ULTRA SMALL, HIGH EFFICIENCY POWER SUPPLIES

AC/DC power supply design in the real world

Designing an AC/DC power supply is an essential part of many projects. But it may not be as straightforward a task as it appears.

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If we follow a typical textbook example, the designer will start with the requirements. Of course we need to consider safety regulations, EMI/RFI standards, efficiency mandates, and power factor correction (PFC) in addition to the basic specifications. Medical instruments and other critical applications create their own requirements, such as keeping leakage below a threshold.

So what does it take to design a medium-power AC-DC supply like the XL280 open frame unit from N2Power shown in Figure 1. The XL280's basic specification is: universal AC input (90-264VAC), 280W total power output (12, 24, 48, 54 or 56V), optional active current sharing on the V1 main output, +12V 5As on the V2 output, +5V 1A standby output, and a 12V 1A fan output. All outputs except the +5V standby are remotely controlled and the unit is up to 90% efficient. It has a power density of over 13W/in3 with a 3 inch x 5.3 inch footprint.

Figure 1:
How easy is it to design a universal-input 280W AC-DC power supply like this 90% efficient unit from N2Power?

Undertaking an in-house design involves many factors. First, you need to find the right components. There's a huge range of power supply ICs available, many of which include sophisticated features and algorithms. Some may even support digitally-controlled PWM modules, which allows for dynamic adjustment to respond to factors such as load and temperature. Selecting the right set of components involves making many decisions and balancing trade-offs to ensure compatible interoperability.

Reference designs and development tools from the chip vendors can make life a lot easier – either with a complete reference design, or with a tool which provides the design in response to user-entered specifications. These designs only go so far, however, often not taking into account paramaters such as magnetics and board layout characteristics that can have a significant impact on the supply's performance in the complete system.

While designing a basic supply isn't too difficult, meeting all of the performance and regulatory specifications makes things much trickier. Then the design needs to be qualified. And sourcing the components takes more time and effort.

Problems with power supply design

Instead of designing your own power supply, which requires all of the above issues to be overcome, the alternative is to buy an off the shelf module that's already designed and built for you.

If you are considering which option is best, here are ten reasons why doing your own power supply design may not be the right choice:

1. Defining and sourcing passive components is often difficult particularly in terms of their secondary characteristics. For example, a capacitor's ESR (equivalent series resistance) affects its operation, especially at higher frequencies.
2. Things can go wrong in procurement. If a nominally identical part is substituted by your purchasing department or a contract manufacturer, for example to cut costs, there may be subtle performance changes that cause problems in the field.
3. If you're looking to serve worldwide markets, do you need to do multiple designs? Or create a costlier product that works everywhere?
4. Testing all cases can be difficult, for example to spot any problems due to maximum temperature, transients and high load occurring simultaneously, plus the other extreme circumstances that happen only rarely.
5. Choosing the right cooling, and modelling its behaviour, is difficult. Can you be sure the cooling will be sufficient? If you need a fan, how do you specify which one?
6. If you are using a reference design, it may not be completely accurate – particularly if the chip vendor has relied on a simulation rather than building and testing the actual supply.
7. Even if the reference design has been properly tested, seemingly trivial changes can cause big performance changes.
8. Few projects run to schedule, and designing your own power supply increases the risk of the entire project being late.
9. Reliability takes time to establish, reputations are destroyed in seconds. Wouldn't it be better to buy a proven design?
10. Achieving agency approvals can be a nightmare, with ever-tighter standards and multiple regulatory bodies across different countries.

Custom or off-the-shelf?

There are, of course, some applications that need a custom design. Reasons for this choice could include:

1. One performance parameter is so critical that only a custom supply will fit, since no commercially available unit prioritises that parameter highly enough.
2. Your product's form factor is unusual and nothing physically fits in the space available.
3. You're aiming at a high volume consumer product, so you may be better off making the investment in up-front design to save a little in unit volumes.
4. You have extreme requirements, such as for high voltages, and no suppliers can meet your needs – although they may provide something you can modify.
5. Your requirements are looser than off the shelf supplies, so a low-cost design does the job. ■

Decision Factors for In-House AC-DC Power Supply Design

Advantages	Disadvantages
Optimized product	Component sourcing time and cost
Opportunity for differentiation	Inventory management time and cost
Lower cost (in very high volumes)	Design time and cost
	Design risk
	Manufacturing management time and cost
	Thermal modeling time and cost
	Test time and cost
	Agency approvals time and cost
	Reliability not field-proven
	Time-to-market risk

Figure 2: The 'make-or-buy' decision factors