XT40 vs QT40

# Two DIN-Rail Power Supply Concepts in Comparison

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In a time when it is becoming less and less the case that the engineers are involved in running companies and making decisions on the use of devices, it is important that the required characteristics of a device are specified with precision. The desire of those running companies for cost-effective solutions is understandable as well as necessary. For engineers and system planners, however, the task of specifying power supplies is becoming more and more difficult. There is a choice between too many offers with different device features, which can only be assessed with special knowledge or experience. In addition, there is a desire for the most simple and cost-effective solutions.
How lean and streamlined the specification of a power supply unit may be, this article will address what features can be designed in and out based on two 960W power supply units of PULS, the semi-regulated XT40 device and the fully regulated QT40.

When looking at costs it is important to compare the overall costs in the system fairly and not to simply reduce them to the savings in the procurement of the power supply itself. It only works if you actually have the option to choose between different power supplies or power supply concepts. With PULS, there are two devices in the 960W class with different approaches for different tasks. The XT40 series was mainly developed for drive tasks or loads where motors are involved and converts the 3-phase input voltage with a semi-regulated resonance converter into an output DC voltage of either 24V, 36V, 48V or 72V.

This single-stage concept is very cost-effective, compact and highly efficient, but makes minor compromises in the input voltage range, the ripple and noise voltage and in the hold-up time in the event of power failures.
The alternative to these devices are the newly rolled out units of the QT40 series. This series is fully regulated and equipped with many features that can in turn save costs in the overall calculation.

**Efficiency**

The advantage of a high efficiency level is obvious and is not an objective in itself for manufacturers of power supplies. It is in fact a tool which serves to achieve a number of characteristics such as: low power losses, small design, less space required on the DIN-Rail, low heat generation, low operating costs, light weight, low temperature stress on component parts in the complete control cabinet, long lifetime, high level of reliability and much more.

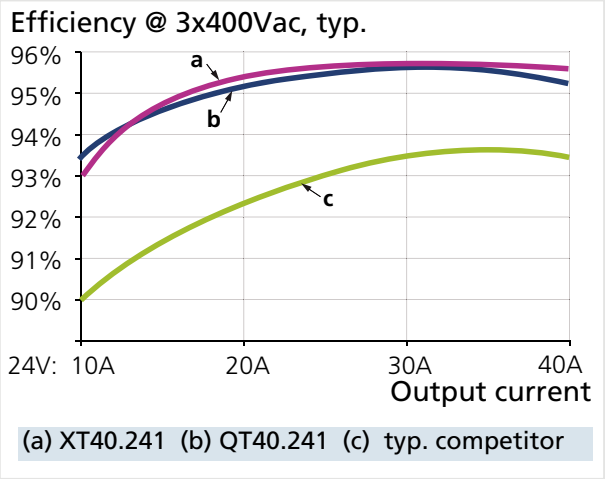


*Figure 1: Efficiency comparisons*

In these disciplines the two devices are leaders and stand out from their competitors. In the 24V variant, the XT40 is only 96 mm wide and achieves efficiency of 95.5%. The QT40 achieves 95.3% and requires only 110 mm on the DIN Rail. With these efficiency values, the power losses of the 40A devices are reduced to a level of several standard 10A devices. This means that 4 times the useable performance is achieved with the same volume of heat waste.

Another benefit of the QT40 units is the optimized efficiency across the entire load range. So far, it has been important to optimize efficiency at maximum load. This facilitates the small design, without exceeding the maximum allowed temperatures of components. As systems and machines seldom run continuously at full load, efficiency at partial load is also of practical use. For these characteristics, complex control circuits and algorithms are required, and these are easiest to realize using digital circuits, microprocessors and software. In a device such as the QT40, there is a total of 3 microprocessors working hand-in-hand.

**Input Voltage Range**

A broad input voltage range increases the immunity to fluctuations in the supply voltages and facilitates global use in the event of differing mains voltages. However, the wide input voltage range is complex and costs money. When the total system is supplied through a matching transformer or the power supply is only being used in a regional project, there is nothing to be gained from this feature. With the XT40 Series, separate devices are required for the 400Vac and the 480Vac mains networks but the QT40 Series covers the entire range with one device.

Another distinguishing feature is the behavior when one phase fails. The QT40 is good-natured in this respect and even at reduced current can also be operated permanently on just two phases. The XT40 device on the other hand, protects itself and switches off in these circumstances.

