Technological advance in DIN rail power supplies

95.2% – World record for 240W power supply

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The development of highly compact and ultra-reliable power supplies for their customers is the ultimate goal of the power specialists at PULS.
This is facilitated by a very high efficiency level. The new CP10 series has the world's highest efficiency and the smallest dimensions in its class, maximizing its service life and MTBF.
Numerous additional features provide ease-of-use in a wide variety of applications.

„Heat is your enemy!" This general rule is used by developers to take convection-cooled DIN rail power supplies to new, higher performance levels. Whereas an efficiency level of 94% used to be seen as state-of-the-art, manufacturer PULS – specialist in DIN rail power supplies – has succeeded in breaking through this barrier to achieve over 95.2%, coming one step closer to the ultimate ideal of 100%.

This step-function performance increase has been achieved with the partial replacement of traditional silicon with the new wide-bandgap material, silicon carbide (SiC), combined with a sophisticated LLC converter topology. All the switching and thermal technology has been calculated, then simulated and optimized in multiple variants, in many cases using software tools developed in-house. Even though each improvement takes the design forward just one small step, it all adds up to a significant result. In comparison to what was already a very good product performance at 94% efficiency, at 95.2% the losses are a significant 20% lower.

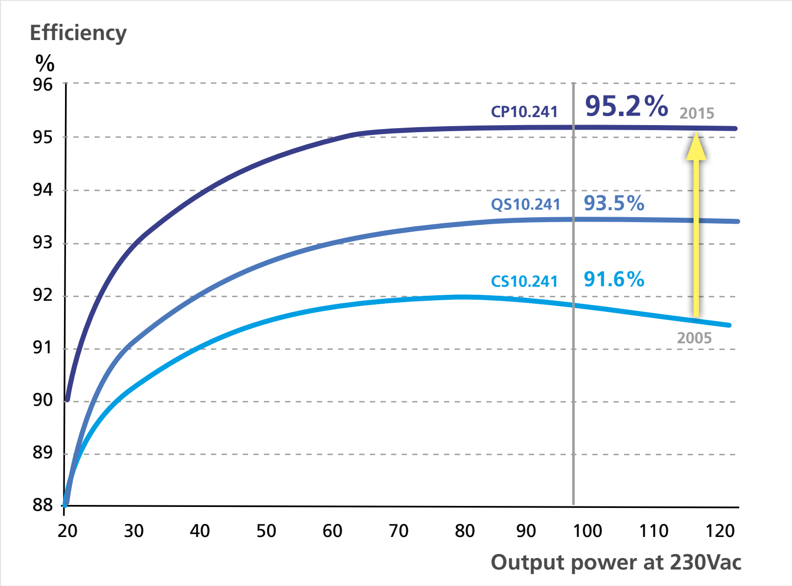

Figure 1: Efficiency comparison

The advantages of high efficiency

Power systems being built today are required to be ever more compact and with the preference for convection cooling, the limit for size reduction is determined by the heat generated. A power supply with inherently low losses therefore offers many advantages:

1.) The power supply requires less volume and surface area to dissipate the heat loss to the environment. For example, with the CP10 this was successfully reduced by 35% to an installation width of just 39mm, opening up new design opportunities.

2.) Lower need for cooling. This is achieved by the lower weight: At 600g the CP10 is 30% lighter than the closest comparable device. The use of silicon instead of aluminium is the key here. This makes the CP10 so resistant to shock and vibration that it also meets the requirements of automotive engineering, including applications in trains or at sea. This lower weight also means less stress on the DIN rail - which was originally designed for lightweight components.

3.) High MTBF – and thus the low failure rate – is a key advantage. PULS has specified this in its comprehensive data sheets for a wide variety of operating and environmental conditions. The usual, more simplistic method of a basic part-count is not used here, as this only counts components and does not take into account the stress in actual use. PULS strives to determine the stress level individually for each component and to calculate the MTBF according to the Part Stress Method. The resultant MTBF figure of 1.2 million hours is outstanding and delivers the highest level of operational reliability. Many suppliers simply imply a high degree of reliability with a long warranty period, but this does not replace the evaluation of MTBF as this is the only relevant specification for the likelihood of failure. When comparing MTBF figures, it is important to pay close attention to how they are defined: according to which standards and under what operating conditions. Unfortunately, in many industry examples, this information is often missing.

4.) The service life is often confused with the MTBF because both values are given in hours, however the meanings are quite different: The MTBF defines the statistically average failure rate **during the normal service life** whereas the service life specifies the date **after which** component wear may have a negative effect. Many believe that electronic components are not subject to wear. However, this does not apply to electrolytic capacitors where the liquid electrolyte is diffused through the seal over time. The electrolytic capacitor dries out slowly and loses its properties. This deterioration is highly dependent on temperature: a 10 degree change has an effect of a factor of 2.

