

Power management with the fieldbus terminal

→ A new three-phase power measurement Bus Terminal for the Beckhoff I/O system allows power management using any fieldbus system.

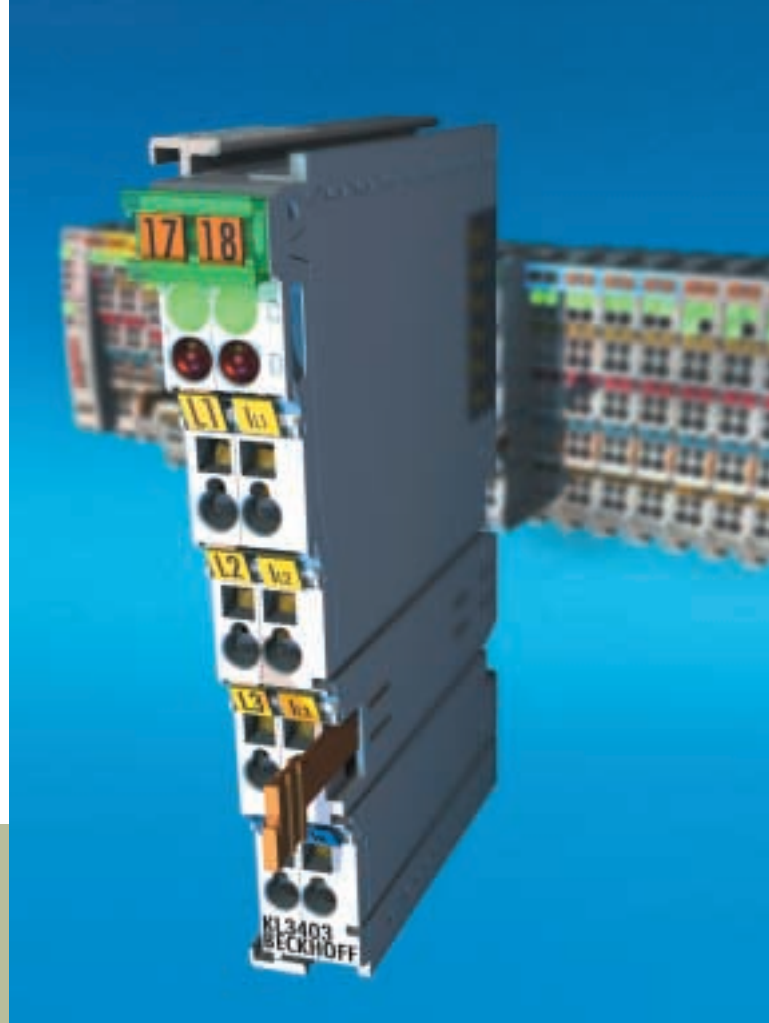
Optimization of energy use has long been a desirable goal, for more reasons than environmental conservation. Reduced energy consumption can be achieved through active power management with the new KL3403 Bus Terminal. Measuring and analyzing electrical current is the basis for monitoring and reduction of energy consumption.

The measuring facilities and the compact form of the new KL3403 Bus Terminal make it scaleable and economical for any power measurement task. Special energy management systems, whose function revolves exclusively around monitoring power, optimizing consumption and load interruption can be extended by the KL3403. A wide range of communication interfaces allows the terminal to be integrated into very different systems.

Fieldbus-independent transmission of measurements

Users can integrate expense/benefit optimization into their application by using the consumption data obtained from the connected loads. This includes, for instance, controlled switching on or off of electrical equipment, or statistical monitoring of electromotive consumers, leading to decisions related to preventive maintenance. A significant benefit is the possibility of broadening power management from a local fieldbus segment up to the possibility of global management functions. The KL3403 is operated like other Bus Terminals, and the measurements taken can be transferred via the Bus Coupler to various fieldbus systems, or, for instance, over Ethernet, to higher level control systems.

The possibilities of power management are of particular interest in the field of building automation. It can, for instance, be counter-productive for heating units to continue operating in a building with controlled air-conditioning at the beginning of the working period, when electrical consumption is running at a high level. The electrical power consumption can be used to provide "pre-regulation" to the heating controller, so that the increased production

