How modular and configurable power supplies can help engineers streamline power system design

In many applications, design engineers require multiple-output AC-DC solutions for their end equipment. Depending on the number of outputs required, there are three main options: multiple, single-output AC-DC power supplies, a distributed power architecture (DPA), or modular and configurable power supplies. In this article, TDK-Lambda explores the technical aspects of using each option and the key advantages and disadvantages.

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Multiple, single-output power supplies

Using multiple single-output AC-DC power supplies seems like a straightforward approach, see **Figure 1**. It is relatively easy to source and purchase standard single-output units from a wide range of suppliers, and the upfront cost of buying them is potentially low compared to more complex solutions.

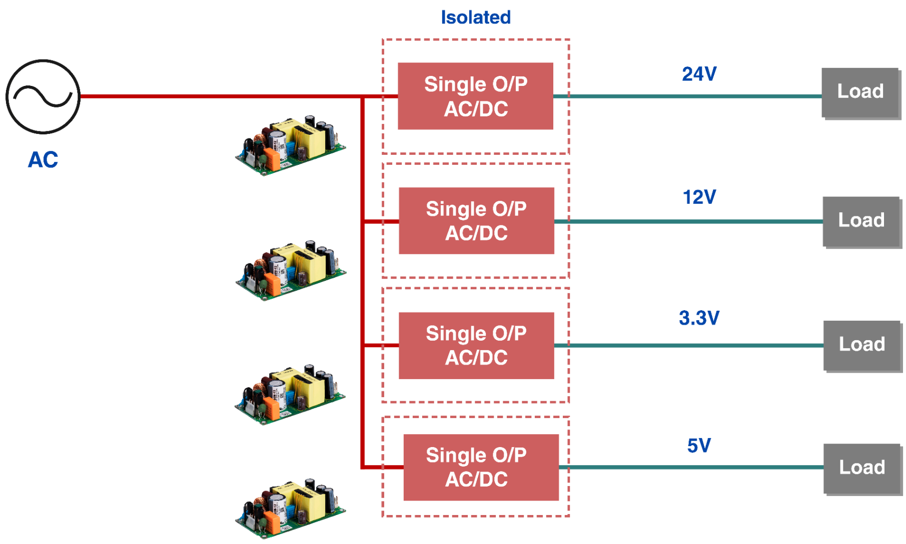

Figure 1: Block diagram illustrates a power system using multiple, single-output power supplies

However, multiple units will inevitably take up more space than a single, multi-output unit – a critical limitation in space-constrained applications. In addition, each power supply generates its own heat, and managing the thermal output of multiple units in close proximity can be challenging, potentially requiring additional cooling solutions, such as heat sinks, cooling fans or both.

With multiple units operating simultaneously, there is also a risk of electromagnetic interference (EMI). EMI can affect the performance of the equipment, reduce power quality, increase noise levels, interfere with other devices, and reduce efficiency. If not kept in check, EMI can also complicate compliance of the end equipment with international EMC standards like those from the International Electrotechnical Commission (IEC).

In medical applications, in particular, the sum of earth leakage currents from multiple units can exceed safety limits, generally 500µA, making this approach less viable – even if each single-output power supply is medically certified. As power supply manufacturers mainly specify their medically-certified units with an earth leakage current of around 250µA, at best, you are limited to using only two of them in your system design. However, a few single-output power supplies on the market go beyond that 250µA specification. For instance, the CUS250M power supplies from TDK-Lambda have an earth leakage current of less than 150µA, enabling you to use three of them in your power system.

There is also the cumulative inrush current to consider, which can pose challenges during installation and potentially require specialised circuit protection or power conditioning. Indeed, wiring, especially for the AC input, becomes more complicated and cumbersome, increasing the risks or errors during installation and maintenance. Each additional unit introduces potential failure points, which reduces overall reliability. During production, managing stock for different part numbers can complicate logistics and increase the risk of stockouts or delays.

Distributed Power Architecture

Distributed power architecture (DPA) is an approach to power supply design that separates the AC-DC conversion process from the DC-DC conversion closer to the point-of-load, see **Figure 2**. This method can offer several benefits for design engineers, especially if only a couple of extra outputs are required. However, like any design choice, DPA comes with its own set of advantages and disadvantages.

