[Putting power forward]

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Introduction

Designers of advanced computing systems are no longer able to consider the power supply as a "black box" that can be plugged in at the end of the project. Giving due consideration to power design at an early stage is essential given the growing complexity of server boards, demands for greater power and efficiency, and the need to plan for multiple product generations. On the other hand, engineers also need flexible power solutions in order to respond to system design changes and adopt a platform approach to the power design, which can help streamline future development. The ability to easily configure, control and monitor power delivery functions is a valuable characteristic enabled by digitally configurable power modules.

Pressure on power design

High-performance computer boards such as data-center servers present increasingly complex routing and component-placement challenges as designers seek to maximize data-processing and storage capabilities in the minimum possible area to comply with the standard rack dimensions. With a mix of advanced processors, ASICs and FPGAs that feature large numbers of I/Os and multiple power domains, the PCB can incorporate 20 layers or more for timing-critical high-speed signal traces and power distribution.

Up to 40 or 50 power rails can be needed, which call for a large number of point-of-load (POL) converters that are powered by intermediate bus converters (IBCs) fed by an AC/DC front-end power supply (**Figure 1**). It is often the case that multiple power rails are used to provide power to a single IC and the order in which the rails power up and down is important so as to not destroy the IC. The required sequencing between the power rails involves routing signals to communicate the status of the different power supplies.

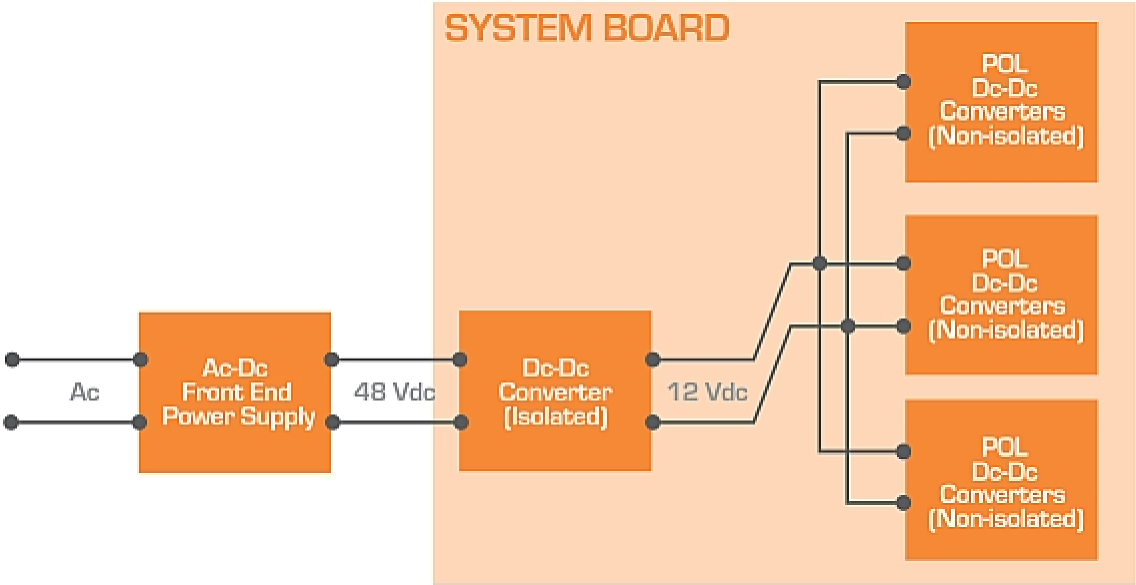

Figure 1 The proliferation of supply rails at the board level has resulted in an intermediate bus architecture (IBA) that requires multiple POL converters on the system board.

The design of the power-delivery infrastructure is becoming increasingly exacting. Multiple power planes are implemented to minimize parasitic inductance and resistance, and there is also demand for large numbers of decoupling capacitors. These must be placed close to the load to provide tight voltage tolerance and ensure stability in the event of sudden load changes. Without adequate decoupling, such load changes can cause voltage rail transients that may then result in undesirable events such as spurious resets. In addition, the power connections must coexist with the signal traces and not interfere with their precision routing designed to ensure accurate control of path lengths for guaranteed timing.

As the constraints on power delivery become increasingly strict, designers need to consider the selection and placement of power modules and associated components at an early stage. Implementing power delivery routing early in the design process enables the PCB traces for power delivery to conform to signal integrity guidelines similar to those used for high-speed signals. Squeezing in the power-distribution circuitry late in the project seldom affords the opportunity for clean power delivery and often results in reduced performance of the product.

