CU81xx: new series of intelligent uninterruptible DC power supplies

Universal UPS systems with One Cable Technology minimize installation effort

The new CU81xx UPS series from Beckhoff can be used anywhere. Due above all to the flexible connection options extending up to One Cable Technology for uninterruptible power supplies (UPS-OCT), it is suitable for an extremely broad range of applications. In combination with the Beckhoff Industrial PCs, particularly efficient wiring is possible with just one cable for supply and communication through UPS-OCT. Signal modulation onto the 24 V supply line is a special feature of the UPS series, which is based on double-layer capacitors or NiMH batteries.

Fig. 1: The new universal UPS series covers a wide range of applications with three device versions currently.

Fig. 2: With just one CU81xx UPS, the 24 V DC supply voltage of both an IPC (in this case a C6030) and a Control Panel (in this case a CP29xx) can be secured.

The subject of UPS (uninterruptible power supply) is certainly as old as the subject of electrical energy supply itself. If you regard rechargeable batteries as the first approach to an offline UPS, then Count Alessandro Volta already built an electrochemical battery storage system around 1770 in Italy. The purpose of a "real" UPS, however, is to maintain the supply of power to a connected consumer intact without interruption in the event of a failure or malfunction of the general power grid.

Selecting a UPS to suit the application

The potential costs and risks caused by a malfunction or even a failure of the supply voltage have grown continuously in the course of digitization, industrialization and networking of our world, and are often out of all proportion to the small cost of purchasing a UPS. Despite being a supposedly simple task, the selection of a UPS according to type and size is a multi-factor decision that is made even more difficult by a confusing jumble of designations. In principle, however, a distinction can be made between three types of industry standard UPS:

– UPSs with an AC input circuit and an AC output circuit ("traditional UPS")
– UPSs with an AC input circuit and a DC output circuit ("combined power supply/UPS")
– UPSs with a DC input circuit and a DC output circuit ("DC UPS")

The new CU81xx UPS series (fig. 1) belongs to the category of DC UPSs for 24 V DC input and output voltage. However, the details of the exact implementation must be observed here too, because this UPS series has been developed with an eye to practical application in the industrial control cabinet. With regard to the operating behavior of the output voltage, it is most comparable with the AC UPS type VI according to the IEC 62040-3 standard because, like the AC VI type, the output voltage is electronically stabilized within the limit values for normal operation. The CX81xx series is conceived for DC loads up to 240 W and currently features three devices:

– CU8110-0120: max. 120 W power, 0.9 Wh energy, double-layer capacitors (EDLC)
– CU8130-0120: max. 120 W power, 15 Wh energy, replaceable NiMH battery module
– CU8130-0240: max. 240 W power, 30 Wh energy, replaceable NiMH battery module

Due to the different energy and power classes, these UPSs are particularly suitable for the protection of control cabinet PCs, Embedded PCs, Panel PCs and other controllers (including third-party). They allow the wiring of a second consumer to the UPS, so a display, for example, can be powered without interruption in addition to the Industrial PC (fig. 2).

