

A New Category of Rugged, Fanless Power Supply

New approach meets large-load requirements at high ambient temperatures for industrial, medical, and outdoor applications.

Introduction

There is growing demand for fanless power supplies that can provide high usable power at elevated temperatures with some environmental protection. The common approach of enclosing a standard open frame unit forces OEMs in to making compromises in their designs. By rethinking this challenge and considering the requirements from the start of a power supply design project, it is possible to create cost-optimized power solutions for a wide range of applications, such as:

Outdoor Applications

- Lighting, signage and billboards
- Communications towers
- Remote monitoring devices
- Security cameras
- Military satellite communications terminals

Indoor Applications

- Clean room or medical equipment
- Surgical beds
- Dialysis machines
- Home diagnostic equipment
- Event and studio lighting equipment for stage and film
- Cash handling machines and ATMs

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A NEW CATEGORY OF RUGGED, FANLESS POWER SUPPLY

There is a category of application which has been poorly served by catalogue standard AC-DC power supplies. These applications combine wide ambient operating temperatures with a requirement for a rugged, reliable power supply. Often the application requires high usable power at elevated temperatures with no derating. In other cases, some level of dust/liquid ingress protection is a must and requirements for reduced or eliminated acoustic noise are becoming more common. Original equipment manufacturers have struggled to find a cost-effective solution for these requirements, so tend to 'make-do' with commercially available products, that compromise on one or more of their requirements, or assemble a solution using multiple component parts, adding cost and complexity.

A new category of power supplies that use conduction-cooling techniques, which are commonly found in DC-DC power converters, but are now finding their way to AC-DC power supplies, could be the answer. The LCC series from Advanced Energy's Artesyn Embedded Power is not a standard open frame unit retrofitted with new mechanicals and an enclosure as a 'make-do' solution. Artesyn has designed the LCC series from the beginning to be both enclosed and fanless. It has been optimized for conduction cooling with wide operating temperature range at full rated power.

For example, the challenge particularly affects designers of outdoor applications, such as exterior lighting, signage and billboards, communications towers and remote monitoring devices. This equipment, together with the power supply, can be exposed to tough outdoor conditions. Avoiding the use of fans in the system can be beneficial, provided other cooling alternatives are employed. Due to the fact it is an electromechanical component, the fan can significantly lower the

equipment's useful operational life and the cost/disruption required to replace worn out fans is prohibitive to end users on some applications. Unexpected downtime can result in large financial losses for end products such as advertising billboards where revenue is tied to the display time and the cost of repair on applications like communications masts or pipeline monitoring cameras - especially in remote or awkward locations - is high.

In fact, the Artesyn LCC600 has been adopted in several RF base station applications, electronic billboards and overhead LED signs on highways. Its 250 watt cousin, the LCC250 is powering outdoor security cameras and military satellite communications terminals among other applications. In fact, the LCC250 series meets the MIL-STD-461 standard for EMI and the LCC600 series can meet the specification using an optional external filter, making these power supplies ideal for military COTS applications. Compliance is verified by an external authority, giving designers the confidence to integrate these power supplies in their end products. The -40 °C to +85 °C operating temperature with no power derating, IP64/65 enclosures and conduction cooling construction makes them a viable outdoor power supply.

INDOOR APPLICATIONS

Fanless operation is also ideal and beneficial for indoor environments. Aside from improved operational lifetimes, the absence of fans in the power supply allows for silent operation. For indoor signage and the office environment, this can be desirable as it helps minimize ambient noise.

In the case of clean room or medical environments, the absence of unwanted airflow minimizes the circulation of controlled particles, contaminants and microbes.

The Artesyn LCC600 has been adopted by manufacturers of surgical beds and dialysis machines as well as home diagnostic equipment, where the noise from a fan can be as critical a design decision as the need for a sterile environment. This is in addition to the conduction cooling construction of the LCC series and the IP rated enclosure, which protects the units from accidental exposure to dripping liquids or the cleaning required for infection control.

Noise was also an issue for a manufacturer of event and studio lighting equipment for stage and film. While they wanted a power supply that matched the reliability of their own system, they also couldn't have fans running during filming or music recording. Similarly, the LCC600 series is used in audio mixing desks, where reliability is critical to revenue and the noise of fans or interference from EMI can cause problems in a recording studio or entertainment venue.

One customer, a manufacturer of cash handling machines and ATMs, has very little air circulation inside its equipment and cannot afford to have paper residue contaminants sucked into a power supply. Filters on a fan were an option, but filters have to be cleaned and that introduces a maintenance challenge to the OEM.

