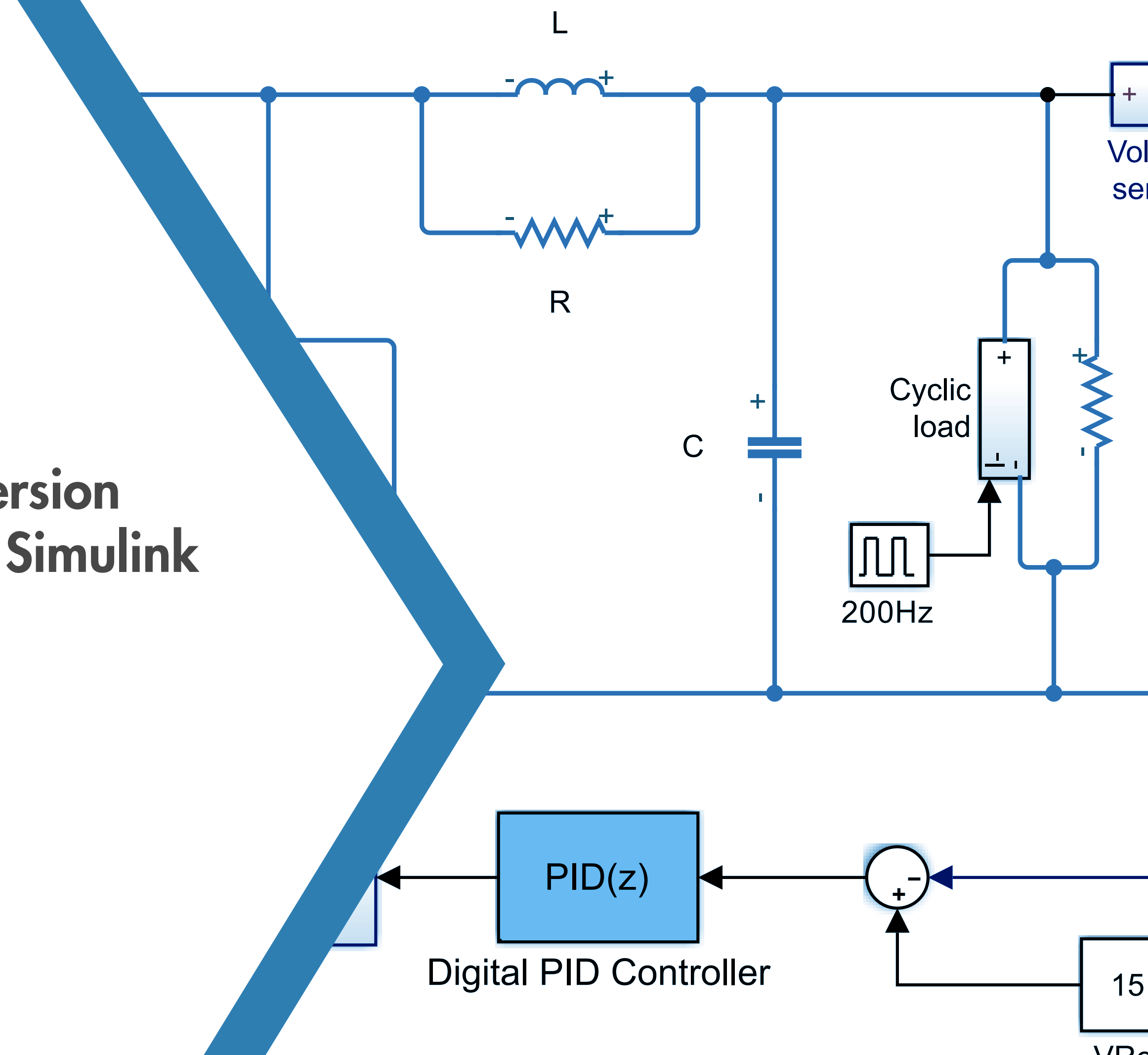


Design Power Conversion Controls Faster with Simulink



PID(z)
Digital PID Controller

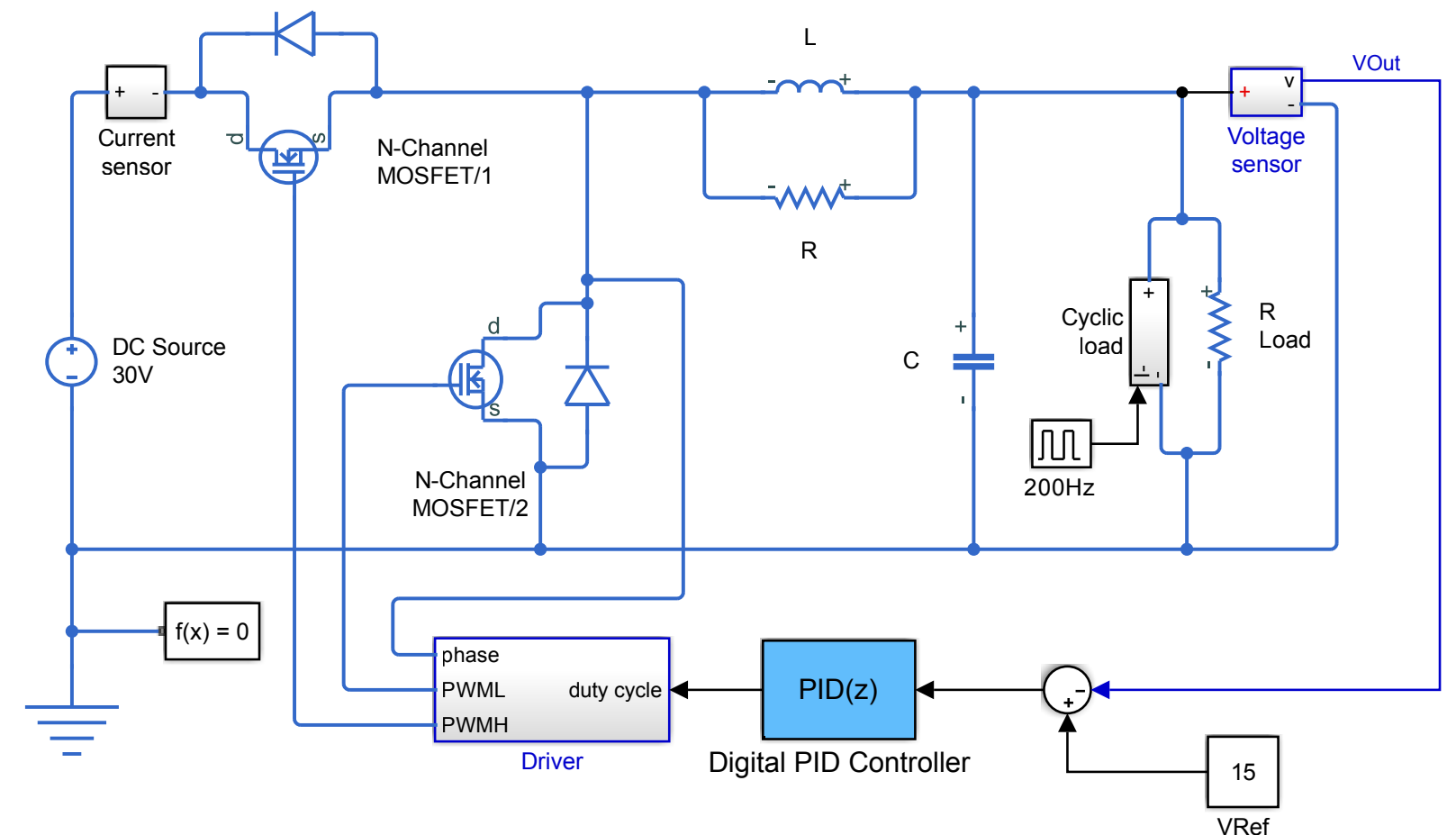
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Introduction

When you're designing digital controllers for power converters, there are many reasons to model and simulate:

- the varying power supply and converter loads
- the balance of passive components (like resistors and capacitors) and active components (like power transistors)
- feedback and supervisory control algorithms that regulate voltage and help you meet stringent design requirements

Simulink® lets you design control algorithms using simulation to test your concepts against complex and varying power sources and electrical loads before you begin hardware-software integration testing.

