

Potentiometers as Unmatched Problem-Solvers:

Position Measurement under Extreme Conditions

Rotary position sensors and linear transducers are available with a number of different physical principles. There is a perception that contactless technologies are inherently superior to potentiometers, but this is not accurate. Although contactless technologies have clear advantages in some applications, potentiometers have advantages in measurement precision, speed, temperature range and response to thermal changes, power consumption, susceptibility to electromagnetic interference, and cost. The following example of a diagnostic system in high-voltage circuit breakers illustrates the capabilities of potentiometers.

Potentiometers owe their reliability primarily to a simple design. They consist mainly of three components; the resistance element of conductive plastic ink on circuit board material, the wiper, and the input shaft or push rod. The input shaft or push rod moves the wiper, which changes its position on the resistance element. The wiper picks off a voltage from the resistance element that is proportional to the linear or angular position. This analog voltage output signal is absolute. If there is an interruption in the supply voltage, the output voltage instantly returns to the proper value as soon as the supply voltage is restored, without any need to re-reference to a known position. Tracking high speed motion is not a problem for properly designed potentiometers, and potentiometer output signals are available in real time, without any lag in reported position.

Potentiometers behave properly even under extreme environmental conditions. Because of the fundamental voltage divider technology, changes in temperature have little effect on precision. With proper design, potentiometers are insensitive to physical shock, vibration, and high acceleration values. Consequently, potentiometers are often used for

demanding applications.

Exact analysis of erosion with high-voltage circuit breakers

In Bremen, Germany, the Weis Company needed a diagnostic solution for high-voltage circuit breakers. These breakers are used in power plants, transformer substations, blast furnaces, etc. Voltages are between 60 kV and 1000 kV. When these breakers switch, a massive arc of electricity initially flows between the contacts until they either physically closed or are sufficiently far apart. The arc causes erosion damage to the contacts, and this damage increases with every switching event. The amount of damage is limited by designing the circuit breakers to have very high opening and closing speeds, but the contacts still sustain damage.

This erosion damage requires replacement of the contacts when the damage becomes excessive. The previously existing practice was to physically inspect the contacts for wear. However, this was difficult and costly, as it required opening the circuit breaker housing. The housing of these breakers is filled with sulphur hexafluoride gas, which is inert to prevent fires, but is expensive. After physical inspection, the housing must be refilled.

To solve this problem, a method was needed to check the condition of the contact without opening the housing. Weis solved the problem with the help of Novotechnik potentiometers. The Weis SA 100 is a durable, portable system for analyzing high-voltage circuit breakers. It provides data on the operational state of the circuit breaker contacts without having to open the housing. The SA 100 measures virtually all critical characteristics of high voltage breakers in one test, with up to 32 analog and digital channels. This includes the operate time and opening/closing speeds, as well as the dynamic measurement of contact surface current and transitional resistances.

Linear or round potentiometers for position detection

The operational speed and acceleration of the breakers is quite high, with accelerations in the range of 30 to 40 g, and velocities of 20 meters/second. To monitor these criteria, Weis engineers needed position transducers that could keep up with the high dynamic requirements of the breakers, and were rugged, reliable, and cost effective.

Weis found an ideal solution with Novotechnik conductive plastic potentiometers. Infrared sensors were considered, but would be many times more expensive, and provide no additional practical benefit. Novotechnik's potentiometers were not only extremely cost-effective, but they were easy to mount on circuit breakers of differing designs. Potentiometers of different types and lengths are used to adapt the SA 100 to a multitude of breaker designs.

For longer stroke requirements, Weis opted for the proven Novotechnik TLH series. These transducers are driven from the side, making for a much shorter transducer. The TLH is available in measuring lengths from 100 mm to 3.0 meters, and with repeatability of 0.01 mm. For short-stroke requirements, Weis selected the Novotechnik TS series. These are available with active stroke lengths of 25, 50, 75, 100 and 150 mm. A ball-style coupling for both types enables actuation free of play and lateral forces.

If the circuit breaker design does not permit use of a linear transducer, then a rotary angle sensor is required. For this need, Weis selected Novotechnik's IP 6000, with an excellent resolution of 0.007° and linearity up to +/- 0.025%. Lifetime durability for all three Novotechnik sensors mentioned above is 10 million rotations or strokes. "This has proven to be more than sufficient up until now for use in our test systems," explains Weis CEO, Detlev Weis, and if needed, "...it's easy to replace and doesn't cost all that much."