QT40: Compact 1,000W Class Power Supply with High Efficiency and Active PFC

Benefits of Digital Technology of Power Supplies

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In the ongoing development of power supplies, the analog control is reaching its limits.
By using microprocessors, these limits can be raised and new levels achieved as users demand smaller, more efficient and more reliable supplies.
Active PFC (Power Factor Correction) also becomes economically viable for 3-phase power supplies.

In the new QT40 power supplies, a total of three microprocessors join forces and ensure a high level of efficiency across the entire load range.

Some may wonder why micropro-cessors have not been used on a broad basis in power supplies long ago, if they offer so many benefits. And this does not refer to microprocessors for just simple interface or housekeeping tasks, but for central control functions. But now there is a match between the requirements of high-performance power supply manufacturers and the range of the components industry with regard to speed, power consumption and costs. For the standard topologies in use so far for standard requirements, there is a variety of analogous components which can perform the control tasks. But if you want to push the boundaries of what has been possible up till now, you can not avoid complex, multi-stage and partly resonant topologies with a significantly higher amount of effort in control. However, this effort is worth it as it opens up new levels of freedom in development which can be used to obtain benefits in the power and control circuits.

Basic Benefits
Digital controlling offers some benefits as it becomes affordable to use multi-stage topologies which use the power components more effectively and improves efficiency. Complex control functions can be implemented and the converters can be operated at the optimum operating point depending on the basic conditions. Reliability is increased through the lower number of components. During the development process, improvements can be done without having to replace the hardware. With software an effective protection of intellectual property is achieved.

High Level of Efficiency
The level of efficiency is the highest discipline in power supplies because the power losses occurring significantly determine the temperature rise and therefore size and reliability. Additional requirements such as a active PFC, transient supression circuits and wide input voltage ranges tend to result in a lower level of efficiency but are important for reliable operation of the system.

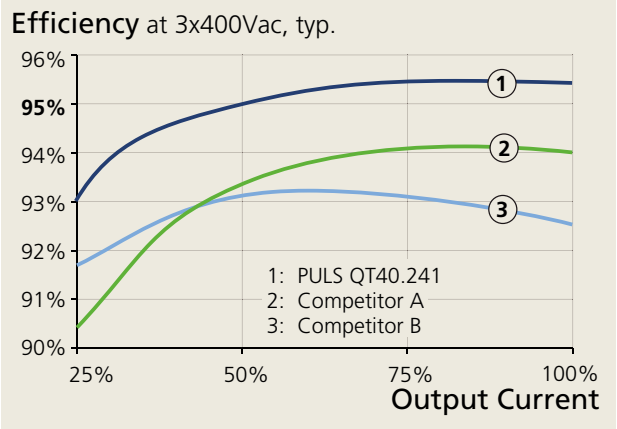
In addition to the efficiency during full loads, the efficiency in partial-load operation will also play a role in the future. Even the idle mode, which at first glance may seem exotic, is being taken into account more and more, as it can occur in certain applications for longer periods of time. Here, a digital control allows for better behavior and less power loss. The diagrams on this page compare the data of three different devices in the 1,000 W class with 3-phase input, which were all brought to market in 2009 by renowned manufacturers.

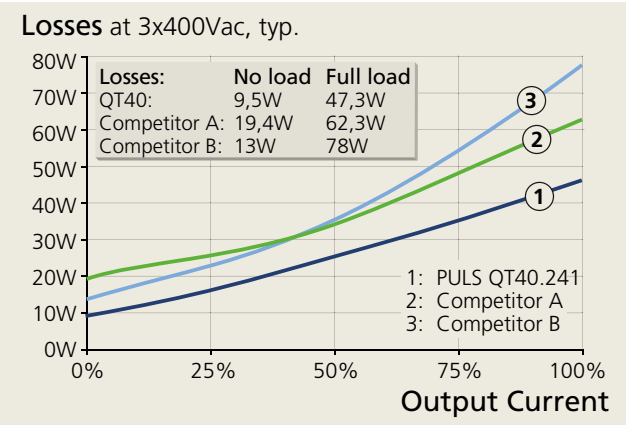
It is clear that it is difficult to implement both low full-load and low partial-load power losses with standard concepts. Thanks to the digital control, the QT40 from PULS can solve this contradiction and achieve significantly better efficiency across all load ranges. The small power losses are not only beneficial for the power supplies but also for the entire panel installation in a cabinet.