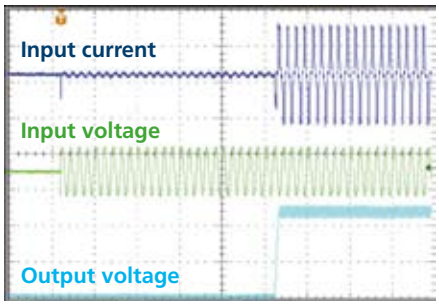


*Figure 2: XT40; No inrush current surge when switching on*

**Inrush Current Surge**

When switching on power supplies, a short but high charge current usually flows in order to charge the input capacitor. This peak current often results in a surprise when commissioning systems. Circuit breakers can trigger or relay contacts get welded. Depending on the quality of the power supply, this current can be larger or smaller. PULS places significant emphasis on minimizing this negative associated effect. Both devices have no electrolytic capacitor directly in the input circuit. The peak input inrush current is therefore negligibly small. External circuit breakers can be sized according to the nominal current of the power supply.

**Output Regulation and Ripple and Noise Voltage**

Here the fully regulated QT40 device offers clear advantages. The output regulation is precise and the output ripple & noise voltage is low. The output voltage can also be adjusted.

The XT40 device uses a semi-regulated resonance converter and behaves differently here. The output voltage is not adjustable and is only regulated to a constant voltage in the core range of the input voltage (360 to 440Vac or 432 to 528Vac). Outside this range, the voltage responds proportionally to the input voltage. At different loads, the output voltage changes slightly as well. Similar to a transformer power supply, a ripple and noise voltage with mains frequency


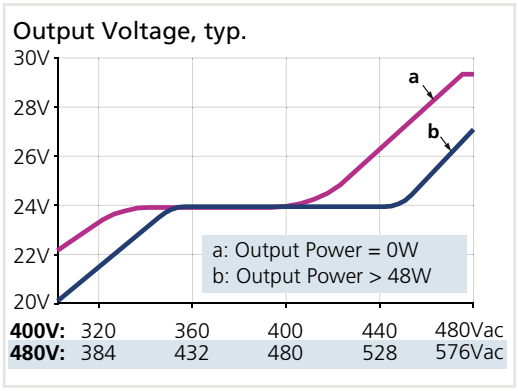


*Figure 3: Output voltage regulation of the XT40 power supply*

is superimposed on the output voltage. The main uses of the XT40 devices are applications to supply motors, valves and load current circuits with a high power requirements where precise regulation as with the QT40 device is not required.

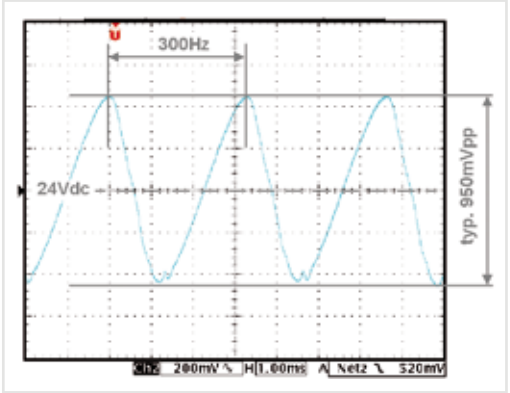


*Figure 4: XT40: Ripple and noise voltage, 24V device*

**Overload Capacity, Parallel Connection and Charging of Batteries**

Both devices have generous overload reserves integrated that make it easier to start motors or connect capacitive loads. The QT40 supplies 50% "bonus current" for 4 seconds (BonusPower®) and then limits the current automatically to the nominal current. The semi-regulated XT40 has a 25% PowerBoost integrated. Whereas the QT40 supplies constant current when there is an extended overload, the XT40 switches the output off after a certain period of time.

Parallel connecting of outputs or charging of batteries is only possible with the QT40 devices. To achieve an uniform distribution of the load current when multiple power supplies are connected in parallel, the QT40 even has a special feature for passive current share included. In the Parallel Use mode the output voltage is controlled in such a way that it is about 5% higher at no load than at nominal load. With this feature an overload of one single device is avoided and almost even temperatures between the parallel-connected power supplies are achieved, which is beneficial for the lifetime of the individual devices.