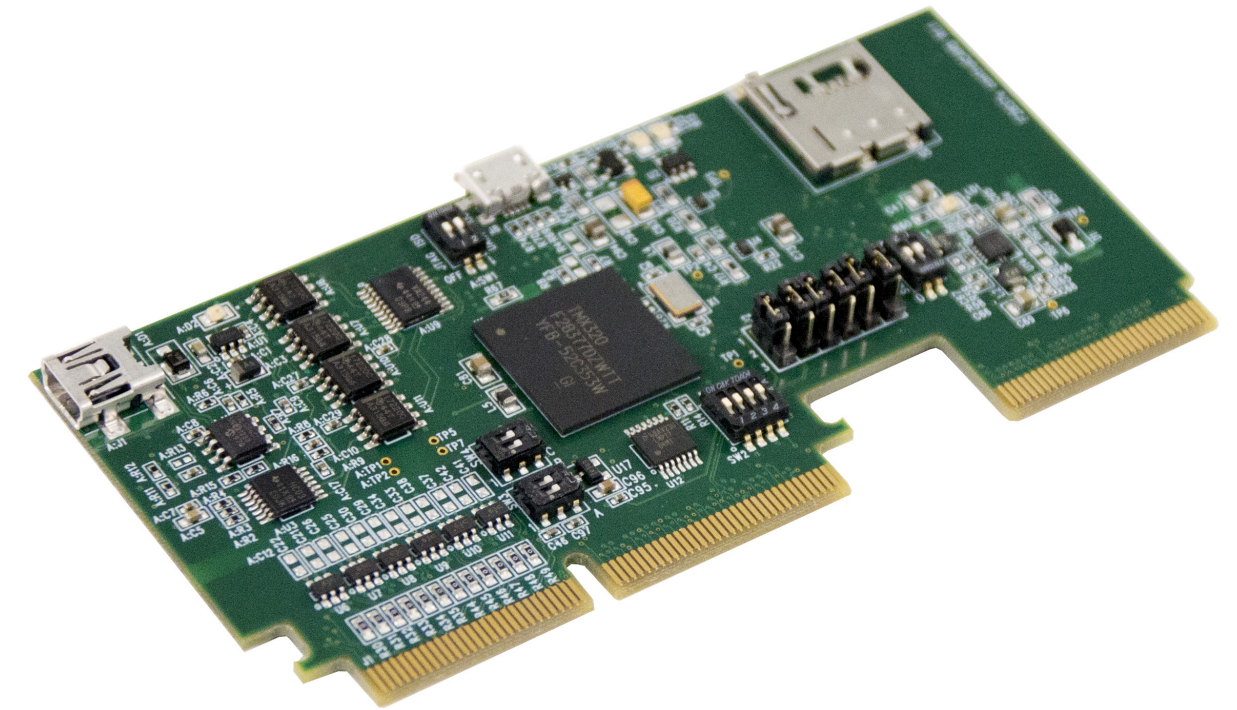


Buck converter model of a switching power supply that converts a 30V DC supply into a regulated 15V DC supply.

Digital Control vs. Analog

Digital control continues to outpace traditional analog approaches for power converter applications. Using a microcontroller helps you:

- Provide greater voltage output stability and maintain a power factor close to unity over a broader operating range
- Decrease the development time to implement complex control schemes for improved performance
- Provide a platform solution, applicable to a range of power levels, whereas analog controls are typically tailored to specific power levels



Simulink provides support for microcontrollers from Texas Instruments, Infineon, STMicroelectronics, NXP, ARM, and Microchip/Atmel; as well as FPGAs and SoCs from Xilinx, Intel, and Microsemi.

