



PowerRox Course Module Overview

Thanks for your interest in the PowerRox Course Series!

PowerRox has a comprehensive and ever-growing list of training modules that cover all aspects of the power conversion market. The modules are **all structured as one (1) hour presentations** so you can mix-and-match to your liking.

Below you will find a list of course modules along with an outline and abstract of each. When you are prepared to make course selections and request a quote, please complete the “**PowerRox Course Options & Fee Schedule**” document that should have been delivered along with this one.

Please direct any questions and/or special requests to PowerRox c/o Brian Zahnstecher (bz@powerrox.com, 508-847-5747). We also welcome any suggestions for future modules you would like to see added to the standard offering listed here.

We are here to be a collaborative training partner and ensure your success in the marketplace!

PowerRox Course Modules

MODULE PR-1 – Data Center Hardware Overview

Abstract: This module provides a general overview of different types of key hardware in the data center by identifying major hardware types, reviewing the fundamental aspects of their power architecture, and looking at some specific power subsystem examples in more detail.

Outline –

- Broad overview of power conversion in the data center following the path from UPS to load
- Introduction to Key Hardware Types
- System Power Architecture Block Diagrams
- Blade System Power Subsystem Detailed Overview
- Network Switch Power Subsystem Detailed Overview

MODULE PR-2 – Data Center Structure Overview

Abstract: This module provides a general overview of how a typical data center is structured and what the high-level factors are that determine key design parameters such as hot/cold aisle layout, cooling, and modularity for efficient upgrade paths.

Outline –

- The Data Center: A Bird’s Eye View
- Small Vs. Medium Vs. Mega Data Centers
- Rack Configurations
- Cooling
- Back-up Power
- The Modular Data Center



PowerRox Course Module Overview

MODULE PR-3 – Intelligent Power Management in the Data Center

Abstract: This module explains how intelligent power management (IPM) is achieved in the data center from the macro level all the way down to the power subsystem of an individual system and everything in-between.

Outline –

- What is the value of IPM?
- Beyond Telemetry Data
- Hardware & Software Hooks Required to Enable IPM
- Dynamic Power Allocation
- What happens when you integrate high-speed data and high power?
- Maintaining Uptime, While Reducing Power Storage
- How to Optimize OPEX with IPM from the Chip to the Grid

MODULE PR-4 – An In-depth Look at Power Efficiency

Abstract: This module goes straight to the core of what most folks consider one of the absolutely most important aspects of implementing just about any type of electronic system or solution. Much time is spent mentioning the need to improve power efficiency, but rarely is there effort devoted to deep-dive on what truly drives power efficiency and where the low-hanging fruit exists to make maximum impact to increasing system power efficiency with minimum cycles.

Outline –

- What is the true cost of 1W?
- What Really Determines Power Converter Efficiency
- Redundancy, Virtualization, & Reliability
- Minimizing Loss and Maximizing Utilization
- Do more work with the same watts or do the same work with less watts?

MODULE PR-5 – Implications of Digital Power Solutions

Abstract: This module provides an overview of digital power solutions by first clarifying what is implied by the many different definitions of “digital power” used in different contexts. Once this is clear, we look to understand where and why digital, non-digital, or hybrid solutions are applied to power conversion and review the pros and cons accordingly.

Outline –

- Defining Digital Power
- Traditional Power Design Vs. Using Z-transforms and GUIs
- Digital Communication Busses for Power Supplies (i.e. – I²C, SMBus, PMBus, etc.)
- Why should I implement digital solutions?
- New Features and Control Can Also Introduce New Problems
- Cost Benefits, Trade-offs



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MODULE PR-6 – Server Power Architectures & Budgeting

Abstract: This module provides a detailed overview of different classes of servers and the typical power architectures and power budgets associated with these different system types. The level of detail presented here allows for enhanced understanding of how power solutions are chosen based on key system design parameters such as efficiency, space, voltage/current/power levels, cost, topology, and schedule.

Outline –

- What a Typical Server Power Budget Looks Like and Why
- How System Requirements Translate to Power Design Requirements
- Rack-mount Servers
- Blade System Servers
- Commodity Vs. High-performance Servers
- OEM vs. White Box Solutions

MODULE PR-7 – Power Supply Design for Commodity Managers

Abstract: This module is specifically tailored to review the critical aspects of power supply design in the context of what matters most to the Commodity Managers and other similar decision-makers to enable them to make more qualitative decisions, faster. We simplify the convoluted and highly technical process of power supply design to provide clear understanding of the key parameters of a power supply specification that drive cost, schedule, and vendor selection.

Outline –

- Which Power Supply Features Drive BOM Cost
- Which Power Supply Features Drive Schedule
- \$ per watt...great metric or the worst thing ever?
- Ensuring a Path for Cost Reduction
- Not all vendors are created the same...even within the same vendor!
- Some Thoughts on Multisourcing

MODULE PR-8 – OEM Front-end Power Supply Design Requirements

Abstract: This module provides an overview of key specifications for a typical OEM front-end (AC/DC or DC/DC) power supply, where they come from, and which ones are most critical to the owner of the specification. There is also detail on how these key design parameters impact the development process, manufacturability, and highlights of which specification aspects tend to bottleneck release to production.

