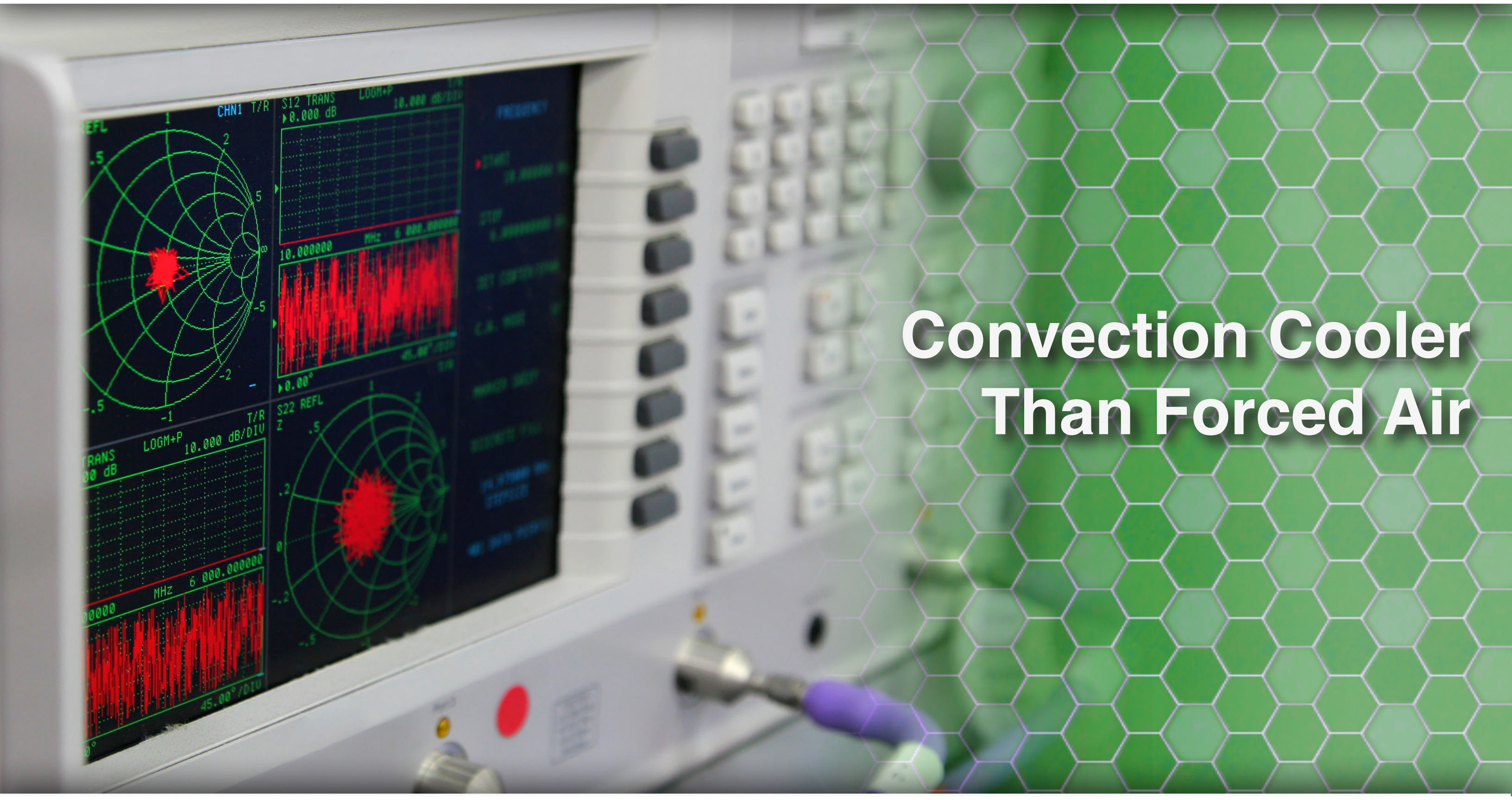

# Convection Cooler Than Forced Air

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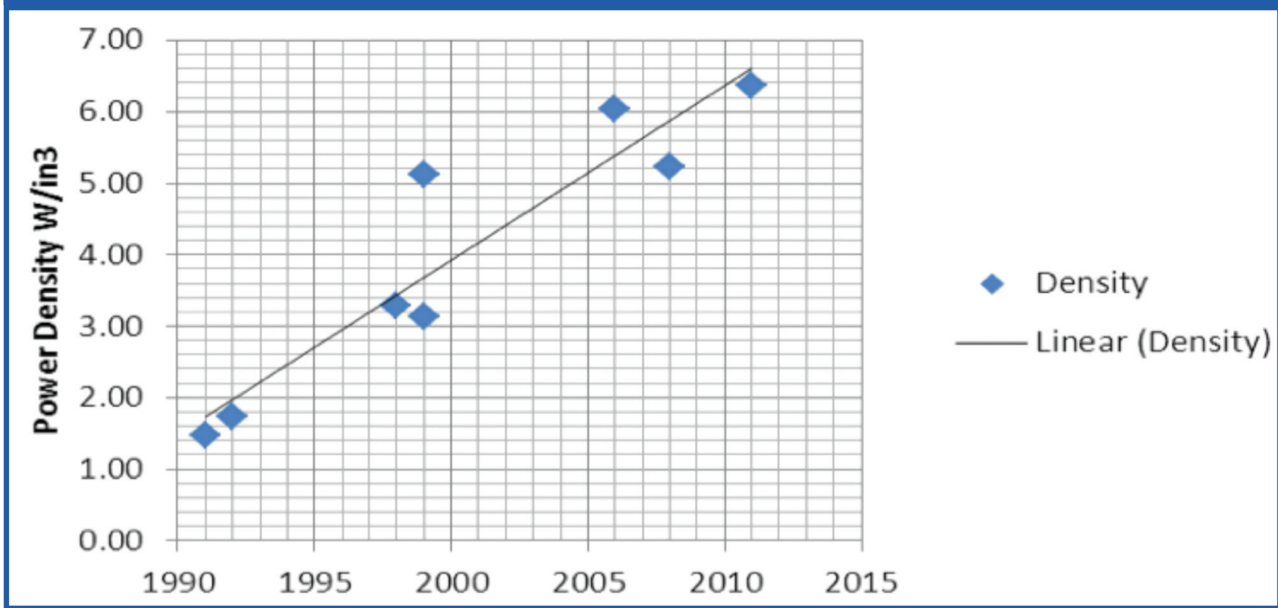
The advancement in the electronics industry puts never ending pressure on power supplies to be smaller, more efficient and lower cost. The power supply manufactures have responded in creative ways to try to accommodate these desires.. Power supplies have become more efficient and smaller thus having higher power conversion density. Pushing power density is achieved using higher switching frequencies, efficient conversion topologies and forced air cooling. However, there are always trade-offs with improvements. Understanding the implications of the trade-offs leads to better decisions and proper selection of a power supply for your application. This paper outlines the merits and drawbacks of these advancements with emphasis on power derating for convection cooling.

Higher switching frequencies and low loss conversion topologies have emerged as leading methods to reduce component size and power losses. The higher switching frequency allows the main power transformer and output filter to become smaller. However, given all else being equal, along with the higher switching frequency comes higher power conversion losses roughly proportional to the switching frequency. To overcome this benefit neutralizing fact, alternate power conversion topologies can be adopted which significantly reduce switching losses and allow improvements in both conversion efficiency and component size.

To understand better the advancement made in power conversion density, we can see from figure 1, the power density trend at SL Power Electronics over the past two decades. It is important to note this is for convection cooling, not forced air cooling. Force air cooling can double or triple the power conversion density ignoring other size limiting performance criteria such as energy storage for line dropout - hold up time, connectors and mechanical requirements.

