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Application Report

Avoiding Risks of High-Voltage Motors

First temperature transmitter for motors up to 11 kV

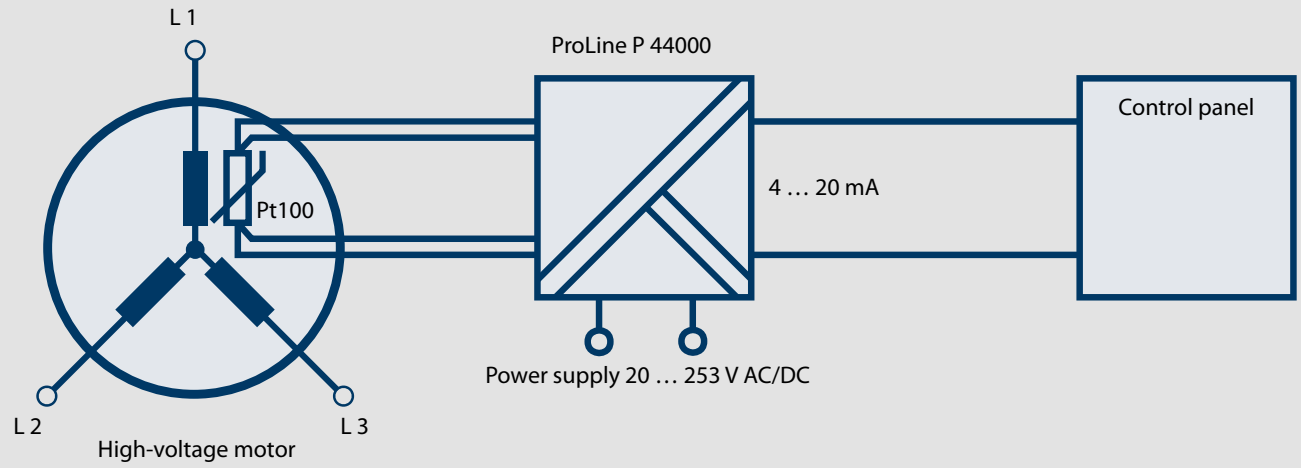

Image 1: The galvanic isolation of the slot thermometer by the P 44000 temperature transmitter provides protection in the event of rare insulation defects that cannot be excluded and ensures interference-free transmission of temperature information to the control panel even with long cables.

A large German company in the process industry that equips its plants with the best available technology has become aware of a previously little-noticed risk: Insulation defects of slot temperature sensors in high-voltage motors after years of use can present serious hazards to downstream systems and to the persons working on them. Knick has taken on the problem and closed this vulnerability with a temperature transmitter suitable for use in high-voltage motors up to 6.6 kV or 11 kV due to its extremely high isolation.

High-Voltage Motors in Continuous Operation

High-voltage motors as used in the process industry for fan, pump and compressor applications often carry out their service for years and decades without complaint. The motors are thermally monitored according to EN 60034-1. The temperature sensors used for this purpose – so-called slot thermometers – are insulated in the stator slots together with the windings of each motor phase and are used to detect increased temperatures due to insufficient cooling or overload. Their proper isolation is confirmed by a high-voltage test.

But the isolation is subject to influences in the course of many years of motor operation, which can lead to wear and at worst, to failure. Also carefully implemented isolation can be heavily burdened by transient overvoltages from the power supply, voltage spikes from converters, overvoltages by reflection, continuous mechanical and thermal loads and other effects. If the isolation breaks down, there is a risk of the temperature sensors becoming stressed by the high potential in a phase. The downstream systems and persons working on these systems are at risk.

Low Probability of Failure, but High Risk

Because conventional temperature transmitters offer no protection against high voltages, they redirect the applied motor voltage outward to the control system. Even if the probability of occurrence is low, the risk of damage including serious personal injury is relevant. For this reason, EN 61140 requires a second, equivalent and adequate isolation barrier for "protection under single-fault conditions" in addition to protection against electric shock.

The temperature transmitters, which are necessary anyway and are installed in the motor's terminal box, can act as this barrier. They must be designed according to standards and according to the potentially high voltage loads. Given motor voltages in the kilovolt range, however, it is clear that this is no trivial challenge.

