

SIPROTEC 7SA6 with Auto-Reclosure on Mixed Lines

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■ The company

With about 2,900 employees and sales of around EUR 1.3 billion, Stadtwerke Hannover AG is one of Germany's largest municipal utilities companies. Under the brand "enercity – positive energy", they offer power, water and services to private and commercial customers. In the Hanover region, municipal utilities company Stadtwerke Hannover provides around half a million people with electricity, natural gas, district heating and drinking water and is currently supplying about 8,000 delivery points nationwide. Thanks to their cooperation with various partners, municipal utilities company Stadtwerke Hannover is also able to promote customer-oriented offers on a national level. In the commercial customer sector, the company offers the full range of services associated with energy management, including consulting, planning, new construction and refurbishment, and plant operation. Their nationwide commitment is proving successful: 2002 was the first year that Stadtwerke Hannover sold more electricity outside its original service area than inside it. In 2003, they further increased sales to just under 19,500 GWh (service area: 3,285 GWh).

■ The starting situation

Stadtwerke Hannover, enercity requested the implementation of 7SA6 distance protection over mixed lines. This application is not limited to a specific plant but can be employed in a variety of applications. Mixed lines means that part of the section to be protected within a grading zone comprises cables and another section consists of overhead lines. The auto-reclosure (AR) function would be appropriate for the overhead line section only. The sections to be protected must be selected accordingly (see Fig. 2).



Fig. 1 Trademark of municipal utilities company Stadtwerke Hannover

■ The concept

For sections with both cables and overhead lines, distance zone signals (resistance (R) and reactance (X)) can be used within a certain framework to differentiate between cable faults and overhead-line faults. With the appropriate interconnections by means of the programmable logic functions (CFC), auto-reclosure can be blocked when a fault occurs in the cable section.

■ Configuration

As usual, the line sections are graded in the 7SA6 distance protection relay into distance zones Z1, Z2, Z3 and Z5, depending on the power system connection. Zone Z1B is primarily used for the auto-reclosure function and for connection functions ("Hand-Ein" = manual close). Zone Z4 serves to measure and select the segments of cable or overhead line in the sections to be protected. Besides being used for the auto-reclosure function (AR), Zone Z1B is also employed for instantaneous switch-onto-fault tripping for the sections to be protected. The protection system must be tripped instantaneously when connecting to the section to be protected if, for example, the ground electrode is still inserted at the remote end. Alternatively, this functionality can also be implemented in the 7SA6 by means of the "instantaneous high-current tripping" function.

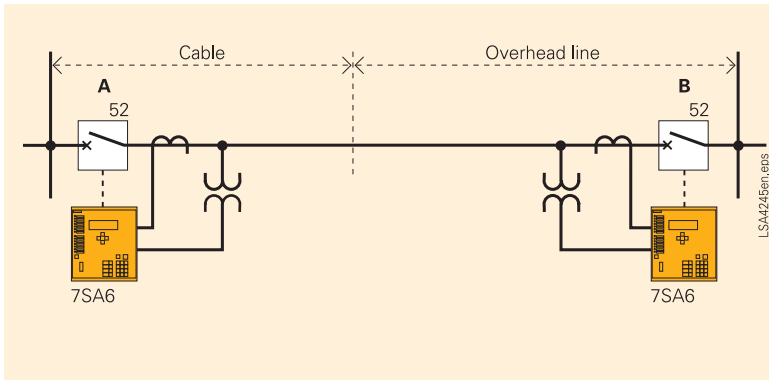


Fig. 2
Mixed-line configuration

This description of the application is based on a general section <A – B> with two 7SA6 distance protection relays. For the protection relay at installation location “A”, the solution includes distance zones Z1B and Z4. The protection relay at installation location “B” can be configured for AR on mixed lines either by means of distance zone Z1B and instantaneous high-current tripping or, alternatively, in accordance with solution “A” with the grading of zones Z1B and Z4.

Settings for project planning in DIGSI

Firstly, the following entries must be made in the parameter set for the 7SA6 by means of parameterization in DIGSI.

