OMICRON

Testing and Diagnostics of Reclosers and Sectionalizers

Recloser and sectionalizer technology

Contents

Many utilities in the distribution segment deploy reclosers and sectionalizers to improve the distribution system's reliability. Both are usually mounted on power poles to save site preparation costs.

Reclosers

... reduce customer outage minutes for permanent and especially temporary self-clearing faults, for example if a falling branch of a tree hits the line. For this purpose, they detect the fault current in the event of a fault. Reclosers are a more cost-efficient option than adding breakers or substations when applicable.

Sectionalizers

... are typically installed downstream of a recloser. They detect and count the successive fault current interruptions of the recloser and, if the fault persists, isolate the particular section after a preset number of counts. Because they are not rated to interrupt fault current they are less expensive compared to a recloser.

ARCO 400
An easy solution to test the recloser control

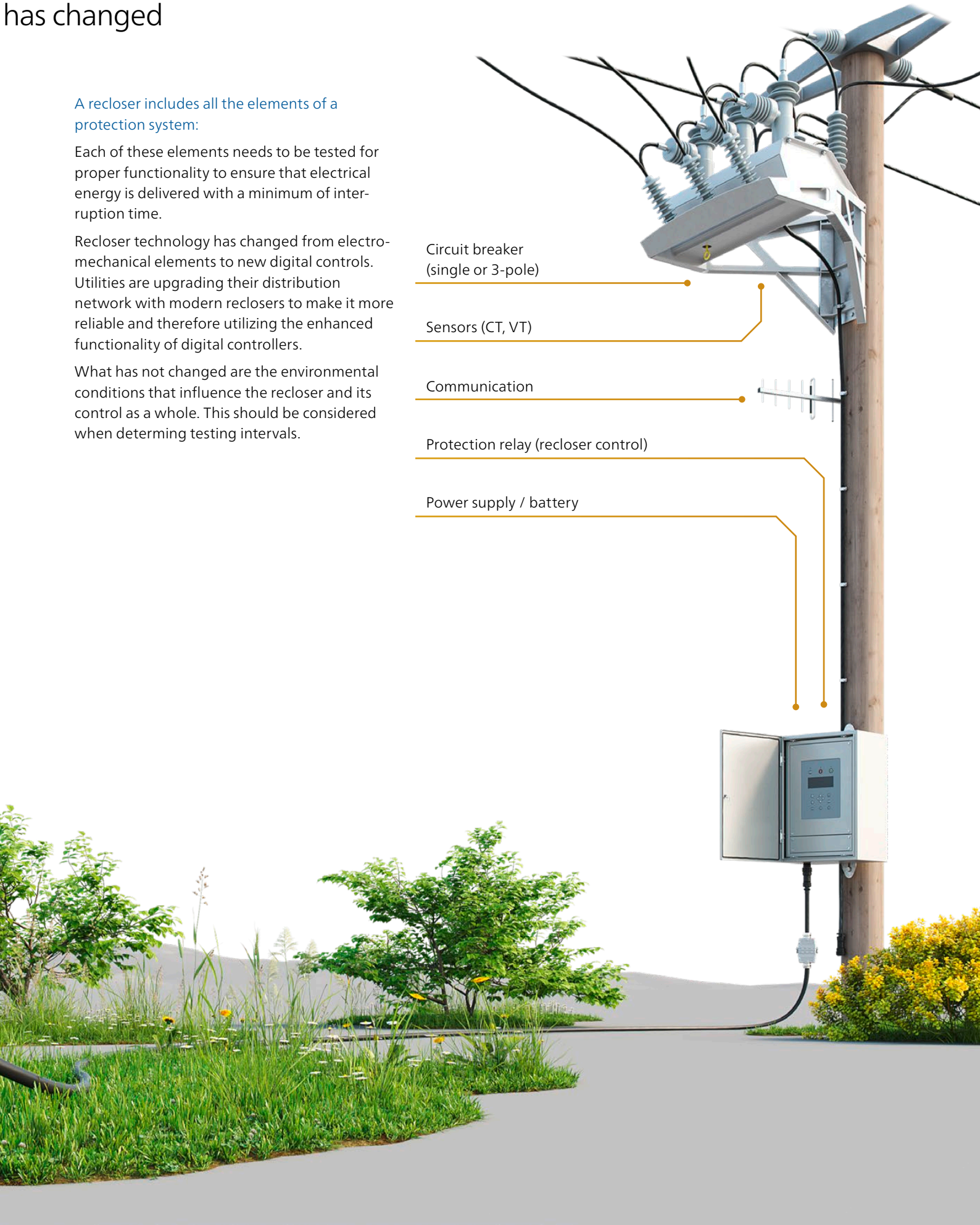
has changed

A recloser includes all the elements of a protection system:

Each of these elements needs to be tested for proper functionality to ensure that electrical energy is delivered with a minimum of interruption time.

Recloser technology has changed from electromechanical elements to new digital controls. Utilities are upgrading their distribution network with modern reclosers to make it more reliable and therefore utilizing the enhanced functionality of digital controllers.

What has not changed are the environmental conditions that influence the recloser and its control as a whole. This should be considered when determing testing intervals.



The need for comprehensive recloser testing

Regulatory requirements

Only in a few countries are there regulatory requirements for testing and maintaining protection systems. For example the North American Electric Reliability Corporation (NERC) defines test and maintenance requirements for protection systems (www.nerc.com) in North America.

The yearly NERC assessment for misoperation has shown that the three largest causes of misoperations remained the same over the last couple of years:

- Incorrect Settings/Logic/Design Errors
- Relay Failure/Malfunctions
- Communication Failures

Causes of misoperation

A misoperation can be caused by literally every component that is part of the protection system and is categorized by relays, reclosers, communications, AC systems, and DC systems failure.

Incorrect settings as well as logic and design errors are the biggest causes of misoperations.

Maintenance prevents nasty surprises

That's why the NERC PRC-005-6 standard "Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance" requires the development of a comprehensive protection system including maintenance and testing processes.

