

Testing the pick-up value of overlapping protection elements/functions without changing the parameter settings.

Boris Bastigkeit, OMICRON

Introduction

Testing of protection functions can often be reduced to include just the testing of **pick-up** or **drop-off** values and testing of the **trip time** of the particular protection function. [1], [2]

The more protection functions that are active in a relay or protection cabinet, the more difficult it is to test the individual functions. In particular, testing the pick-up values of all individual functions creates challenges for the tester which often lead to the use of risky methods when testing. These might include the omission of the pick-up value test or the temporary deactivation of "disturbing" protection functions.

Testing of the pick-up values of all individual functions is frequently required. In addition, changing the parameter settings for the test is often forbidden as this is a frequent error source. Due to this, only two test methods remain:

- The first method includes testing with continuous ramps and routing one start contact for every single protection function. This method has the disadvantage that a lot of contacts have to be routed depending on the number of available protection functions. These additional contacts must be wired extensively when performing the test.
- The more elegant method is testing with so-called pulse ramps.

This background provided the motivation for OMICRON to develop its new test module **Pulse Ramping**. This presentation explains what a pulse ramp is and the new testing possibilities this module can provide.

Application example: Overcurrent protection function

How a threshold value test works by using a pulse ramp can be described very easily with the help of a definite time overcurrent protection function consisting of 2 elements.

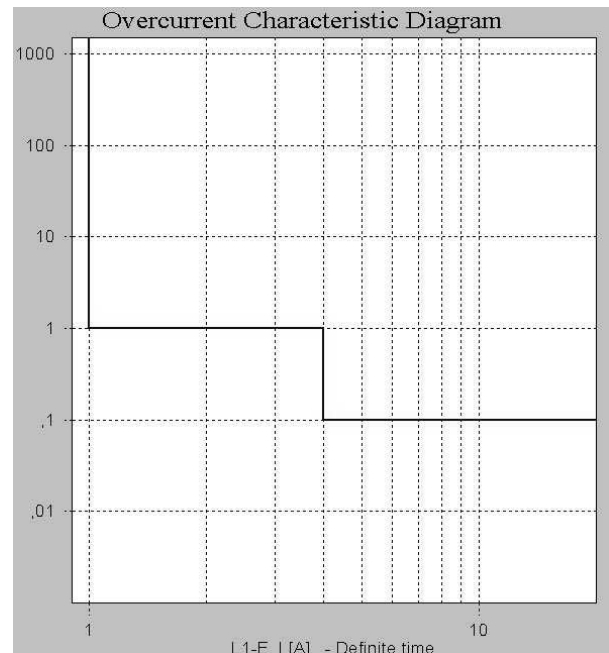


Figure 1: Definite time characteristic consisting of two steps

The aim of the test is to determine the pick-up value of the first and also the second Overcurrent element. The pick-up value of the first step can be determined quite easily and very exactly with the help of a simple ramp. In this case, the step width of the ramp must not fall below the trip or pick-up time, depending on whether a start or trip contact is used for the test.

