

 Orange & Rockland

Smart Grid testing

Reclosers and sectionalizers are located along distribution lines to limit the effect of problems on the system thus reducing the geographic area and number of customers affected. Modern types of this equipment are now increasingly used as part of the "Smart Grid" automation systems. This means that reclosers and sectionalizers no longer only isolate the problem or fault but they can now be set to reconfigure the circuit(s) to automatically re-energize the system for those customers not directly connected to the problem area of the circuit. Compared to the former hydraulic and electro-mechanical types, the new generation of reclosers and sectionalizers with their new abilities and digital controllers put much higher demands on the test personnel and the test equipment used.

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The new digital controllers of reclosers and sectionalizers can trip and/or close 1, 2 or 3 phase modes depending on the fault type and logic settings. This means that only the faulted phase may be set to trip. They can detect an evolving fault and change the operation when a fault evolves into a multi-phase fault. They can also detect a defective primary switch and activate the logic to

block re-closing. The latest applications include a variety of auto restoration systems used in looped and/or underground systems. With these automatic distribution restoration (ADR) systems comes the need for checking synchronization of each phase before the circuit is automatically closed.

New aspects to be considered

While digital controller settings are unlikely to drift and contacts are unlikely to corrode in the same way as electromechanical and solid-state controllers did previously, digital controllers do have new sources of possible unexpected operation including:

- > Circuit wiring is now virtual wiring or programmable logic
- > Radio frequency interference (RFI)
- > Breakdown of MOVs (metal oxide varistors)
- > Firmware upgrades

It is for these reasons that the same tests performed on electro-mechanical controllers, such as finding the pick-up with a 3 to 5% accuracy test system or checking the output contacts with a light bulb or a buzzer, do little to ensure proper operation of a digital controller or to find potential problems. Therefore new approaches to testing digital controllers need to be established.

NERC operating rules

The 2003 blackout in North America and previous blackouts have resulted in the North Electric Reliability Corporation (NERC) changing the operating rules for the reliability councils of North America. They are auditing all utilities working according to their guidelines of being able to impact the reliability of the bulk power grid. If the transmission utilities depend on the distribution utilities for load shedding then they may have to show how the practices of these distribution utilities meet these guidelines.

NERC auditors require the utility to show detailed documentation to prove their maintenance practices are being followed and that schedules are adhered to. The substance of their practices is also evaluated. New utility system testing programs require shorter times between scheduled testing cycles. This means that the complexity of tests is increasing and necessitates higher accuracy test equipment than that which has been used before. The challenge is to achieve all of this with a growing lack of experienced people. This also affects the testing of reclosers and sectionalizers.

New test equipment required

Some of the needed functions of an up-to-date recloser and sectionalizer test system include:

- > Simulation of any and all signals and contacts that the device being tested would see when in service, and monitoring of all critical signals given by the device being tested
- > Set up programs to automatically provide real-life system conditions and sequences for all test specifications
- > Reproduction of the exact test conditions and comparison of results (e.g. annually) on each device tested
- > Accuracy better than 0.1% for voltages and currents

- > Variable frequency with accuracy better than 0.001 Hz
- > Operation of several test systems in a synchronized mode to perform ADR system testing and trouble shooting (for many schemes at least four test sets are required)
- > Easy updating of the tests with the actual recloser or sectionalizer settings being used
- > Ability to perform tests in the field when supplied from a portable generator, or from the inverter in the vehicle, without loss of capability or accuracy
- > High impedance inputs to detect a damaged or leaking MOV before it causes a mis-operation

Testing functions to be included

In short all of the details must be known about how the device is intended to operate as applied to the power system including the protection and restoration logic. The test must confirm correct operation if there is a problem, and also that the device will not mis-operate when there is no problem or only certain system conditions exist.

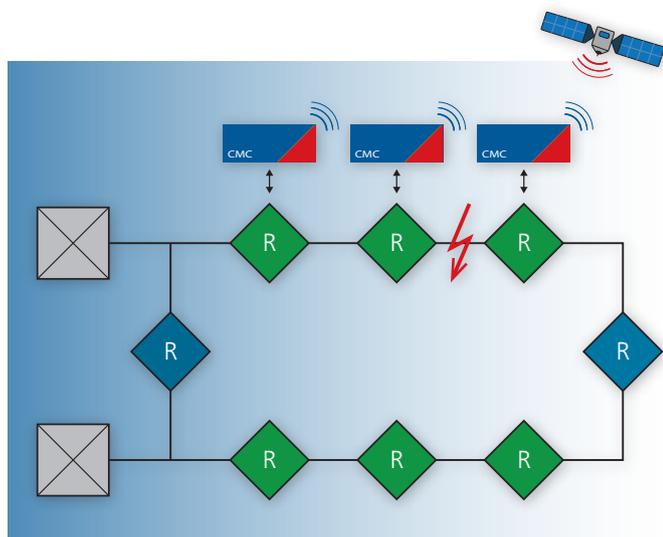
Points to consider:

- > Communication system times and delays are a frequent cause of ADR system failure
- > Logic program errors are the next most common cause of system failure (both the standard logic for the device and the communications logic errors)
- > Testing all of the related parts of the system together is the only way to be sure the whole system truly is working the way expected
- > Laboratory testing does account for the actual communications system being used in the field; many problems are found in the field related to geography, structures, and other forms of interference.

Simplified testing: CMC with recloser test cable and software test plan



44 Application



ADR system with reclosers: GPS synchronized end-to-end testing

Implementation at Orange & Rockland

Some companies have already started to consider the new challenges described within their organizations. For instance, at Orange & Rockland Utilities (O&R) – a subsidiary of Consolidated Edison headquartered in Pearl River, New York – a new group focusing on this subject has recently been established as part of the Smart Grid department. Each crew consists of two people, one from Overhead Line Operations and one from Substation Relays. The overhead line personnel offer years of field and construction experience, while the relay technicians provide expertise on communications and testing of the equipment. This is seen as a perfect merger of both skill sets that are required for this work. Using CMC test sets and special test cable solutions from OMICRON, this new group is testing and building the foundation and communications for the Smart Grid technology throughout O&R.

New test cable solutions

Each recloser and sectionalizer contains a switch and a controller connected via a control cable, provided by the device manufac-

turer. OMICRON has developed test cables and other accessories to simplify testing of distribution reclosers and sectionalizers for use with the multifunctional CMC 356/256 test sets. Each test cable is built with all components necessary to make a direct connection from the device to be tested at one end to the CMC at the other end. Each test cable package has been designed to allow testing of all functionality that the manufacturer provided between the interrupter/switch and the controller. Included are sample test plans for the CMC operating software and instructions for connecting and using the test cables.

Testing recloser or sectionalizer controllers

OMICRON test cable systems simulate the switch end with all of its voltages, currents, and status signals to give the controller all system conditions for which the tester needs to test the controller without changing settings. The functional tests for the controllers include: current pick-up levels and timing, voltage pick-up & drop-off levels, complete logic trip cycles to lock-out sequences, partial trip cycles to confirm no false trips under load currents, under-frequency load shedding logic, trip-fail-to-detect logic tests, etc.

Testing recloser or sectionalizer switches

OMICRON test cables can be connected directly to the recloser/sectionalizer switches to be tested and provide them with the voltage, power, and command signals which they normally receive from the controllers. The test system then records the resulting timing of the trip and close operations, a & b contact times, and the metered currents and voltages from the switch. The testing allows the collection of data to compare first trip times to subsequent trip times, and, where applicable, allows timing of the spring charging times which can be used to determine if the switch needs additional maintenance.

Orange and Rockland Utilities, Inc.

Orange and Rockland Utilities, Inc., a wholly owned subsidiary of Consolidated Edison, Inc., is an electric and gas utility headquartered in Pearl River, NY. O&R and its two utility subsidiaries, Rockland Electric Company and Pike County Light & Power Co., serve a population of approximately 750,000 in seven counties in New York, northern New Jersey and northeastern Pennsylvania. O&R's headquarters is located at One Blue Hill Plaza, Pearl River, NY 10965.

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OMICRON recloser and sectionalizer test cables available:

Controller test cables for	Switch test cables for
> ABB PCD	
> Cooper Form 4C, 5, 6	> Cooper DC Nova, VWVE
> G&W Vipers S & ST	
> McGraw-Edison GWC Form 1, 2	> McGraw-Edison GWC Form 1, 2
> SEL 351R, 651R	
> S&C 2801, 5801/SH, 5801/SV, 5901/G	> S&C ScadaMate
> S&C IntelliRupter PulseCloser	

For more information please download the paper "Advanced Smart Grid Testing of Reclosers & Sectionalizers in a Distribution Automation & Restoration (DAR) System" at www.omicron.at/en/recloser-testing