Knick

Reliable Measurement and Testing Technology in High-Voltage Environments

Applications in the Energy Sector

THE ART
OF MEASURING

When precision meets long-term stability: Knick's high voltage transducers and signal conditioners keep you on the safe side even with the most complex applications—regardless of whether in power generation, transmission, distribution, or storage.

Why Knick?

For over 80 years, Knick has been developing solutions for current, voltage, temperature, and speed measurement. Signal conditioners and transducers from Knick deliver the signals required for downstream processes, always interference-free and with high precision.

Thanks to decades of experience in analog signal processing, functional safety, and electromagnetic compatibility, Knick lays the foundation for safe, reliable systems across all levels of the energy infrastructure.

Content

Knick—Electrical Measurement and Control Technology

Developed and Manufactured in Germany

For over 80 years, Knick has ranked among the leading manufacturers of electronic measuring devices. The Berlin-based company's high voltage transducers and isolated signal conditioners are successfully used worldwide in various sectors, including rail transport, power electronics, and high-voltage motors.

In 1945, engineer Ulrich Knick invented the world's first zero-point stable DC voltage amplifier—an absolute innovation for its time. Since then, Knick has been developing, manufacturing, and selling high-quality electronic measuring devices.

The long-term stability of measurement accuracy and exceptionally reliable current and voltage measurements at extremely high isolation requirements—up to 4,800 V AC/DC continuous voltage—characterize Knick's high voltage transducers.

Transducers and signal multipliers provide standard galvanic isolation between the three ports of the input, output, and power supply circuit. The 3-port isolation reliably protects against measurement errors caused by ground loops and the propagation of interference voltages. Input and output current circuits can be connected to any potential, taking into account the permissible operating voltage.

This distinguishes Knick from many other manufacturers whose transducers have the output signal galvanically connected to the auxiliary power. Knick integrates these functions and characteristics into a broad standard product range but can also develop customized solutions tailored to specific application needs.

Precision and Reliability—Made in Germany

Spirit of Innovation
New standards through expertise and technology—our driving force both then and now.

Performance
Optimal solutions for demanding conditions—challenges motivate us.

Precision
Sophisticated technology and meticulous verifications—accuracy is our standard.

Premium Quality
High-quality materials and exceptional reliability—outstanding products are what we deliver.

From Nuclear Energy to Green Hydrogen

Interface Technology for a Modern Energy Infrastructure

Energy systems are undergoing profound change around the world. The expansion of renewable energies is rapidly advancing and reducing dependence on fossil fuels. This transformation places new demands on the flexibility, stability, and structure of our supply grid—and on the measurement technology used for its monitoring and control.

How can the global power supply successfully transition into an "All Electric Society" and a CO_2-neutral world? Selected measurement technology plays a key role in applications: It must be not only extremely precise but also robust and stable over the long term. Moreover, galvanically isolated transmission of measured values ensures protection for people and equipment. Ultimately, providing signals with minimal delay and distortion is essential for the efficiency and control quality of many processes.

Knick's high voltage transducers and signal conditioners have proven themselves over decades in power generation, transmission, distribution, and storage applications. Our interface technology products have a vast range of uses: Current and voltage measurement in synchronous generators, monitoring large-scale battery systems, or tracking the performance data of wind turbines are just a fraction of the applications in which Knick impressively demonstrates its products on the following pages:

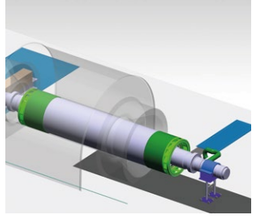
THE ART OF MEASURING

Conventional power generation

Renewable energies

Energy transmission and distribution

Energy storage



Current and Voltage Measurement in Synchronous Generators

Precise Signal Transmissions in Excitation Systems

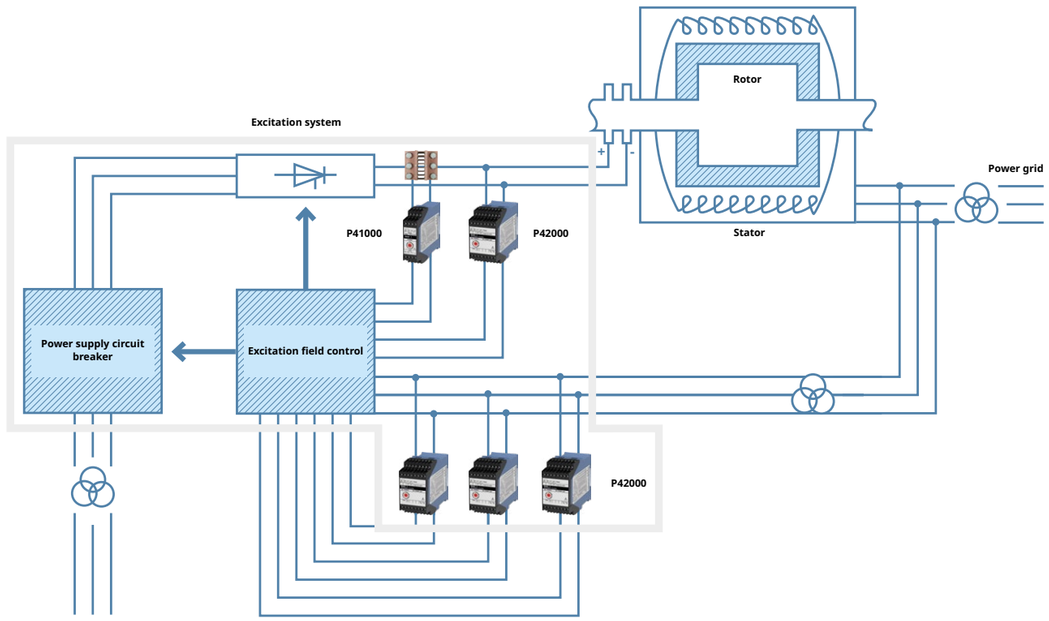
Thermal and hydroelectric power plants make a significant contribution to satiating the global appetite for energy. A key component of these systems is the synchronous generator, which ensures stability in our power grids.

This is no easy task. After all, frequency and voltage fluctuations in the grid require dynamic excitation systems on the generator side that must react immediately to power changes. If this fails, there are considerable risks for operating a power plant—from serious damage to the generators up to complete plant failure.

High Demands on Today's Excitation Systems

Excitation systems manage the most challenging tasks in synchronous machines, optimizing the generator performance while preventing damage or failure: They deliver direct currents of up to 10,000 A to the rotor windings of modern generators. Given such high currents, excitation systems require adequate isolation in accordance with IEEE 421. They also feature high control dynamics to be able to compensate for abrupt load changes by rapidly switching large consumers off or on.

To ensure precise and responsive control of the synchronous machine, excitation systems also monitor all relevant variables, such as exciter currents and generator terminal voltages.