THE CHALLENGE

Most system designers facing this problem are working in highly competitive markets and with small- to mid-volume production runs: for them, the luxury of specifying a custom power supply is not financially realistic. To keep materials costs low, these systems must use a reasonably priced standard power supply.

The lack of availability of optimized off-the-shelf power supply solutions that cater to this category of applications makes it challenging for system designers. The available 'make-do' power solutions can result in undesirable trade-offs, such as:

- Limited system operating temperature range
- Poor power delivery at elevated temperatures
- Undesirable noise from fans and the reliability implications

Compensating for these trade-offs can prolong the project development and exceed internal cost targets.

The problem, then, is how to deliver a low-cost, ruggedized power supply which can operate at full power at high temperature, but without requiring a fan.



Fig. 1: A new category of AC-DC power supplies, such as Artesyn's enclosed LCC250 and LCC600 series, is optimized for conduction cooling and fanless operation up to 85°C baseplate temperature

In this type of power supply, the aluminum baseplate serves as both the mounting point to the host device and thermal interface for conduction cooling. The power supply therefore needs to be mounted to a thermally conductive surface – normally this will be the metal case or cabinet of the host device. This metal surface then serves as a large heat sink to transfer the heat dissipation away from the power supply.

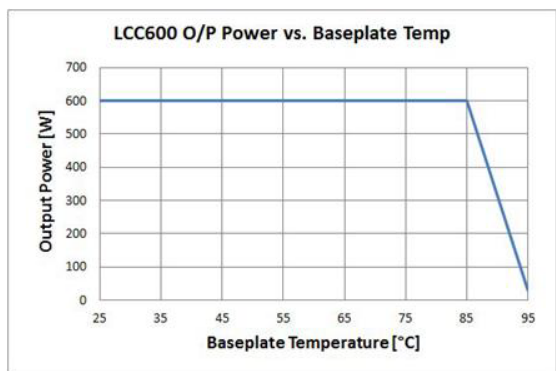


Fig. 2: Typical output power vs. baseplate temperature curve showing full rated power delivered up to maximum baseplate temperature

The LCC series was designed from the outset for fanless and conduction cooling operation. This required optimization of the thermal path from components to the thermal interface (the base plate). So the layout of the unit’s circuit board is designed to provide direct thermal coupling between the power supply’s hottest components – such as MOSFETs, rectifiers and magnetics – and the base plate. In other words, the board layout is not optimized for cost or ease of assembly, as it would be in a standard open-frame power supply unit, but for optimum thermal performance.

In addition, an effective thermal path from other components which are not directly coupled to the base plate is provided by potting the enclosure with thermally conductive compound. As a result, the thermal resistance from components inside the unit to ambient air is far lower than in a ‘make-do’ ruggedized (enclosed) standard open frame unit. This approach offers full power operation supporting a 250W or 600W load right up to 85°C baseplate temperature, and down to -40°C.

By comparison, standard mid- to high-power supply units typically offer full power operation up to just 50°C, and heavily derated operation up to 70°C. Many power supplies offer just 50% of power at 70°C. At the other extreme, standard units typically only operate normally down to -20°C.

As an alternative to today’s normal procedure of enclosing a standard open-frame unit, the new category of power supplies offers markedly superior power output and operating temperature range, while offering a moderate degree of ruggedization. Full potting enables a level of mechanical ruggedization that is difficult, perhaps impossible, to achieve by enclosing a standard power supply.

CONCLUSION

Through careful design of the thermal pathways inside the power supply unit from the start of the design project, it is possible to produce an AC-DC power supply that can operate at full power over wide operating temperature ranges, and with no requirement for forced-air. The LCC series provides cost-optimized power solutions for these harsh applications adding more product choices for system designers.

As an alternative to the common approach of enclosing a standard open-frame unit, this new category of power supplies offers far superior performance and reliability in applications which require moderate ruggedization, at comparable cost.

More information is available from Artesyn:

<https://www.artesyn.com/power/power-supplies/cat/141/conduction-cooled>

KEY FEATURES OF THE ARTESYN LCC SERIES

Fanless: No acoustic noise

- Ideal for noise-sensitive applications

Fanless: No fan wear-out

Suitable for long life applications

Suitable for low maintenance applications

IP (64,65) options

- Robust to dust & moisture
- Ideal for outdoor applications
- Ideal for dusty environments

6-sided metal enclosure

- Simplifies system EMI design
- Radiated EMI easier controlled

Military EMI Filters

- LCC250 meets MIL-STD-461
- LCC600 meets with filter option
- Ideal for military COTS applications



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ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. We design and manufacture highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

PRECISION | POWER | PERFORMANCE

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