With Maximum Flexibility, Ready for Anything

SIPROTEC 4 line differential protection for five line ends and distance protection

The company

Providing area-wide power – and thus a basis for economic growth - is the job of the power supply company. This is why Vietnam's national power company Electricity of Vietnam (EVN) is constantly expanding its power supply system. A power plant complex is currently being built in the Phu My industrial park. Upon its completion, it will supply up to 3600 MW of power to the 500 kV and 220 kV transmission systems.

Siemens Power Generation (PG) is part of the project. "Phu My 3", currently Vietnam's largest private GUD power plant and located about 70 km southeast of Ho Chi Minh City, was commissioned by PG. Three power station units supply 720 MW to the extra-high voltage system.

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Fig. 1 Industrial area Phu My

The starting situation

The customer wanted a fully redundant protection system, plus a cost-effective solution for the long-distance transmission of trip commands to circuit-breakers at remote line ends. This requires that trip commands from the busbar and breaker failure protection relays be transmitted from the 500 kV station to the circuit- breakers upstream from the power station units via binary inputs on the protection relays. In the opposite direction, TRIP commands must be transmitted from the protection relay of the power station unit transformers and from the breaker failure protection to the circuit-breakers in the 500 kV station. For reasons of cost, no circuit-breakers were installed on the 500 kV side of the generator transformers. For protection purposes, optical fibers were integrated into the overhead earth (ground) wire of the 500 kV line.

The concept

Following an analysis phase, Siemens Power Automation Vienna presented a comprehensive protection system with the following components (see Fig. 4):

- One 7SD523 line differential protection relay and one 7SA522 distance protection relay for each of the two ends of overhead line 11. Both relay types are equipped with a fiber-optic connection.
- For the three ends of the protected zone, comprising overhead line 12 and the outgoing circuits of generator transformers T2 and T3, Siemens recommended three 7SD523 line differential protection relays and three 7SA522 distance protection relays. One optical ring is provided per protection relay for a dual redundant communication link.

SIPROTEC 4 line protection relays protect the power station's two major 500 kV outgoing cables. With a total of ten 7SD523 and 7SA522 line differential and distance protection relays, Siemens Power Automation (PTD PA) has designed a state-of-the-art, flexible protection system. Moreover, SIPROTEC 4 line protection relays can be interconnected via optical rings, meaning they can immediately detect a communication link failure. In a matter of milliseconds, the protection relays switch from the failed ring connection to a chain connection. Neither the protection functions nor long-distance signal transmission is affected by this fault, which is extremely important – especially when transmitting long-distance trip commands.

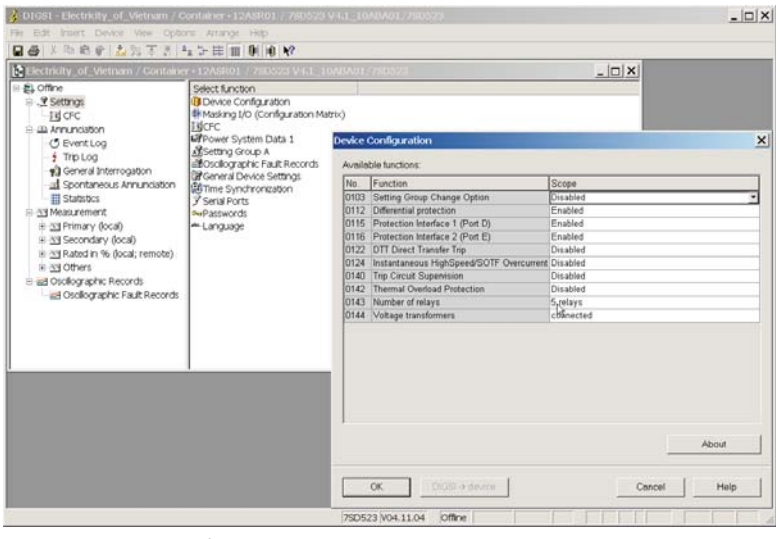

Fig. 2 Easy setting with DIGSI program

Fig. 3 Main and backup protection 7SD52 and 7SA522

Another innovative, detailed solution involves independent communication links for the long-distance signal paths used for transmitting trip commands. Transmission is via both the 7SD523 main protection relay and the 7SA522 backup protection relay.

■ *The special advantages*

Flexible, secure and fast thanks to pre-parameterization with DIGSI

The SIPROTEC 4 protection relays can be quickly and reliably adapted, based on the primary system's degree of completion. The parameter sets can already be prepared during the project planning phase. All the Siemens protection relays will be configured, parameterized, tested and safely commissioned with the aid of the DIGSI universal operating program.

■ *From practical experience*

Power transmission without a station

The flexibility of the SIPROTEC product range was of particular advantage in this project, making many things possible that would otherwise have been impossible. When the day appointed for the power station's commissioning finally arrived, for example, construction of the 500 kV station and new 500 kV transmission lines for transporting power to the metropolitan areas had not yet been completed. Consequently, our engineers decided to build a provisional structure next to the site of the new 500 kV station. Two transformers, each with 450 MVA transmission power, were temporarily installed to feed power from the Phu My 3 plant to the 220 kV power system via a nearby substation.

