

The Numerical Advantage in Protection Technology

Intelligent protection systems spare LEW power supply company expensive power system expansion

The company

Lechwerke AG (LEW) is one of the largest regional power supply companies in southern Germany. Its core business consists of electric power supply and all related services. The area supplied by its power supply system covers 8,245 square kilometers and is mostly located in the provincial administrative district of Swabia. LEW also supplies electric power to some adjacent portions of Upper Bavaria.

To provide power to its 885,000 directly and 600,000 indirectly supplied customers, LEW maintains a medium-voltage system 7,198 kilometers in length, a 380/220/110 kV high-voltage system with a total length of 2,429 kilometers, and 104 transformer substations.

Initial situation

The Lechhausen substation feeds a fairly large municipal utilities company. In normal operation, the energy demand is met over a 380 kV/110 kV system interconnection from the 380 kV system. A second system interconnection exists as a backup transformer in the Lechhausen substation but remains disconnected in normal operation.

A rise in the municipal utilities company's power demand created the risk that a failure of the 380 kV/110 kV supply transformer would cause trips on faults due to power system overloads in the 110 kV system. This would interrupt the supply to the connected municipal utilities company.

To increase the power transmission from the 110 kV system in the Lechhausen substation, a substantial and costly power system expansion would have been called for. Among other requirements, an additional overhead line would have had to be looped into the Lechhausen substation, and the substation would have had to be expanded by two additional switchgear feeders with circuit-breakers.



Fig. 1 Gersthofen hydro power plant of LEW

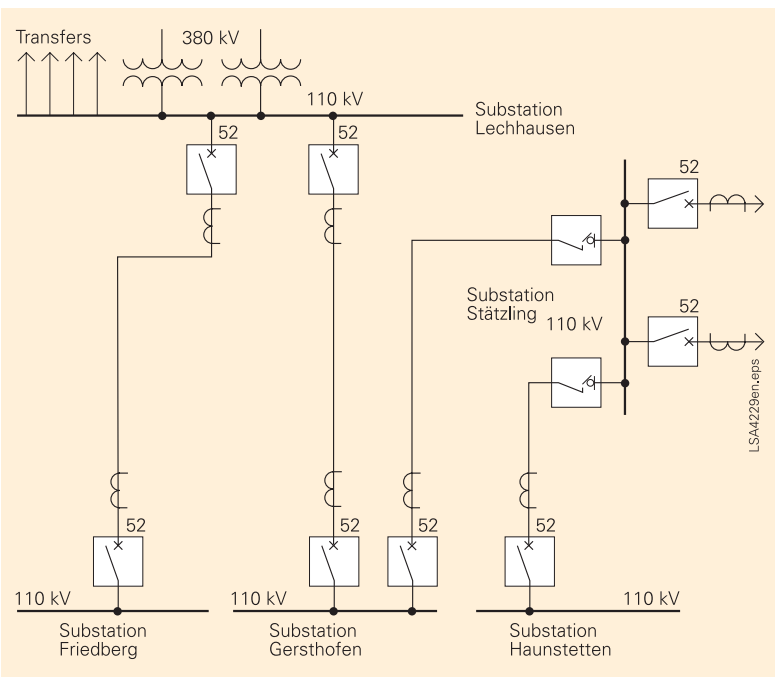


Fig. 2 110 kV power system configuration

■ The concept

In view of such high cost estimates, LEW developed an alternative concept that also effectively protects against a power failure – but at much less expense.

The solution was to integrate the Lechhausen substation via a dual tie line into the 110 kV power system, which resulted in a three and a four line-ends configuration. As a result, it was possible to increase the available level of power transferred from the 110 kV power system with the existing circuit-breakers and switchgear panels. A failure of the 380 kV/110 kV transformer can now be compensated by the 110 kV power system without causing power outages in the dependent municipal utilities company. The multi-end configuration also made it possible to increase the short-circuit power in the 110 kV power system and to optimize the load flow.

To provide selective and fast protection for this three and four line-end power system configuration it was necessary to expand the existing distance protection relays by a line differential protection relay capable of protecting even three and four line-ends.

The existing distance protection would not have been able to protect the new power system configuration selectively and swiftly in all cases. In combination with the line differential protection relay, the distance protection now also functions as backup protection.

Lechwerke decided in favor of the SIPROTEC 7SD52 multi-end differential protection relay, which can protect up to six line-ends. The existing distance protection was augmented by one 7SD52 differential protection relay per switchgear feeder.