Small and Lightweight
The high level of efficiency permits heat sinks to be avoided completely and therefore the device can be built in a smaller and lighter way. At 1.5 kg, the weight of the QT40 is significantly less than that of the two competitive devices at 2.5 kg or 3.4 kg. The lower weight is particularly significant for devices of this power class, as the DIN- Rail and its mounting were not originally designed for the support of heavy devices. In combination with a large overall depth, the high weight creates a large leverage force and can result in problems during transport or operation in the event of shock and vibration loads. For the QT40, PULS has therefore observed a moderate overall depth in addition to its low weight.

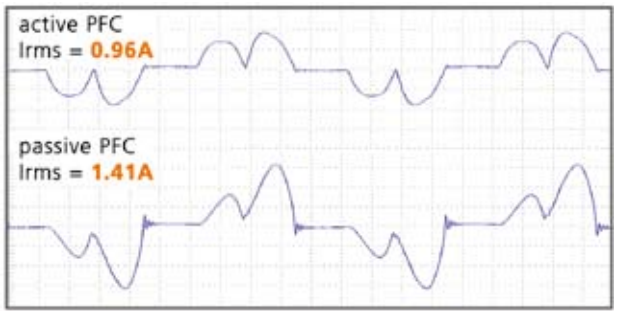
In addition, the QT40 device with the smallest installation volume has integrated mains fuses unlike the other devices and in many cases saves the space and costs of other circuit breakers.

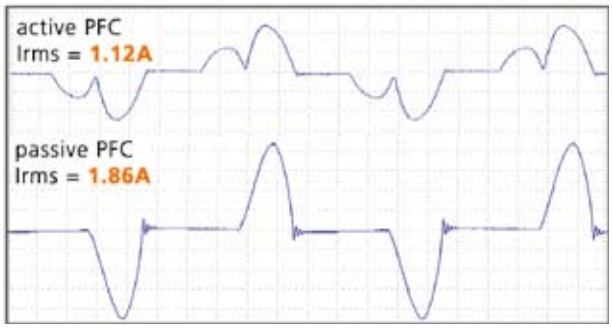
Benefits of the Active PFC
Another reason for the low weight in the device from PULS is the Power Factor Correction that is implemented actively with high frequency instead of passively with low-frequency inductors. In addition to the lower weight, the behavior is always better with non-symmetric mains voltages. In this case, with a passive PFC the current in the phase with the lowest voltage drops back disproportional and must be equalized in the other two phases with additional current. Even at a 5% undervoltage in one phase, the current increases in the other phases by the factor of 1.4. With a 10% miss-balance increases the factor to 1.9 compared to the current flowing with symmetric mains voltage. With a 10% miss-balance there is actually no current flowing in the phase with the lowest voltage and this equals a 2-phase operation which means considerably higher stress for the power supply.





The relationships realized in the active PFC by PULS are entirely different.
In this case the current only increases by 1.1 times to 1.3 times the current and even at 10% miss-balance, there is still a substantial amount of current flowing in the phase with the lowest voltage. Problems due to an uneven loading of the phases are safely avoided. However, if a phase fails completely, the device can also be operated on two phases for a certain period of time. Devices with active PFC also have an improved power factor, meaning a lower current demand. PULS introduced the active PFC in 2005 as the first manufacturer of 3-phase power supplies for DIN-rails and even today is still the only supplier of this technology with these devices.





Reliability and Service Life

A particular highlight of the digital control in the QT40 device is the replacement of the linear optocoupler in the analog control feedback-loop by a non-ageing signal transformer with pulse-width modulation. This avoids age-induced drifts and achieves high long-term stability.
The low temperatures on the electrolytic capacitors ensure a long service life and the relatively lower number of components due to the digital control results in a high level of reliability.

Functions for More User Convenience

Many functions can be realized digitally in a cost-effective way and some have been integrated as standard in particular with regard to larger systems. For instance, in addition to the standard DC-OK contact there is also a signal input included which can switch on and off the devices with a signal voltage referenced to the output voltage. Optionally, this also makes possible an analogous adjustment of the output voltage. For applications where multiple power supplies are connected in parallel, it is possible to achieve an uniform current distribution of the load current to the individual power supplies with the Parallel Use mode function. Another convenient function in these devices is that the input current is so low when switching on that inrush current does not need to be taken into account in the system or machine concept.

The Future

The digital control is very much only just beginning to be integrated into high performance power supplies and we can only guess at its potential. However, it certainly represents one of the key turning points in the history of power supplies and is opening up whole new opportunities. And just as the digital control has been integrated into the heart of the power supplies, we can imagine that thanks to the many benefits, it will also quickly win users over.