Solutions with Long-Term Stability for Uninterrupted Power Generation

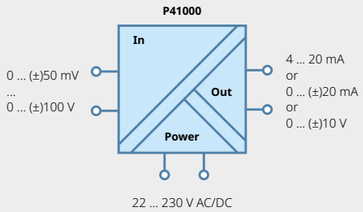
Transducers in the P41000 series are ideal for monitoring exciter currents. Current measurement is performed via the voltage drop across the shunt resistor, whose cables are continuously checked for potential wire breaks. A gain error of < 0.1 % of the measured value and a T_{90} response time of < 110 µs ensure a precise and nearly instantaneous transmission of the outgoing standard signal. This enables the excitation field control to react quickly to possible load changes and optimally control the generator.

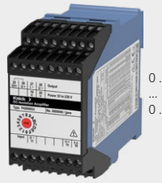
The generator terminal voltage is measured by P42000 series high voltage transducers. The signal conditioner determines the generator's output voltage and then transmits a distortion-free standard signal to the control system—with a gain error of < 0.3 % and a T_{90} response time of < 110 µs. The excitation field control is therefore able to correct measurement errors by adjusting the voltage in the rotor windings, keeping the output voltage of the synchronous machine constant.

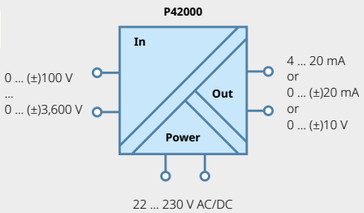
Why Knick?

The high voltage transducers of the P40000 family have stood the test of time in current and voltage measurement. Their basic insulation withstands continuous voltages of up to 3,600 V DC, as well as transient overvoltages of up to 20,000 V. Additionally, precise measurements of currents up to 20,000 A are possible. The product family boasts an exceptionally long mean time between failures (MTBF) of 2,700 years, based on independently verified field data. Beyond these outstanding specifications, both the P41000 and P42000 are suitable for mounting on DIN rails—and are extremely space-saving thanks to widths of just 45 mm or 22.5 mm.

5-year warranty







Product Highlights of the P41000 and P42000

- Precise measurement of high DC voltages and currents up to 3,600 V DC or 20,000 A
- Continuous shunt monitoring for detecting wire breaks (with P41000)
- Extraordinarily high MTBF of 2,700 years, based on field data
- Distortion-free signal transmission thanks to high cutoff frequencies
- Extremely low gain error
  < 0.1 % of the measured value (current) and
  < 0.3 % of the measured value (voltage)

Temperature Measurement in Water and Steam Circuits of Nuclear Power Plants

Signal Conditioners Approved for Nuclear Applications in Safety-Related Measurement and Control Circuits

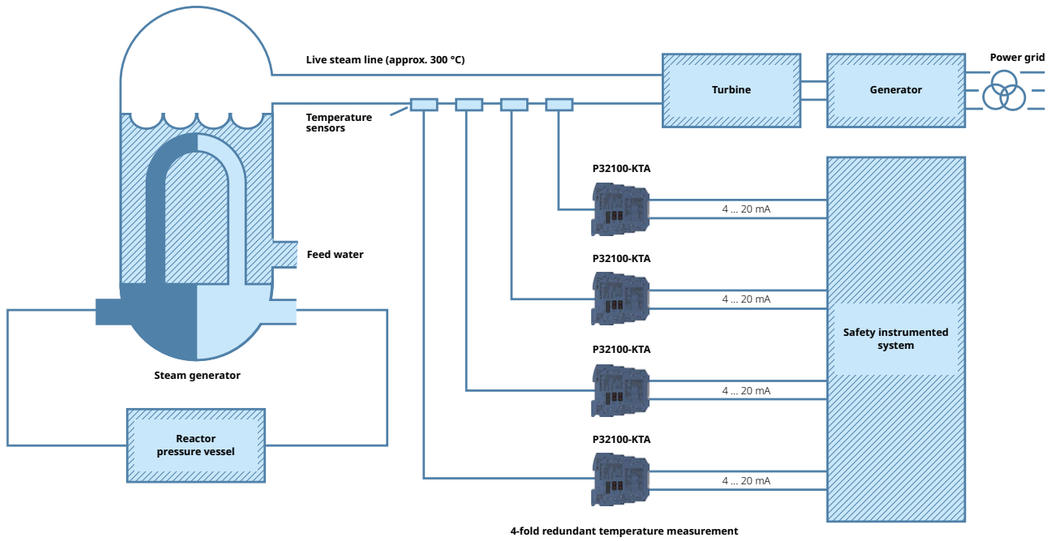
Nuclear power plants could play an important role in achieving climate targets. After all, they are capable of reliably generating electrical energy. Safe and efficient operation of the plant requires constant monitoring of critical parameters such as temperature.

Deviations could lead to reduced performance or, in serious cases, even pose a safety hazard. As a result, nuclear power plant operators place the highest demands on transmitters used for temperature monitoring.

Safety is the Top Priority

Temperature is monitored at numerous measuring points in a nuclear power plant. In order to improve the reliability of measurements, system operators rely on the principle of redundancy.

By using multiple sensors and transmitters, they aim to automatically detect faulty measurements and device failures. Consequently, safety-critical situations can not only be identified, but also immediately prevented.



4-fold redundant temperature measurement

Reliable Solutions for over 50 Years

Transmitters of the P32100-KTA series have provided a reliable and flexible solution for temperature measurement in nuclear power plants for years. They fulfill the specifications and standards of the German Nuclear Safety Standards Commission (KTA), are certified according to KTA 3503, and meet the specifications for functional safety in accordance with IEC 61508 thanks to their specially designed hardware and software.

P32100-KTA offers flexible use due to its broad compatibility with all common thermocouples and resistance thermometers, making it ideal for applications such as temperature monitoring of the secondary circuit. The sensor's measured value is precisely converted into a standard signal and transmitted with galvanic isolation to a safety instrumented system (SIS). The SIS can therefore react and counteract even the smallest temperature deviations in the circuit.

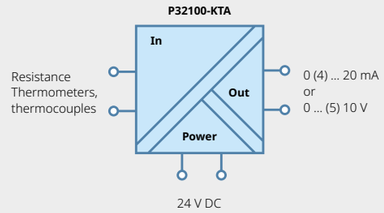
Why Knick?

For over 50 years, Knick has supplied transducers and signal conditioners for nuclear power plants. In addition to temperature transmitters, the range includes standard and universal isolated signal conditioners, signal multipliers, and AC and DC transducers. These are approved for use in safety-related measurement and control loops in nuclear power plants on the basis of type tests in accordance with KTA 3503 or KTA 3505. Knick supports a QM system in accordance with ISO 9001 and a system for nuclear power applications in accordance with KTA 1401 and ISO 19443.

