Rapid Prototyping of Power Supplies By Programmable Power Modules

It is often overlooked, but the power supply is one of the most essential part of all hardware products. A high-efficiency power supply design directly benefits the overall system cooling requirement, thereby reducing the cost and volume of the final product. A low-noise power solution design ensures that the final products pass applicable EMI standards, such as IEC EN61000. In some applications, such as data transceivers and DAC/ADCs, the performance of a product is highly dependent on the design and noise level of the power supplies. To meet target specifications, power engineers may have to do a complete redesign of the power supply during the prototyping stage. Plug & play digital programmable power modules enable now rapid prototyping of power supplies. **Heng Yang, Sr. Applications Engineer, Monolithic Power Systems, USA**

The design cycle of a hardware system is an iterative process that involves design, prototyping, and verification (see Figure 1). Each iteration adds to the system development cost and time. If specifications of a project changes, a new prototype need to be developed. Besides, modern power management ICs have embedded more features, which increase the complexity in the power stage design and board layout. Consequently, it is not trivial to accurately predict the behavior of a power supply design in advance, considering the complex compensation network and parasitic elements introduced by PCB traces. If the power supply of a prototype fails to meet target specifications, the entire system may not function properly. Realistically, it is often required to modify the power stage. Therefore, a new prototype must be built to improve the power supply design. For example, an original stable power converter may become unstable at a larger load step due to an insufficient phase margin. To stabilize the power supply, the compensation network must be redesigned.

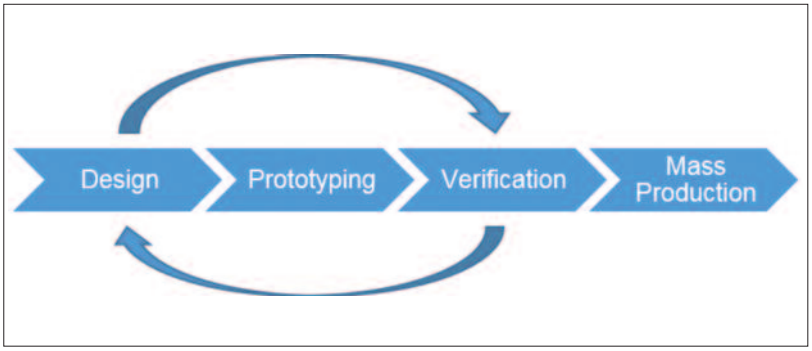

Figure 1: **Iterative hardware system design process**

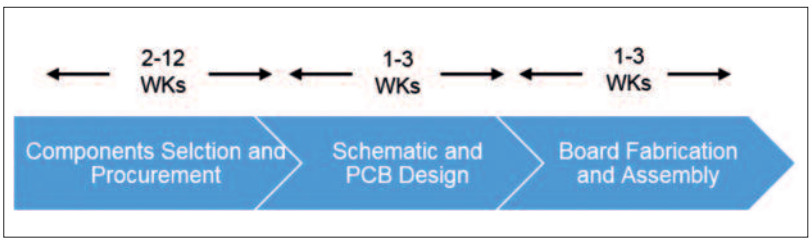

Figure 2: **Steps involved in traditional power supply prototyping**

Rapid power supply prototyping

The prototyping of a hardware system involves component procurement, schematic design, PCB layout, and board fabrication and assembly. Each of the steps below involved in the prototype development can be costly and time consuming (see Figure 2). The lead-time of component procurement can be very long and unpredictable. Complex systems require a wide variety of components. Customized parts and ICs require an even longer wait time?

The schematic and PCB design can be accelerated. However, a fast design service would require a higher price, which adds to the total development cost. Lead-time of board fabrication and assembly also correlate to their cost. A 3-day PCB fabrication turn-time can cost as much as two times a 7-day turnaround time.

As shown in Figure 2, the lead-time of a new prototype can be as long as 18 weeks. This delays the overall project schedule significantly. A rapid power supply prototyping solution can help power engineers control the schedule and budget of the any new product development (see Figure 3).