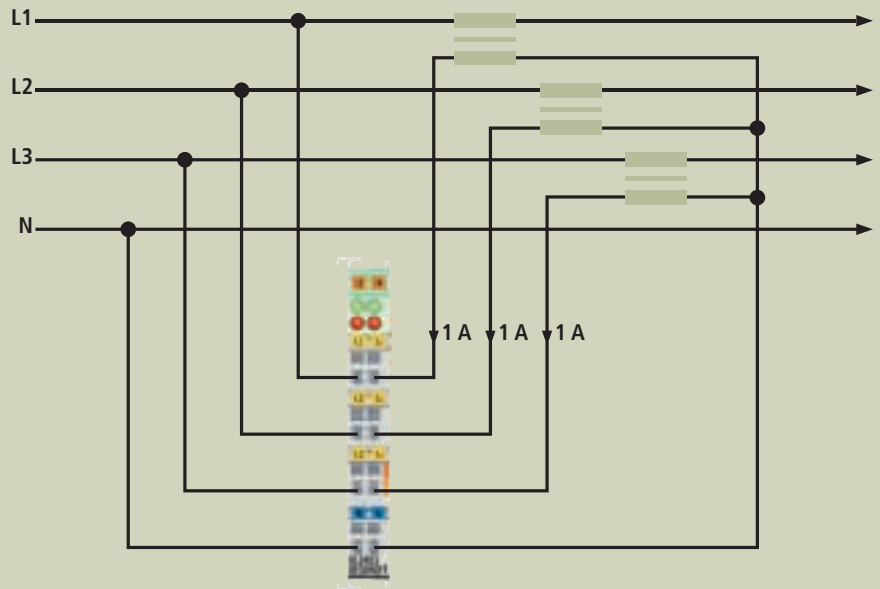


of heat does not inevitably lead to increased power consumption in the cooling system by the air-conditioning plant and fans. Hidden loads that unintentionally remain switched on overnight and at the weekend can be tracked down through the KL3403 Bus Terminal by detecting their consumption of electrical energy. Correlation of production figures, numbers of staff on site, external temperature and electrical energy consumption allow new possibilities for energy-saving to be found.

Comprehensive network analysis

The new KL3403 Bus Terminal enables the measurement of all relevant three phase electrical data. The voltage is measured via the direct connection of L1, L2, L3 and N. The current of the three phases L1, L2 and L3 is fed via simple current transformers. All measured currents and voltages are available as root-mean-square values. In the KL3403 Bus Terminal, the effective power and the energy consumption for each phase are calculated. All other information such as the apparent power or the phase shift angle $\cos \varphi$ can be derived through the relationship of the root-mean-square values of voltage x current and the effective power P. For each fieldbus, KL3403 provides a comprehensive network analysis and an energy management option.

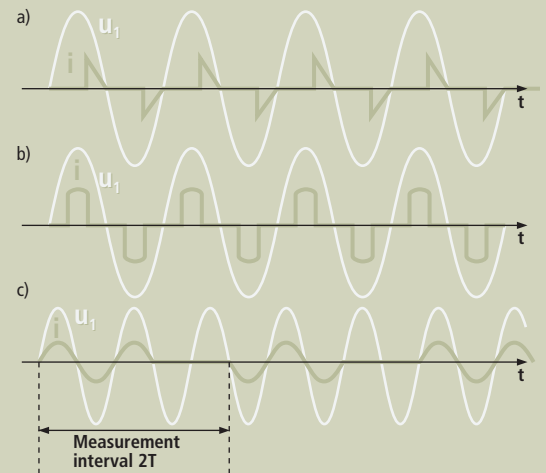
The basic technical principle of the KL3403 Bus Terminal is based on the KL8001 Power Terminal. The KL8001 Terminal, like a standard motor protection relay, is fitted to a power contactor up to a switching capacity of 5.5 kW. The power terminal switches the installed contactor and takes over all the functions of the motor protection relay. The power terminal can also carry out numerous diagnostic functions on the motor and make the information available to the controller via the fieldbus. The same applies to the KL3403 Bus Terminal. A combination of switching and control is not, however, necessary for every application. For this reason, only the measurement functions are integrated into the stackable standard Bus Terminal.



Developed on the basic principle of power measurement terminals, the KL8001 Power Terminal is also a master of switching.



Types of current that can be measured: The KL3403 can handle voltage and current curves under phase control (a), pulse duration control (b) and burst firing control (c). For burst firing control (c), the measurement interval of the KL3403 is set to equal the control interval, in this case $2T$. The KL3403 this always makes the current value available – without the necessity for further calculation.



Energy management and analysis in the terminal

The KL3403 Bus Terminal supplies the necessary electrical data for power management with "any" fieldbus connection similar to the KL8001 Power Terminal which supplies the necessary data for motor management. The KL3403 terminals data allows plant operators to control specific drives or machine components in an optimized manner, protecting them from damage or failure.