Outline –

- High-level Sections of a Front-end Power Supply Specification
- Which specifications add the most risk to release? To qualification? To cost?
- Design & Derating Guidelines
- Quality and Reliability Testing...Standalone and In-situ
- Design for Manufacturability, Commonality, and Cost Reduction
- Why high voltage DC (HVDC)? Experiment or new reality?



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MODULE PR-9 – OEM On-board Power Supply Design Requirements

Abstract: This module provides an overview of key specifications for a typical OEM on-board (isolated or non-isolated) power supplies, where they come from, what is driving the form-factor of the solution, and which ones are most critical to the owner of the specification. There is also detail on how these key design parameters impact the development process, manufacturability, and highlights of which specification aspects tend to bottleneck release to production.

Outline –

- High-level Sections of an On-board Power Supply Specification
- Which specifications add the most risk to release? To qualification? To cost?
- Embedded (i.e. – discrete) vs. Modules vs. Collocated (i.e. – granular or integrated) Power
- Design & Derating Guidelines
- Quality and Reliability Testing...Standalone and In-situ
- Design for Manufacturability, Commonality, and Cost Reduction
- Why power management ICs (PMICs)?

MODULE PR-10 – OEM Power Supply Hardware/Software Interface Requirements

Abstract: This module provides a comprehensive overview on understanding which aspects of power supply design and implementation drive hardware design, which drive software design, and how they have to all play nice together to enable success in a modern system application.

Outline –

- A Software Functional Specification is as Critical as the Hardware One
- Common Gaps Between Software and Hardware Specifications
- A GUI Alone is Not Going to Be Sufficient
- Qualifying the Software...Standalone and In-situ
- Corner case for failure or risk of major field recall?
- Options for Mitigating Performance Failure Post-release

MODULE PR-11 – OEM Power Solutions System Qualification

Abstract: The objective of this module is to assist one in achieving the impossible, which is to have confidence in shipping power solutions that are improperly specified, tested, or supported (did I mention highly rushed to develop?). This may sound like an impossible scenario for a power vendors' success, but the sad reality is that this description is actually quite common and even worse is the fact that this situation worsens by the day in this industry.

Outline –

- Methods to Recognize and Mitigate Lack of Specification and Scope Creep
- Standards for Enterprise System Design and Qualification
- How can I qualify the power solution without the real system?
- How do I realistically test an infinite number of permutations?
- How am I supposed to test or hit schedule milestones when I cannot even get a response from the customer?
- How to Ensure Qualification Costs Are Properly Accounted for in the Quoting Process



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MODULE PR-12 – OEM Power Solutions Manufacturing Requirements

Abstract: This module provides an extensive overview of the numerous and often painful manufacturing requirements an OEM will force on its vendors before it ever purchases a single unit. A primary objective is to enlighten and humble a vendor, while at the same time making them aware of the shocking demands that will be made and savvy enough to deal with them and still keep the customer happy.

Outline –

- Building a Similar Product or Working With a Comparable OEM Means Nothing
- Building a Product in One Factory/Country Does Not Imply it Will Work Elsewhere
- Know What You Are Getting Yourself Into Ahead of Time
- How to Prepare for the Audit of a Lifetime
- Quality Expectations from Product Ship Start to End of Life (EOL)

MODULE PR-13 – OEM Multisourcing & Supply Chain Requirements

Abstract: This module provides a comprehensive overview of the top needs and pain points for some of the most demanding, primary decision-makers in the project award process. The goal is to make one aware of what to expect, how to compromise and mitigate showstoppers, and to enable enhanced negotiation and strategy for those looking to be a top-tier power vendor, while still maintaining quality and profit margin.

Outline –

- Does multisourcing enhance or degrade assurance of supply?
- Can a smaller vendor compete with billion dollar competitors?
- Maybe a Showstopper, but Almost Anything is Negotiable for the Right Price
- The Huge Difference Between Being a 1st Source vs. 2nd Source
- Shifting Liabilities...the Hub Model for Global Logistics
- Project Awarded, but That Does Not Imply Revenue

MODULE PR-14 – OEM Market Penetration

Abstract: This module is dedicated to turning the extremely steep, uphill battle of penetrating a major OEM into a little more of a level playing field. A one-size-fits-all approach will absolutely fail in today's market so vendors must approach with extensive knowledge of an entire army of different stakeholders, their motivations, and how to speak to them on their own terms. Only then can you get them to fight for you internally and be your best advocate for success.

Outline –

- How to Get a Foot in the Door
- You Have One Shot to Really Hit the Target
- Know Your Audience and What Motivates Them
- He hates what she loves...so how do I satisfy both of them?
- How to Know If You Are Even Making Progress



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MODULE PR-15 – OEM Customer Support Expectations

Abstract: This module is focused on helping a vendor differentiate in a sea of competition. The best way to do this is to really stand out and show the customer you understand their needs and are willing to do what it takes to win their business. Considering how many Field Application Engineers (FAEs), Sales, and Marketing folks a major customer is exposed to, it is remarkable how few actually know how to support that customer to their expectations.