5-year warranty

KTA approved

Safety Integrity Level
SIL 2/3
IEC 61508



Product Highlights of the P32100-KTA

- Recognized, type-tested temperature transmitter for nuclear applications
- Offers flexible use due to compatibility with all common thermocouples and resistance thermometers
- Meets the requirements for use in safety-related measurement and control loops in nuclear power plants
- Certified for SIL 2 and SIL 3 in redundant operation in accordance with EN 61508
- Menu-guided parameter setting via IrDA interface
- Minimal space consumption in the enclosure (modular housing just 6 mm wide)

Current and Voltage Monitoring in Photovoltaic Installations

Fewer Decentralized Measuring Points Required in Solar Parks

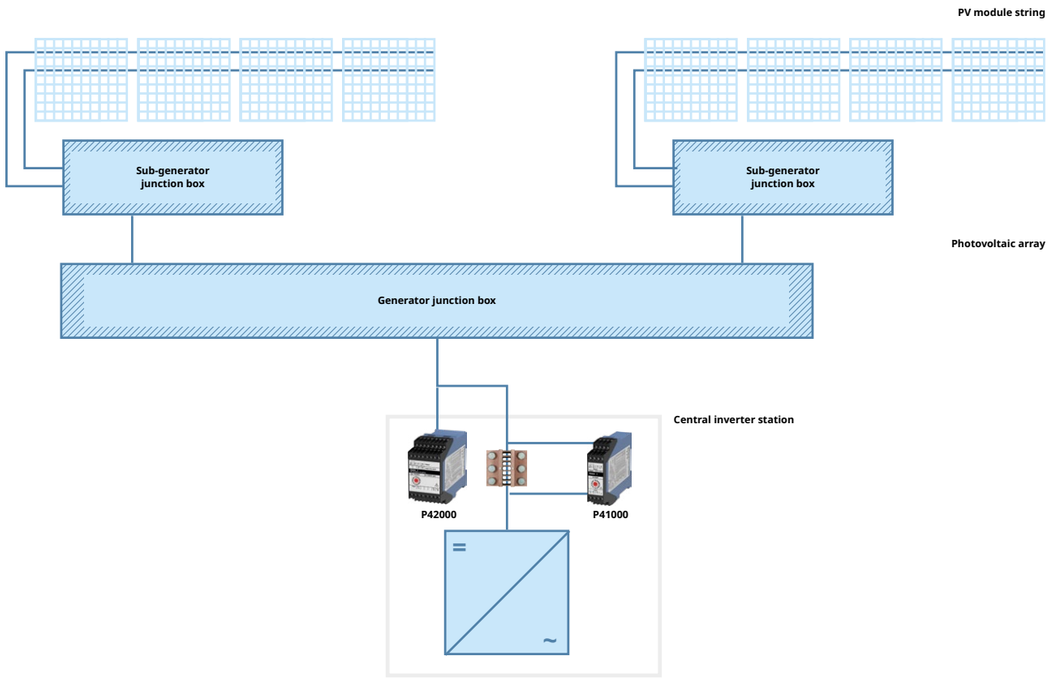
Solar parks are an essential component of the global energy transition. As a result, their expansion marches on relentlessly. For system operators, the priority is always the efficiency of their solar parks: Achieving higher output and better efficiency while keeping costs low.

Transitioning the system voltage from 1,000 V DC to 1,500 V DC appears to be the logical consequence. Operators can achieve both economic and safety advantages by using high-quality high-voltage measurement technology in the inverter stations.

Inverters: The Cornerstone of Every Photovoltaic (PV) Installation

Inverters are a key component of every solar park. They convert the direct current of the PV module into alternating current and then feed it into the power grid. Moreover, inverters monitor essential parameters of the installation, such as voltages, currents, and power.

This data is indispensable for purposes such as maximum power point tracking (MPPT), which can be used to optimize the performance of individual solar cells. Moreover, the transducers used in the inverter stations detect power drops caused by line interruptions and other faults at an early stage.



Reduction of Decentralized Measuring Points

If system operators rely on precise high voltage transducers in their inverter stations, monitoring can be centralized in many cases. This saves costs and reduces the number of measuring points that were previously needed on each string, which is a series of PV modules connected in series.

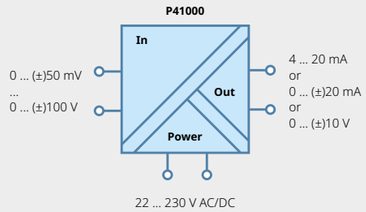
Transducers in the P41000 series monitor currents with a gain error of < 0.1 % and a T_{90} response time of < 110 µs, transmitting the measured values as a standard signal almost instantaneously to the inverter. This results in an exact total current measurement that enables system operators to detect minor deviations at an early stage and easily localize the reason for the fault in the PV installation.

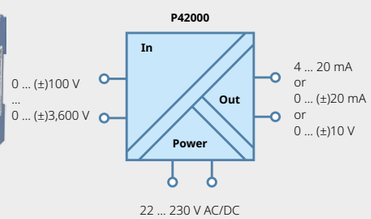
Transducers in the P42000 series have proven themselves in monitoring the (string) voltage. Due to their limited gain error of < 0.3 % and a T_{90} response time of 110 µs, P42000 devices guarantee precise measured values that facilitate the immediate detection of power losses and potential hazards such as overloads or short circuits.

Why Knick?

The high voltage transducers of the P40000 family have already demonstrated their reliability in current and voltage monitoring for solar parks. Their reinforced insulation for up to 1,800 V is ideal for PV installations with system voltages of 1,500 V and protects not only downstream control and evaluation systems but also ensures the safety of personnel. Additionally, the product family boasts an exceptionally long mean time between failures (MTBF) of 2,700 years, based on our field data.

5-year warranty





Product Highlights of the P41000 and P42000

- Reduction of decentralized measuring points thanks to high-precision centralized current and voltage measurements
- Extremely low gain error
  < 0.1 % of the measured value (current) and
  < 0.3 % of the measured value (voltage)
- Protective separation due to reinforced insulation for up to 1,800 V AC/DC
- Withstands operating ambient temperatures from -10 to +70 °C
- Extraordinarily high MTBF of 2,700 years, based on field data