This also includes recloser control tests that are part of the load shedding and restoration plans that effect the Bulk Electric System (BES).

All reclosers affecting the BES must be maintained and tested in accordance with the standard. This includes Evidence Retention, Monitoring, and Assessment Processes.

After all, maintenance programs require proper documentation showing how the verified protection system segments overlap so that no segment is left unverified.

Nearly every functional part of a Recloser can be tested. This table shows an overview of available OMICRON test sets for testing the respective Recloser part.

Recloser controls

Recloser controls use functions that are similar to protection relays in substations, hence a comparable testing procedure and scope should be in place.

During commissioning, all the functionality implemented in the recloser controls should be tested before they go into service to ensure the unit is functioning properly after being transported, and to verify that protection settings were loaded into the device. When replacing the battery inside the controller housing, it is recommended that a maintenance test is performed through secondary injection to ensure the device is still functioning properly. This way, problems can be detected prior to the event of an actual fault on the line, and hence increase reliability of the network.

If a recloser is part of an automated distribution scheme, the communication links are an important part and have to be included in a test to guarantee proper functioning of the overall system.

Accessing the terminal blocks of a recloser control to connect a test system is often problematic, especially if they are mounted higher on the power pole or when leads have to be disconnected in order to inject test signals. The latter can lead to accidental short circuits or leave the recloser in a faulty condition when a test is finished.

To avoid this problem, OMICRON recloser control test sets use special test cables which fit exactly to the respective controller to enable safe, non-intrusive connection and testing.

Breakers

The breakers are housed either in an oil-filled SF6 or solid dielectric housing. Currently, it is mostly vacuum breakers with magnetic actuators which are installed since they operate quickly and require little maintenance.

However, breakers are often located in outdoor environments, which can introduce a variety of environmental factors. For instance, large temperature changes (summer and winter) can cause accelerated aging to critical components like the actuator's energy storage capability and insulation. Preventative field maintenance and testing of breakers will help detect these types of problems early and help prolong the lifespan of the breaker.

Instrument transformers

CTs and VTs are very important components of the whole system since they provide the current and voltage values necessary for the recloser control and its monitoring function.