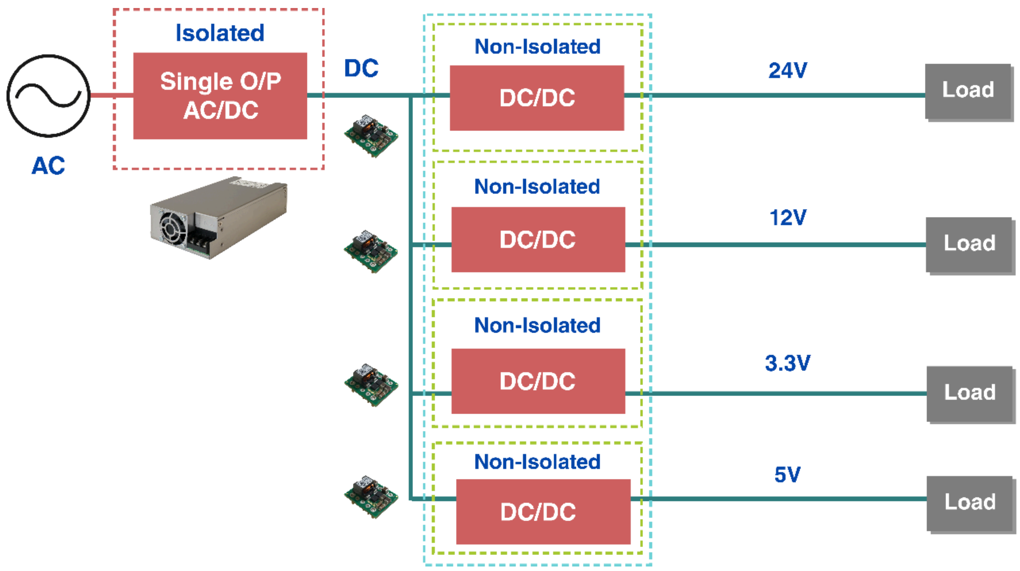

Figure 2: Block diagram illustrates multiple loads supplied using a distributed power architecture (DPA)

Initially, DPA can be more cost-effective in terms of buying cost. By using a standard AC-DC converter and distributing DC power where needed, designers can leverage economies of scale and reduce the cost of the overall system. It also allows for greater flexibility in the design and mechanical layout of the system. Since DC-DC converters can be placed closer to their loads, engineers have more design freedom in arranging components within the equipment, potentially leading to more efficient use of space and better performance.

This DPA approach also facilitates scalability and modularity in design. Engineers can easily add or remove DC-DC converters to match the specific power requirements of different parts of the system without redesigning the entire power supply. However, as the output power required on secondary outputs increases, their mechanical and thermal integration becomes more critical. Ensuring adequate cooling and mechanical stability for high-power DC-DC converters can be challenging, especially in compact designs.

Implementing DPA requires a team capable of integrating various components across one or more PCBs. This demands a higher level of expertise in electronic design, including an understanding of power management, EMC considerations, and thermal management. The onus is on the engineer to arrange for full EMC testing and compliance, as well as thermal testing. These additional steps can add significant time and cost to the development process – in terms of 'EMC chamber time' and extra 'engineering time' – especially for complex systems in medical equipment with stringent regulatory requirements.

As with multiple, single-output solutions, the DPA approach necessitates sourcing various components and possibly managing external Electronic Manufacturing Services (EMS) suppliers. The result can be a more complicated supply chain and increased management overhead costs. Also, if galvanic isolation is needed between different parts of the system, isolated DC-DC converters are needed, which are typically larger and more expensive than non-isolated ones, diminishing the cost advantages of DPA.

Modular or configurable products

Employing a modular or configurable power supply is an appealing option for engineers seeking a versatile, off-the-shelf solution for their system design needs, see **Figure 3**. They are generally more compact than an equivalent solution comprising several single-output units. This space-saving attribute is particularly beneficial in applications where real estate is at a premium.

