Efficiency of power supplies

Small differences, great savings

Maximilian Hülsebusch | **Marketing Communications Specialist**

Having a DIN-rail power supplies of the CP10 series, PULS achieves an outstanding top efficiency of over 95%. When designing new products, a large part of the development work is dedicated to the minimisation of no-load losses in the form of heat. But how does this actually affect users' cabinets?

For a power supply, it is essential to achieve a high level of efficiency throughout the entire load range. It helps users minimise system costs and increase system availability, irrespective of the area of application, industrial branch or region. Anyone, who attaches importance to the efficiency, reliability and longevity of his machines and who wishes to save money, should be familiar with the efficiency of his power supply.

One important factor for the reduction of system costs is to allow as little heat as possible to form inside the cabinet. Heat puts a strain on the lifetime of essential elements. This means that a high level of effort is required for cooling. However, the higher the efficiency of a power supply, the lower the no-load losses in the form of heat.

Figure 1: Experimental setup after a 4-hour runtime

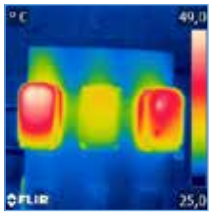

Figure 2: Thermal image of the experimental setup after a 4-hour runtime

The following description of an experimental setup, which was implemented by the PULS Application Support team, shows clearly how much the cabinet temperature depends on the efficiency of the power supply.

Test setup: Heat generation in the cabinet

Three DIN-rail power supplies of the device class 240W 24V / 10A are operated under identical conditions (load: 8A / input voltage: 230VAC) and in identical boxes (volume = 3.15l). The initial temperature in all boxes is 21.5°C (±0.3°C). The ambient temperature is 20.6°C (±0.1°C). In the middle box, you can see the PULS DIMENSION CP10.241, which has an efficiency of 95.2%. The competitor device (left) A has an efficiency of 88.5%. Power supply B (right) reaches at least 91%, according to the manufacturer's datasheet information.

These three devices run for four hours without interruption. The thermometer at the CP10.241 in the middle box, which has the thermally most unfavourable position due to the heat emitted from the right and the left, shows a temperature increase to 40.5°C. The temperature in the box of the left competitor rises to 56.8°C. On the right a temperature increase to 48.3°C is measured. (see image 1 and 2) This means that an efficiency difference of 6.7% or 4.2% makes a temperature difference of 16.3°C or 7.8°C. (*see diagram 1*)

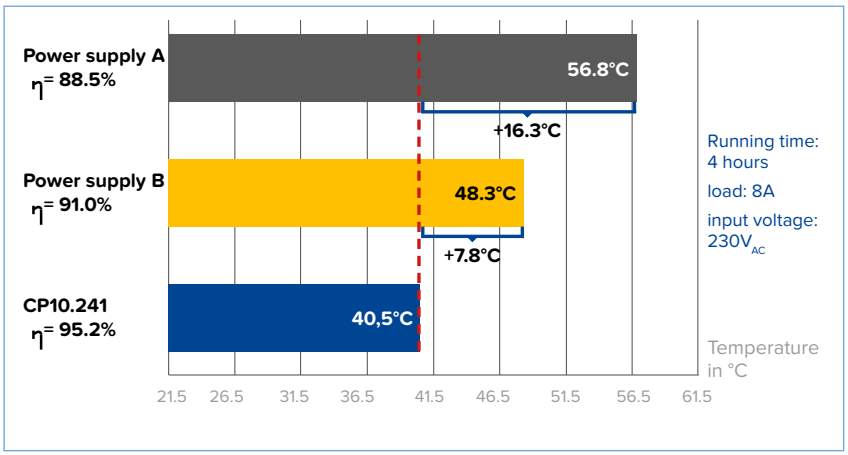

Illustration 1: The effects of efficiency on waste heat in the 240W device class

A high level of efficiency ensures system availability

These are important findings when considering what harmful effect high temperatures can have on the lifetime of the power supply and other essential elements in the cabinet, which can put at risk the availability of the entire system. In power supplies, the electrolytic capacitors are subject to the greatest wear and therefore determine the lifetime. The following formula applies to these temperature-sensitive components: any increase in the operating temperature by 10°C reduces the electrolytic capacitors' lifetime by factor 2. This becomes evident in the clearly decreasing capacity of the electrolytic capacitors. This loss of capacity does not necessarily result in an immediate failure of the power supply but it impairs the availability of the system. For instance, this can also be felt in the device's control behaviour, performance and output values or in case of power failures.

"Any increase in the operating temperature by 10°C reduces the electrolytic capacitors' lifetime by factor 2."

Electrolytic capacitors should therefore not be exposed to overly high ambient temperatures. This rule should be taken into consideration right from the beginning, when designing the devices. For this reason, PULS designs its switch-mode power supplies based on the principle of „Cool Design". Temperature-sensitive components are positioned at the coolest spots within the device and their temperature is controlled perfectly by means of convective air flow. Our Cool Design

clearly focuses on customer benefit, since the combination of thermal and electrical layout always presents a great challenge to the designers.

However, even the other essential cabinet elements profit from this effort. If the waste heat is lower, they age significantly slower. If a cooling system is used, less energy is required and this saves on costs.

"Our Cool Design clearly focuses on customer benefit."