The CTs and VTs on reclosers have to be tested within a specified maintenance interval.

Available OMICRON test sets

	ARCO 400	CMC Test Sets	COMPANO 100	CPC 100	CIBANO 500	CT Analyzer
Controller	✔	☐				
Circuit Breaker			☐	☐	✔	
Current Transformer			☐	☐		✔
Voltage Sensors				☐		
Wiring			☐	☐		

✔ specialized to test this part of a recloser

☐ can also be used to test this part of a recloser

Commissioning and maintenance: Quick and easy testing of typical

This page covers:

Why are commissioning tests important?

During the commissioning process, recloser controls receive all setting values that are necessary to detect a fault on the line and to execute the trip and reclosing operations. In very rare cases, they are installed with default settings.

Without testing the proper function of the new recloser control there is a risk that issues are not unveiled until a fault event. That's why a recloser control should always be tested before it is put into operation.

The 3-phase ARCO 400 test set provides an easy way to connect to the recloser control to simulate faults and test the control's settings. Previously created test plans reduce the testing time and an automatically generated test report provides documentation that the unit is functioning properly.

More information about Recloser control testing with ARCO 400 in the YouTube Video: https://youtu.be/9h2yQ2sJeUo

recloser control functions

Why are maintenance tests important?

In a run-to-failure strategy, no recloser control maintenance is performed. If the recloser misoperates, utility personnel have to be dispatched to a possibly remote location to locate the fault, which can be time consuming and customers are left without power. The equipment then has to be replaced or bypassed during the outage. This practice leads to longer outages, higher costs, and lost revenues when compared to a scheduled maintenance program. A defined maintenance program can reveal errors before a fault or misoperation occurs. For example, when checking or replacing the recloser control backup battery, a maintenance test of the controller can be included with little additional effort.

Environmental influences

Reclosers use electronic controls which are similar to substation protection relays in terms of their protection functions. However, recloser controls are mounted into the control housing in the field where they need to withstand wide-ranging environmental conditions such as extreme temperatures and varying humidity.

These conditions can cause components in the controller to age more quickly, and they are thus more likely to fail compared to a substation relay – a good reason for maintenance testing, which takes only about 15 minutes using a prepared test plan and the ARCO 400.

Why use OMICRON ARCO 400?

ARCO 400 is the universal and dedicated solution for testing all types of recloser controls.

- Compact and rugged but lightweight (10 kg / 22 lbs)
- Easy to use, plug-and-play
- Safe, secure and easy connection
- Self-configuring breaker simulator
- Control through USB, Ethernet or WiFi
- 3-phase 12.5 A, 6-phase 8 V (150 V as an option)
- Simple open and close checks without software
- Guided user interface to test typical recloser functions
- Test plan creation
- Standardized testing procedures
- Combined automatic report with test results

Complex testing of recloser controls, IntelliRupter controls and prote

This page covers:

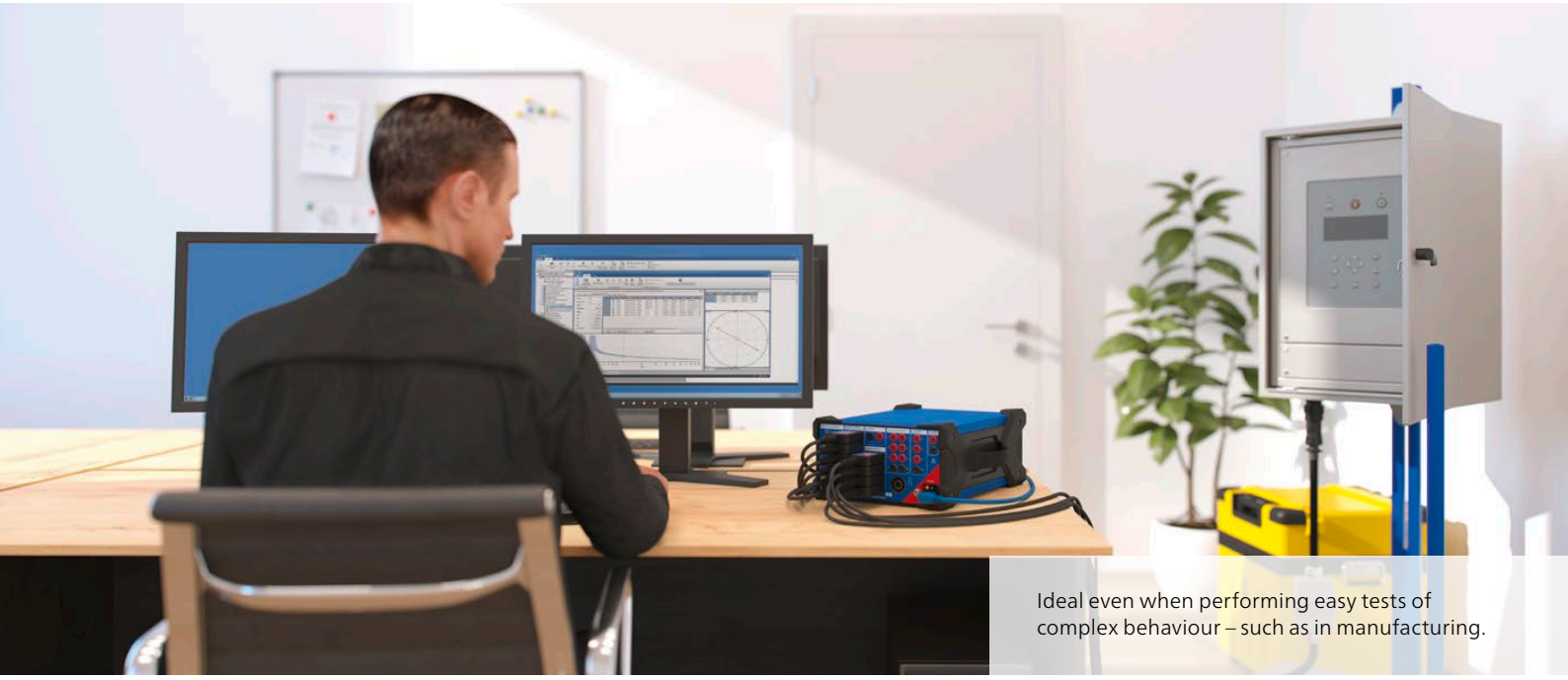
When are in-depth or complex tests important?

Modern reclosers have very accurate and versatile electronic controls that offer complex functions which need to reliably work in the field. Manufacturers are required to simulate different and changing fault scenarios during development and need to thoroughly test every firmware and software revision prior to a release, to meet high quality and reliability of their protective equipment. Utilities often run their own additional testing to rule out any issue with a new release from a manufacturer before they install or deploy a new firmware to all of their electronic relays or controls.

Your test set of choice

The multifunctional CMC test sets are designed to test equipment such as protection relays and recloser controls. Together with the powerful Test Universe software, they meet the demand of manufacturers and utilities alike to perform even the most complex tests.

OMICRON's free-of-charge Protection Testing Library includes test templates for common recloser controls and relays, which allow the automatic import of settings exported by the relay or recloser control configuration software. This allows fully automatic test sequences to be executed and repeated.



Ideal even when performing easy tests of complex behaviour – such as in manufacturing.

How to test S&C IntelliRupter® PulseCloser®

S&C´s IntelliRupter PulseCloser control modules verify that a power line fault has been cleared before initiating a closing operation and therefore can reduce stress to overhead distribution systems.

Based on this technology the IntelliRupter fault interrupter is a highly-integrated protection and switching device with an intelligent circuit testing capability available. The IntelliRupter integrated protection and control module is best tested using an OMICRON CMC test set in combination with the OMICRON RIR1 testing package and Test Universe.

Your test set of choice

The extremely accurate low-level outputs of a CMC test set are used to inject secondary test signals simulating the IntelliRupter 's Rogowski coils and high-impedance voltage sensors.

The switching mechanism simulator within the RIR1 testing package enables testing of the control module as if it were still installed in the fault interrupter, executing the advanced mechanism operations associated with the PulseClosing™ technology.

Why use OMICRON CMC test set?