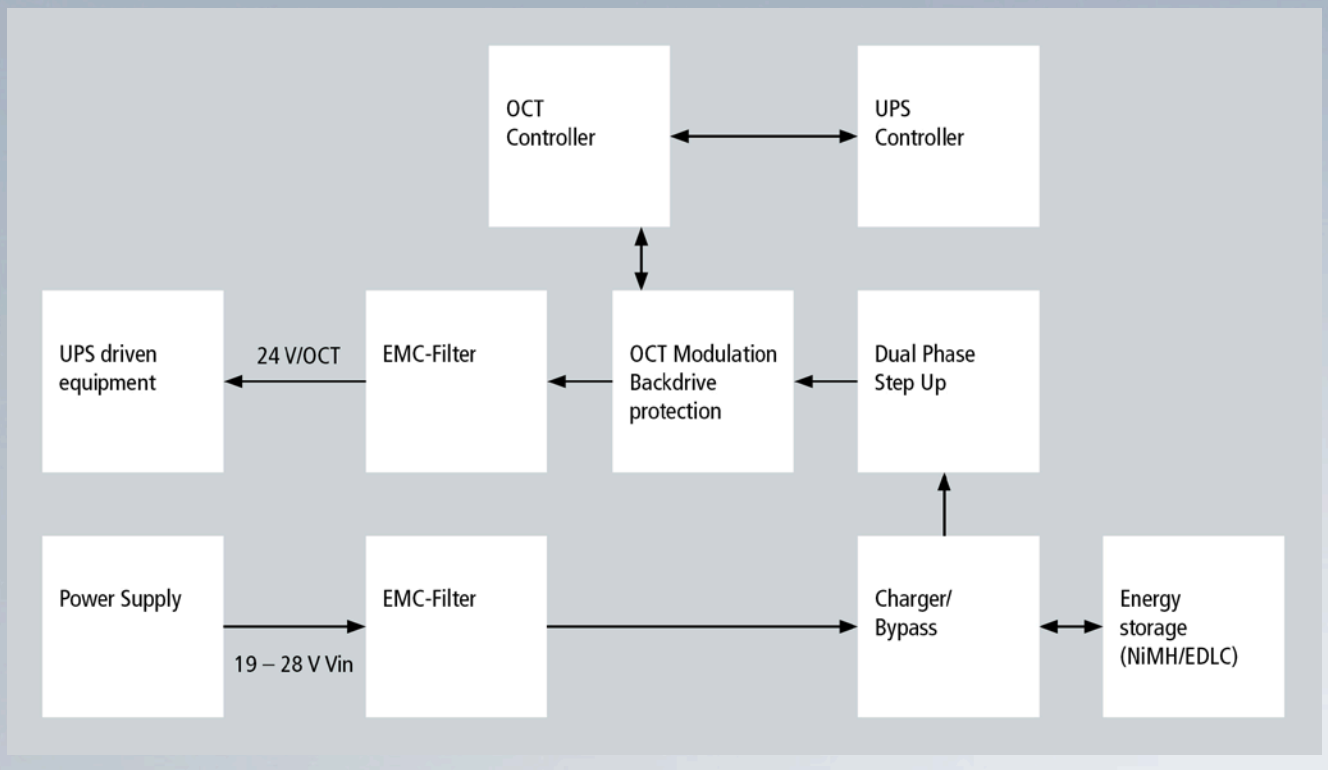

Fig. 3: Basic block diagram of a UPS from the CU81xx series

The previous UPS solutions from Beckhoff (e.g. the IPC UPS with lead-acid batteries or the integrated capacitive 1-second UPSs) are retained. However, the use of the new UPS technology in future product developments is preferred in order to replace the lead-acid batteries with the more environmentally friendly NiMH battery technology.

UPS series available with capacitors or batteries

The types of energy storage in the new UPS series have been chosen consciously, because both storage technologies – EDLC or nickel-metal hydride batteries – have their own advantages and disadvantages. One or the other technology will be more or less suitable depending on the application.

The key advantage of EDLC is that it is maintenance-free. Therefore, the energy module doesn't need to be replaced even after several decades. It is merely necessary during the initial design to make sure that the required amount of energy should be overdimensioned by a factor of 2 to 3. This is to make up for the disadvantage of EDLCs, which is that the charging capacity reduces over the course of years. It is proven practice to assume a maximum loss of capacity of 30% over a period of 10 years. This means, for example, a maximum loss of energy of 51% after 20 years or 66% after 30 years. In practical use, such double-layer capacitors have proven themselves to be maintenance-free energy storage devices capable of supporting high currents in numerous application examples – including and especially in UPS applications.

If you're looking for a storage device with a higher energy density than EDLCs, nickel-metal hydride offers many advantages as a battery technology:

– Newer NiMH batteries have no loss of capacity down to –10 °C.
– The number of cycles is around two to four times higher than with lead batteries.
– High discharge currents are possible.
– NiMH cells are free from cobalt and cadmium and, unlike Li-ion, are not classed as hazardous goods.
– NiMH cells are sealed and do not degas in normal operation. Nevertheless, adequate ventilation should be ensured in case there should be a fault.

Beckhoff recommends the replacement of NiMH-based battery modules after five years. In this context, great importance was attached to the ease of replacement and the best possible sustainability: after releasing just two fixing screws, the plug-in battery module can simply be pulled out of the UPS and replaced by a new module. The UPS electronics can remain in the mounted and wired state in the control cabinet and used further.

Functional principle of the UPS

The basic block diagram of the CU81xx UPS is shown in fig. 3. The input voltage V_{IN} typically comes from a single-phase (230 V) or three-phase (400 V) AC power supply, which provides the 24 V DC operating voltage on the secondary side, regulated or unregulated. The charging electronics takes the energy for charging the energy carrier, i.e. the batteries or capacitors, from this input voltage. The charging electronics ensures that all parameters of the energy carrier (e.g. maximum charge/discharge currents, temperatures, minimum energy) remain within the permitted limits.

If the input voltage is at least 20.2 V (24 V – 15%), the UPS, which is connected between the AC power supply and the load to be supported, always supplies at least 24 V at the output due to a step-up converter. If the input voltage drops below this value, operation is switched to UPS mode and the output is supplied by the energy storage device (UPS mode). The UPS then continues to supply