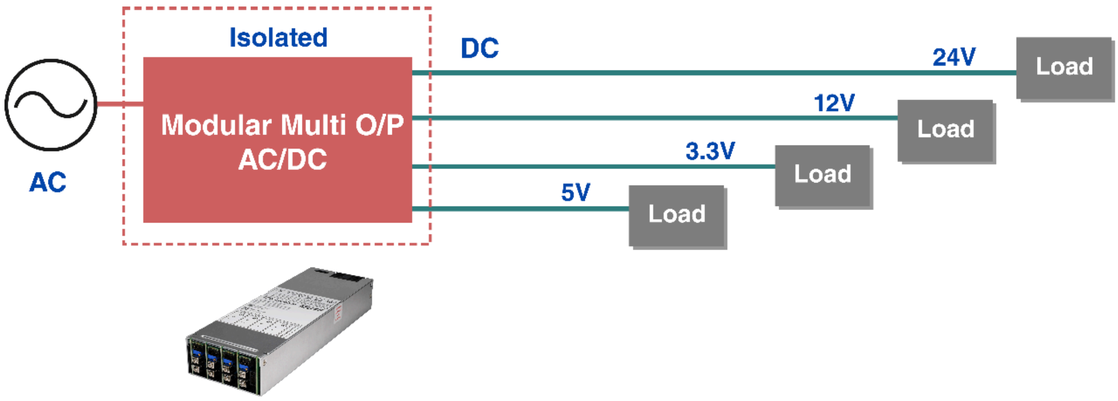

Figure 3: An off-the-shelf modular, multi-output power supply like the TDK-Lambda MU4 series can supply up to five loads

Another benefit of using a modular or configurable power supply is that it does not require a deep technical understanding of the product or the maintenance of specialised R&D and safety departments. It comes with full safety certification, known EMC performances, and specified earth leakage current values. The compact TDK-Lambda MU4 series, for instance, can provide up to five outputs and features full means of patient protection (MOPPs) isolation, including output to earth, to simplify implementation into body floating (BF) rated medical applications. These attributes significantly reduce the time and resources needed to ensure the end equipment meets stringent regulatory requirements. Additionally, these units produce very low audible noise, enhancing the user and patient experience.

Both modular and configurable power supplies are designed to be adaptable, allowing for customisation according to the specific needs of the end equipment. This plug-and-play approach facilitates easy installation and cabling, reduces setup times and simplifies future maintenance, making it particularly attractive for smaller teams or companies looking to streamline their development processes.

Going that one step further, TDK-Lambda's Quick Product Finder is a simple-to-use online tool that automatically produces an optimised module selection after filling in the desired output voltages and currents. In addition, as the specified power supply will involve only one part number, inventory management is significantly more straightforward. It can also reduce logistical complexity and storage requirements, translating into cost savings and improved manufacturing efficiency.

Conclusion

While opting for multiple single-output AC-DC power supplies might seem cost-effective and straightforward at first glance, the long-term implications on size, thermal management, reliability, and compliance can significantly detract from the perceived initial savings. Exploring integrated multi-output AC-DC solutions is often the more prudent approach for applications requiring a high-quality, reliable, and compact power solution, especially in sensitive or high-performance environments like medical or industrial applications.

On the other hand, DPA offers a flexible and potentially cost-effective approach to developing multi-output AC-DC solutions. However, it demands a high level of power system design expertise and comprehensive testing to ensure reliability, compliance, and performance. The choice to use DPA should be based on a careful consideration of these factors, balanced against the specific requirements and constraints of the end application.

Modular and configurable power supplies offer a compelling solution for engineers looking to balance the demands of power delivery, certification, and ease of integration in their projects. They provide a streamlined path to compliance with safety and EMC standards, simplify inventory and logistics, and make power supply integration accessible to teams without deep technical expertise.

Whatever power system design approach you decide to take, it is strongly recommended that you contact your supplier for advice and guidance. The manufacturer of the power products, and even its distributors, will likely have insight and experience developing a similar system design.

For more information about power supplies from TDK-Lambda, please visit:

www.emea.lambda.tdk.com/medical

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