- > Multifunctional testing
- > Highly automated testing
- > Broad range of R&D applications
- > Customizable object specific test templates
- > Safe, secure and easy connection
- > Unique range of test cables
- > 3 high-precision current outputs (CMC 430)
- > 6-phase V (CMC 430)
- > IntelliRupter testing

Examples of functionality testing

- > Test changing fault conditions
- > Replay of COMTRADE files (ROCOF)
- > Other relay and recloser control functions

Distribution automation scheme testing with reclosers and protection

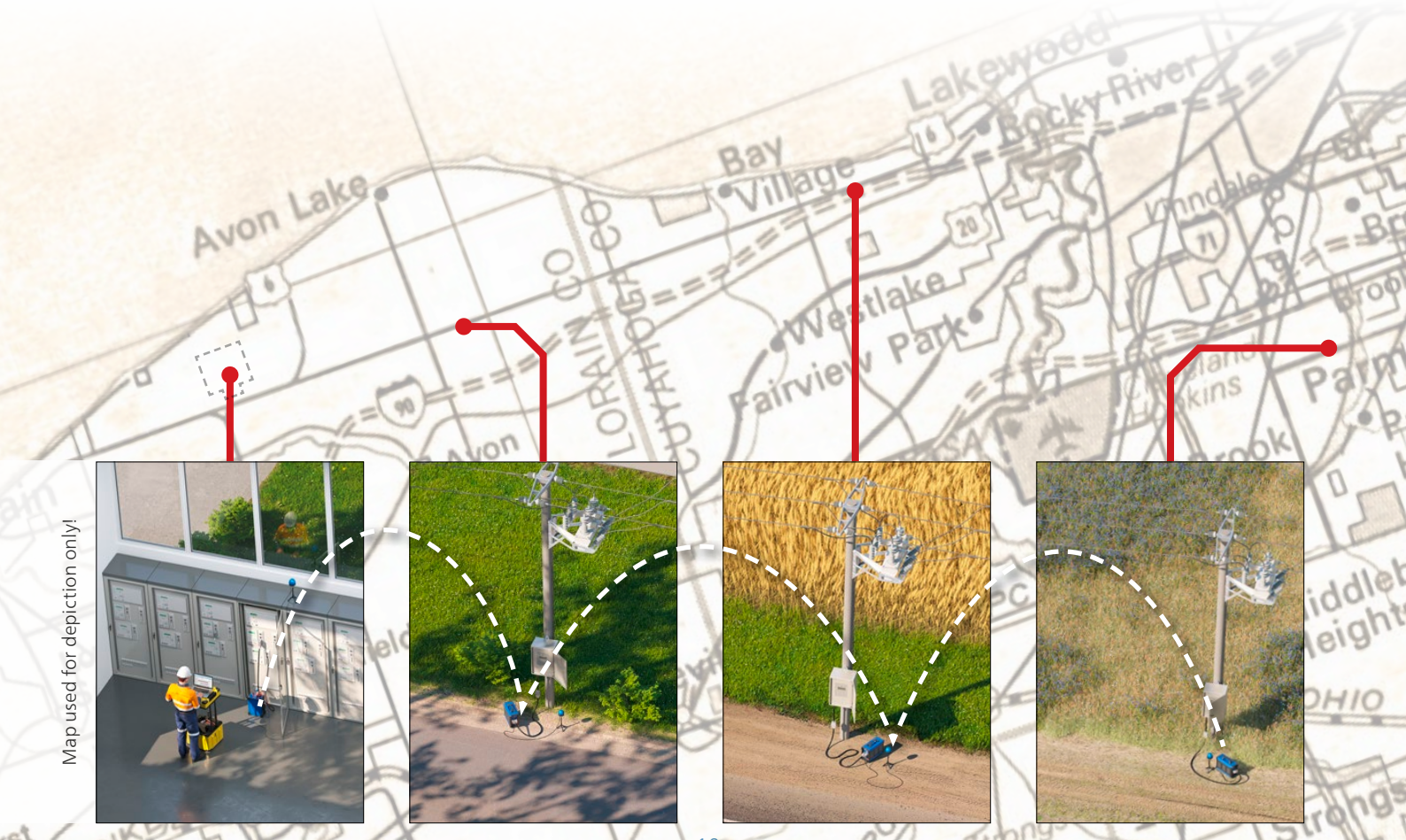
This page covers:

Why test distribution automation schemes?