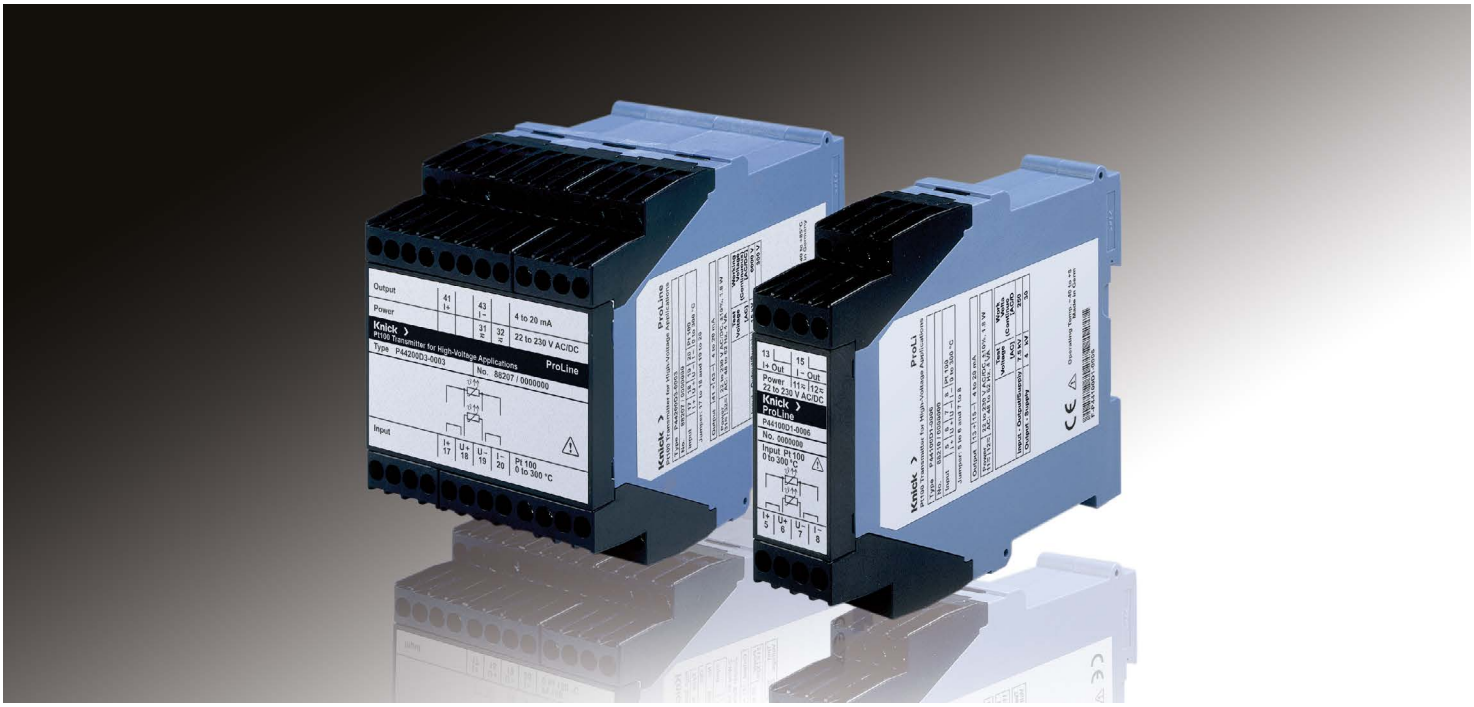

Image 2: ProLine P 44000 in the 67.5 mm housing for 6.6 kV and in the 22.5 mm housing for 2 kV working voltage

The Specially Developed Solution

The company that wanted to protect its assets against the risk described had sought unsuccessfully for market-wide standardized temperature transmitters designed for high-voltage motors. Ultimately, those in charge turned to the measurement technology specialists at Knick, who have handled devices for temperature measurement and high galvanic isolation of measured signals in industrial applications for decades. For the first time with the temperature transmitters of the ProLine P 44000 series, the company has now introduced products for monitoring high-voltage motors that combine extremely high isolation with high-precision detection of Pt100 slot thermometers.

The signal from these temperature sensors is transferred to the control system from the transmitter as a standardized 4 to 20 mA signal. The extremely robust galvanic isolation in the transmitter prevents the potential of the motor phase from redirecting in the simple case of a fault, i.e., in the event of insulation defects of slot thermometers: The basic insulation of the P 44000 withstands continuous working voltages up to 6.6 kV AC/DC and depending on the supply type, can be used for high-voltage motors with up to 11 kV rated voltage. Downstream systems are protected and compliance with the requirements of EN 61140, for example, can be ensured by a suitable system design. In the design, the voltage load on the sensor in the event of a fault must be considered, e.g., the phase to ground voltage, which is 11 kV / $\sqrt{3}$ = 6.4 kV for 11 kV motors in the IT system.