Configuration matrix (Group: “Automatische WE” (auto-reclosure) or “Dis general”):

a	FNo. 2703	>Block AR	configured to "Destination CFC"
b	FNo. 3747	distance protection pickup in ZoneZ1B, L1E	configured to "Destination CFC"
c	FNo. 3748	distance protection pickup in Zone Z1B, L2E	configured to "Destination CFC"
d	FNo. 379	distance protection pickup in Zone Z1B, L3E	configured to "Destination CFC"
e	FNo. 3750	distance protection pickup in Zone Z1B, L12	configured to "Destination CFC"
f	FNo. 3751	distance protection pickup in Zone Z1B, L23	configured to "Destination CFC"
g	FNo. 3752	distance protection pickup in Zone Z1B, L31	configured to "Destination CFC"
h	FNr. 3759	distance protection pickup in Zone Z4	configured to "Destination CFC"

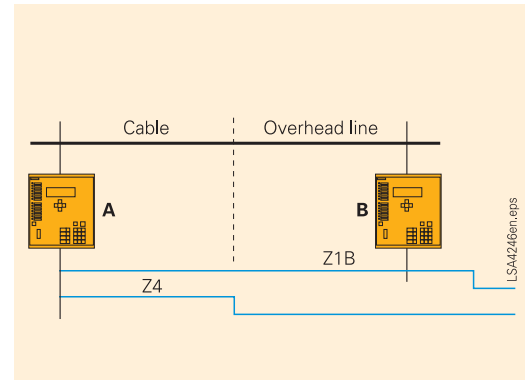


Fig. 3 Zone grading of distance protection relay A

Parametrization: (Parameter group A, distance protection - polygon, zone Z4) parameter 1335 “Delay time T4”

Tripping time for zone Z4 (parameter 1335 = T4) has to be set to indefinite ($T4 = \infty$) because this zone is only used for selecting the cable or overhead line sections of this line. In this application, zone Z4 is to indicate only one pickup. Tripping is not relevant in this zone. Especially in the case of a single-pole auto-reclosure function this setting is important, because then tripping may only initiated via zone Z1B.

Creating the logic sequences

All that is left is to create, link and translate the corresponding CFC logic diagrams in DIGSI. The CFC priority class used is the “Fast” PLC Task (PLC0). The individual logic functions and their effect on the protected zone are described below.

For the section <A – B> described, appropriate allocations must be implemented in both distance protection relays for detecting the AR range on the overhead line.

Controlling auto-reclosure in 7SA6 for protection relay A

7SA6 – protection relay A

Zone Z4 is graded in accordance with the R and X values of the cable section. As usual, Zone Z1B is dimensioned to approx. 120% of the line length. Because AR should not be executed in the cable section, the overhead line section in Zone Z1B is selected by means of a CFC. The result of the CFC (FNo. 2703 : “>AR block”) is that auto-reclosure is blocked when a fault occurs in the cable zone (Zone Z4), see Fig. 4.

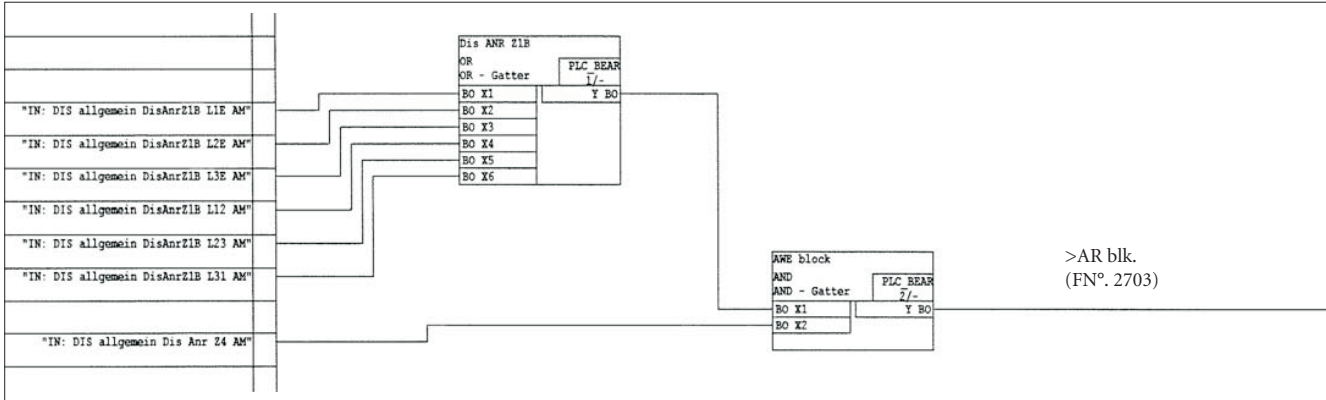


Fig. 4 CFC logic diagram for AR control for relay A

Controlling auto-reclosure in 7SA6 for protection relay B

Solution 1:

7SA6 with Zone Z1B and instantaneous high-current tripping:

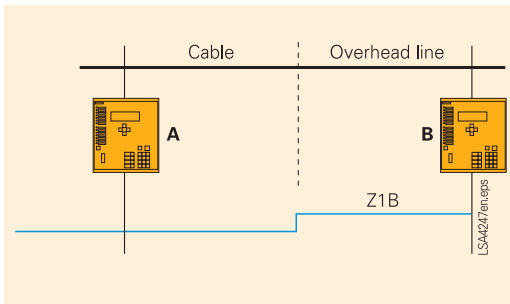


Fig. 5 Setting of zone Z1B in relay B

7SA6 – protection relay B

Zone Z1B is graded in accordance with the R and X values of the overhead line on which the AR function should be executed. For instantaneous switch-onto-fault tripping, the instantaneous high-current tripping function is used in the 7SA6 for the full protection of the <A – B> section.

Solution 2:

7SA6 with grading of zones Z1B and Z4:

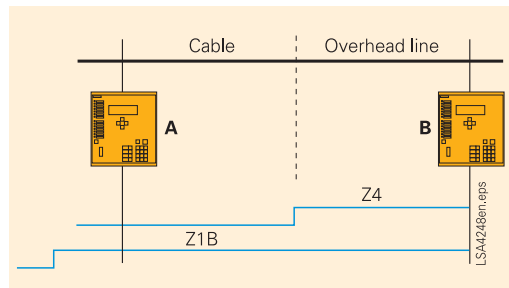


Fig. 6 Grading of zones Z1B and Z4 of relay B

7SA6 – protection relay B

Zone Z4 is graded in accordance with the R and X values of the overhead line. As usual, zone Z1B is dimensioned to approx. 120% of the line length. Because AR should not be executed in the cable section, the overhead line section in zone Z1B is selected by means of a CFC. The result of the CFC (FN°. 2703 : ">AR blk") is that auto-reclosure is blocked when a fault occurs in the cable section (i.e. pickup in Z1B and no pickup in Z4).

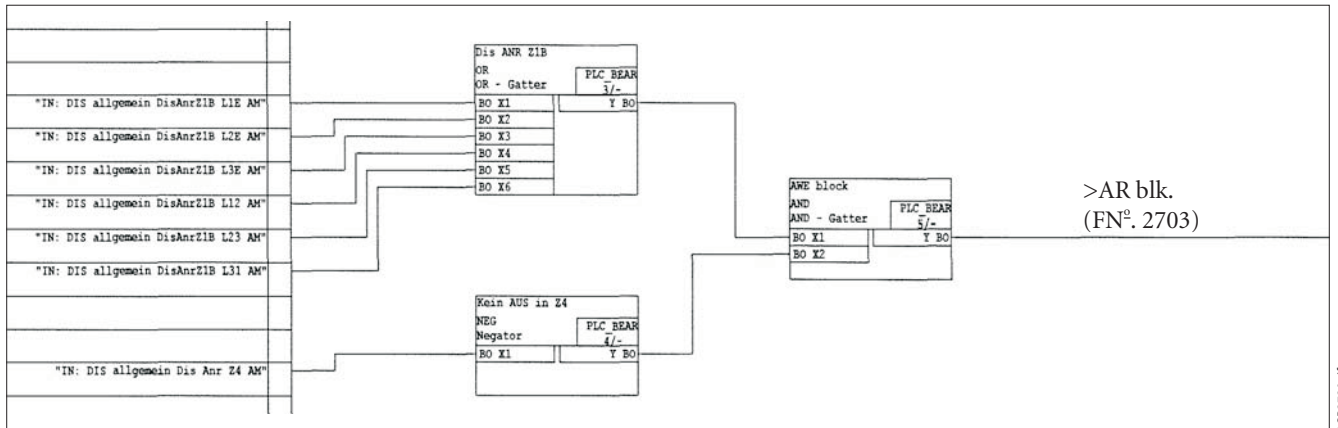


Fig. 7 CFC logic diagram for AR control for relay B

■ The special advantages

The division into two distance protection zones (Z1B and Z4) makes it easy to select the cable and overhead line sections in the event of a fault.

■ From practical experience

In practice, the auto-reclosure function can be executed on the overhead line only. A fault in the cable section immediately results in a lockout command.

A similar, slightly modified CFC function for application in an other distance zone was successfully implemented for the Stadtwerke Hannover AG.

■ Conclusion

In the past, sections could either be protected without any selectivity or else separate sections were required for the cable and overhead line sections. Today, thanks to CFC add-on logic, offered as standard feature of SIPROTEC the complete line length can be covered intelligently with 2 relays thus requiring much less primary technical outlay.