Flexibility and future-proofing

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While it makes sense to establish the power distribution architecture early in the project, designers also need flexibility to be able to modify aspects such as POL output power, rail voltages or power-up and power-down sequencing as the system design evolves.

Digital power modules give designers the flexibility they need. Unlike a traditional analog power architecture, which is fixed and can require hardware or wiring changes if modifications are needed, digital modules can be reprogrammed thereby allowing parameters to be adjusted quickly and at low cost (**Figure 2**). Voltage rail sequencing, for example, can be easily configured and reconfigured with digital voltage regulators (**Figure 3**). Digital modules also require fewer external components, and so help simplify design while also relieving pressure on board real-estate.

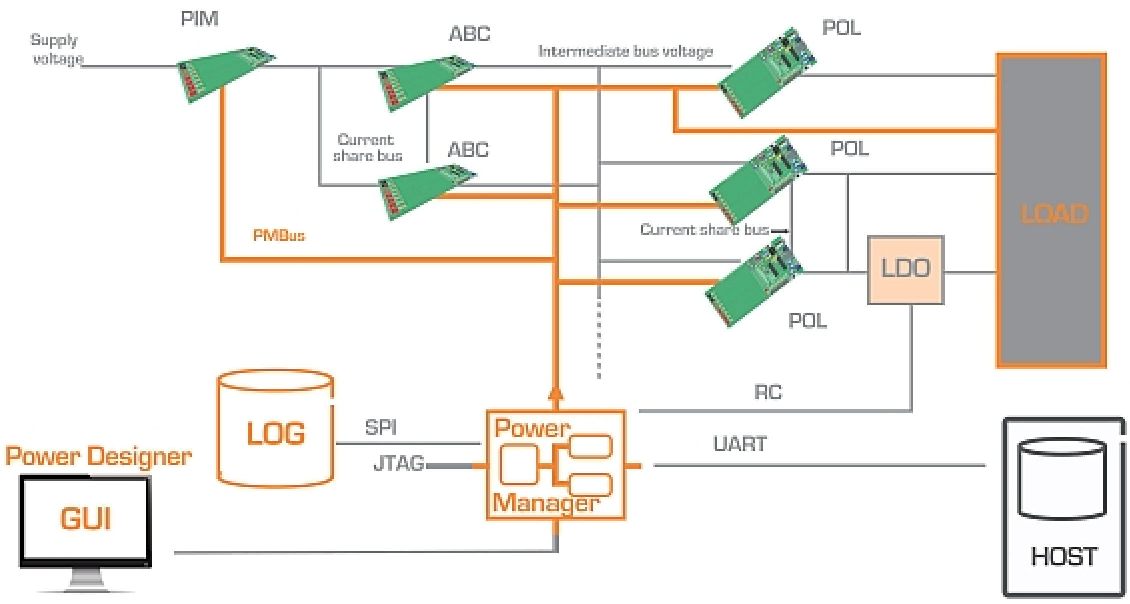

Figure 2 Systems using a digital power architecture are extremely flexible and the site manager can access any part of the board, down to a single POL through the digital interface.

