High-powered medical devices present power-supply design challenges

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Thermal management, audible noise minimization, and safety/EMC must be addressed as power levels increase

The medical industry prides itself on designing leading edge medical electronic devices capable of offering solutions where, historically, electronic devices have not previously been available for use. For example, mechanical/chemical devices are now being replaced by electrical/mechanical/chemical devices with higher performance and higher precision capabilities than ever before and new electro-mechanical devices are being introduced for the medical market that requires higher power. These exciting trends place great pressure on designers and manufacturers of the AC/DC medical power supplies that are needed to power these new products.

High power medical AC/DC power supply design requires careful consideration of many important factors, three of which are discussed here:

- Thermal management
- Audible noise minimization
- Safety/EMC considerations

These three factors are not limited to high power medical devices, but are more difficult to address in power supply design as the power levels increase.

For the purpose of this article, I will define “high power” to be a range of 400 W to 1000 W since this is typically considered a range where designers of medical devices are seeking an “off the shelf” power supply that is designed and built to address many different applications in the general medical market and their associated end products. There are other medical products where more ‘custom’, application specific power supplies are needed, which are not discussed in this article.

Thermal management
The first, and probably the most challenging, parameter in high power medical power supply design is thermal management. As power increases, heat increases. This needs to be addressed in two different ways, one to minimize the heat generated and then, the second, to manage that resulting heat through various techniques.

Thermal management – minimizing generated heat. Minimizing heat generation starts with making the power conversion as efficient as possible. Remember, we are not ‘supplying power’ here, we are ‘converting power’. When power is converted from one form (AC) to another form (DC), there will inherently be losses in the process. The challenge is how to minimize these losses.

Audible noise and EMC/safety certification considerations
Audible noise is a key consideration in medical devices, since they are typically used in a clinical environment where noise is not tolerated. High power medical devices are difficult to design without the need for cooling fans for the AC/DC power supplies. The goal is to reduce and keep the audible noise to a minimum. Achieving the highest possible efficiency minimizes the heat generated that the fan has to remove. Intelligent control of the fan reduces audible noise because the fan operates only during the times when needed by the circuitry.

The remaining topic for this article is the Safety/EMC Considerations. As the new EN60601-1 3rd edition is in force throughout Europe, and soon will be in North America, the criteria of MOOPs and MOPPs (Means of Operator Protection and Means Of Patient Protection) makes new power designs more challenging than before. One of the main safety goals in AC/DC power supply design, and a requirement of 3rd edition, is to maintain isolation between the AC input and any patient or operator that is using or is attached to the output DC voltage. For high power AC/DC converters, this becomes more difficult when safety spacing and failure mode simulations become more stringent. Techniques used to satisfy these safety requirements may adversely affect other performance areas such as EMC.

For high-power medical power supplies, it can be difficult to optimize ALL of these factors/parameters. Frequently, design tradeoffs are made between them, to meet the required safety requirements and maintain efficiency goals, while realizing market driven cost goals.