To debug and verify the control algorithm and its nine proportional-integral (PI) control loops, STEM engineers simulated the controller and the plant in Simulink, generated C code from their controller model, and deployed it to a Texas Instruments DSP.

“Writing code with nine PI loops in it by hand and then debugging it on hardware would have added six months or more to the schedule.”

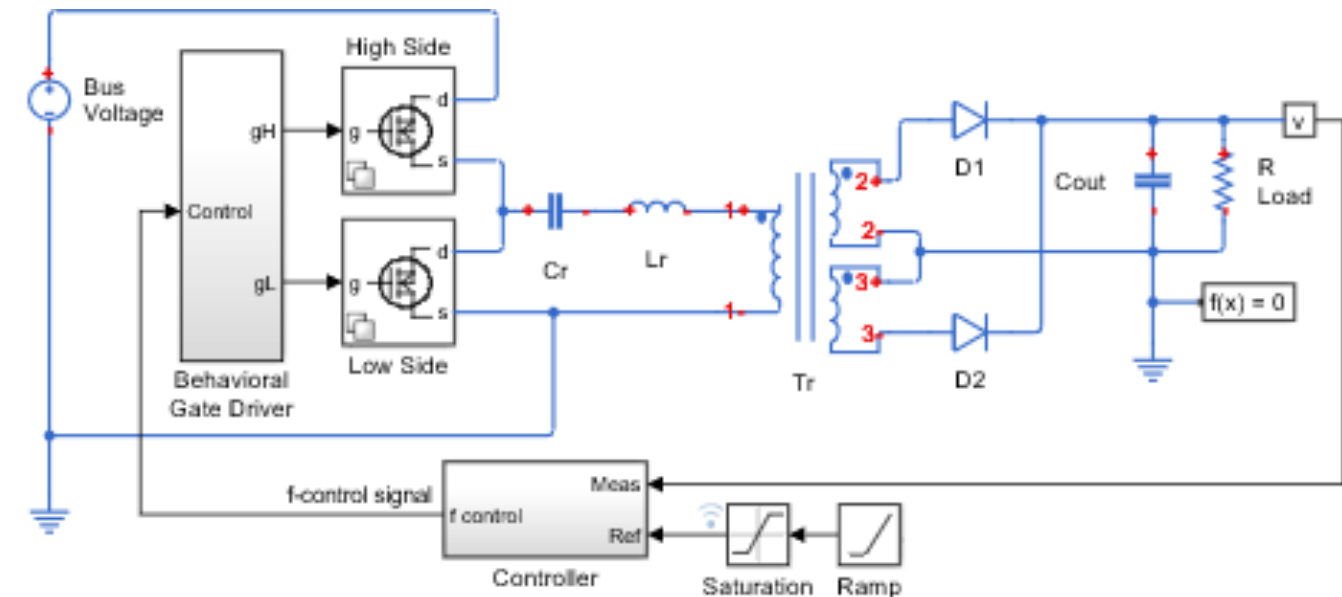
— Brad Landseadel, Chief Power Electronics Engineer, STEM

Limits of Circuit Simulators for Digital Control Design

SPICE and other circuit simulators are optimized for designing and analyzing power converters at the circuit level. However, these detailed models are not well suited for digital controller design. That's because these large models:

- Contain hundreds of parameters that are unnecessary for controller design
- Fall short for sensitivity studies and fault analysis
- Run too slowly for designing and analyzing a digitally controlled power converter

For these reasons, analog circuit simulations alone can be inadequate for power electronics control engineers who need to quickly evaluate different power converter topologies, develop feedback and supervisory control algorithms, and maintain a proper power factor for varying converter power supply and loads.



Simulink model of a DC-DC LLC converter with frequency control.

"Circuit-level simulations took three days. With Verilog-A they took 20 minutes—still too long to enable sufficient exploration of design alternatives. Using MATLAB and Simulink, we reduced simulation time to just one minute."