Manufacturers of electrolytic capacitors specify the time at a given temperature after which the performance would have deteriorated by more than a pre-defined value. This time is the minimum service life. PULS measures the operational temperature of each electrolytic capacitor in the device and then calculates the service life according to the manufacturers' specifications. If a power supply with a long service life is required, it needs high quality electrolytic capacitors that must not be operated in a hot environment. Users can also estimate the service life for themselves: measure the electrolytic capacitor temperature and calculate the service life in accordance with the manufacturer's data sheet.

TThe CP10 achieves a minimum service life of 101,000 hours measured at 40°C ambient temperature and full power supply load, making it significantly better than standard market values.

PULS believes that the specification of the service life is fundamentally important information for the user and as a consequence, has been a pioneer in providing these important specifications in their data sheets for all products in the DIMENSION family since 2005. There is an internal standard for the operating range 50,000 hours at 40°C ambient temperature. This is a challenging goal to achieve so „it's the developers that sweat at PULS, and not the devices."

5.) All other components in the system benefit from the high efficiency level: the wasted energy due to heat is low, reliability increases, and as a result, ventilation can be significantly reduced.

Low mains input inrush current

Due to their design concept, switch-mode power supplies have a large buffer electrolytic capacitor on the input that needs to be charged when the supply voltage is applied. To limit the input inrush current, a thermistor is usually connected to the network in series. This presents a high impedance when switched on. As the input current of the power supply flows through, it then heats up and becomes low impedance. However, to become low impedance it must get hot, as the name suggests.

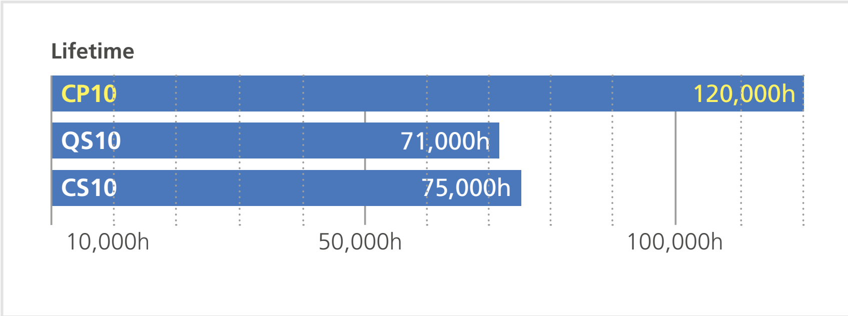

Figure 2: Service life comparison

The thermistor is therefore a hot spot with up to 160°C surface temperature in the power supply. It also generates avoidable losses. To minimize this, a low-impedance thermistor is sometimes used, but then it only provides moderate limitation of the input inrush current. Other issues with the thermistor are that it is still hot during a hot start and provides minimal limitation, or vice-versa that it does not heat up enough at very low temperatures - and with a sudden load variation and low power voltage, the output voltage collapses because its voltage has dropped too far.

All these issues and potential contradictions can be avoided with the implementation of active inrush current limiting as used in the CP10. It bridges the high-impedance thermistor after the switch-on operation with a relay. This provides a low starting current, high efficiency and the potential to work down to -40°C.

Enhanced functions

Despite its compact size, the CP10 is easily installed. The terminals are generously sized and facilitate easy connection of wiring. Connection cables of up to 4 mm² cross-section are possible and the negative pole is available on three terminals. Additionally, highly vibration-resistant spring clamp terminals are also available as an option to facilitate rapid connection. The 'DC OK' signal for monitoring the output voltage is output via a practical relay contact and 288W of power is permanently available up to +45°C. The temperature range is from
-25°C to +60°C without derating and an ATEX/IECEx approval is included in the standard.

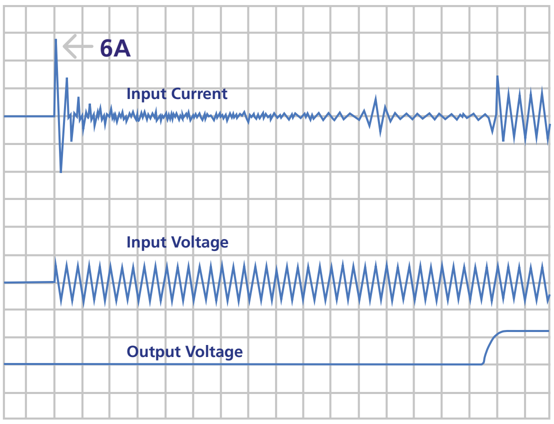

Figure 3: Input inrush current