Topic: COOL DESIGN

480W: Simple and effectively designed

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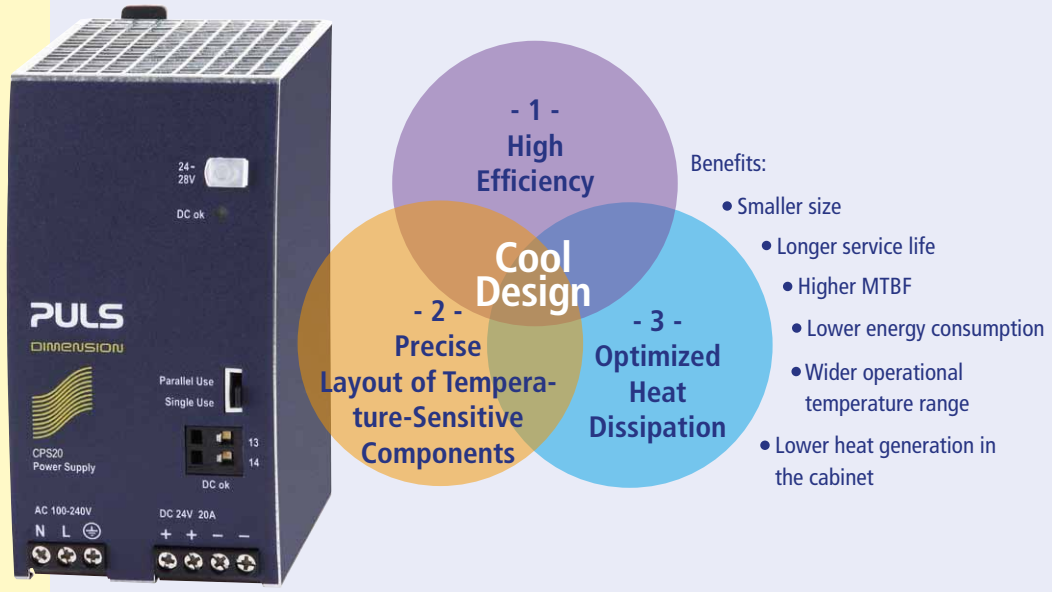
The development time for advanced designed power supplies are getting longer and longer. Teams of engineers have been working for years to develop new power supply platforms for market readiness.

There are many good reasons for this: detailed improvements are required and compromises to the design must be avoided. Ongoing critical questioning of old design practices is necessary to bring about new levels of performance. The results are power supplies that are an outstanding competitior even many years in the future.
This benefits the customer in many ways as can be seen in the "Cool Design".



Cool Design

The "Cool Design" from PULS describes a concept that places the emphasis on a low heat generation and long life. It is based on three principles: firstly the consistently high efficiency, secondly the optimized heat dissipation of the unit and thirdly the precise layout of temperature-sensitive components in the unit.

High efficiency

The percentage of efficiency describes the ratio between the output power and the input power of a power supply. The difference is dissipated as heat. The advantage of high efficiency in power supplies is obvious as it produces lower losses resulting in reduced cooling costs, extended servicelife and increased reliability.

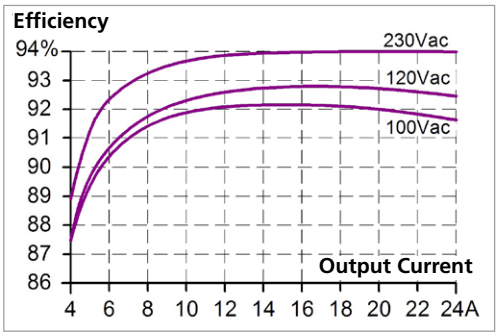


Figure 1: DIMENSION CPS20.241:
High efficiency over a wide current range.

As well as the high full load efficiency, which enables such compact designs, it is becoming increasingly important to achieve good partial load efficiency. Usually, power supplies are not continuously operated under full load and therefore the losses at the average load are particularly important for control cabinet design. To achieve high partial load efficiency, PULS uses complex control concepts and algorithms which are most easily implemented with digital circuits and software. This puts PULS ahead of many competitors. Losses that occur in the no-load state must also not be forgotten and should be kept as low as possible. The CPS20 has this incorporated into the design so that the heat rise in the control cabinet is not increased while the power supply is idle. It
is not uncommon for no-load losses to equal one third of full load losses in some competitor brands.

