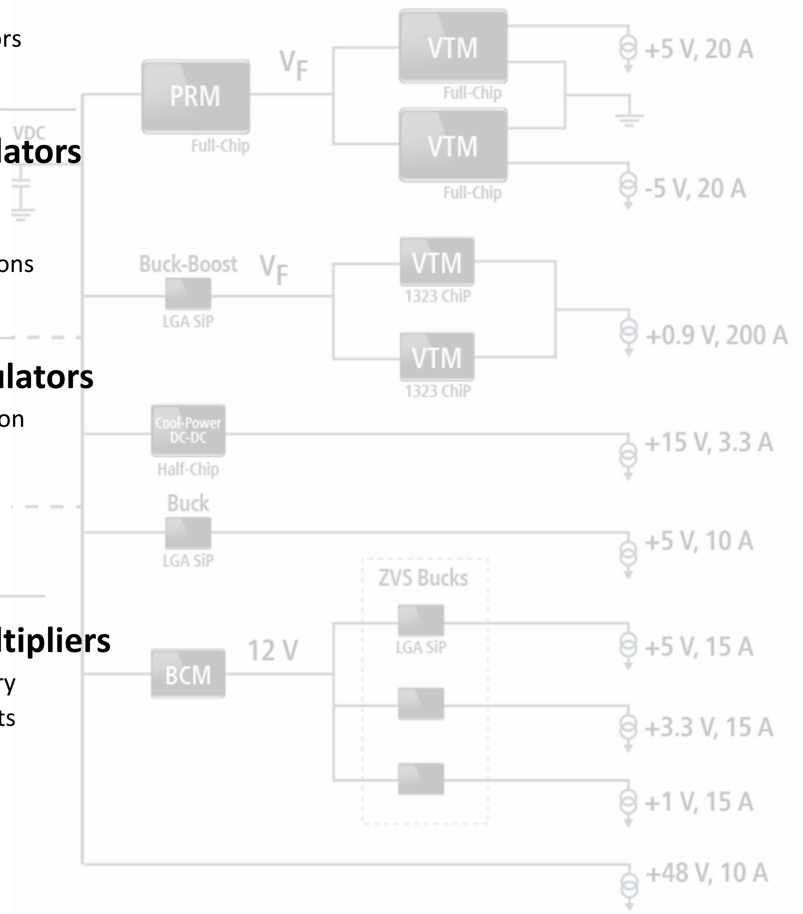
- Over 98% efficiency
- 8 Vin - 60 V_{IN} nominal buck-buck regulators
- General purpose and VTM compatible versions
- LGA and ChiP packaged

VI Chip PRM ZVS Buck-Boost Regulators

- Regulated, non-isolated buck-boost operation
- 24, 28, 36, 48 V_{IN}
- Up to 98% efficiency
- Up to 250/600 W (parallelable) in half/full VI Chip package

VI Chip VTM ZVS/ZCS Current Multipliers

- Fixed-ratio solutions for high current delivery
- Used with PRM and ZVS Buck-Boost products for complete regulated DC-DC converter
- VI Chip and ChiP packaged



Power Component Design Methodology Advantages

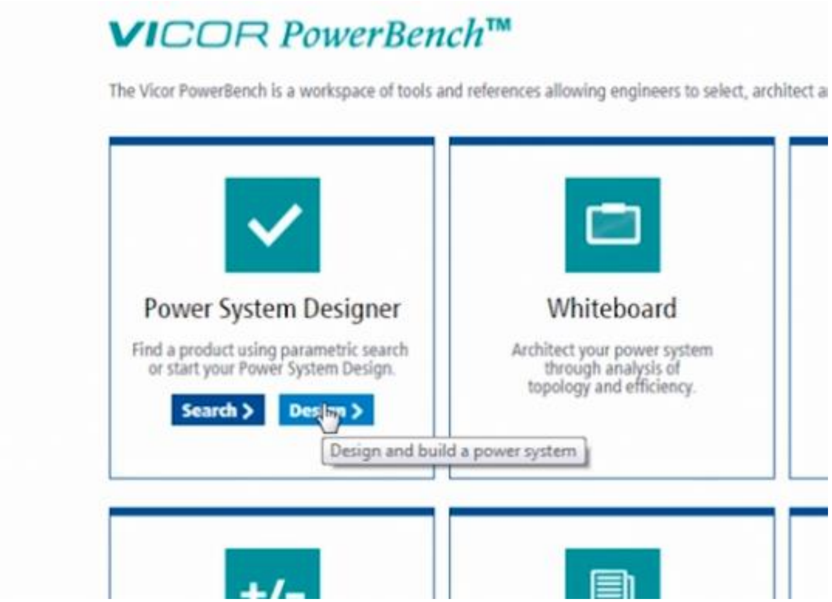
- **Products**
  - Lower risk by providing proven interfaces between front end and point of load conversion functions
  - Reduce complexity by providing power conversion building blocks
    - No need to design a power stage – use a power stage
    - Each building block has agency approvals – facilitating the approval of the power system as a whole
- **Tools**
- **Support**

Problem: How to use the Power Component Design Methodology

- **Understanding all the options offered by Vicor requires significant effort**
  - Thousands of products
  - Dozens of product lines
  - Many terms and three letter acronyms
  - Constantly expanding product offerings
- **Saving time in designing a system is not an option if it takes as much if not more time to identify the options for a system**
- **In order for the PCDM to be a useful, it needs more than just products; it needs tools**

Power System Designer: Tools for designing a power system

- Web based tool for generating power systems using PCDM
- Enables a user to view options for power systems based on their requirements and choose an optimal solution based on Vicor products.
- Allows the user to assess key features of each option
  - System Efficiency
  - Power footprint
  - Cost
  - Component Count



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Power System Designer: Saves Time

- **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*.**
- **Provides a drawn-to-scale representation of the complete system without the need to consult mechanical drawings or create a CAD file.**

Power System Designer: Reduces risk

- Systems are created using proven configurations of components that are engineered to work together
- Systems are created based on user entered requirements – removing the risk of incorrect interpretation of datasheet or design
- Critical performance and mechanical attributes of the system can be known up front

Power System Designer Demo

Support: Save time and reduce risk

- **Development kit for physical evaluation of complete power system**
  - Power up your system before you start a single board layout
  - Verify your power system performance before starting your design cycle
- **FAE support**
  - Talk with experts familiar with your power system before they have seen it
  - Get valid feedback on your design without training an expert
- **Sample availability**
  - Receive samples quickly to be able to rapidly prototype your system
  - Reduce prototyping time by using modules instead of discretes

Power Component Methodology: Save time, reduce risk

- **Products**
  - Complete power conversion components – not discretes
  - Verified, proven, in mass production, widely used elsewhere – not new
  - Safety approvals in place
- **Tools**
  - Design a system without being an expert in all of the product offerings
  - Find the optimal solution in minutes – not days
  - Know that you've picked a valid solution – not subject to misinterpretation
- **Support**
  - Use a development kit to physically evaluate your complete system
  - Consult with experts familiar with your system – even if they have never seen it before

Use the Power Component Methodology to cut your risk and design time in half

Thank You!