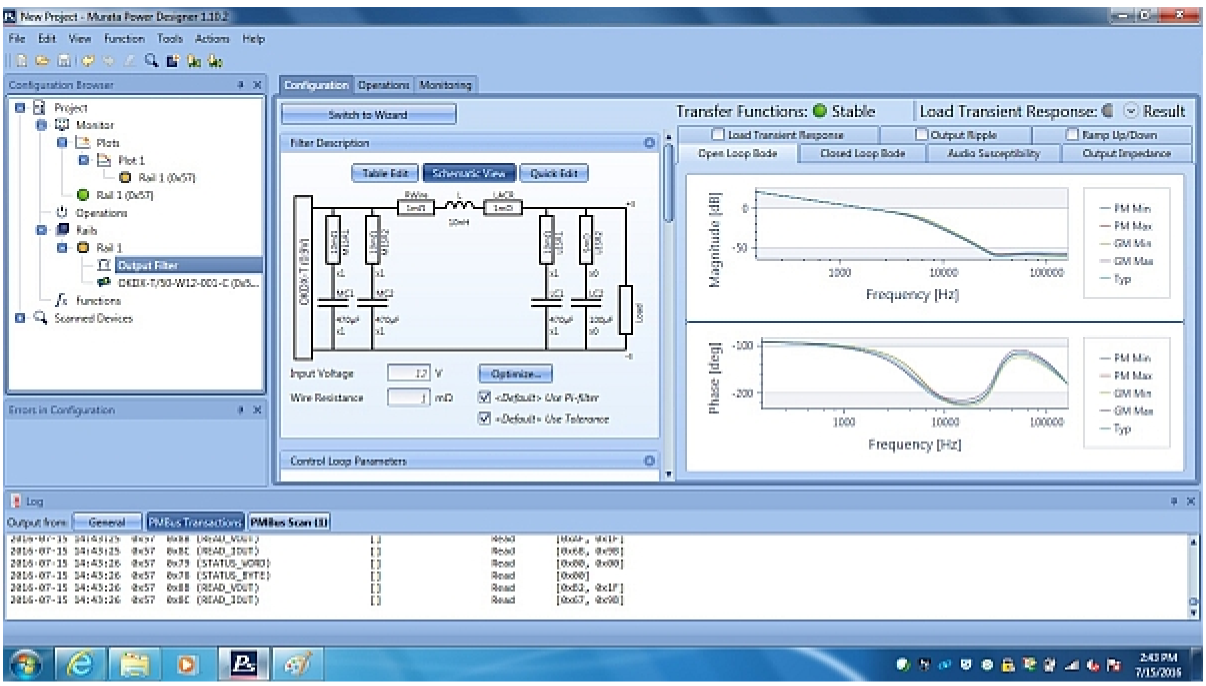

Figure 3 An example of a digital power graphical user interface. Digital power offers virtually instantaneous control of margining, monitoring operating parameters and configuring the supply.

During the course of product design and development it is recognized that changes and upgrades will occur. As has already been discussed, many of the changes and upgrades can be addressed by reconfiguring digitally controlled power modules already designed into the system and thus no physical changes are required to the host PCB or to the power delivery modules. There will be times when a physical upgrade to the original power circuit will be required.

A common reason this situation occurs is that the load current increases beyond the original specifications and thus the need for electrically larger components to supply the additional load current. One advantage of using power modules is the impact of the design upgrade to the complex and expensive host PCB can be minimized. Upgrading a power module to one with a larger output power rating often involves only moving the existing mounting holes or pads and not changing any other design feature on the host PCB.

Moreover, digital power supports an efficient "platform" approach, recognizing that system power demands will become more complicated in the future. Due diligence in decision making is vital, and choosing a power module vendor that can offer a wide choice of products helps not only to simplify changes during the project but also helps streamline the development of future product generations.

Thermal management and efficiency

Thermal management and efficiency

As typical total system power demand continues to rise, it is increasingly critical for engineers to understand how much heat the system will need to dissipate. Although the cooling requirements of high-power components tend to dominate the thermal design, the cost of cooling the power-supply modules should also be considered. Paying attention to power supply design early helps optimize thermal management. In addition, digital modules simplify monitoring of power performance in real-time, which permits on-the-fly adjustment to optimize energy efficiency. Digitally configurable power modules provide additional tools for design, evaluation and maintenance teams to utilize in evaluating and monitoring the thermal health of the system. The power modules can be used to both monitor the local thermal environment and to easily create 'what if' configurations to stress and evaluate the thermal status of the system.

Simplifying digital power

The PMBus specification provides a common language for configuring, controlling and monitoring digital power modules in a power system. The AMP Group (Architects of Modern Power) consortium has simplified the design-in and interchangeability of digital power modules by standardizing the behavior of digital power modules in response to PMBus commands.

The AMP Group was founded in 2014 by CUI, Ericsson Power Modules and Murata. The group has defined a number of specifications for point-of-load converters and intermediate bus converters of various power ratings. These common specifications include performance characteristics and firmware consistency in addition to the traditional mechanical properties such as form factors and pin assignments. These specifications ensure interoperability between comparable modules from any of the member companies and so permit second sourcing. The AMP Group members are delivering products today and will also have new products to meet the needs of future designs.

Conclusion

As the power requirements of high-performance computing and data equipment become increasingly stringent, engineers must engage with the power supply design at an earlier stage of system development. Today's systems require increasing numbers of power rails, and impose exacting demands in terms of sequencing, regulation and transient performance. Maximizing energy efficiency is also increasingly important.

Satisfying these demands calls for careful management of board real-estate and routing resources, but designers also need flexibility to fine-tune the power architecture as the system design evolves. Digitally configurable power modules allow design and development teams the ability to easily configure, control and monitor the power delivery system and the effects it has on the final product. Paying close attention to power design at an earlier stage, and taking advantage of the flexibility provided by digital modules such as POLs and IBCs, is vital in order to meet performance, cost and time-to-market targets.

Also see:

- Power management for optimal power design
- Optoisolation for intelligent power modules
- Power module redundancy
- 10 predictions for the next 60 years in power electronics