In addition to straightforward measurements based on instrumentation transformers, a wide range of diagnosis can be carried out with the KL3403 Bus Terminal. The mains voltage and phase angle are determined in addition to the current measurement function. The KL3403 calculates the apparent and active power of the loads that are actively connected from the voltage

and current. These values can be transmitted as instantaneous values, permitting very rapid reaction to changes. The calculation of the true effective value in the KL3403 Bus Terminal makes useful information available in the process image, which does not presuppose high computing power on the part of the controller. Even non-sinusoidal voltage and current curves can be read-in with a practical accuracy of 1% to 5%, depending on the type of curve. The cut-off frequency of the calculations amounts to 2 KHz. As the time interval for calculating the values can be adjusted, optimization is possible under a very wide range of circumstances.

The evaluation for each phase takes place independently. Adaptation for a very wide range of currents is achieved through external current converters. Failure of a conductor, or asymmetry in the current, is detected by

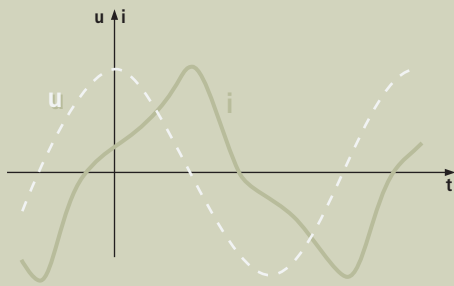
the KL3403 terminal, as is the fault current resulting from an earth short. The usable resolution of 16 bits means that a difference of 10 mA can be reliably detected when the full scale value is 60 A. The precision of the current measurement is largely determined by the quality of the instrumentation transformer. The use of electronic transducers also allows non-sinusoidal currents and DC to be measured. It is possible to determine the effective value and the power consumption of a load operating under phase control.

In-house energy counter

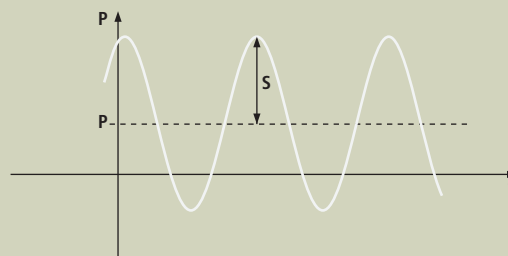
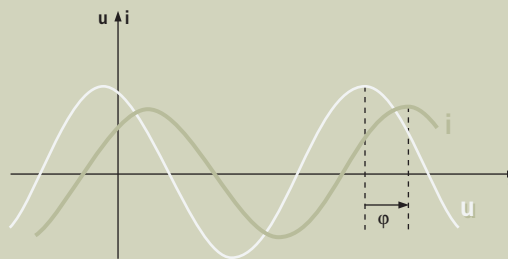
The KL3403 can be used as an energy counter for internal purposes. The counter can be read at any time, although resetting, in contrast, is protected by a pass-

word. This information is retained in the KL3403 Bus Terminal even when the power supply is switched off.

The KL3403 Bus Terminal is mounted on the mains voltage side. It can therefore continue to measure the mains voltage if the load is switched off in the course of power management. Integrated phase sequence monitoring protects against serious equipment damage, and configurable switch-off and alarm thresholds are used to monitor current and voltage. Critical conditions can be detected promptly in this way, and damage can be avoided. Measuring the current by means of transformers allows the installation at any location within the plant. The KL3403 requires a 4-wire connection. The low internal resistance of 33 mΩ minimizes transducer errors, and means that power dissipation is small.



Complex current curves in a coil: The KL3403 determines the root-mean-square value of the current along with the power dissipation and the apparent power from the complex current curve in a coil. It is possible to draw conclusions about the quality, loading or mechanical magnitude.



Calculating the power: The apparent power, S , is calculated from the product $u \times i$. This calculation is performed 64,000 times a second. The effective power, P , is the mean of these values, and depends on the phase angle, ϕ , in addition to the amplitude of u and i . The interval over which the effective power is to be calculated can be selected over a range from 5 ms up to several seconds, depending on the application. Periods of 5 ms, 10 ms, 20 ms or multiples of 20 ms are useful for 50 Hz mains.



Bus Coupler connects I/Os with Universal Serial Bus

The BK9500 USB Bus Coupler enables the integration of I/O signals without "real-time demand" into the PC world. Application examples are general metrology, environmental engineering, laboratory applications, collection of operating data or data loggers, among others. The advantage is that no additional hardware, such as PC card or interface adapter, is required, since nearly all PCs have a USB interface. In the Full Speed Version used, the transfer rate of 12 Mbaud is several times higher than with RS232. The connection to the fast periphery bus is established via the standardized USB connector, the distribution of the peripheral devices via hubs. A bus system with a maximum of 127 devices can thus be configured. System integration is straightforward and is done via the TwinCAT System Manager from version 2.8 .