Modern types of reclosers can be equipped with communication equipment and use complex algorithms to adapt to the network and failures. They are increasingly used as part of the "Smart Grid" and embedded in distribution automation schemes. Therefore, reclosers and sectionalizers no longer only trip and lockout on faults, they can now be set to isolate and reconfigure the distribution network to automatically re-energize the system for those customers not directly affected by a fault on a line section.

As a result, simple function tests of single controllers are not sufficient for testing the automation functionality due to the distributed protection logic. A test must confirm the correct operation of the entire system under different fault conditions in different locations or devices. For that reason, synchronized injection into the controllers involved in the automation scheme is required to test not only the switching logic, but also the communication channels which are an essential part of the scheme.

Conditions in the field are different than in the lab, primarily due to longer and possibly weaker communication links. Thus, tests of the scheme in the field are important, too.



Map: 1970 National Atlas of the US

Why perform system-based testing?

System-based testing covers the new demands of distribution automation schemes using a transient simulation of the primary power system. This process does not depend on recloser or relay type, manufacturer, or the detailed parameters of a single controller. A correct switching behavior for various fault types in different locations is the only variable that is of concern.

With modelled transient signals and an "Iterative Closed-Loop"* simulation, testing of reclosing functions in a distributed protection system under real life fault conditions is possible.

Your test set of choice

The ARCO 400 and CMC test sets with their synchronization possibility using CMGPS 588 are the perfect choice for performing such tests, both in the lab and in the field. Multiple CMCs and/or ARCO 400s can simultaneously test high-speed distribution automation schemes using RelaySimTest, controlled by only one PC.

Remote test sets are connected through an existing Ethernet-based connection between the devices under test, or by using an Internet connection.

Why use OMICRON RelaySimTest?

RelaySimTest is a unique solution for distribution automation scheme testing with transient signals. It can reveal failures in the logic of the switching scheme as well as communication issues.

- Easy and flexible
- Recloser/relay independent
- Predefined ready-to-use templates
- Intuitive and flexible grid editor to model power networks
- Simulation of realistic operating conditions
- Testing with extensive fault scenarios
- Controlling multiple test sets from one PC
- Testing over long distances
- Time synchronizing via GPS
- Automatic report generation

* Iterative Closed-Loop simulation mimics the behaviour of a real-time closed-loop simulation. It automatically reacts on trip and close commands from the relays or recloser controls under test, so that no manual user interaction is needed.

Testing instrument transformers and breakers

This page covers:

Why test circuit breakers?

Many recloser controls monitor the breaker's auxiliary contacts when performing a closing or opening operation and indicate an error if the auxiliary contact feedback is not received within a certain time frame, indicating if the breaker is healthy or not.

To determine the actual clearing time of the breaker however, the primary contacts need to be used for the measurement. This can be achieved with the CIBANO 500.

The recloser overall function can be tested through injection into the primary terminals with a CPC 100, which generates up to 2000 A with a booster.

A micro-ohm test validates that the main contacts have a very low resistance path to ensure that load current flows with low losses. This is one of the additional function tests and condition assessments the CIBANO 500, CPC 100, and COMPANO 100 offer.

Instrument transformers and breakers suffer from rough environmental conditions 24/7/365.

Why test instrument transformers?

Like all other protection systems, reclosers use instrument transformers to convert high currents and voltages into measurable values that are processed by the recloser control. This requires a high accuracy over a wide range of currents and voltages.

The importance of transformer tests is often underestimated. Risks such as damage to the core and/or winding, as well as aging of insulation can be recognized easily at an early stage through testing.

As the market leader in advanced testing and diagnostics systems for the electric power industry, we also offer state-of-the-art testing solutions for instrument transformers, for example, for testing the winding ratio, ratio errors, polarity and wiring or burden checks.