Monitoring the Performance Data of Wind Turbines

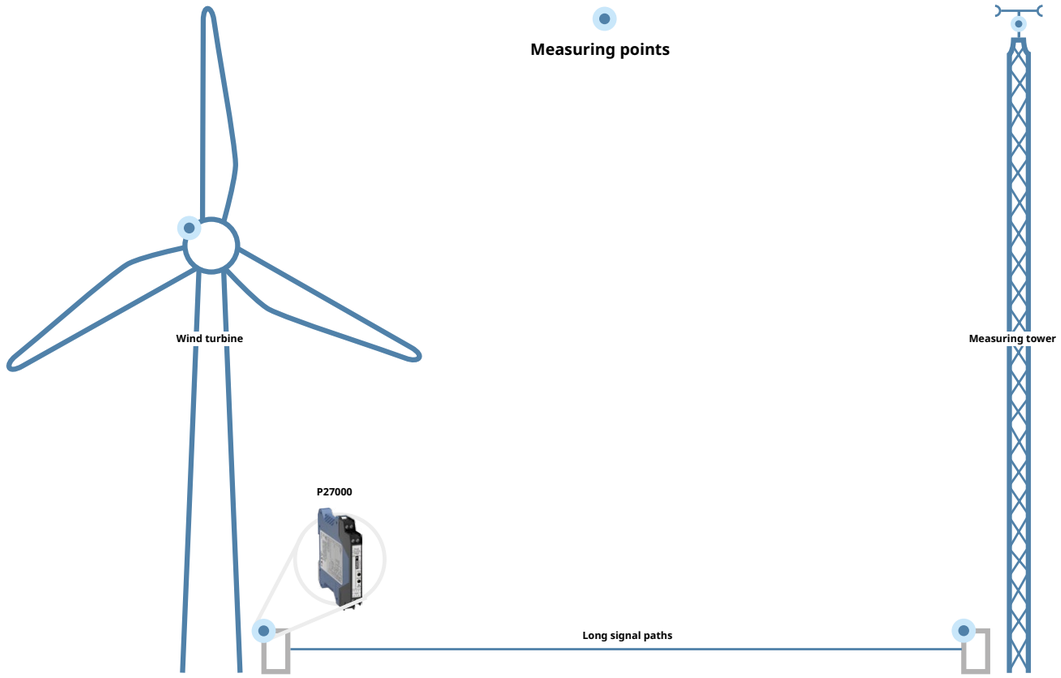
Floating Measurement Data Transmission over Considerable Distances

The performance data of wind turbines (WT) is essential for reliably assessing their efficiency. To ensure that the data can be meaningfully analyzed, it is compared with the measured values from a measuring tower erected at a greater distance, which serves as an independent reference.

The performance of a WT is tested over an extended period—a finicky task for the measurement technology used that considerably benefits in this situation from high robustness and long-term stability.

Technically Challenging: Data Transmission between WTs and the Measuring Tower

Successfully recorded measurement data are usually transmitted over a distance of several hundred meters between the wind turbine and the measuring tower. Signal transmission over greater distances poses a number of challenges, such as different earth potentials or transient overvoltages. These can cause faults or even damage to measurement technology, impairing the assessment of the wind turbine.



Therefore, signal conditioners with a low failure rate are used for measurements. These conditioners ensure galvanic isolation between the signal source and the analysis unit. At the same time, unipolar and bipolar signals from different systems, e.g., data loggers or SCADA, are converted into uniform standard signals for further processing.

Robust, Featuring Long-Term Stability, and Universally Applicable: The P27000 Series

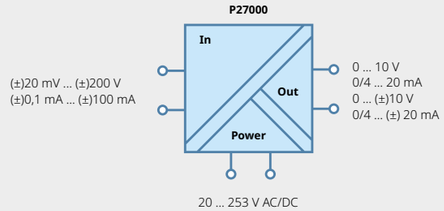
Universal isolated signal conditioners of the P27000 series have proven themselves as an optimum solution for monitoring performance data. With a mean time to operate between failures (MTBF) of 3,941 years, based on field data, the series demonstrates high availability and minimizes the risk of costly interruptions in measurement series over longer periods.

Thanks to a gain error of < 0.08 % and a temperature coefficient of < 0.005 %/K of the full scale value, P27000 devices consistently deliver precise measurement results, even with strongly fluctuating ambient temperatures.

Why Knick?

With 480 calibrated, switchable measuring ranges and a broad-range power supply for all common supply voltages, the P27000 is the “multimeter” among signal conditioners. The series guarantees a nearly perfect and instantaneous signal transmission thanks to a gain error of < 0.08 % and a T90 settling time of just 70 µs (at a cutoff frequency of 10 kHz). Moreover, the signal conditioners feature plug-in screw terminals for quick and easy assembly and a compact design.

5-year warranty



Product Highlights of the P27000

- Diverse range of applications thanks to up to 480 calibrated, switchable input and output ranges
- Temperature coefficient < 0.005 %/K of the full scale value
- Consistently high transmission quality
- No readjustment necessary
- Extremely low gain error < 0.08 %

Temperature Measurement in Wind Turbine Generators

Highly Insulating Temperature Transmitters Offer Protection Against Insulation Defects

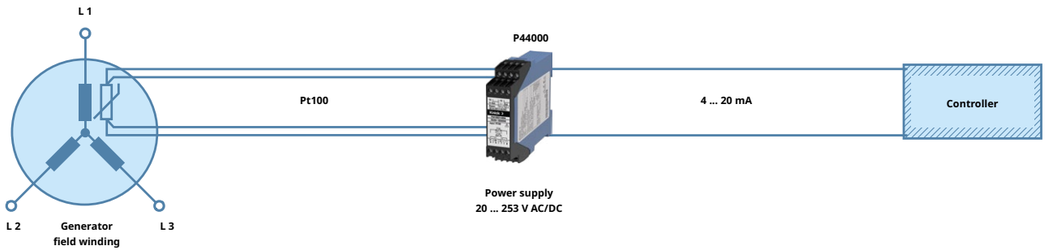
Continuous temperature monitoring in wind turbine (WT) generators is essential for the precise control of the turbine, because the desired high efficiency requires reliable temperature management—in particular the ability to counteract thermal overload at an early stage.

If an insulation fault occurs in the temperature detector at the generator, there is a risk of damage to the controller. As a result, the pitch control of the rotor blades could fail, potentially resulting in catastrophic turbine failure. WT operators therefore benefit considerably from highly insulated, robust measurement technology that reliably protects the controller, thereby preventing consequential damage.

Insulation Defects: An Expensive Risk

In gearless systems, where the nacelle of the wind turbine serves as a stator and the rotor is mounted directly on the rotor shaft, the temperature is monitored directly in the pole pieces of the rotor. Slot thermometers are inserted there for measurement. Since the effects of wear may occur even in carefully installed insulation, there is a risk that slot thermometers or supply lines may come in contact with the high potential of a phase and pose a hazard to downstream control systems.

High isolation of the transmitters that are used is therefore an essential prerequisite for preventing a thermal overload of the generator.



Excellent Insulation, Vibration Resistance, and Cold Resistance

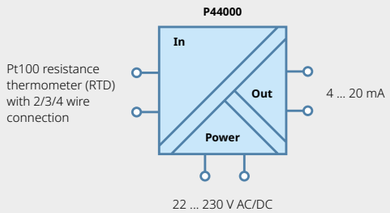
The P44000 series temperature transmitters have already proven their robustness in countless applications worldwide. They are designed for permanent working voltages of up to 6.6 kV DC and convert the signals of Pt100 slot thermometers into standard signals with a very low measurement error of typically ±0.5 K. This enables precise control of the turbine that is stable over the long term.

Moreover, the vacuum encapsulation and the high vibration and shock resistance of the transmitters provide the necessary mechanical stability required for installation on the rotating part of the generator.

Why Knick?

Where conventional temperature transmitters are unsuitable due to insufficient isolation, Pt100 transmitters from the P44000 series are used worldwide. Knick is able to develop customized solutions that easily withstand ambient temperatures ranging from -40 °C to +85 °C (as in the case of wind turbines), ensuring reliable operation despite these extreme conditions.

