



Reliable Protection

Precise line parameters with the CPC 100 + CP CU1

Power suppliers strive for both the highest level of supply security and optimal protection at the same time in the event of a fault. This means that a network segment which is affected by a fault would be separated from the rest of the grid to protect the grid from disruptions. For this reason, distance protection relays and fault locators are used for power lines. Precise line parameters help to optimize their settings. ENDESA DISTRIBUCIÓN ELÉCTRICA S.L., Spain's largest power supplier, is looking for ways to optimize its parameterization.



Precise line parameters are required for distance protection relays and fault locators. Line parameters can either be calculated mathematically or measured. When performing a mathematical determination of line impedances, multiple simplification steps are taken which do not apply in practice. Therefore the results are often not precise enough. In particular,

line-to-ground impedances are influenced by the physical characteristics that are present such as metal pipes or neighboring cables in the ground and are not sufficiently accurate when calculated mathematically. This is because these calculations are based on uniform soil with constant resistivity – conditions which do not give an accurate representation of the real world.

Optimal protection with precise parameterization

ENDESA was aware of this problem: "Our aim was to reduce malfunctions to a minimum," explains Antonio Castillo, Head of the Protection Department for the Andalucía Center at ENDESA. "We knew that we had to optimize the parameterization of the distance protection relays

«We knew that we had to optimize the parameterization of the distance protection relays by using precise line impedance values.»



Antonio Castillo
Head of Protection Department for Andalucía Center at ENDESA



by using precise line impedance values. Only then could we be certain that the protection system reacts according to the impedance scheme," Antonio Castillo outlines the problem. "Otherwise our customers could have been affected by unnecessary power cuts."

Precise results with the CPC 100

The company approached us with this concern. Together with ENDESA, we conducted measurements on an affected line. "First, we wanted to check whether the relay was already set optimally on the basis of the previously calculated impedance values," says Moritz Pikisch, Product Manager at OMICRON. The measurements were conducted with the CPC 100 and CP CU1. The CPC 100 and CP CU1 test system use testing currents with frequencies different from the power frequency.

Thus, power frequency interferences, which influence the accuracy of the measurement, can be eliminated. This ensures that precise measurement values are obtained. A total of seven measurements were performed to determine the impedances of the line accurately. These consisted of three for phase-to-phase loops, three for phase-to-ground loops and one for all three phases connected in parallel to ground. "The result was surprising," recalls Antonio Castillo. "We found out that the theoretically calculated values didn't consider the impact of the combined overhead line with the underground cable. Therefore, the calculated X-value of the zero-sequence impedance was only about 50% of the measured value, which is much too low. And this value is crucial for the protection of line-to-ground faults which are the most common ones." ▶

ENDESA

Since 2009 ENDESA DISTRIBUCION ELECTRICA S.L. is part of the Enel Group, a multi-national power company and a leading integrated player in the world's power and gas markets. ENDESA operates a multi-branched distribution network in southern and central Europe. More than 10 000 employees serve 12.6 million customers.

 www.endesa.com

10 Application

CPC 100 + CP CU1

- > Measurement of line impedances and k-factors of overhead lines or power cables.
- > Ground measurements of large installations
- > Power frequency interference does not affect the measurement – extremely precise results are produced
- > Easy to transport – heaviest component: 29 kg / 64 lbs

 www.omicronenergy.com/cpcu1



Extensive analysis

Using the CPC 100 Test Templates the actual zone reach for each arbitrary fault combination was subsequently calculated. "We entered the previously used protection parameters and checked the line length up to where the relay trips without delay – called Zone 1," explains Moritz. "Normally, the value should have been around 80%. However, the measurements we obtained showed that when a fault occurred in the line-to-ground loop, immediate tripping only happened within the first 56% of the line." In the case of a fault in Zone 2, which should reach from 80–120% of the line length, the line should be shut

down within 500 ms. "With the calculated parameters for Zone 2 we only achieved 87% for line-to-ground faults. This indicates a tremendous under-reach for the protection of this line," explains Moritz.

Optimal protection guaranteed

ENDESA was convinced by the results of the measurement. "We immediately changed the relay settings to the new parameters for the measured line," says Antonio Castillo. "A subsequent line-to-ground fault revealed that the distance protection relay now trips as it should." ▀

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Moritz Pikisch

Product Manager, OMICRON

Zone Reach of Zone 2 / % of Line Length