— Jun Uehara, Epson Toyocom

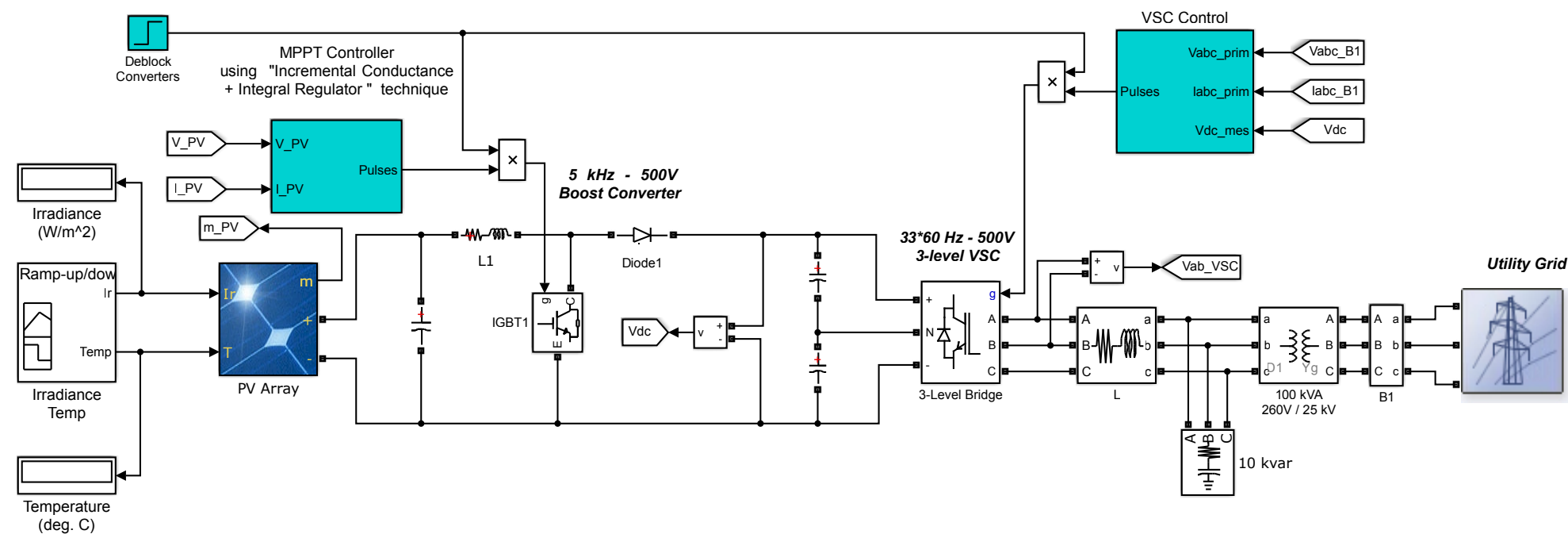
Advantages of System-Level Modeling and Simulation

With system-level models and simulation, you represent your power converter as a behavioral model, based on combinations of algebraic and differential equations. This approach lets you:

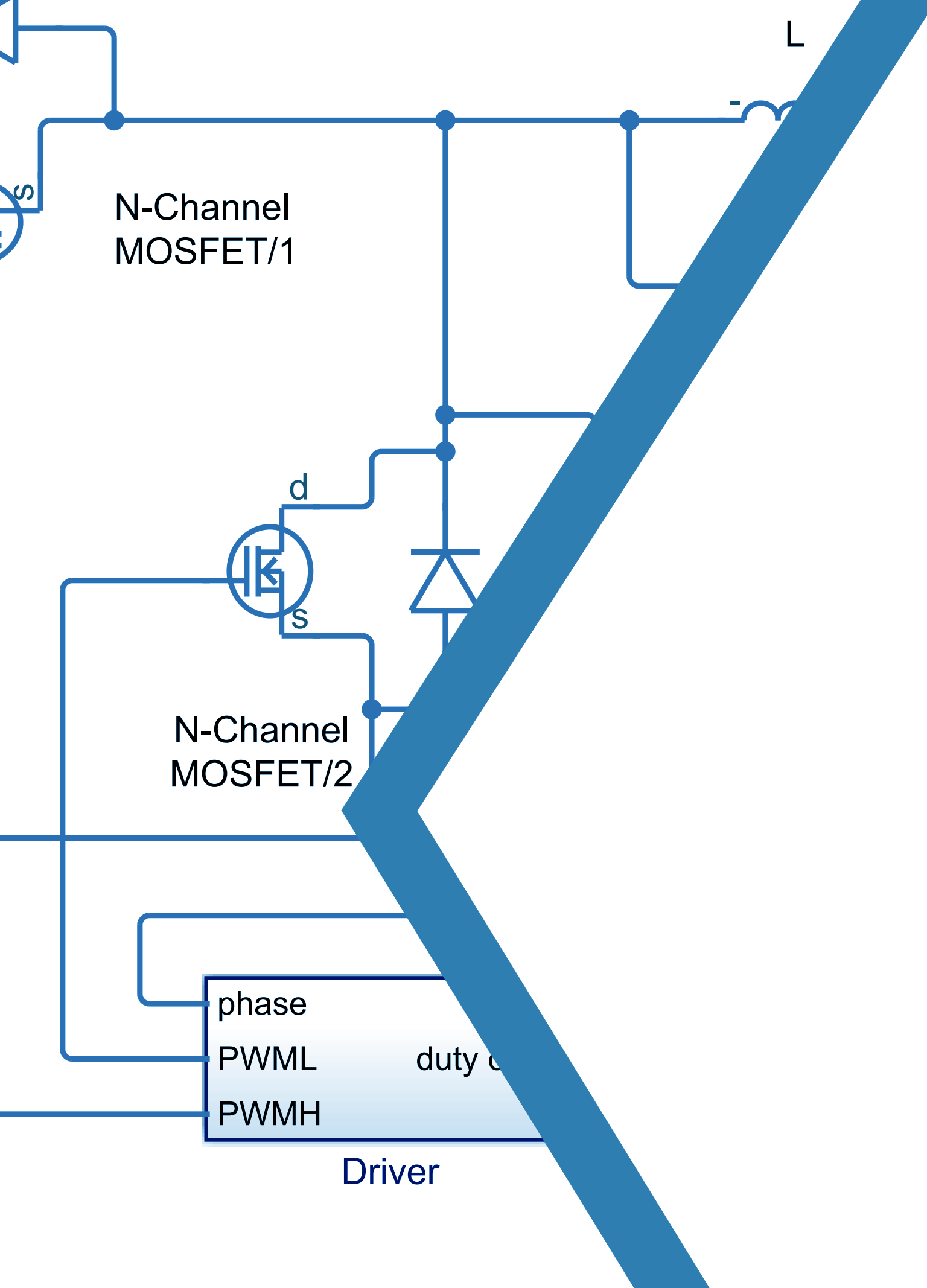
- Employ various levels of fidelity depending on the application, from fast ideal switching behavior to more detailed transistor models that capture thermal and loss behavior
- Model circuit and control algorithms using a block diagram, a natural environment for control engineers
- Capture the dynamic response of the control system to varying power inputs and load outputs
- Validate control algorithms before coding and testing on hardware

"In fact, our simulations with Simulink and Simscape Power Systems enabled us to make hardware design decisions. As a result, we shortened the product development cycle, completing it with just one board respin."

— David Erhart, Stem



Detailed Simulink model of a 100KW array



Learn More

Explore 10 proven ways that system-level simulation with Simulink can improve your digital controller development for power converters:

1. Simulate analog and digital components at the same time
2. Automate controller analysis and tuning in the frequency domain
3. Develop feedback control algorithms to improve power quality
4. Verify fault-detection, mode logic, and supervisory control across operating conditions
5. Verify operation of the power converter within a larger electrical system
6. Validate control code on the processor without damaging hardware
7. Generate control code for real-time testing
8. Develop real-time simulations of your electrical system
9. Generate code for microcontrollers, FPGAs, or ASICs from your model
10. Reuse existing code

Download **whitepaper**

10 Ways to Speed Design for Digitally Controlled Power Converters with Simulink