The CPC 100 is one of our well-known test sets for comprehensive electrical tests on conventional and even non-conventional instrument transformers.

Most reclosers use magnetic current transformers (CTs). To perform automated testing and calibration of such CTs during production, the CT Analyzer is the best choice. It automatically determines all relevant CT values and compares the results with the selected standard.

Why use OMICRON test sets?

CPC 100

- Tests embedded in a multi-functional test set
- Test signals up to 2 kA and 12 kV
- Extendible for other measuring tasks

CT Analyzer

- Testing magnetic CTs with highest precision
- CT evaluation by pressing only one button
- Testing results within a few seconds

CIBANO 500

- 3-in-1 test system
- Mains independent, built-in AC/DC power supply

COMPANO 100

- Mains independent, built-in AC/DC power supply
- Portable due to light weight (10 kg / 22 lbs)
- High output accuracy

We create customer value through ...

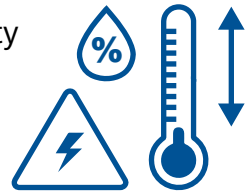
Quality

You can rely on the highest safety and security standards

Superior reliability with up to

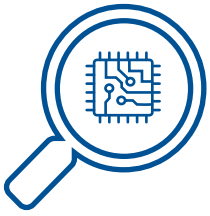
72

hours burn-in tests before delivery



100%

routine testing for all test set components



ISO 9001
TÜV & EMAS
ISO 14001
OHSAS 18001

Compliance with international standards

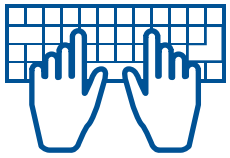
Innovation

... a product portfolio tailored to my needs

More than

200

developers keep our solutions up-to-date



More than

15%

of our annual sales is reinvested in research and development

Save up to

70%

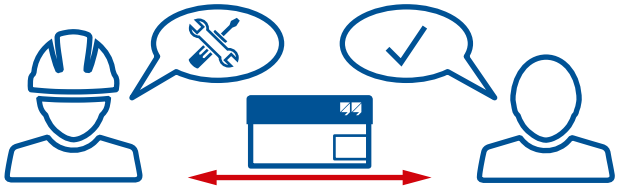
testing time through templates, and automation

Support

24/7

Professional technical support at any time

Loaner devices help to reduce downtime



Cost-effective and straight-forward repair and calibration

offices worldwide for local contact and support

Knowledge

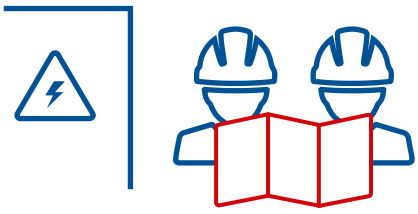
More than

300

Academy and numerous hands-on trainings per year

Frequently OMICRON hosted user meetings, seminars and conferences

to thousands of technical papers and application notes



Extensive expertise in consulting, testing and diagnostics

OMICRON is an international company that works passionately on ideas for making electric power systems safe and reliable. Our pioneering solutions are designed to meet our industry's current and future challenges. We always go the extra mile to empower our customers: we react to their needs, provide extraordinary local support, and share our expertise.

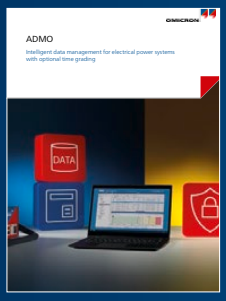
Within the OMICRON group, we research and develop innovative technologies for all fields in electric power systems. When it comes to electrical testing for medium- and high-voltage equipment, protection testing, digital substation testing solutions, customers all over the world trust in the accuracy, speed, and quality of our user-friendly solutions.

Founded in 1984, OMICRON draws on their decades of profound expertise in the field of electric power engineering. A dedicated team of more than 900 employees provides solutions with 24/7 support at 25 locations worldwide and serves customers in more than 160 countries.

The following publications provide further information on the solutions described in this brochure:

ARCO 400

RelaySimTest



ADMO

Product Catalog

For more information, additional literature, and detailed contact information of our worldwide offices please visit our website.

www.omicronenergy.com

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