Optimized heat dissipation

Heat generated by losses cannot be prevented and must be dissipated by the shorted path to the environment. Housing surfaces and convection air current flowing through the unit are used for for evacuating heat from the supply. Optimally, the convection air flow should not be impeded by components but in reality this often cannot be avoided. Therefore it is all the more reason to provide channels as part of the design and keeping the heat flow away from more sensitive components inside the unit. This has been thoroughly accomplished with the units in the new DIMENSION CPS20-series.
Besides providing the necessary cooling channels, the design also achieves a short direct connection from the heat source to the housing and avoids adverse thermal transitions. The sophisticated cooling concept of the CPS20 series completely eliminates the need for internal heat sinks. This enables light unit weight and also significantly reduces the cost of the power supply.

Well thought out arrangement of temperature-sensitive components

Circuit designers tend to optimize the layout of the components for the electrical or manufacturing requirements and often make compromises in the thermal design. For many years and on its own initiative, PULS has set the company standard for service life at a minimum of 50 000 hours for the units in the DIMENSION series, which is valid at 40°C ambient temperature, nominal load and nominal input voltage. This forces the development teams to place service life-defining components in the cooler areas. If the target of 50 000 hours is not achieved an additional development step is imposed.
Electrolytic capacitors, varistors and opto-couplers are components which are particularly temperature-sensitive. The number of electrolytic capacitors in the DIMENSION CPS20 series power supplies is reduced to a minimum of 4, all of which are positioned close to the cooling air intake. Comparable competitive units can use up to 22 of these capacitors, which are then naturally arranged throughout the entire board.

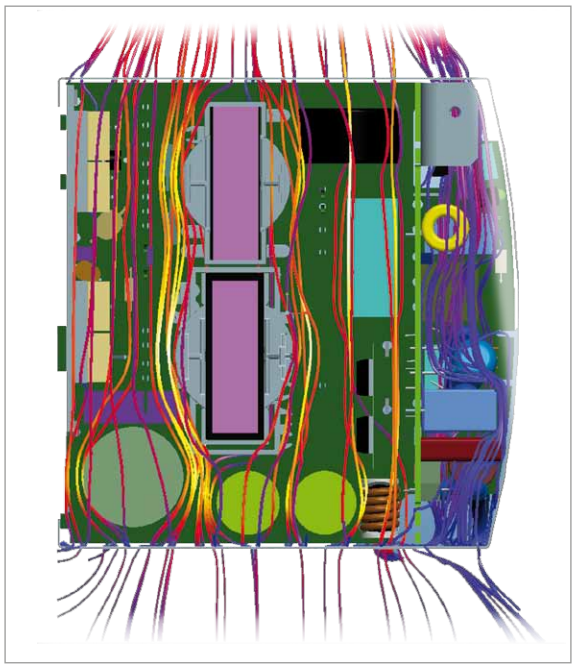


Figure 2: DIMENSION CPS20.241 Side view:
Distinct air channels and simulation of the air flow

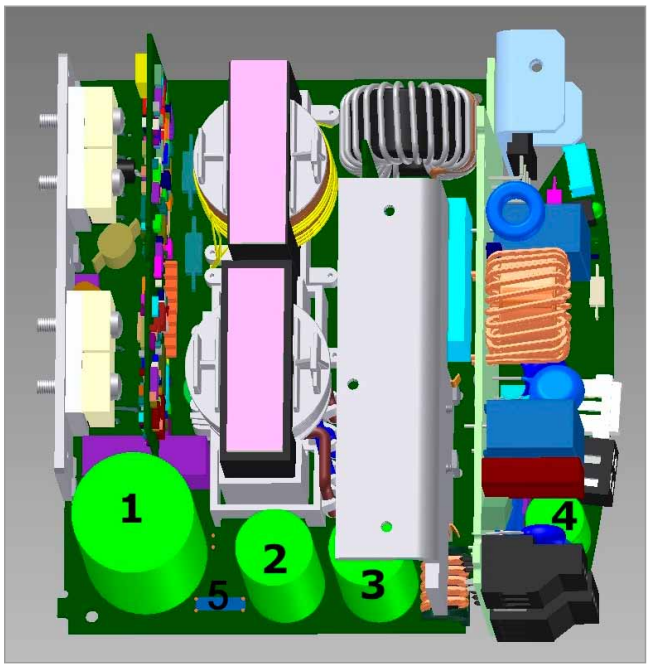


Figure 3: DIMENSION CPS20.241
Arrangement of all electrolytic capacitors (1-4) and the opto-coupler (5) in cool areas in the vicinity of the air intake

The benefits of the "Cool Design"
Small size and light weight
Two of the most important criteria of modern power supplies are small sizes and light units. These bring a direct benefit to the user and the greatest advancements in this endeavour have come about in the past 20 years. The small designs made possible by increased efficiency do not only save space on the DIN rail, but also allow smaller sized control cabinets. Another benefit is easier integration in machines. The volume and weight of the cabinets are reduced and bring about additional possibilities for optimization. This is where the "Cool Design" concept has its strengths. As no internal heat sinks are required, the equivalent weight and volume are eliminated along with the associated installation and insulation materials. Ultimately, the cost for these components is also saved which is reflected in the unit price. The 480W units in the CPS20 series require only slightly more space than the units in the 240W class.

