The InterNational Electrical Testing Association Journal

SUMMER 2017

NETA WORLD™

www.netaworld.org

IMPROVING SYSTEM RELIABILITY WITH OFFLINE PD TESTING

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2017 ALLIANCE RECOGNITION AWARD PAGE 84

ISSN 2167-3594 NETA WORLD JOURNAL PRINT
ISSN 2167-3586 NETA WORLD JOURNAL ONLINE

REQUIREMENTS FOR TESTING SWITCHGEAR QUICKLY AND ECONOMICALLY

BY CHRISTIAN STUDEN, *KoCoS Messtechnik AG*

Switchgear devices are situated at key points of electrical energy transmission and distribution systems. Their reliability has a decisive influence on the availability, safety, and economic efficiency of electricity supply systems. Switchgear devices are constantly exposed to the elements, such as dirt, moisture, and temperature fluctuations, which can have negative effects. They are often not operated for years at a time and then have to operate reliably up to 20 times within a very short period under fault conditions, like a thunderstorm. The demands placed on their operational reliability are extremely high.

It is essential to take preventive measures at an early stage in reaction to changes in breaker performance and to regularly acquire and verify all relevant device parameters. This should not be limited to the maintenance cycles in a revision plan. Various mechanical and electrical parameters can be instrumental in making a full assessment of the reliability of a switchgear device, including the main contact velocity, its stroke, and the operating time of the breaker. Deviations from the rated values can point to defects in the drive or in the main contact chamber.

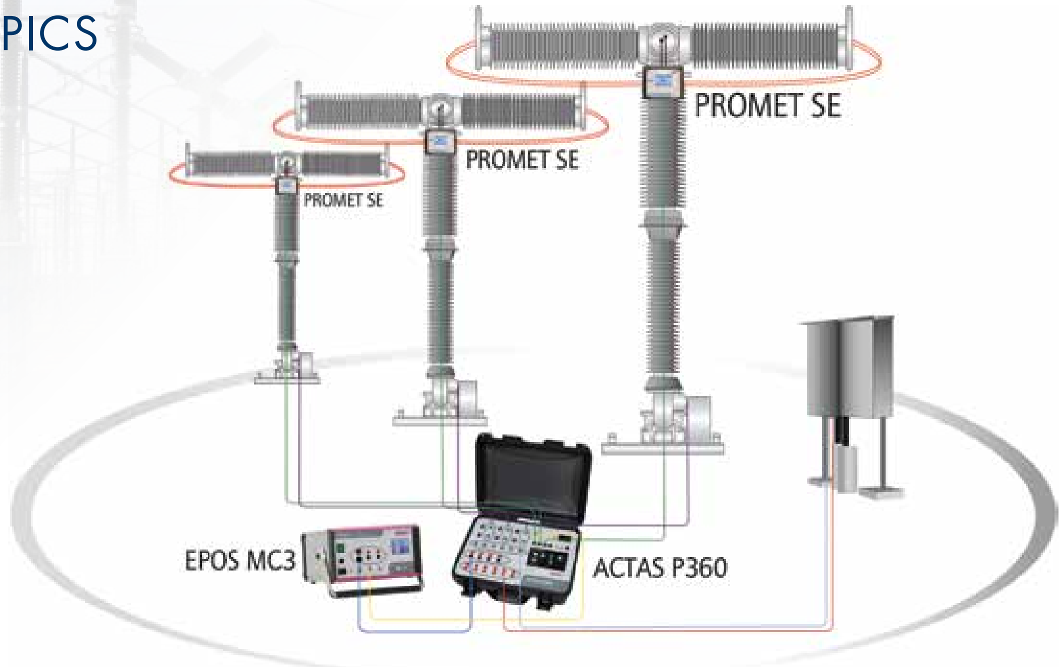

Figure 1: *Test Setup for an Outdoor Breaker*

Electrical as well as mechanical parameters are important indicators for detecting impending faults. The amplitudes and time-dependent characteristics of the operating currents of release coils, for instance, can give a good indication of what state they are in, as changes in the operating forces can occur as a result of mechanical wear and tear and usually show up directly in the amplitude and curve shape. For this reason, in addition to measuring main and auxiliary contact status, modern test systems are capable of measuring resistive contacts, coil operating currents, the operating currents of spring-charging or pump motors, valve pressures, and travel and mechanical main contact travel. Only then is it possible to investigate all the parameters that determine the reliability of a switchgear device and to assess the conditions inside the switchgear device without opening the drive or even the main contact chambers.

SIMPLE TEST TECHNOLOGY SAVES TIME AND MONEY

While demands placed on switchgear testing are increasing all the time, fewer personnel are available to carry out the tests, and the person carrying out the test may not have time to assess the recorded measurement data and results adequately. Modern test technology can provide tools for the automatic execution and evaluation of some test routines. A system solution with a switchgear test system, an ohm meter, and a motor-and-coil test system has a number of significant differences over all-in-one systems, including:

- Price advantage compared to all-in-one systems
- Stand-alone operation of each individual system for maximum flexibility
- Simple, joint operation of all devices plus central data management with the same testing software
- Common test plan for controlling the individual devices

Networking and flexible deployment of individual test devices allow conventional measurements to be carried out with one test setup when a system solution is used. Figure 1 shows the setup for testing an outdoor breaker. The ohm meters are put into position on the main contact chambers and are connected to the switchgear test system via only a data line.