5-year warranty



Product Highlights of the P44000

- Unique high basic insulation for working voltages up to 6.6 kV AC
- Long-term insulating properties thanks to vacuum encapsulation
- Vibration and shock resistance in accordance with IEC 61373
- Suitable for ambient temperatures from -40 °C to +85 °C
- Very low measurement error of typically ±0.5 K

Detection of Short-Circuit Currents in DC Substations in Rail Transport

Optimized High Voltage Transducers for Detecting Rapid Voltage Surges

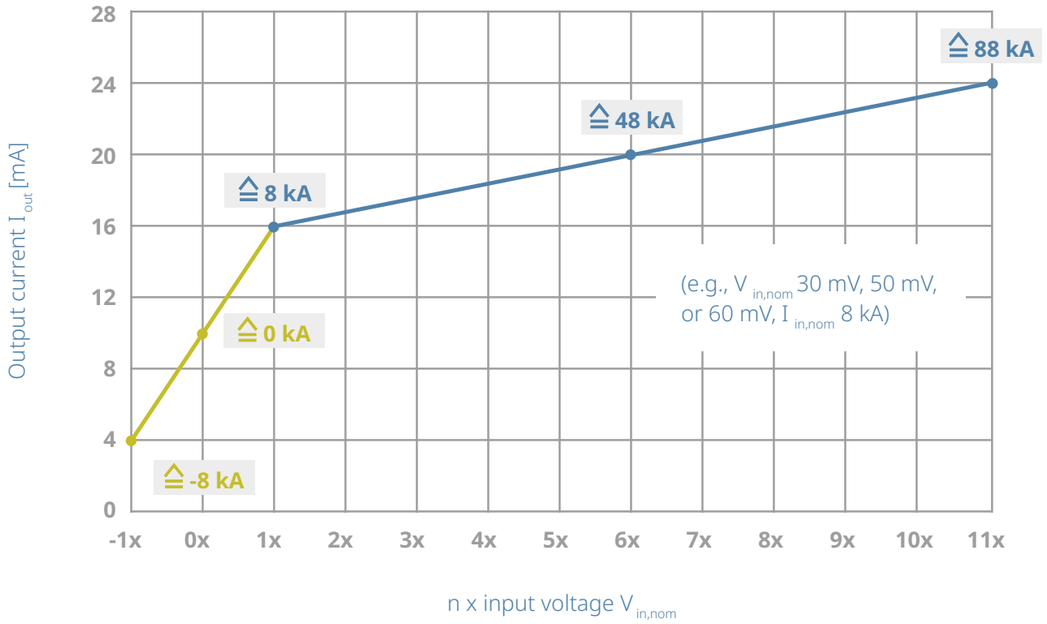
Protective devices in DC substations play a key role in ensuring the operational safety of the traction power supply. They reliably differentiate between the high current peaks from approaching rolling stock and error states caused by short circuits. To enable a rapid and targeted response in safety-critical situations, the use of precise measurement technology is essential.

Transducers play a key role in this regard: They must clearly identify different currents and errors and ensure distortion-free signal transmission even during rapid current increases.

Early Fault Detection: Indispensable for Safe Rail Operation

Circuit breakers in DC substations must respond immediately in the event of a short circuit or the formation of an arc and both quickly and reliably disconnect the affected network sections from the rest of the traction power supply. This is the only way to prevent thermal overloads or even fires.

High voltage transducers are crucial for maximizing system availability and ensuring safe regular operation: They monitor the level of the fed-in current as well as its rate of rise, in addition to monitoring contact line voltage, guaranteeing undistorted signal transmission even under the most demanding operating conditions.



Two in One: Adaptive Gain for Rated Current and Overcurrent Measurement

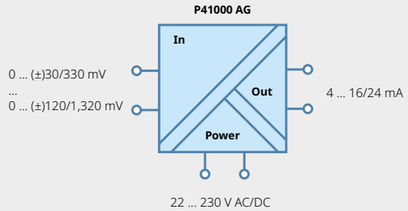
The high voltage transducers of the P41000 series have stood the test of time in traction power supply systems worldwide. The P41000 AG (Adaptive Gain) version is capable of measuring overcurrents in addition to regular traction currents. This is always used in combination with a shunt resistor. The transducers detect short-circuit currents up to 11 times greater than the nominal current with sufficient accuracy.

The transfer characteristic shown in the chart illustrates the two different gain ranges of the high voltage transducer: one for normal operation, the other for overload situations. The combined functionality saves customers the need for additional signal conditioners and extra measuring channels in downstream protective devices that would be required for detecting overcurrents. Moreover, the P41000 AG offers tremendous added value for the condition-based maintenance of protective devices since overcurrent measurements can usually be carried out right up until shutdown.

Why Knick?

Whether for current measurement in DC substations or in electrical test benches for the automotive industry, the P41000 AG series' high voltage transducers are ideally suited for current and overcurrent measurements. They have stood the test of time in thousands of traction power supply systems worldwide, where they impress with their high level of accuracy and reliability. With its excellent common-mode interference, a gain error of < 0.1 %, and a cutoff frequency of 5 kHz, P41000 AG devices provide an exceptionally precise and stable signal transmission at all times.

5-year warranty



Product Highlights of the P41000 AG

- Specially optimized for current measurement in DC substations
- Combined measurement of traction currents in normal operation and overcurrents up to 11 times greater than the nominal current
- Stable measurements and no undesired faults thanks to excellent common-mode interference
- Undistorted signal transmission even during rapid power surges
- Continuous shunt monitoring for detecting wire breaks

Voltage Stabilization in the Supply Grid

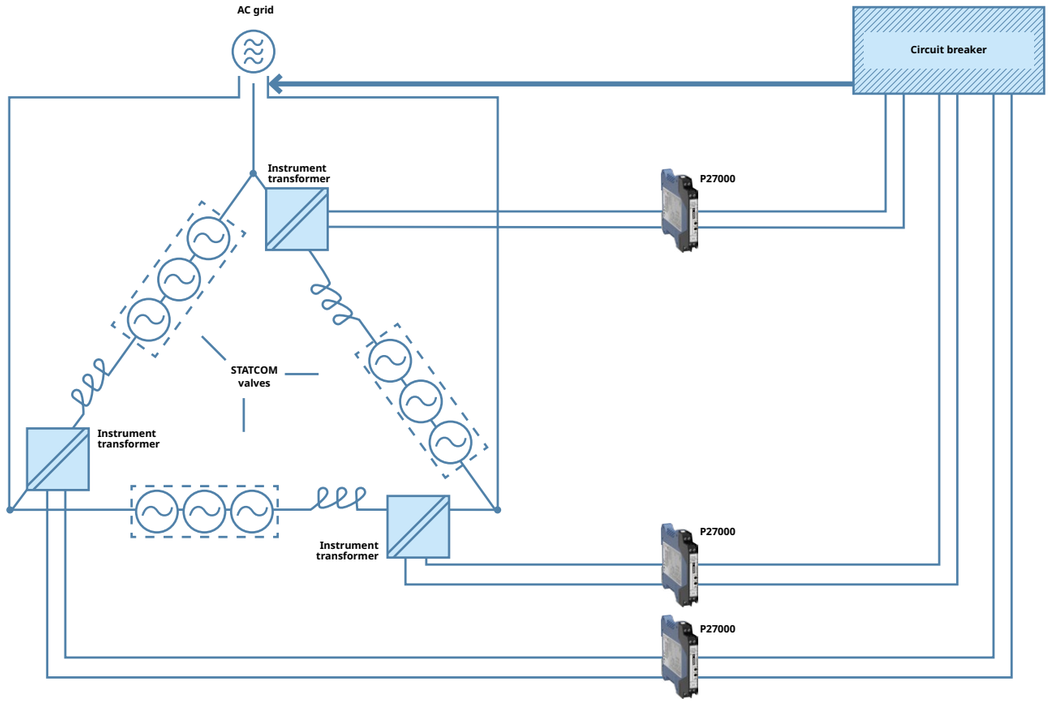
Protecting STATCOMs from Short-Circuit Currents

