Bodo´s Power Systems®

Handling Late Changes in Power System Designs

Providing power to today's electronic systems designs has become a complex and challenging exercise. Stable power, efficiently delivered at the correct levels, is the bedrock on which all other performance parameters rest. The pursuit of ever-more demanding specifications and ever-lower power losses has come to be seen as requiring more specialised expertise. Those working in the power area see some serious problems ahead, and anticipate a need for more engineering resources, for better-qualified and more-experienced power system engineers – and for new approaches to architecting, and implementing the power system design.

By Lev Slutskiy, Business Development Manager, Central/Eastern Europe, Vicor

Not every application area will have the same set of challenges, but it is inescapable that power supply design has become a key expertise, no matter what the end-product.

Seeking real-world opinions

Against this background, Vicor commissioned a survey of power system engineers to sound out their concerns and priorities. It was conducted "blind", to an audience independent of the company's own customer records, to ensure an authentic result. High on the list of issues was meeting performance targets (75% of respondents said so) and as many as 80% said they struggle to meet the allocated timescales for completion of a design.

Perhaps coming as no surprise to those working in the field is that the very notion of the "power system specialist" is somewhat flawed, and that those who describe themselves so, are rather rare; 70% of those surveyed said they spend less than half their time with power design. The survey also indicated that those responsible for recruiting power system engineers are finding it difficult to fill positions.

Very little in the survey indicates that designing a power system in the "conventional" way has become impossible. There is certainly no shortage of components on the market, all promising high levels of performance. This only adds to the dilemma of how to allocate scarce resources; should a project manager (for example) pursue an additional percentage point in efficiency by having an engineer get up to speed with the latest technology: or stay with known techniques? "Keeping up with best practices/new technologies in power design" was listed as a concern by 65% of respondents.

Change notices; a major concern

However, sitting at the top of the list of issues faced by the power system designers, is that of specification changes during, and even late, in the design process; almost 87% of those who replied, said that they struggled to cope with such design changes, which make it even harder to deliver a project on time and on budget.

Changes are most often requested or driven by technical issues, especially when the exact power budget is not known at the start of the project, loads are changed, or restrictions are placed on thermal management due to space restrictions. It is desirable to start the power design as early as possible: the days of it being the last task in the project lie in the past. However, this makes the process vulnerable to changes. External market or competitive forces can also cause revisions to specifications.

A power system that has been designed from the "ground-up" can lack flexibility when its designers are challenged to accommodate changes late in the evolution of the end product. The revision may call for new power semiconductors, or controller ICs: even if the major components remain unchanged, the power system will be operating at possibly different voltage, current and power points, and every aspect of its performance will require verification.

Power design with modular function-level components

A way forward is offered by Vicor using its Power Component Design Methodology (PCDM). This power system design methodology, can provide engineers with a means of not only simplifying the power systems design in the first instance, but also with a route to accommodating changing specifications without incurring significant delays.

PCDM uses dense, easily interchangeable power components, that perform a range of power-system functions at various power levels; come with guaranteed performance figures; and allow changes to be accommodated quickly and easily, either by altering the operating point of a given module, or exchanging it for another.

The Power System Designer (PSD)

The entire methodology is supported by VICOR's Power System Designer (PSD), a powerful, easy to use on line tool, that allows engineers to enter their key power system specifications with the tool offering various architectures and power component selection based on lowest density, highest efficiency, lowest component count and lowest cost. Engineers can then select which of these system designs meets their needs and then go on to simulate their design using additional online tools. A designer embarking on a new power system design needs only to enter the power system's key input and output parameters into the Power System Designer to generate a complete power system design.