Combining a switchgear test system with three ohm meters makes it possible to carry out dynamic and static resistance determinations on six interrupter units. In addition, the operating times of the main and resistive contacts of six interrupter units can be determined with a dynamic timing method. This is also possible when the switchgear device is earthed on both sides, ensuring that the most stringent safety criteria are fulfilled while considerably reducing the time and effort involved in cabling. With conventional measurement methods, resistance measurement may only be possible on one interrupter unit; for the outdoor breaker mentioned previously, this means that at least six measurements have to be made, taking up more time.

CONTACT TRAVEL VISUALIZATION

Unlike evaluation based on a simple binary signal, as used in high-frequency test methods, the use of switchgear test systems in combination with ohm meters enables a sound diagnosis of interrupter units throughout the whole switching operation. The measurement result is displayed in a curve that visualizes in detail all the events of a switching operation. This allows an accurate assessment of the start of travel and the final position of the contacts; it even reveals time differences between the movements of the main and resistive contacts.

ASSESS THE INTERRUPTER UNIT BY ANALYZING CONTACT RESISTANCE

Regular measurements of the static and dynamic contact resistance allow an accurate assessment of the condition of the entire contact system. This ensures that maintenance requirements can be identified at an early stage and downtimes kept to a minimum. With an ohm meter, contact resistance measurements can be carried out on up to six main contact chambers and can be incorporated directly in the test procedure. Using a state-of-the-art ohm meter, the test current can be set to a maximum of 200 A. Even very low resistance values in the single-digit micro-ohm range can be measured extremely accurately. The measured values can be used in the evaluation of tests and included in the test report.

A high-contact resistance within a switchgear device leads to high power loss coupled with thermal stress, which can cause serious damage to the switchgear device. Problems such as high transfer resistance resulting from poor connections can be identified by measuring static contact resistance. Dynamic contact resistance measurements can determine the resistance characteristic during a freely definable switching operation. These measurements, for example, give an indication of the length and state of the arcing contacts of high-voltage breakers (Figure 2).

Figure 2: *Analysis Monitor with Dynamic Resistance Determination*

MOTOR AND COIL TESTS

The ability to connect a powerful ac/dc voltage source makes it possible to test the correct functioning of the additional components of switchgear devices directly and independently of the station voltage. To perform an under-voltage release, as well as minimum reading test on coils, disconnection from the station supply and a connection to an adjustable power source is necessary.

PORTABLE TEST SYSTEMS WITH INTEGRATED CONTROL PANEL

In addition to carrying out the previous measurements, modern test systems also need to score high on functionality, ergonomics, and performance. An integrated control panel with touch screen, a streamlined operating concept, and powerful hardware guarantee simple operation with optimum display of all information. The user interface should be clear, well structured, self-explanatory, and user-intuitive. All test parameters

Figure 3: *A Compact Portable Hard-Top Case*

need to be displayed clearly, and it should be possible to set them directly. The measurement results should be shown on the display together with the associated signatures, enabling conclusions to be drawn directly as to the state of the switchgear device. The ability to control the test system using a smartphone, tablet, etc. can be an advantage, as this allows a test instrument to be remotely controlled, making it possible to carry out measurements at the prescribed safety distance.

The number of analog and binary signals measured differs depending on the type and design of the specific switchgear device. The requirements for a test on a medium-voltage breaker with only one interrupter assembly per pole and a three-pole spring energy drive are much less exacting than for a test on a high-voltage breaker with four interrupter assemblies and a single-pole hydraulic drive. Switchgear test systems need versatility to fulfill these different requirements.

QUICK, EASY HANDLING AND INTUITIVE TESTING SOFTWARE

Direct integration in a rugged, hard-top case makes a test system able to withstand dust and water. Low weight and compact dimensions are ideal for on-site use (Figure 3). The weight of cables and accessories should also be taken into account, as many technicians travel all over the world with their portable test systems.

Time is often the limiting factor when preparing tests, connecting cables, and carrying out tests on site. With some software, tests can be prepared in full with all the necessary switchgear and test parameters. No further settings need to be made on-site, and the desired test can be carried out without delay. Once the device under test has been connected to the test system, the test prepared in advance can be started and run immediately.

Configuration and analysis of tests can then be carried out with the aid of testing software and the control panel located on the test system itself or a PC. Test data and parameters can be imported or exported as required using a USB flash drive or network connection. Another useful feature is a graph of all measured signal characteristics, featuring zoom functions and measurement cursors and offering additional options for detailed analysis. This makes it easy for tests to be called up, edited, or used as templates. Some systems can compress switchgear data and measurement results and send them by email. Archiving the data in databases can also be an important feature.

Following fast test execution, modern devices should help evaluate the measured results. It should be possible to set limits as well as options for subsequent calculations or recalculations with the raw data from the test systems. At the end of a test, a modern test system can often directly provide a test report.

Christian Studen *is Product Manager for Circuit Breaker Test Systems at KoCoS Messtechnik AG in Korbach, Germany. He provides product and application support to distributors and customers throughout the world. Christian joined KoCoS in May 2013 and spent the first two years on the Service & Support team acquiring knowledge and practical experience in electrical power engineering. After completing an apprenticeship as a power electronics installer with Viessmann in Allendorf, Germany, Christian earned a B.S. in Electrical Engineering at the University of Applied Sciences in Lemgo, Germany. While working towards his M.S. in Mechatronic Systems, he was employed as a research assistant in the power electronics laboratory.*