Over the course of the energy transition, conventional large-scale power plants are slowly being shut down. This leaves a gap in the provision of reactive power, an important instrument for stabilizing grid voltage. This task is now increasingly handled, among others, by STATCOM systems capable of rapidly compensating for fluctuations.

However, reliable voltage control can only be achieved if the system is effectively protected against short-circuit currents. It therefore requires signal conditioners that accurately transmit measured values to safety systems within microseconds.

A Key Technology for Modern Supply Grids

STATCOMs (static synchronous compensators) are power-electronic compensation systems used to stabilize the voltage in the supply grid. Voltage fluctuations are compensated as required by absorbing or feeding in reactive power. If the grid voltage drops, the system feeds capacitive reactive power into the grid; if the grid voltage is higher than that of the STATCOM, the device absorbs inductive reactive power.



If a short circuit occurs in the supply grid, the power supply to the STATCOM valves is immediately disconnected. Without this protective mechanism, the system's power electronics may be damaged, negatively impacting voltage control as a result. Current monitoring with the help of fast-responding signal conditioners installed at each of the three phases of the system ensures high availability of the STATCOM systems.

Optimum Protection Against Short-Circuit Currents with Knick's P27000 Signal Conditioner

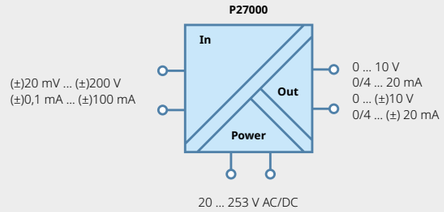
The P27000 series signal conditioners have proven to be an excellent solution for STATCOM manufacturers. Thanks to a high cutoff frequency of 20 kHz, these devices can process even rapidly changing input signals. With a gain error of < 0.08 % and a T_{90} response time of < 70 µs, the measured values are transmitted to the circuit breaker almost instantaneously.

The rapid signal processing protects not only the STATCOM components but also enables manufacturers to define higher overcurrent limits, thus optimizing their product's dimensioning.

Why Knick?

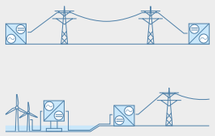
With 480 calibrated, switchable measuring ranges and a broad-range power supply for all common supply voltages, the P27000 is the "multimeter" among signal conditioners. The series guarantees a nearly perfect, distortion-free signal transmission thanks to a gain error of < 0.08 % and a high cutoff frequency of 10 kHz or, as in the application, 20 kHz. Moreover, the signal conditioners feature plug-in screw terminals for quick and easy assembly and a compact design.

5-year warranty



Product Highlights of the P27000

- High cutoff frequency of 20 kHz for distortion-free signal transmission; additional customized cutoff frequencies available on request
- Minimized reaction times during sudden input changes
- High EMC robustness
- Basic insulation for up to 1,000 V AC/DC



Monitoring and Control in High-Voltage Direct Current Transmission Systems

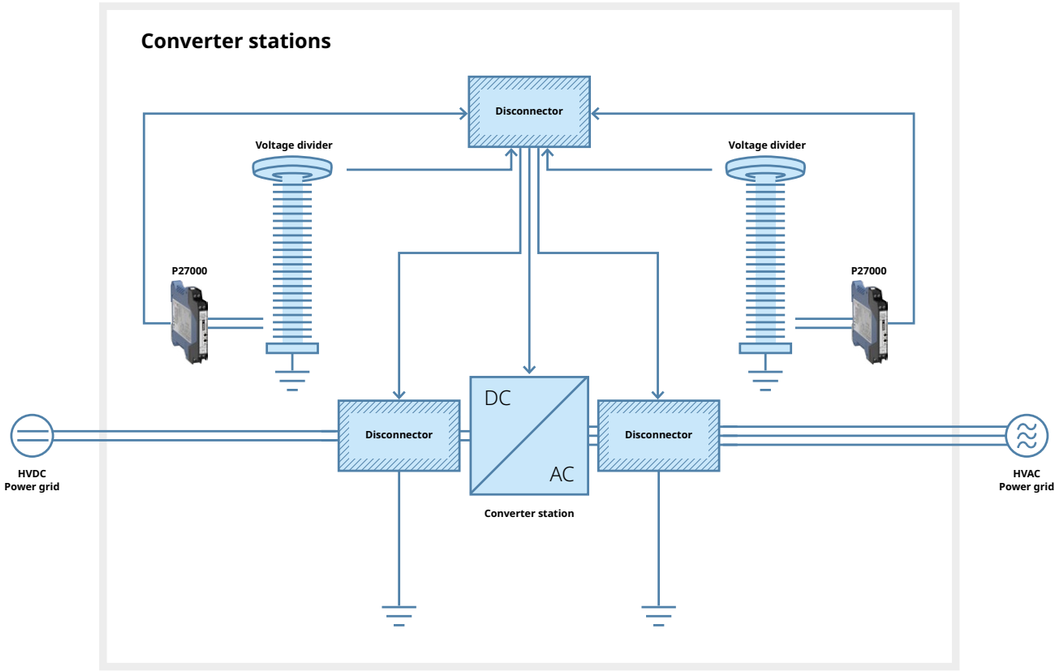
Reliable Voltage Measurement in Converter Stations

From offshore wind parks in the North Sea to ultra-long overhead lines in western China, high-voltage direct current (HVDC) transmission is deployed wherever conventional alternating current transmission reaches its technical and economic limits.

Modern HVDC systems operate at voltages of up to 1,100 kV. These high direct current voltages facilitate the low-loss transmission of large quantities of energy over long distances. Continuous, on-site voltage monitoring is imperative to ensure accurate and secure grid integration in converter stations.