Overview of the ProLine P 44000 Features

The transmitters of the ProLine P 44000 series provide measuring ranges of 0 to 150 °C, 0 to 200 °C and 0 to 300 °C for all typical motor temperatures and achieve a high accuracy of typically ±0.5 K. Pt100 sensors can be connected in 2-, 3- and 4-wire circuits. Devices with a basic insulation of 6.6 kV AC/DC are tested using test voltages of 15 kV AC. Despite the high isolation, the transmitters in the 67.5 mm wide modular housing have very compact dimensions. The vacuum encapsulation ensures mechanical stability and high insensitivity against external influences.

In addition, due to their durability in ambient temperatures of -40 to +85 °C, the devices can be used in extreme conditions.

Unstable power supplies or reversed polarity do not affect the function of the transmitters. For medium insulation requirements at working voltages of up to 2 kV AC/DC (motors up to 3 kV AC), a narrow version of the P 44000 is available at Knick in a 22.5 m wide modular housing. All designs have the usual five year warranty from Knick.

Conclusion
When temperatures are to be measured using Pt100 resistance thermometers in environments of high electrical potential, standard temperature transmitters are often unsuitable due to their insufficient insulation.

Resistance thermometers can be insulated against high voltage. In practice, however, the available installation space is often too small.

Moreover, the insulation is weakened by thermal and mechanical aging. For temperature measurement on components of power electronics and monitoring of the winding temperature of electric motors and generators in particular, the high galvanic isolation of the ProLine P 44000 ensures safety.

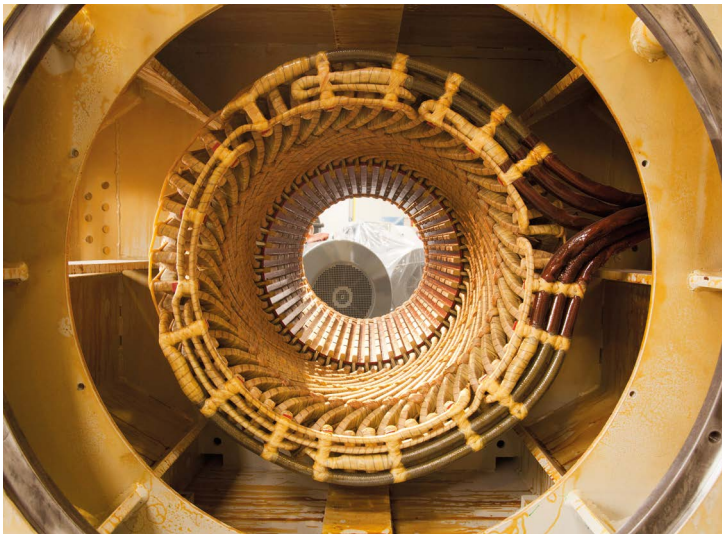

Image 3: Illustration of an open high-voltage motor

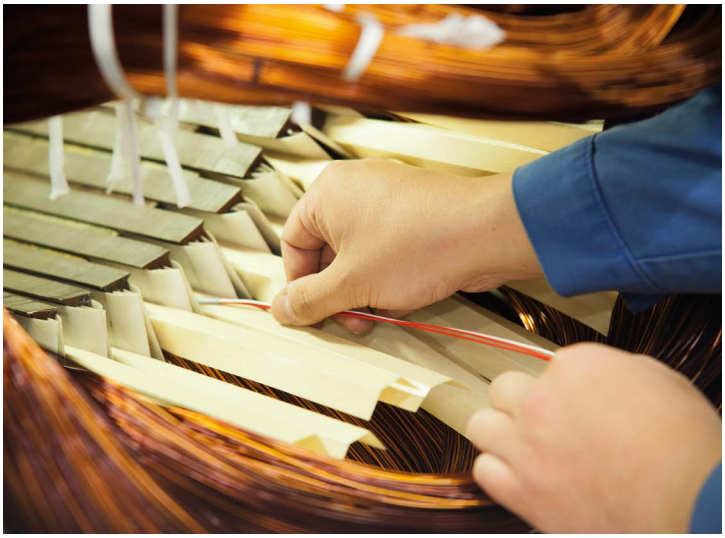

Image 4: Installation of a slot thermometer in an electric motor

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