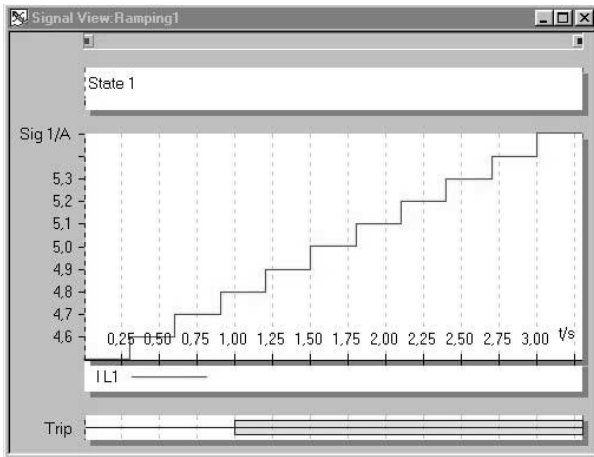
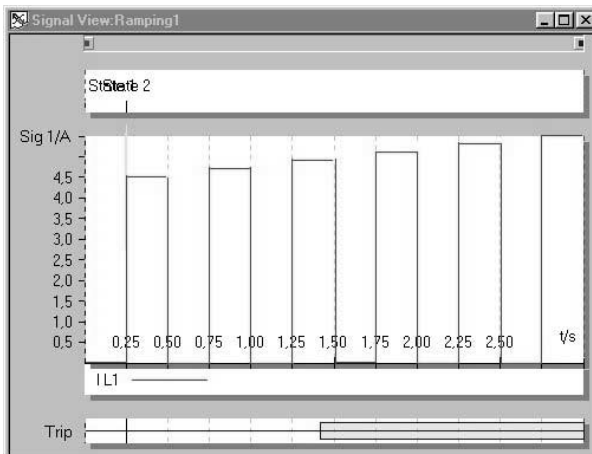


Figure 2: Testing the threshold value of the first Overcurrent Element using a simple ramp.

In order to determine the threshold value of the second step, this method using a simple ramp is limited. Further, if the pick-up value of the second step is also to be determined with a normal ramp, this would only be possible if an independent start contact is available for the second element.

Here the advantage of the pulse ramp becomes noticeable because with the help of this ramp it is possible to test the pick-up values of all steps using only the trip contact. This is done by outputting the fault quantities for a time long enough to allow the element to be tested ($I >>$) to trip but the (longer) trip time of the $I >$



element is never reached. This way it is guaranteed that the threshold value of the $I >>$ element is determined if tripping occurs.

Figure 3: Pulse ramp for testing the pick-up value of the second definite time step.

In summary, a pulse ramp consists of a ramp interrupted after each step (pulse), for which the fault quantities are increased step by step until the pick-up value is determined. After each step of the pulse ramp a reset state is inserted which performs a reset of the relay. By setting the pulse duration the element or function of the relay to be tested can be defined. The pulse duration

must be longer than the trip time of the function to be tested and also the duration must be shorter than the trip time of preceding protection levels. By setting the reset state duration, the time by which the relay is required to perform a reset is defined. It is possible to freely define amplitude, phase and frequency for all used voltages and currents, and also to exactly adapt the protection function to be tested by using the ramp of fault states.

Second application example: Generator protection

The second example describes the protection functions which can be displayed in the generator capability curve. [3]

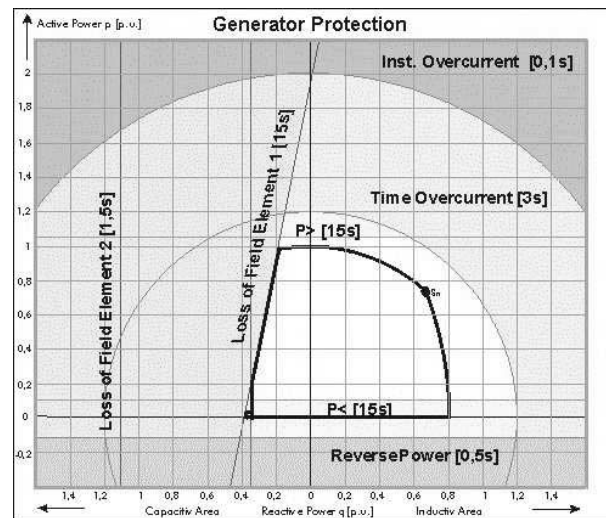


Figure 4: Typical generator protection functions displayed in the generator power characteristic.

- Under-excitation (2 elements)
- Definite time overcurrent protection (2 elements)
- Overload forward $P >$
- Reverse power
- Too low forward power $P <$.