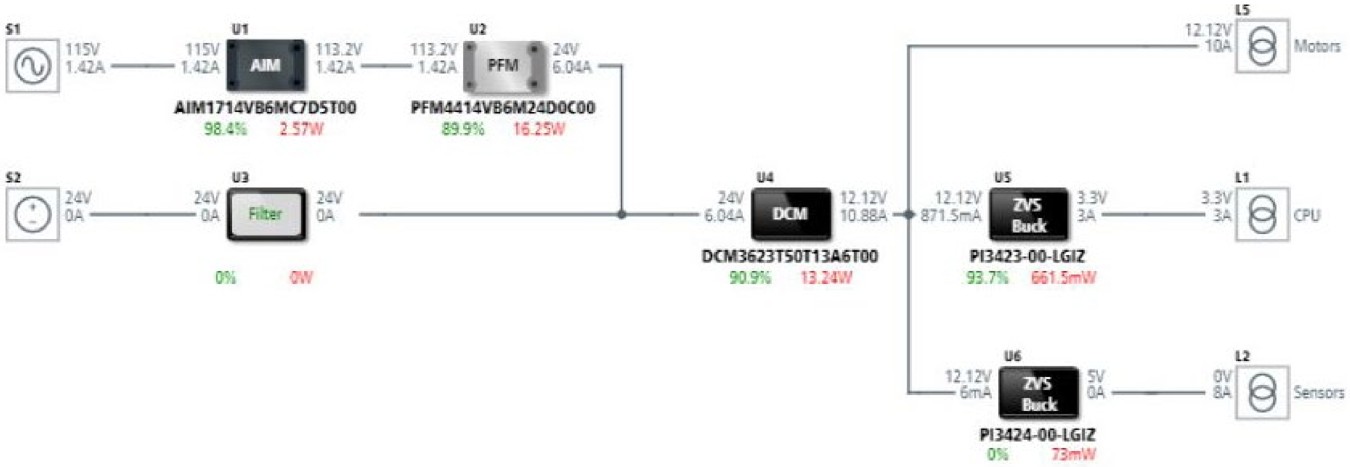

Figure 1: Initial Power System for Robot

Using proven power components with on line tools, increases power system design certainty; it also becomes much easier to accurately forecast the size and performance of power systems developed using this approach and to automatically change the design if new performance parameters are to be met. The following are real world examples of engineers utilizing the PCDM.

Robotics

One design challenge concerned a specialised robot: one that is employed by law enforcement and bomb disposal agencies to remotely inspect and defuse suspicious objects. For a unit that must be transported easily to where it is required, and that can make its way into possibly confined spaces, the smaller and lighter the robot can be made, the better it can perform. To this requirements list, was added the need to operate from AC mains power (universal) if available, or from either internal or external batteries. That is to say, from 115 or 230 VAC, or from 12 or 24V DC. In this case the development team were specialists in various aspects of design of the robotic system, but lacked in-depth experience in implementing a power system design. Their initial solution is shown in Figure 1.

When AC input is in use, the AIM/PFM combination – forms an isolated, AC/DC converter with power factor correction (PFC) providing a 24 VDC output. Alternatively, the 24 VDC supply is derived from batteries – via a filter block. Noise filtering is an important feature; the robot could be operating in an electrically-noisy environment, and it is essential that any such noise, that might disrupt operation, be kept out of the microcontroller and control circuitry. When AC power is in use, the AIM/PFM modules provide this filtering. The DCM module down-converts 24V to 12VDC, that directly powers the robot's motors; two ZVS (Zero Voltage Switching) regulator modules efficiently generate 3.3 and 5V rails to power the robot's control circuits.

This design not only provides a robust and flexible power system architecture: it also dramatically reduces the size and weight of the power system. The solution occupied an area of 66.8 cm², and the use of proven modular components selected by the PSD tool, greatly reduced the design effort., The additional online simulation tools provided confidence that the entire system would operate within design parameters, with good end to end efficiency (80%).

Scientific instrumentation

In another recent project, a design team developing scientific instrumentation found that using the Power Component Design Methodology not only provided an optimized power system, but also helped to quickly accommodate changing specifications. The product under development used two sensors to make measurements for DNA analysis, and had previously been powered by a fan-cooled discrete based power system, which needed to provide 12V, 2.5V and 3.3V rails for the sensors as well as a 2.5V and two 3.3V rails for housekeeping functions. The total power requirement was around 200W.