Converter Stations: The Linchpin between HVDC Lines and the Power Grid

High-voltage direct current transmission offers a decisive advantage over long distances compared to alternating current transmission (HVAC): There are no reactive power losses caused by the capacitative coating of cables. To leverage the performance capabilities of the lines with maximum efficiency, HVDC systems operate at voltages of up to approximately 1,100 kV.



The direct current used for transmission is reconverted into alternating current in converter stations. Continuous voltage monitoring is essential for precisely controlling the grid integration of electrical energy and ensuring system safety. However, the high voltages of the HVDC systems cannot be measured directly. Resistive-capacitative voltage dividers that reduce the input voltage to a maximum of 200 V are required.

Reliably Measure Voltage with the P27000 Series

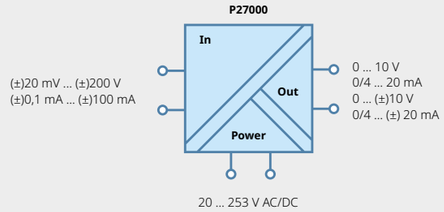
The high-speed signal conditioners of the P27000 series have proven their value in HVDC monitoring applications in converter stations. For the redundant measurement of partial voltages up to 200 V DC, the cutoff frequency of P27000 devices is tuned to 20 kHz according to the application requirements.

This allows system operators to ensure that measured values are transmitted to the appropriate control system with minimal delay, even during rapid voltage fluctuations. Basic insulation for up to 1,000 V AC/DC, combined with the signal conditioner's high EMC robustness, ensure reliable, precise, and safe signal processing.

Why Knick?

With 480 calibrated, switchable measuring ranges and a broad-range power supply compatible with all common supply voltages, the P27000 is the "multimeter" among signal conditioners. The series guarantees a nearly perfect and instantaneous signal transmission thanks to a gain error of < 0.08 % and a T90 settling time of just 70 µs (at a cutoff frequency of 10 kHz). Moreover, the signal conditioners feature plug-in screw terminals for quick and easy assembly and a compact design.

5-year warranty



Product Highlights of the P27000

- High EMC robustness
- Basic insulation for up to 1,000 V AC/DC
- High cutoff frequency for distortion-free signal transmission; customized cutoff frequency available on request
- High availability thanks to a MTBF of 3,941 years, based on field data

Voltage Monitoring in Electrolyzers and Fuel Cell Systems

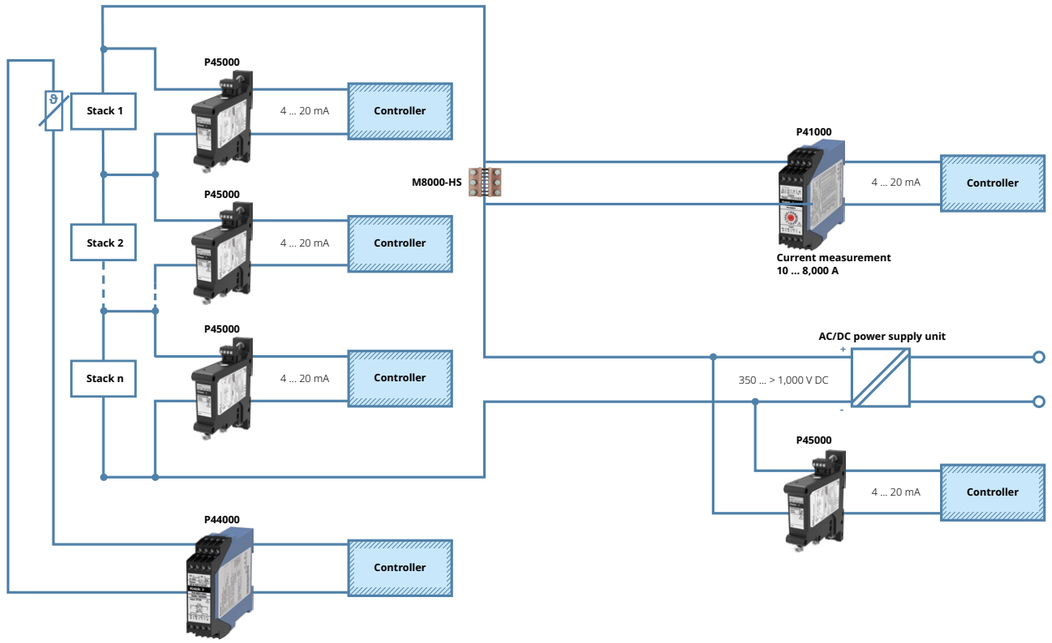
Early Detection of Cell Defects and Aging

Green hydrogen is regarded as a promising solution for the energy transition, especially because of its versatility. During production, water is broken down into its components in electrolysis cells using electricity from renewable energy sources.

This method can also be used, among other things, to indirectly store surplus electrical energy, which fuel cells can release again in an inverse process. The safety and availability of both systems depend critically on continuous, precise, and reliable condition monitoring of the cells.

Voltage Monitoring for Purposes of Diagnostics

Like fuel cell systems, electrolyzers are built from stacks. A single stack consists of numerous cells connected in series, each operating at a voltage of up to approximately 2.2 V. To achieve total voltages of several hundred volts up to 1,500 V for current hydrogen applications, system operators interconnect multiple stacks into so-called strings. The efficiency and reliability of these systems depend largely on the condition of the cell components, especially the membrane and electrodes.



To detect defects or signs of wear and tear at an early stage, continuous monitoring of high stack and string voltages is necessary in addition to current and temperature measurement where appropriate. For this purpose, the signal conditioners used must meet stringent requirements for reliability, accuracy, be low maintenance, and have robust isolation. Furthermore, transducers with SIL certification are becoming increasingly important for functionally safe voltage monitoring in electrolyzers.

Increase System Availability and Improve Safety with P45000

Whether for measuring the voltage of each individual stack or the total voltage of a string, high voltage transducers of the P45000 series have proven to be a highly effective solution for voltage monitoring. The P45000 series reliably detects even the slightest voltage changes, and partially redundant measurements minimize sources of error. System operators in high-voltage environments benefit particularly from the transducers, which support safety-oriented shutdowns of machinery and systems in accordance with IEC 61508.

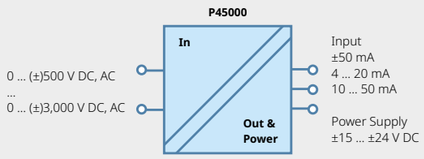
Why Knick?

The high voltage transducers of the P40000 family have already demonstrated their reliability in current and voltage monitoring for hydrogen applications. The P45000 series is also certified to SIL 2 (or SIL 3 in redundant configurations): a significant advantage in meeting the growing requirements for functional safety. The highly reinforced insulation of both series protects not only downstream control and evaluation systems but also ensures the safety of personnel. Lastly, a low gain error and short T_{90} response time ensure precise signal transmissions.

Reinforced insulation for up to 4,800 V protects against high potential differences that can occur due to the method of interconnection. Moreover, our transducers require no recalibration over their entire service life. This saves time and costs while avoiding disruptions to system operations.