There are four key features of this solution. The entire power solution is integrated into a single standard DIP/LGA package. The integrated power solution enables cold swap of a power supply and significantly simplifies the PCB design – only the input and output copper planes

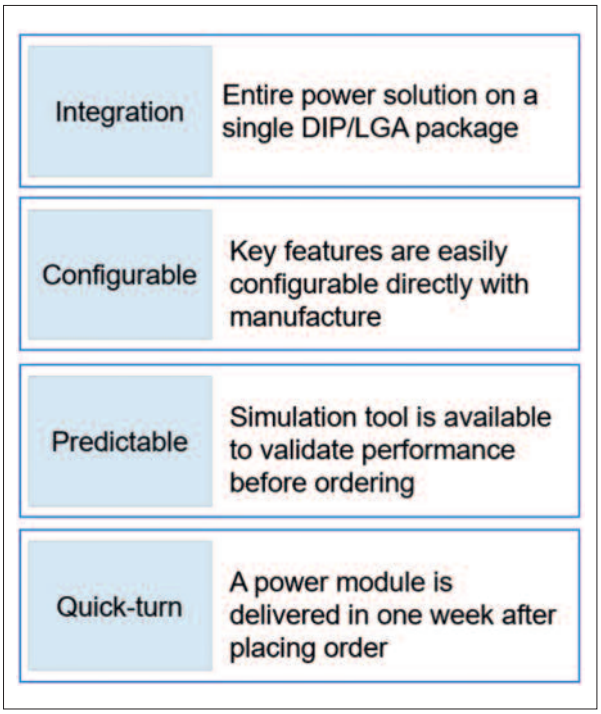

Figure 3: Rapid power supply prototyping solution

are needed. Furthermore, the integrated power solution eliminates the possibility of PCB routing errors. The parasitic elements are well controlled and predicable within the power solution package. Therefore, unexpected power supply behavior due to parasitic elements is eliminated.

The key features of the power supply can be configured online when ordering to satisfy an initial or revised specification. The configurable power solution eliminates the need for a complex power stage and compensation network design. The power supply is optimized by a vendor before shipping to meet the given specifications.

The power solution is modeled precisely. The exact behavior, including stability, output voltage ripple, power dissipation, fault limits, and soft-starting time, can be simulated in advance before ordering. The simulation minimizes the chance of falling to meet specifications.

The last key feature of the rapid prototyping solution is quick turnaround. The customized power solution can be delivered within one week after placing the order.

By employing the fast power supply prototyping solution, a power engineer can shorten the power supply prototype development time by as much as 95 % (see Figure 4). Additionally, the cost of non-power components and board fabrication and assembly are reduced, which reduces the overall cost of product development. The power engineer can leverage an existing hardware prototype by simply swapping the power solution with a new one if only the redesign of power stage is needed.

The process for prototyping development are simplified into three easy steps:

- Configure the integrated power solution online based on an initial or revised specification
- Simulate the configured power supply at rated operating condition to validate the performance of the power supply.
- Replace the power module on an existing prototype with the new one.

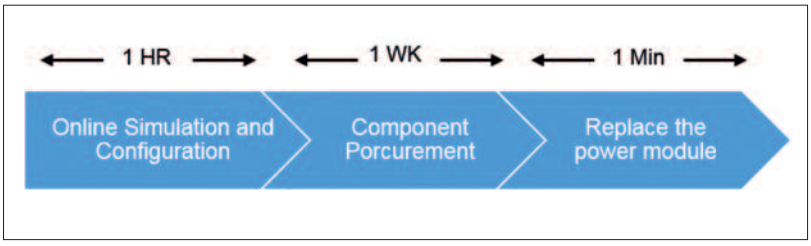

Figure 4: Fast prototyping development

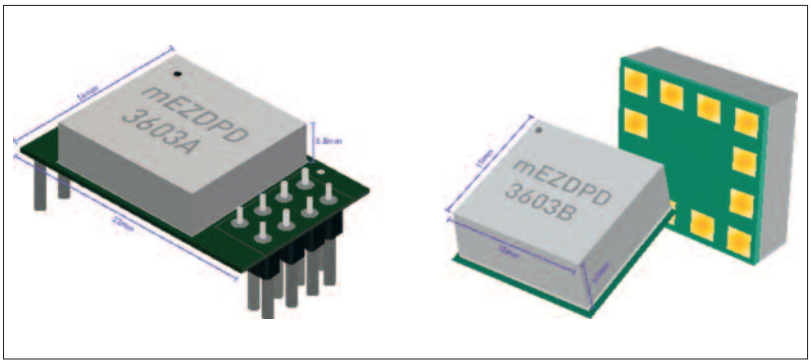

Figure 5: mEZDPD3603 power module with DIP and LGA packages

Field programmable power modules

Monolithic Power Systems' mEZ series of field programmable power modules is specifically developed to meet the rapid prototyping needs. Figure 5 shows an example of an mEZ field programmable module, the mEZDPD3603, which operates at a 4.5 V to 36 V input, 0.6 V to 12 V output, and provides up to 3A continuous current.