Initial studies had envisaged a design using discrete devices. Re-casting the design in the Power Component paradigm using the online PSD tool, produced an immediate benefit; the size of the power system was reduced from 161 cm² to 64 cm², a saving of 60%. This was achieved, as set out in figure A, using an AIM, PFM and ZVS buck regulator Power Modules, that allow power system attributes such as level conversion, isolation and regulation. In this example, the AIM Component is providing off-line AC/DC rectification; the PFM block is providing an isolated, regulated voltage of 24V; the ZVS (zero-voltage switching), regulators further step-down to the point of load power rails.

Extra power demanded

During development, however, it became clear that an increase in throughput was required if the product was to remain competitive, and therefore it was decided to increase the number of sensors from two to four. This meant that the current demanded on all three sensor power rails doubled and the total power requirement increased from 200W to 350W, yet the size of the power system had to remain more or less the same.

Fortunately, the engineers at this company were able to use the Power Component Design Methodology to meet this late change in specification. By simply entering the new requirement into the PSD, the tool selected two additional ZVS Buck regulators used for each power rail, as depicted in Figure 3. The sensor power rails are the three outputs shown on the right of the diagram - each regulator for those rails is now a paralleled array-of-two. This increased the size of the power solution by just 6%, to 67 cm². An equivalent discrete solution would have needed 346 cm²: an increase that simply could not be accommodated by the system.

Flexibility: A key element of power system design
The market for electronic equipment, such as the examples in this article, changes rapidly. This means that power system designers can no longer be sure that the specification they receive at the start of the project will not change: in fact, it's likely that changes will be needed. Flexibility to adapt to these changing requirements is now a key element of effective power system design, and something that can be enabled by modern approaches such as the Power Component Design Methodology.

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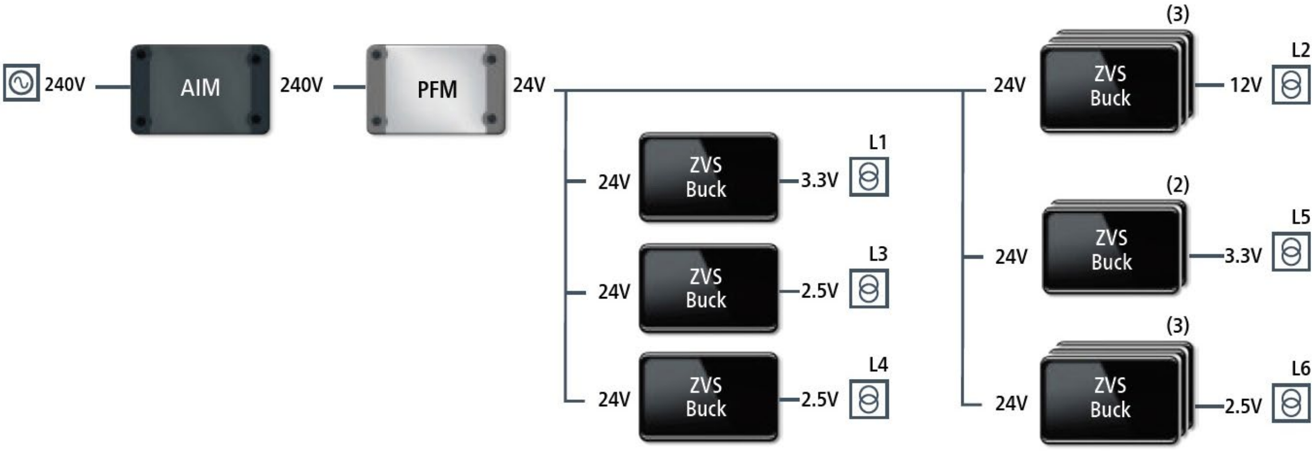

Figure 2: Design solution for the Scientific Instrumentation