PULS is convinced that the minimum service life specification of a power supply is fundamentally important information for the user. Since 2005, the company has therefore been providing corresponding specifications in their datasheets for all products of the DIMENSION product family. The family standard that applies to DIMENSION is a lifetime of at least 50,000 hours at an ambient temperature of 40°C under full load. The CP10.241 achieves a minimum lifetime of 120,000 hours under these conditions.

High level of efficiency enables higher packing density

Efficiency even influences the dimensions of convection-cooled power supplies. The devices require less volume to dissipate the heat loss into the environment. Thanks to their high level of efficiency, the housing volume of the CP10 power supplies could be reduced to just 0.57 litres and a width of 39mm. The narrow design saves space on the DIN-rail and enables higher packing density within the cabinet, thus reducing operational costs.

High level of efficiency saves energy costs

Efficiency can potentially also help save on electricity costs. Due to international competition, companies must face strong cost-related pressure. This pushes buyers into acquiring system components that are as cheap as possible. However, when it comes to power supplies, it is wrong to focus on the purchase price only. Cheap power supplies do not achieve efficiency levels higher than 92%. The additional costs arising from the purchase of energy-efficient power supplies are balanced off by lower energy costs.

The following short calculation example demonstrates this. A user requires a power supply of the device class 240W with 24V / 10A for his system. The electricity rate is about €0.153/kWh (Federal Association of the German Energy and Water Industry, 2014 average industrial electricity). A machine runs 21 hours a day and 300 days a year. We can choose between the three power supplies from the experimental setup.

When transferred to electricity costs, this means: Due to its no-load losses, the resulting annual electricity costs for CP10.241 amount to €11.66. Power supply A costs €30.07 per year and power supply B €22.84 per year. (*see diagram 2*)

If the user opts for the CP10, he saves operational costs of €18.41 or € 11.18 per year, thanks to the higher level of efficiency of 6.7% or 4.2%. If one extends this to a lifetime of 10 years, the amount that can be saved on operational costs is €184.10 or €111.80. If the user also uses a cooling system, these savings can be multiplied by 2 because less energy is required for cooling the system.

Power supply A:	Efficiency = **88,5%,** no-load loss =	**31,2W**
Power supply B:	Efficiency = **91,0%,** no-load loss =	**23,7W**
CP10.241:	Efficiency = **95,2%,** no-load loss =	**12,1W**

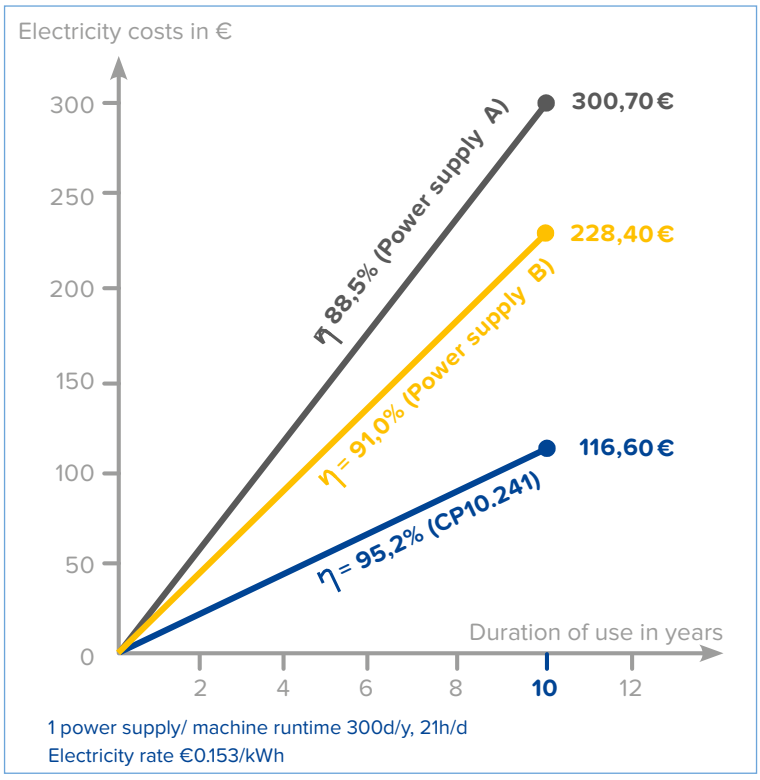

Illustration 2:
The effects of efficiency on electricity costs in the 240W device class

It is worth asking and comparing

It is important to compare the efficiency rates of different power supply service providers, however, in practice this is easier said than done. Instead of binding efficiency values, many manufacturers only specify potential maximum values (up to x % efficiency) in their datasheets. This is a best-case statement and actually just means that this value is not exceeded. For instance, power losses at different mains voltages, loads or ambient conditions are not mentioned to the user. When it comes to measuring efficiency, there are no binding standards for manufacturers. PULS sees a great need for information and catching up with technologies. This is why the company provides clear and binding information on the efficiency of all its products. PULS also informs about its measurement methods to make them transparent and theoretically reproducible for everyone – provided that the necessary equipment, such as a power analyser, is available. Being one of the founding members of EPSMA (European Power Supply Manufacturers Association), the company actively promotes standardised efficiency measuring methods.

About PULS

PULS is the only company worldwide focused entirely on the development and production of DIN rail power supplies. We concentrate our engineering knowledge, resources and energy on one goal: To be the best in this technology. As a result of this focus, our product families DIMENSION, PIANO and MiniLine set standards in terms of efficiency, size and service lifetime.

PULS Website