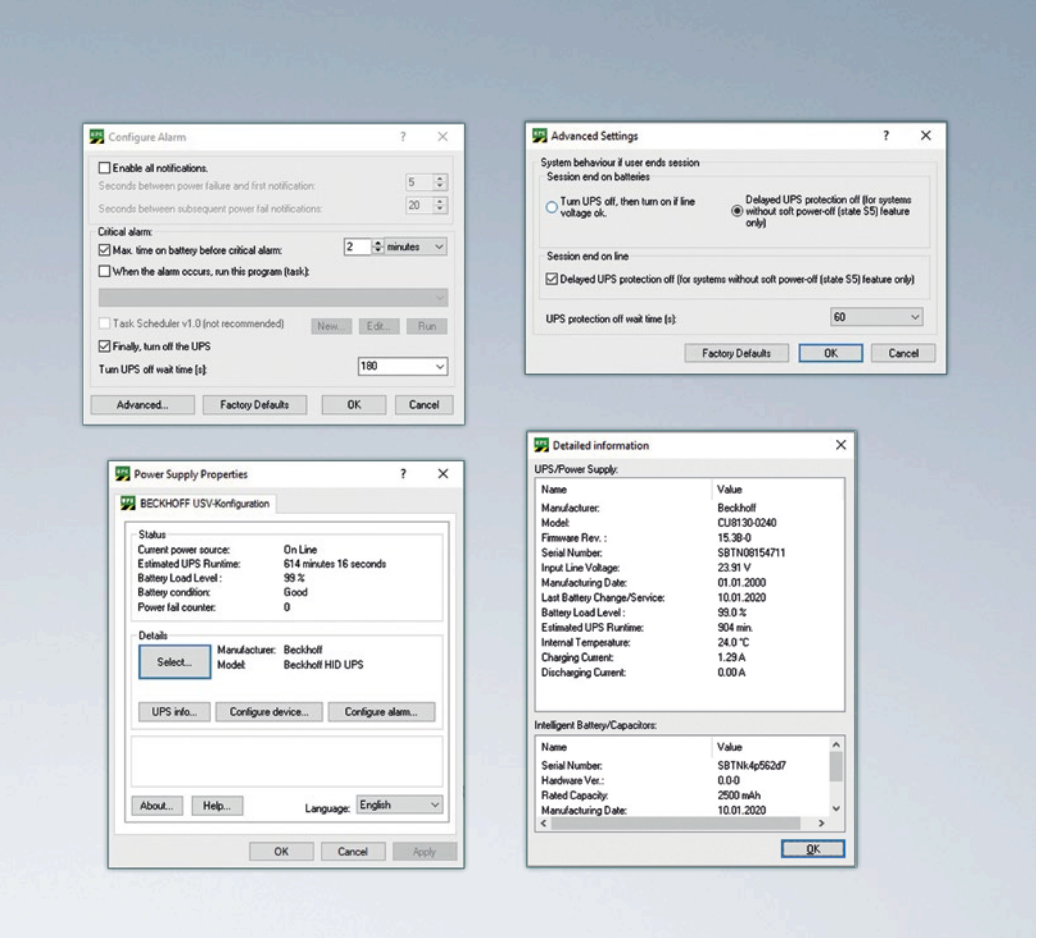

Fig. 4: The UPS software for the CU81xx series from Beckhoff displays all relevant UPS parameters and enables the flexible configuration of UPS functions.

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exactly 24 V. In the case of an input voltage from 24 V to 28.8 V (24 V + 20%), this is present directly at the output due to the bypass circuit. If the input voltage exceeds the threshold of 28.8 V, a transition to UPS mode takes place in order to protect the end devices. At the same time, an "overvoltage" warning is displayed. Therefore, less than 24 V and more than 28.8 V can never be present at the UPS output.

The CU81xx UPSs are wired via two 9-pin push-in plugs. The input voltage and the devices to be supported are connected to the left-hand connector. There are two outputs (+24 V, 0 V) for this – one for the combined communication/power supply and one for a further, non UPS-OCT-capable consumer (e.g. a display). The righthand 9-pin connector is equipped with digital control inputs and digital status outputs. The complete control of the UPS is handled by the central UPS controller, which orchestrates the interaction of all other microcontrollers (UPS-OCT communication, charge controller).

Transparent communication via UPS-OCT or USB

One of the particular advantages of the CU81xx DC UPS series is the various possibilities to communicate with the devices and in this way to query the status or to control the device state up to switch-off. The Beckhoff UPS-OCT One Cable Technology, i.e. the communication modulated onto the two supply lines (+24 V, 0 V) between IPC and UPS, is ideally suited for this. This is a half-duplex connection, which means that both sides can transmit and receive, but not at the same time. The use of the supply lines, which exist anyway, for the digital transmission saves having to use an additional data line, but requires both sides to be UPS-OCT-capable. This will initially only be possible with controllers from Beckhoff.

If UPS-OCT is not desired, or if the existing end device (older Beckhoff IPCs or third-party hardware) does not have this function, the connection can be realized via USB 2.0. The UPS can also be operated via digital 24 V I/O signals (e.g. with a PLC). For this purpose, the UPS provides information on the status of the power supply and the charge level and can be switched on and off via inputs. In this way, smaller machines can be brought into a safe state prior to shutting down, for example.

Whether you choose OCT or USB, the corresponding UPS software from Beckhoff offers the same parameterization and monitoring options in every case (fig. 4). It is currently available for Windows; other operating systems such as the new TwinCAT/BSD are being prepared. The software installs a UPS service and its function is independent of the TwinCAT automation software. PLC function blocks available in TwinCAT signal the UPS activation to the PLC programmer and enable an appropriate response on the part of the control program.

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More information:
www.beckhoff.com/cu81xx