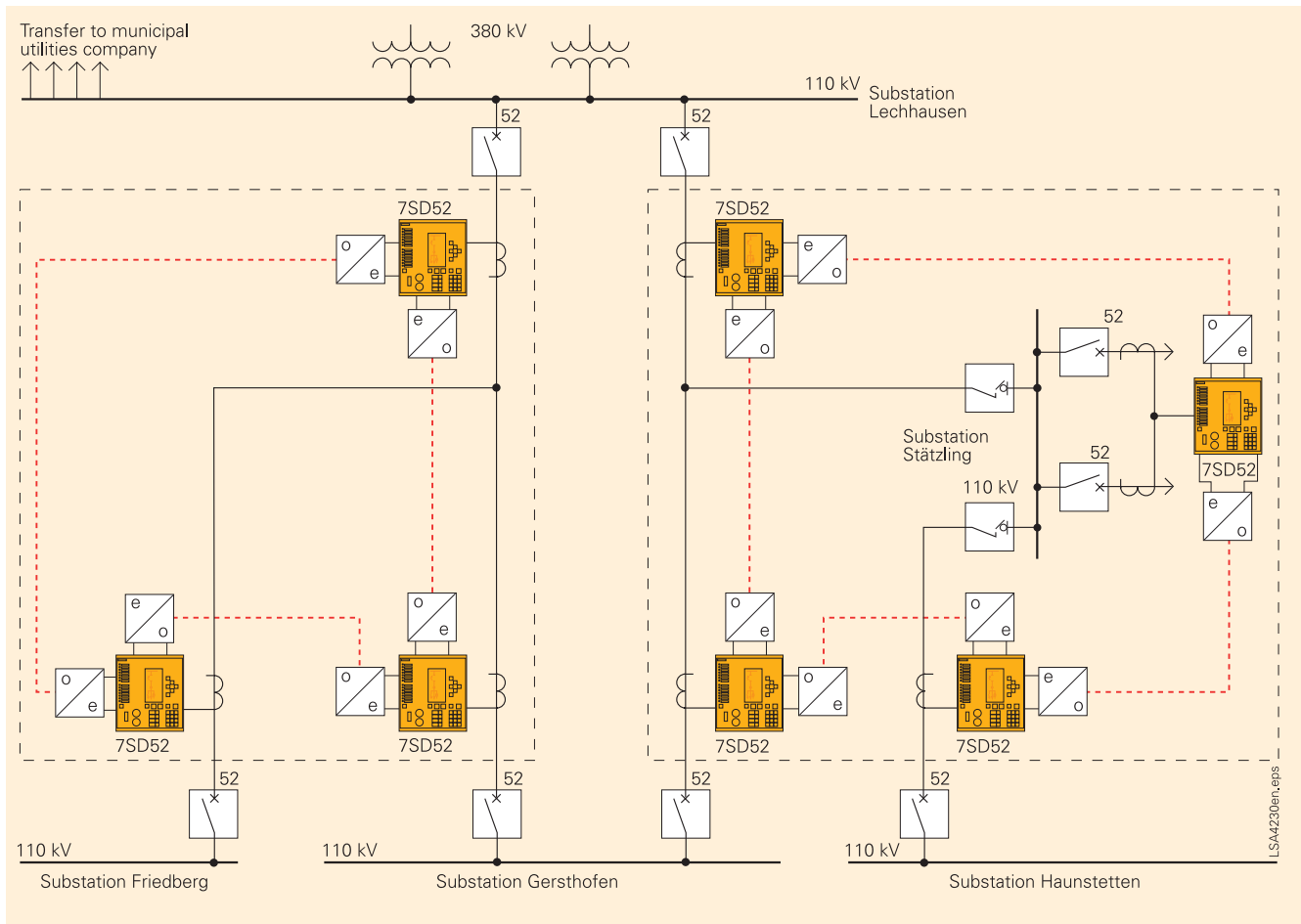


Fig. 3 Protection scheme of a three and four line-end configuration

No current transformers or circuit-breakers exist in the 110 kV lines at the Stätzling substation. If a fault occurs, the existing switch disconnectors in the feeders can't shut off the short-circuit current, which causes the line differential protection to trip the circuit-breakers of the transformers in such an event. The current is measured at the bushing-type current transformers of both transformers. The measured values are adjusted via a summation transformer and transmitted to the 7SD52. This adjustment via a summation transformer was feasible because the installed 7SD52 required very little power from the transformer.

Since no direct communication links exist between the different substations for the transmission of protection data, this is provided between the differential protection relays via a digital PCM (Pulse Code Modulation) communications network. The adaptation to the digital communications network in turn is implemented via external converters by means of a synchronous electrical X.21 interface to effect the connection to the communications devices. With these communication converters, two protection relays can communicate synchronously with each other and exchange large data volumes over long distances.

■ *The special advantages*

To further increase the availability of the system, Lechwerke decided to equip all of the installed 7SD52s with two R2R interfaces. As a result, each protection relay can exchange data with two neighboring relays – so that a ring topology can be established for the exchange of protection data.

Failure of a communications connection between two devices does not result in blocking of the differential protection function, since the devices detect this condition and re-route ring topology automatically to chain topology while the differential protection function is immediately reactivated.

■ *Conclusion*

Conversion of the existing 110 kV power system into a three and a four line-end configuration made it possible to increase the short-circuit power at the Lechhausen substation and to substantially improve the reliability of the power supply to the connected municipal utilities company, without requiring large investments in primary technology. The use of state-of-the-art SIPROTEC numerical protection technology made it possible to safely and selectively protect the resulting, complex power system configurations. The use of existing communication channels made it unnecessary to invest in new fiber-optic connections in the communications network.

