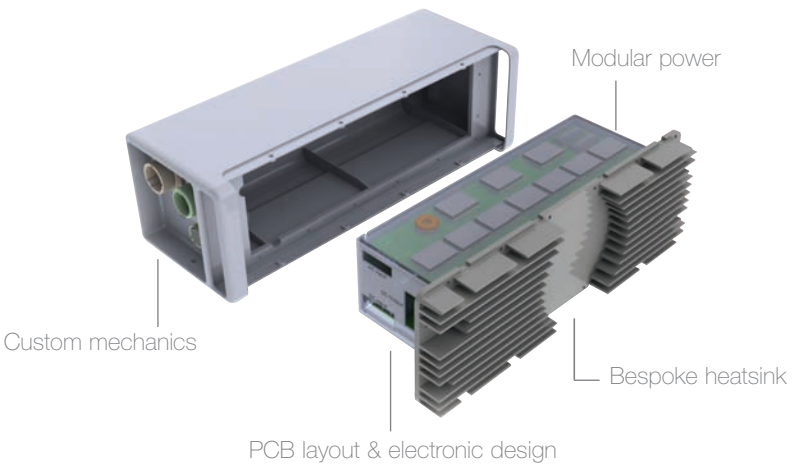
Technical Article

Custom power without custom pain

Despite the best intentions at the outset of an electronic product's design, it's commonplace for the power supply specification to evolve during the process and to only be finalized later on. At this point, it's not uncommon to realize that the remaining physical space cannot accommodate an industry standard power supply, or that such units cannot fulfill other technical requirements.



Obsolescence also creates demand for non-standard power supplies. Power supplies may fail in equipment that is otherwise perfectly functional and economical refurbishment can only be undertaken if a replacement power unit can be found, or developed.

In both of the above circumstances, designing a fully customized power supply in house, or contracting the work to a third party are potential options. However, both routes present technology, cost and time-to-market risks. This is particularly true with grid connected power supplies that have to meet stringent safety and EMC standards in order for the end equipment to meet the requirements of regulatory authorities such as TUV and UL.

The option to create a simple AC-DC input then populate a printed circuit board (PCB) with standard DC-DC modules, sometimes called “bricks”, may look straightforward. But even this apparently simple approach is fraught with challenges. Why else would brick manufacturers offer training courses to help designers define requirements, avoid instability through source impedance control, minimize EMI, ensure effective decoupling, improve load regulation and develop effective parallel arrays? Overcoming these technical challenges takes knowledge, experience, and considerable design time.

A process for creating reliable customized power from standard products

For a growing number of companies, the solution to creating customized power within acceptable time and cost limits is to take the semi-custom route. In other words, using standard building blocks as the basis for power supplies which meet specific requirements with respect to form, fit and function.

As mentioned earlier, doing this in house requires experience and resources. The electrical design must meet technical requirements in the most economically viable way. Electronic design automation tools are then needed for schematic capture and PCB layout, mechanical layouts need to be modeled in 3D and thermal imaging is required to identify potential hotspots. Access to safety and EMI test equipment, and the knowledge of how to use it properly are essential.

The process for designing a reliable semi-custom power supply needs to be the same as that for a standard unit. The typical process adopted by XP Power is shown in Figure 1.

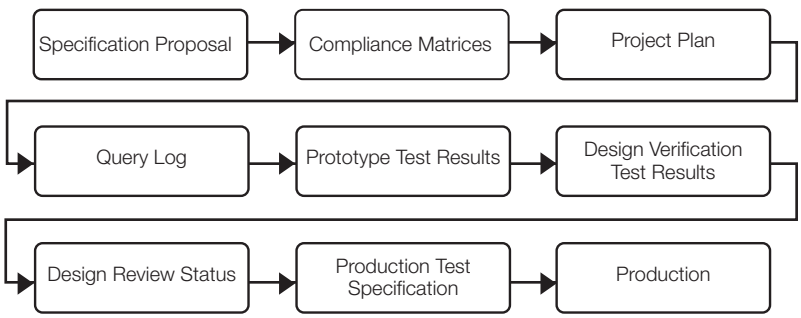


Figure 1: Design and development process for a semi-custom power supply

After receiving a definition of requirements, the company draws up a specification proposal and compliance matrix for its customer. These are reviewed and approved before a detailed project plan is prepared. Design is always an iterative process, so a detailed “Query Log” is maintained to provide a record of decisions taken along the way. Prototype testing is followed by provision of full design verification test results. These include results of temperature cycling and other accelerated aging tests, where appropriate. A detailed design review process is fully documented throughout the development of the product and a production test specification is agreed before it goes into full production. The end result is a customized product that has been created to the same rigorous standards as a standard power supply.