Less heat generation in the control cabinet
The lower losses provide not only for a longer service life of the power supply, but also for a longer service life of all components installed in the control cabinet. For example, a DIMENSION CPS20 installed in a control cabinet with a size of 254 x 180 x 165 mm and loaded to 80% of the nominal power will result in a temperature increase in the control cabinet of approximately 30°C. If a device with only 2% less efficiency is used (92% instead of 94%), the increase in temperature in the control cabinet would be higher by 10°C, resulting in the service life being cut in half.

Wider working temperature range
Power supplies are usually a "hot spot" in control cabinets. For exactly this reason, the maximum permitted temperatures for power supplies are of significant importance. Even if the control cabinet is specified only at 45°C, the conditions in the immediate vicinity of the power supply can be substantially higher. Due to the sophisticated thermal design and low losses, the units in the DIMENSION CPS20 series may be loaded with full power at up to 60°C ambient temperature. The ambient temperature is defined at the air inlets 2 cm below the device.

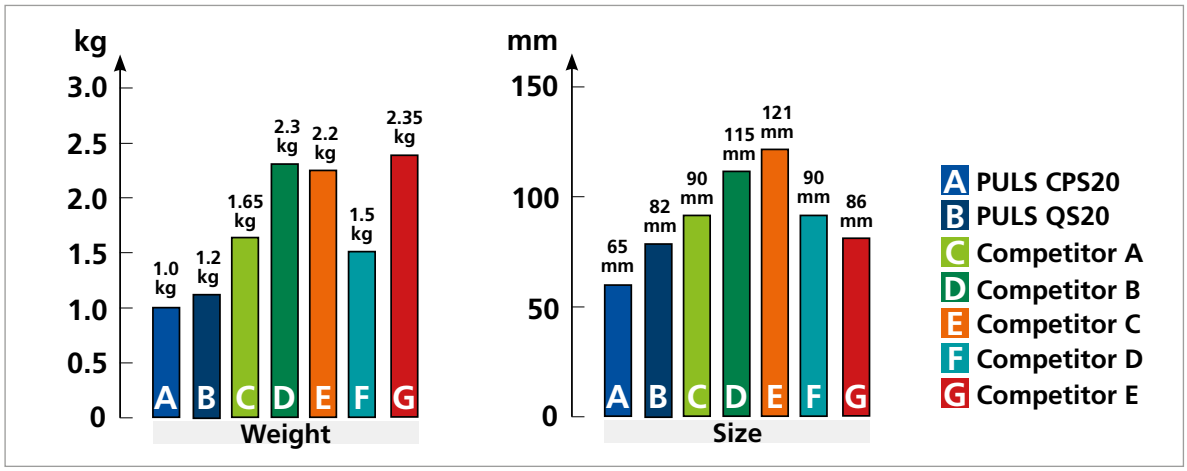


Figure 4: Comparison of size and weights of different manufacturers of 24V, 20A single phase power supplies

Longer service life

The expected service life of a unit indicates the useful operation in hours. This is the time during operation of the device until the first signs of wear-out occur such as a dried capacitor. The component with the shortest service life expectancy in a unit determines the service life of the entire unit. In practice, these are the electrolytic capacitors used in power supplies. For the units in the DIMENSION CPS20 series, the same self-imposed design guidelines apply as for all other DIMENSION units. At least 50,000 hours service life at 40°C ambient temperature, nominal load and nominal input voltage. This makes PULS on average better than many competitors by a factor of 3. To achieve this, an absolute minimum number of best quality capacitors with a minimum diameter of 10 mm are utilized. Thinner capacitors naturally have a shorter service life because of the poor ratio between the amount of electrolytics and the tightness of the seal. In the "Cool Design" concept these are also placed in the coolest possible locations. Only by consistent compliance with these rules can such long service lifetimes be achieved. PULS does not use tantalum capacitors because they generally have significantly higher failure rates than classic electrolytic capacitors. Service life hours must not be confused with MTBF hours. MTBF hours are calculated according to statistical failure criteria.