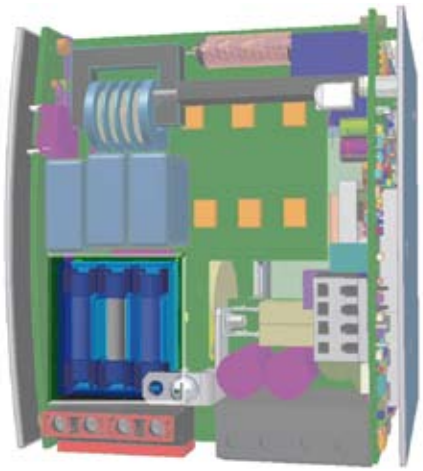

*Figure 5: QT40 device with 3 in-built fuses save installation costs and space*

**Hold-Up Time**

The hold-up time or ride-through time is the time between the loss of input voltage and the dropping of the output voltage. With the QT40, some half-waves of the sinusoidal input voltage can be bridged, depending on load current. With the XT40, the voltage drops immediately after the loss of input voltage. You must be certain whether or not a bridging is required. If motors are being supplied with power, short mains voltage interruptions generally do not result in a fault as the rotating masses capture these. However, controls react very sensitively to short interruptions. If they are not supported by a DC-UPS or a buffer module, supply with the XT device is not recommended.

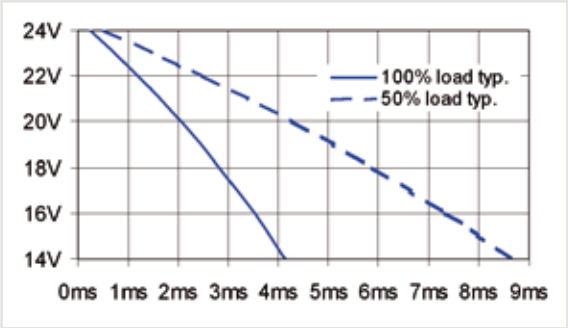


*Figure 6: XT40: Buffer time depending on the output load*

**Further Potential Savings with the New QT40 Power Supply Unit**

Every phase is equipped with a large fuse. Additional input protection is only required if the supplying branch is protected with a value greater than 32A. The QT40 may therefore be connected to a classic 32A-CEE industrial outlet without additional protection. The output of the QT40 can be remotely monitored with the DC-OK relay contact. This is particularly helpful for redundant applications, as the voltage created by the power supply itself and not only the voltage on the connection terminals is monitored.
A defective power supply can therefore also be identified if several devices are connected in parallel. An additional feature is the shut-down input. If the two signal inputs are shorted or supplied with external voltage, the output can be switched off. This avoids the use of contactors or large relays, which are not cheap particularly in this ampere class.
If a defect does occur in a device, a second voltage control loop (redundant OVP) ensures that the output voltage never exceeds 32 Vdc. This prevents subsequent damage to systems. Of course, this protection only reacts if the over voltage is created by the power supply itself and does not trigger with return voltages. With the 24V device, return voltages up to 35 Vdc are allowed.

The range of different power supplies in one power class will become greater and greater in the future. The devices are differentiated via various features for the different application areas. Detailed data sheets and specifications are becoming more and more critical. If the devices are chosen correctly, it is possible to save a lot of money in comparison to a fully-featured standard device.
In this case, the devices in the XT40 Series are around 25-30% lower in price (depending on the output voltage) in comparison to the QT40 Series. With PULS, for many power classes there are already standard devices with optimized or reduced features available.

| | **QT40.241** (fully regulated) | **XT40.241 / XT40.242** (semi-regulated) |
|---|---|---|
| **Output** | 24-28V, 40A | 24V, 40A |
| **Output voltage** | 24-28Vdc adjustable | 24Vdc not adjustable |
| **Tolerance of the output** | ±0,2% | ±3% |
| **Efficiency / power losses** | 95.3% / 47.3W | 95.5% / 45.2W |
| **Input** | Wide-range<br>3AC 380-480V (-15%/+20%) | XT40.241: 3AC 400V (±10%)<br>XT40.242: 3AC 480V (±10%) |
| **Inrush current surge** | typ. 4.5A peak | typ. 2A peak |
| **Input fuses** | integrated internally (3x) | none installed |
| **PFC / power factor** | active PFC / 0.9 | active PFC / 0.93 |
| **Hold-up time** | typ. 25ms | typ. 3ms (output > 18V) |
| **Ripple & noise voltage** | < 100mVpp | < 1.5Vpp |
| **Parallel connection** | allowed | not possible |
| **Series connection** | allowed | allowed |
| **Charging of batteries** | allowed | not possible |
| **2-phase operation** | allowed | not possible |
| **Power reserves** | 50% BonusPower® | 25% PowerBoost |
| **Overload behavior** | Permanent current | Shut-down, manual reset required |
| **Signals, etc.** | DC-OK, Inhibit, Parallel Mode | none |
| **Dimensions (WxHxD)** | 110x124x127mm | 96x124x159mm |
| **Weight** | 1.5kg | 1.4kg |
| **Costs** | 100% | 75% |

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