5-year warranty

SIL 2/3 IEC 61508



Product Highlights of the P42000 and P45000

- Transducers with functional safety for SIL 2 applications or SIL 3 in redundant operation in accordance with IEC 61508
- Reinforced insulation for up to 4,800 V AC/DC
- Compact design thanks to fully encapsulated fixed-cable version
- Low gain error (≤ 0.1 %), rapid T_{90} response time (< 70 µs)

Monitoring Large-Scale Battery Systems

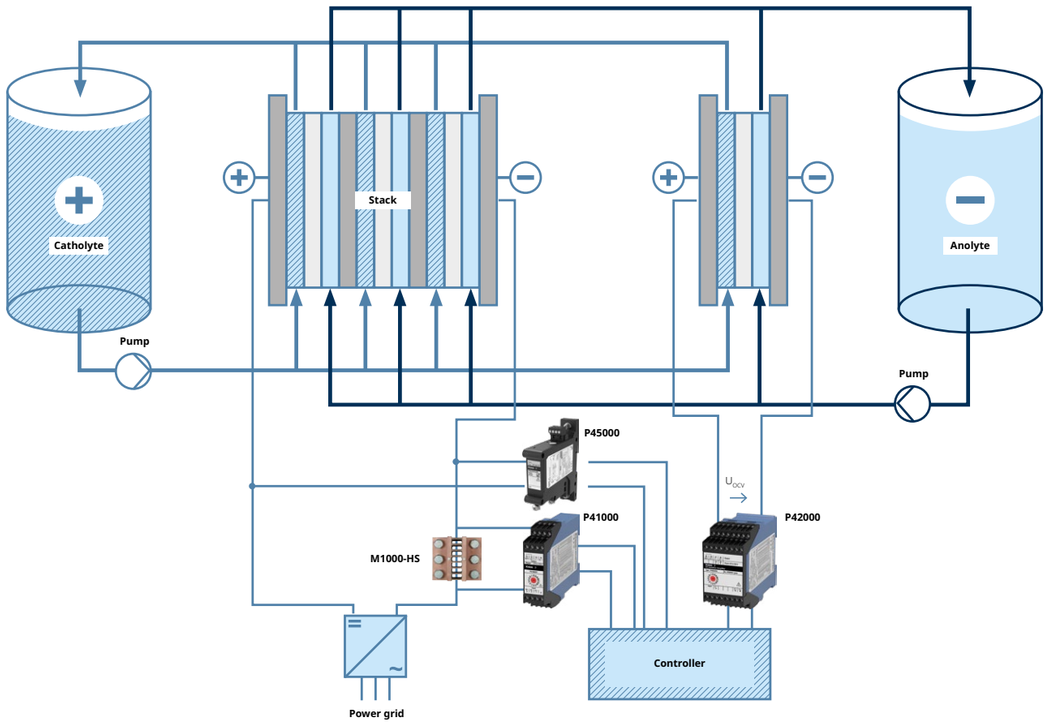
High Voltage Transducers with SIL Certification for Modern Storage Technologies

Photovoltaic installations and wind turbines are subject to weather-dependent fluctuations in energy production. This poses new challenges for supply grids worldwide.

Large-scale battery systems offer an effective solution: They store surplus energy, release it as needed, and stabilize the power grid. The safety of these systems depends largely on the precise measurement of stack and string voltage—and can be further enhanced through the use of SIL-certified high voltage transducers.

Redox-Flow Batteries: The Storage Technology of the Future

Redox-flow batteries (RFBs) are ideally suited for storing surplus energy from renewable technologies. They are easy to scale, feature a long service life, and offer flexible capacity expansion. RFBs use two separate tanks filled with electrolyte solutions, which are pumped through galvanic cells.



Through reduction and oxidation processes, electrolyte potential differences of a few volts develop on the cell membrane. System operators interconnect hundreds of these cells into so-called stacks, which are then combined into strings. Based on this design, large-scale battery systems achieve total voltages of up to 1,500 V DC.

Voltages and currents in the battery stacks and strings must be reliably measured for process control and monitoring. Measuring the open-circuit voltage U_{OCV} at a single tapped cell also provides insights into the state of charge as well as aging and degradation processes.

Increased Safety with SIL-Certified High Voltage Transducers

Highly insulated signal conditioners of the P45000 series have proven themselves in safety-critical applications such as voltage monitoring of large-scale battery systems, thanks to their certification in accordance with SIL 2 or SIL 3 in redundant configurations. Reinforced insulation for up to 4,800 V DC protects downstream control and evaluation systems from high potential differences.

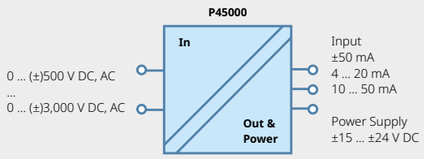
Why Knick?

Precise measurement of nominal voltages of up to 3,000 V DC, combined with SIL 2 certification (or SIL 3 in redundant configurations) mean that the P45000 series high voltage transducers are ideally equipped for all future energy storage applications. In addition to reinforced insulation for up to 4,800 V DC, a common-mode interference of > 150 dB ensures error-free measurement and protects downstream control and evaluation systems. The signal conditioners are compact and support flexible mounting: horizontally, vertically, or on a 35 mm DIN rail. Moreover, multiple P45000 devices can be stacked as needed without difficulty.

Unwanted disturbances such as electromagnetic interference are suppressed thanks to a common-mode rejection of > 150 dB. The result is accurate and reliable monitoring of the stack and string voltage.

5-year warranty

Safety Integrity Level
SIL 2/3
IEC 61508



Product Highlights of the P45000

- Transducers with functional safety for SIL 2 applications or SIL 3 in redundant operation in accordance with IEC 61508
- Flexible installation options
- Reinforced insulation for up to 4,800 V DC
- More compact design thanks to the fully encapsulated fixed-cable version
- Safe and precise measurement of small voltages at high potential levels

Product Overview and Suitable Fields of Application

	P32100	P27000	P41000 AG	P41000	P42000	P45000	P44000
Measuring Range							
Temperature, universal	●						●
Voltages up to 4,800 V/Currents up to 20 kA						●	
Voltages up to 3,600 V/Currents up to 20 kA			●	●	●		
Voltages up to 200 V/Currents up to 100 mA		●					
Basic Insulation AC/DC (Test Voltage)	**300 V (2.5 kV)**	**1,000 V (5 kV)**	**3,600 V (15kV)**	**3,600 V (15kV)**	**3,600 V (15kV)**	**4,800 V (20 kV)**	**6,600 V (15 kV)**
Areas of Application							
Electrolyzers and fuel cell systems		●		●	●	●	●
Functional safety	●					●	
Large-scale battery systems				●	●	●	●
Nuclear power plants	●	●			●		
Conventional power plants (steam, coal, gas)	●	●		●	●		
Photovoltaic installations				●	●		
Power supply grids	●	●	●				
Hydropower plants	●	●		●	●		
Wind turbines	●	●					●

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