Together with other protection functions, which cannot be displayed in the generator capability curve, these functions are used for the generator protection. Modern and multifunctional generator protection relays contain all these functions. The power characteristic clearly shows how the individual protection functions overlap. The pick-up values of all functions and their individual steps can be determined easily and quickly using OMICRON's new test module **Pulse Ramping**. To do this, only the trip contact is required. Deactivating individual functions for test purposes is not required.

For this example it is notable that the reset state of the pulse ramps has to lie somewhere in the valid operating range of the generator, for example, in the rated operating point S_n . The combination of protection functions shown in figure 4 shows that the relay cannot be reset by simply switching off the voltages and currents because in this case the function $P <$ trips.

OMICRON Pulse Ramping – field of application

This module allows, for the first time, the extensive but nevertheless simple testing of all protection functions of multifunctional relays or complete protection cabinets without an error-prone changing of parameter settings.

When developing this test module, it was considered that it is often not sufficient to simply switch off the test quantities in order to reset a relay. With the **Pulse Ramping** module, any desired state can be defined as a reset state such as dropping back to the rated operating point (e.g. normal load state) or any other operating point.

The output of binary signals is also possible for the fault and reset state.

Advantages of the pulse ramping method

The method described above for testing pick-up values of protection functions has the following advantages:

- Complete and exact testing of all pick-up values with low time expenditure
- No error-prone changing of the relay settings required for the test
- No extensive routing of additional starting contacts or associated wiring because all tests can be performed using the start contact.

Further features

- Complete test automation through the use of the OMICRON Control Center and automatic assessment and logging of the results.

- Integrated distance protection fault model. Accessing the distance protection RIO data is possible directly from the test module.
- End-to-End testing with GPS is supported.
- Clear display of all test quantities in the vector diagram and time signal view.
- Display of the trip time.

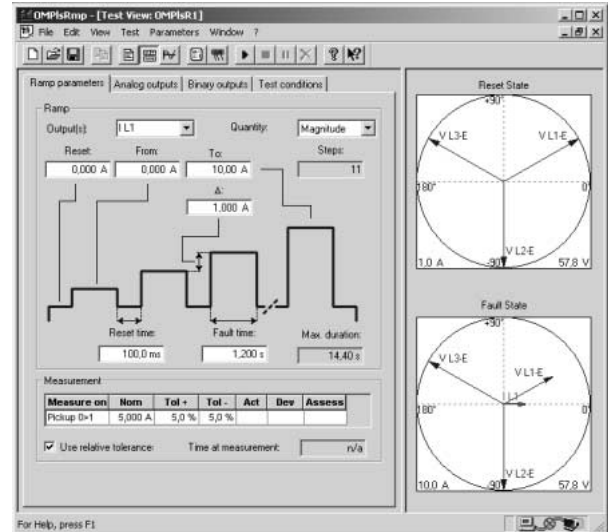


Figure 4: New OMICRON test module **Pulse Ramping**, Test View

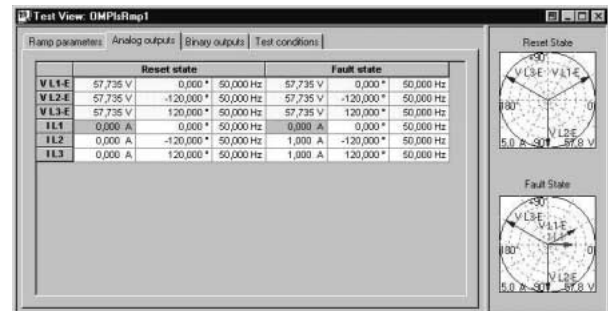


Figure 5: OMICRON **Pulse Ramping**, detail view for defining the reset and fault state.

Literature

- [1] IEE Power and Energy Series 28: Protection of Electricity distribution Networks
- [2] Doemeland: Handbuch Schutztechnik; Berlin, Verlag Technik 1995
- [3] Bastigkeit: Generator Protection Testing; Degree Dissertation 1998, Technical University Graz