Typical customization options

Customization can be as simple as changing connectors. This might involve just removing a vertical connector and replacing it with a horizontal one. Other simple modifications include customizing covers with different fixings or producing custom wiring looms to reduce assembly time for the end equipment. Some of the most common requirements for more comprehensive customization are:

1. Additional input surge protection. This may be needed where the power supply is going to operate in a particularly demanding situation involving high-energy surges and voltage spikes. The customization may involve creating a surge suppression circuit on a printed circuit board upon which a standard AC-DC power supply is then mounted.

2. Power factor correction. Some companies prefer to manage the DC-DC parts of power system design in-house but do not have the expertise or resources to handle power factor correction (PFC). Standard PFC units may not be suitable, so a customized active or passive PFC module may be developed to fit the form and function needed.

3. Creating a Eurocard form factor. Eurocards are widely used in embedded systems but the range of Eurocard power supplies is limited. Designing a Eurocard to take a non-Eurocard format power supply is a common requirement to give the system designer greater flexibility in the choice of power supply.

4. Eliminating fans. In some applications, fan cooling is not a viable option. As the only moving electro-mechanical part within a power supply, a fan will always represent a weak point with respect to reliability. Furthermore, the need to clean air filters adds a maintenance task. Where equipment operates in remote environments and maintenance becomes expensive, or where particularly harsh operating conditions limit product life, it's often possible to design a standard power supply into a convection-cooled package than can be bolted directly to the equipment enclosure.

5. Integration of batteries and charging circuits. Some applications require integral battery back-up to protect against failure of the main input supply. Here, the power supply will include a charging circuit for the battery and automatic switching circuits, effectively turning a standard power supply into an uninterruptible power supply (UPS).

6. Addition of control and monitoring circuits. Customized control and monitoring can be added to many power supplies and some vendors, including XP Power, have in-house expertise in writing software for these functions. The addition of input and output "OK" signals, temperature sensors and fan speed controllers are popular options.

Example – *a customized power supply for a high reliability application*

Figure 2 shows a customized power supply for a portable, secure, communications modem used in the field. It was developed around three standard, 150 Watt, DC-DC converters, type MTC150. XP Power added a discrete, 600W AC-DC boost converter with active power factor correction, two DC input conditioning modules, a further commercial DC-DC unit to create a 28V bus, and a 300W DC-AC inverter module. The resulting unit has a 28V battery input, a wide-range input of 10-36V DC, and a universal 90 to 264V AC input. The outputs are 28V DC, 12V DC, and 110V AC. The power supply was designed in a low-profile form factor with integral heat sink. This unit is a good example of a very heavily customized product with custom electrical and mechanical elements built around standard modules.

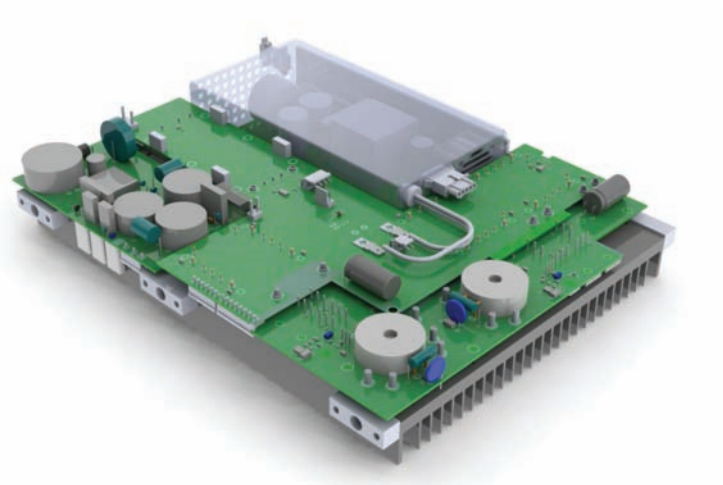


Figure 2: Four DC-DC converters, an AC-DC boost converter with active PFC and a DC-AC inverter make up this uniquely rugged power supply created around standard building blocks

Avoiding problems with agency qualification

Agency qualification (UL, TUV etc.) is required for most grid-connected power supplies. The cost and time taken to obtain qualification for end equipment is an important consideration so it's vital that the risk of failure is minimized. Standard power supplies will have already gone through rigorous approvals processes but it is essential to ensure that customized units have been tested to the same standards. A supplier of customized power solutions must be able to provide test documentation that gives a high level of confidence with respect to agency requirements and customers should expect the same level of warranty on the customized power supplies as would be applicable to comparable standard products.

Time-to-market and economics

The balance of quantity and complexity determines the economic viability of a semi-custom power supply design. Simple changes can be applied to relatively low cost products for quantities in the low hundreds. Large programs involving complex customization are only likely to be viable where the final value of business to the power supply manufacturer is in excess of $50,000.

Full custom power supply design has a much higher economic entry point and few products will see the light of day in less than 6 months. In contrast, prototype semi-custom power supplies can typically be created in 6 to 12 weeks using field-proven, standard building blocks.

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