These programmable power modules offer three key advantages in system prototyping: They offer a complete power supply in a single package (standard DIP and LGA options are available). Power engineers can replace the entire power solution with a new design by swapping the power modules. They are fully configurable on the MPS website. The output voltage, compensation, switching frequency, output current limit, fault limits, soft-start time, and PWM mode are all able to be customized to customer specifications. The configuration parameters are transferred to the manufacturer after ordering, and the customized part will be delivered to the customer. The mEZ power modules provide a one-time programmable (OTP) memory for applications where an I^2C communication bus is available. When paired with the virtual bench graphical user interface (GUI), the key features of the power modules can be programmed once by customers.

The power supply rapid prototyping is simplified to three steps: Power engineers determine specifications for the power supply, such as input and output voltage, output current, required efficiency, load transient dynamics, and fault protection limits. Simulating the power solution using the web-based simulation tool, which generates simulated waveforms including

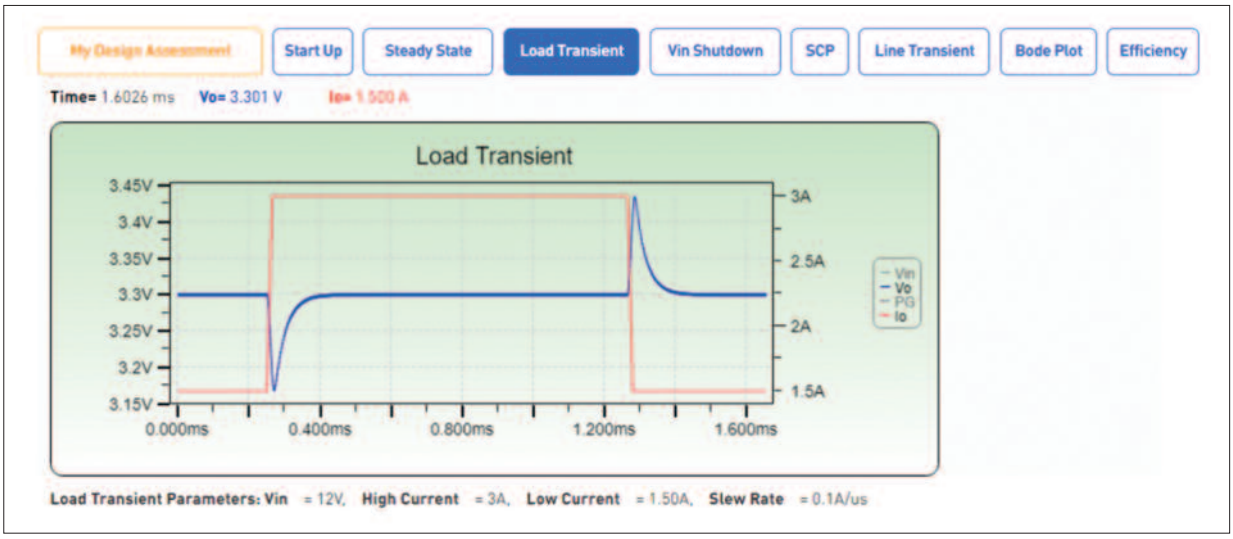

Figure 6: Online simulation tool for mEZ field programmable power modules

start-up and shutdown, steady state, load and line transient, short-circuit protection, and Bode plot (see Figure 6). Power designers can leverage the simulation tool to fully verify the configuration before placing their order to ensure that the performance meets the specification. Once the performance is satisfied, entering the configuration into the system. The manufacturer will ship the customized part to customer.

Conclusion

Power engineers can utilize the power supply rapid prototyping solution to help them deliver a product on time and within budget. The rapid prototyping solution requires an integrated power solution that is swappable on prototype, configurable with the manufacturer, predictable before procurement, and deliverable in a quick turnaround. The mEZ field programmable power modules align with the concept of power supply rapid prototyping. A power engineer can simply configure a power module online to meet their specifications, simulate the power solution to validate the design, and receive the customized part quickly and easily.