**SLPE Power Density Trend - 40 - 150W**



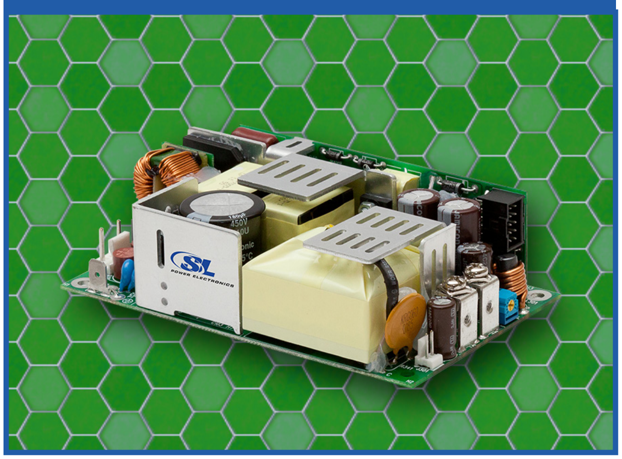
As mentioned previously, to achieve the higher power conversion density, especially for convection cooling, power conversion losses must be reduced. The higher efficiency obtained has many benefits, most notably, less heat to be dissipated and cooler components. Component temperature is one of the most important factors in achieving high reliability and long product life. A reduction of 10°C will approximately double the life of electrolytic capacitors for example. Higher efficiency also reduces operating costs and although this is not a direct benefit to the power supply manufacturer, it is to the end user. Higher efficiency reduces the losses in the power supply but also reduces the amount of cooling required in building air conditioning systems. This is not evident considering one particular power supply but in a facility with many hundreds of units, it all adds up and can be a significant contributing factor to the building utility costs.

To ensure adequate service life and avoid premature product failure or malfunction, the power supply output rating must be reviewed carefully. Good design practice follows a 20% derating in output power to account for unforeseen load increase, margin for transient response and excess operating temperatures above the norm that could occur and to expend product MTBF and life. That being said, understand there can be a very significant power derating with temperature and cooling method. Many products on the market are comparable in output power ratings of similar size or power density but reading the notes and fine print in a datasheet exposes the differentiating conditions. Forced air cooling is quite effective in removing heat and allows significant decreases in power supply size. Conversely, convection cooling is limited by the physics of natural convection currents caused by expanding air molecules displacing cooler molecules and flowing up into the local environment. This places restriction of the system thermal design compared to forced air cooling where air can be directed in any direction desired. However, forced air cooling has many disadvantages also; while–convection cooling is often the first choice. So it is wise to review the product specification to fully appreciate the amount of power derating you may need to apply when selection a power supply for an application using convection cooling.

For the industrial, test and measurement market segment, SL Power Electronics has developed a cost effective and highly efficiency power supply capable of 180 watts while in a convection cooled environment.

Convection cooling has significant benefits in some markets. There is an inherent simplicity in design for the applications, just requiring some provision for natural heat flow to the ambient, often achieved by adequate venting on the system chassis. Compare this to a forced air cooling

**SL Power CINT1275**



environment, a cooling fan is required to push or pull air at higher velocity through the enclosure and over the power supply. This can present some challenges to ensure adequate air flow is moving over the hot components and not by-passing them. The additional cost of the fan and perhaps speed control of the fan to aid in acoustic noise mitigation should not be forgotten. The acoustic noise of the fan can be a significant impediment to market acceptance of the end product. Experienced system designers and product managers are well aware of the negative view of fan noise. It can be very distracting in an environment where people are working or communicating.

Other considerations of forced air cooling are the possibility of dust and other contaminants being drawing into the power supply and reducing cooling efficacy and possibly premature failures. Air filters can help mitigate this, but then there is the extra cost of the filter and maintenance to clear or change the filter. Also, fans are one of the highest failure rate items due to their limited life. The most common failure mode with fans is dry-out of the bearing and loss of speed or locked rotor due to the degradation of the bearing lubricant. This can be a significant disadvantage in products intended for long service life ( ~ > 5 years). In some cases, it is the best alternative; however, having a power supply with a high output convection rating such as the SL Power Electronics' CINT1275, many of the drawbacks of force air cooling can be avoided. With a power density of 8.5 watts/cu.in, this model family has one of the highest power densities using only convection cooling. Due to its high convection rating, the CINT1275 is suited for industrial applications like test and measurement, lighting and communications equipment.

The CINT1275 high convection cooled power rating of 180 watts makes it a leader in the market and offers features aligned with system designer needs. This competitive product simplifies the system thermal design while achieving small size, high reliability and efficient power conversion.

In summary, when selecting a power supply for an application, power derating is an important factor that may not be evident at first. A thorough review of the product specification is necessary to determine the usable power, especially for convection cooled applications. Consideration or the trade-offs between force air cooling and convection cooling reveals cost and reliability benefits of convection cooling. Although the power density is lower for convection cooled power supplies, there are products, such as the SL Power Electronics' CINT1275 that offers a very competitive solution.

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