Outline –

- Ask a Lot of Questions, but Do a Lot of Listening
- Best Questions to Ask and Answers to Know
- What Differentiates a Power Vendor from the Crowd
- Service Providers Meet Short-term Needs, but Collaborative Partners are Around for the Long-term
- Take an Action and Deliver on It
- Doing their job gets them credit, but gets you paid...everyone wins!

MODULE PR-16 – OEM Key Stakeholders Overview

Abstract: This module provides critical knowledge and strategy for any vendor working to penetrate and support any major engineering organization. A very common mistake of vendors is to assume a single set of collaterals and sales approach will yield quick success. Here we identify all the key (and sometimes ancillary) stakeholders in the decision path and give an in-depth look at what drives/hinders them, how to speak to them in their unique language, and even how to understand some of the unusual internal politics that yield counterintuitive decisions.

Outline –

- Who are the key players and why?
- How to Speak to Each Stakeholder in Their Own Language
- Optimizing Presentation Collaterals and Approach for the Audience
- Demonstrate your Ability to Empathize With the Customer
- So you made a mistake 20 years ago...who cares? That one guy does!

MODULE PR-17 – Traditional vs. White Box Server Solutions Overview

Abstract: The server industry has gone through some major metamorphosis over the last 10-15 years and will continue to do so even more dramatically over the next 5 years. This module serves to provide both historical context and a current state of the industry to assist in understanding how to remain current in the near to long term.

Outline –

- How Big Iron Turned Into Commodity Hardware
- The student is now the teacher...so how does that impact my approach to the customer?
- Working for an OEM vs. a Contract Manufacturer (CM)
- Why buy your server when I can make my own?
- How the Cloud is Driving an Unprecedented Paradigm Shift in the Server Industry



PowerRox Course Module Overview

MODULE PR-18 – Enterprise Power Supply Market Overview

Abstract: This module provides a general overview of the data center power supply market that enhances understanding of who the major players are today, what technology is driving them, and what should be done to remain competitive tomorrow.

Outline –

- Front-end Power Supply Market Data Review and Analysis
- On-board Power Supply Market Data Review and Analysis
- Power Supply Component Market Data Review and Analysis
- Changes in the Power Technology That are Impacting the Power Supply Markets
- Changes in the Data Center That are Impacting the Power Supply Markets

MODULE PR-19 – Power Supply Market Disruption

Abstract: This module helps to bring vision and focus to potential major power supply market disrupters through mostly objective (and sometimes speculative) analysis of key shifts to traditional power supply applications. Major changes to loads changes the power architecture and that can ripple through the entire power value chain from a point-of-load (PoL) converter all the way to the power plant.

Outline –

- Eliminating Power Conversion Steps
- The Customer is Now the OEM
- Power Supply Cannibalization
- Will power disappear from the board?
- Impacts to the Power Value Chain

MODULE PR-20 – The Internet of Things (IoT), Wearables, & Energy Harvesting (EH) Ecosystem

Abstract: This module provides a detailed look into the many forms of energy harvesting (EH) and the associated ecosystems, which is no longer a lab experiment nor producing negligible amounts of power. The incredible growth predicted in the number of connected devices, particularly IoT and Wearables, can only come to fruition with major improvements in intelligent power management (IPM) and energy storage. The eventual goal is to power these billions of small devices with ambient energy around them, thus freeing the limitation of plug-in recharging and/or the frequent exchange of expensive, non-ecofriendly batteries.

Outline –

- Making Science Fiction a Reality
- The Market / Motivations
- How will power electronics make the difference?
- Energy Harvesting
- The Energy Harvesting Ecosystem



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MODULE PR-21 – Assessing the Power & Market Impacts of 5G

Abstract: This module provides a broad overview on the key components of proposed network improvements that are eventually to define what we will all come to know as 5G. It is a unique opportunity to gain insight on the global cellular market as well as the technical constituents that emphasize dynamic concepts such as heterogeneous networks (HetNets), software-defined networking (SDN), network function virtualization (NFV), densification, disaggregation, and mobile edge computing (MEC). In particular, these components will be scrutinized for how they contribute to power utilization, changes to energy storage requirements, power savings, and provide a framework for the aspirational promises of the 5G standard currently in definition and targeting deployment in the ~2020 timeframe.

Outline –

- The Global Cellular Market
- What does a production cellular network look like today?
- 5G: What? Why? How?
- Heterogeneous Networks, Mobile Edge Computing, & Densification
- Software-Defined Networks, Network Function Virtualization, & Disaggregation
- The Paradigm Shifts in Power Brought by 5G

MODULE PR-SPECIAL – Custom Analysis

Abstract: This module is a special option for customers to provide a particular power supply specification, test plan, or other type of documentation for specific analysis by PowerRox expertise. The desired materials to be reviewed and expected outcomes should be discussed and agreed upon ahead of time.

Outline –

- **TBD per customer requirements.**

Thanks again for your interest in PowerRox training and we look forward to providing you with excellent service and a very valuable return on investment of your training dollars!