Longer MTBF

The MTBF (Mean Time Between Failure) number indicates the statistical probability of failure. An MTBF figure of 1,000,000 hours means if there are 1000 units in service, then statistically one unit will fail every 1000 hours. However, it is not possible to state whether a failed device was already in service for 50,000 hours or only 100 hours.
Various standards are available to calculate the MTBF values; SN 29500, IEC 61709, MIL HDBK 217F and Belcore to name a few. The calculations are always made by applying the same method. The standard provides a database where base failure rates are available for individual components which are then adjusted with the stress factor for actual application. The calculated failure rates of all components are added together and result in the failure rate for the overall unit.

When comparing the MTBF data of different manufacturers, it is essential to apply uniform parameters. It would be unfair to compare values which were determined according to different standards or where the parameters such as temperature are not uniform. If a manufacturer does not specify the applicable parameters, the MTBF number is worthless.

Lower energy consumption

Beyond a doubt, the prevention of unnecessary energy consumption is one of the best contributions to active climate and environmental protection. The high efficiency of PULS power supplies brings a double benefit. The environmental impact is reduced while energy and system costs are lowered resulting in a significant savings. In a 24/7 operation, a power supply which consumes 20W less power saves 175kWh of energy per year.

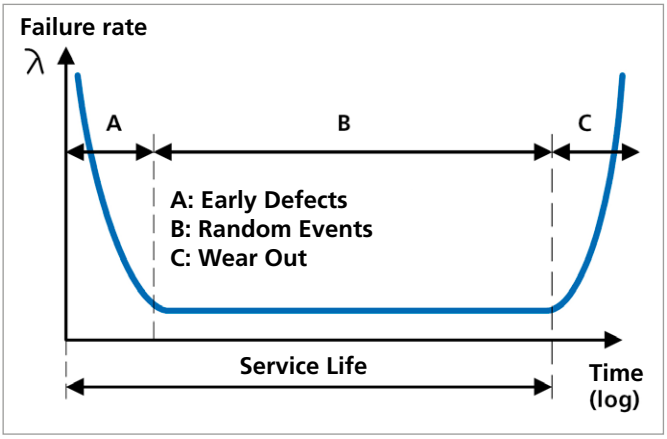


Figure 5: Bathtub curve
Failure rate over the lifetime of a unit

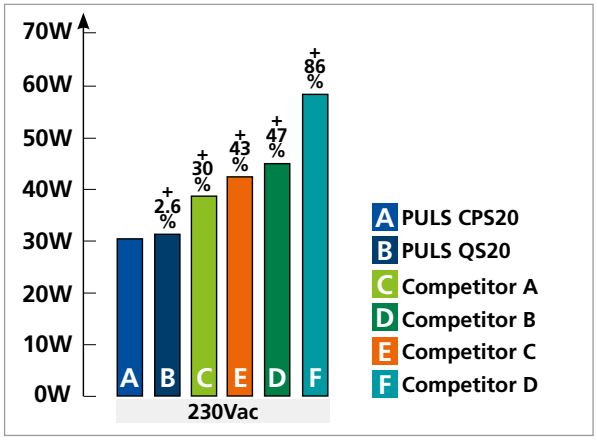


Figure 6: Comparison of the losses of different manufacturers of 24V, 20A single phase power supplies

Figure 7: DIMENSION CPS20.241

CPS20 at a glance

With a unit width of only 65mm, the CPS20 units are available with four different output voltage (12V 15A, 24V 20A, 36V 13A or 48V 10A). All units are equipped with the Hiccup^{PLUS} overload behavior with a balanced power management which in normal operation mode provides generous power reserves but effectively protects connected equipment and cables against damage in the event of failure.

Full power is available through a wide temperature range of -25°C to +60°C. Up to +45°C, an additional 20% more power can also be be achieved. For the fast opening of the secondary-side fuses or breakers in case of a fault, the units provide 4 times the nominal output current at close to full output voltage for 15ms. Other features in these units include, 94% full-load efficiency and excellent partial load efficiency, active PFC, electronic inrush current limitation, DC-OK signal for remote monitoring and a provision for load sharing when multiple power supplies are connected in parallel. The units are equipped with a wide range input and can be used in all global 1-phase networks between AC 100V and AC 240V. Versions with ATEX approval and DC/DC converters for input voltages from 88 to 375Vdc are also available to complete the CPS20 family.