Power station test run under extreme conditions

But how can you hand over a power station to the customer unless you first test it at nominal load? The challenge: Transmit 570 MVA power from power station units 2 and 3 via 500 kV line 12 and the underdimensioned 450 MVA transformer. The solution: Connect the two 500 kV lines in parallel during the Phu My 3 test phase. This made it possible to use the standby capacity of the second 450 MVA transformer connected to line 11. However, if a short-circuit occurred while testing the overall system – comprising three generator transformers, two 500 kV lines, the two provisional transformers and connecting cables on the 220 kV side – the power could be shut down only by an emergency trip. It was therefore decided that the parallel connection of the two 500 kV lines would be dismantled once the test phase was over. Until the new 500 kV station is completed, the power station will be operated so as to prevent the provisional 450 MVA transformer connected to line 12 from being overloaded.

SIPROTEC 7SD523 and 7SA522 temporarily protect the transmission system with 5 line ends

Siemens Power Automation gladly accepted the challenge of protecting this 5-end system. The planning, setup and testing of the protection cubicles had already been completed when the owner issued a new request. In this case, the flexibility of the SIPROTEC relays permitted a fast and simple conversion to a protection system for five line ends.

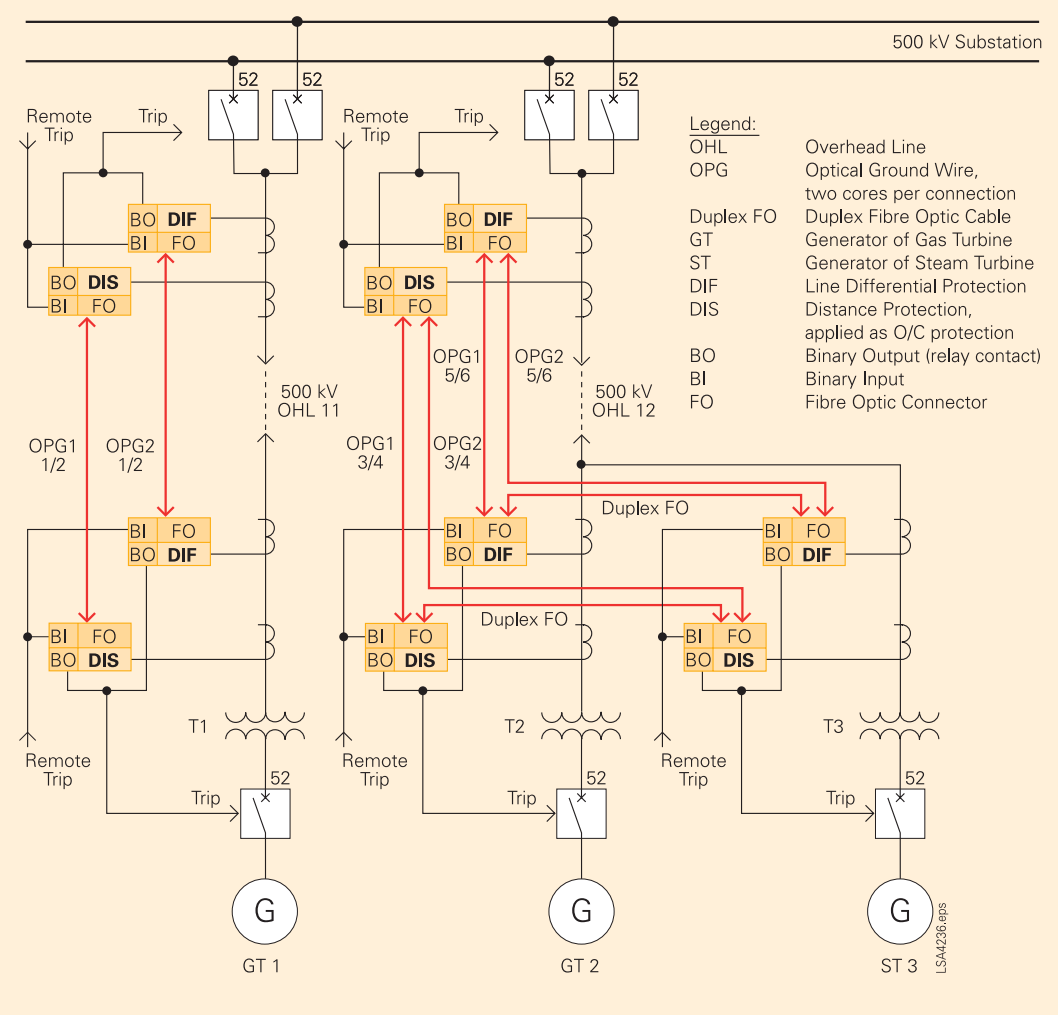

Fig. 4 Concept for the final scheme

The 7SD523 differential protection relays for multiple line ends can be connected to the 2- to 6-end protection system and parameterized at any time at no additional cost. The 7SA522 distance protection relays, in combinations of one two-end and one three-end optical link, can also be connected to the 5-end protection system via copper-wire connections and conventional contacts.

Within a very short time, the protection solution was ready for presentation to the customer and the protection system could be adapted to the primary system's modified topology in three phases at no substantial additional cost:

- Phase 1: Protection of the 5-end transmission system during the power station test phase.
- Phase 2: Protection of the 2-end and 3-end transmission systems with long-distance signal transmission of commands from the protection system of the provisionally installed 500 kV/220 kV transformers and provisional 220 kV circuit.
- Phase 3: Protection of the final 2-end and 3-end transmission systems.

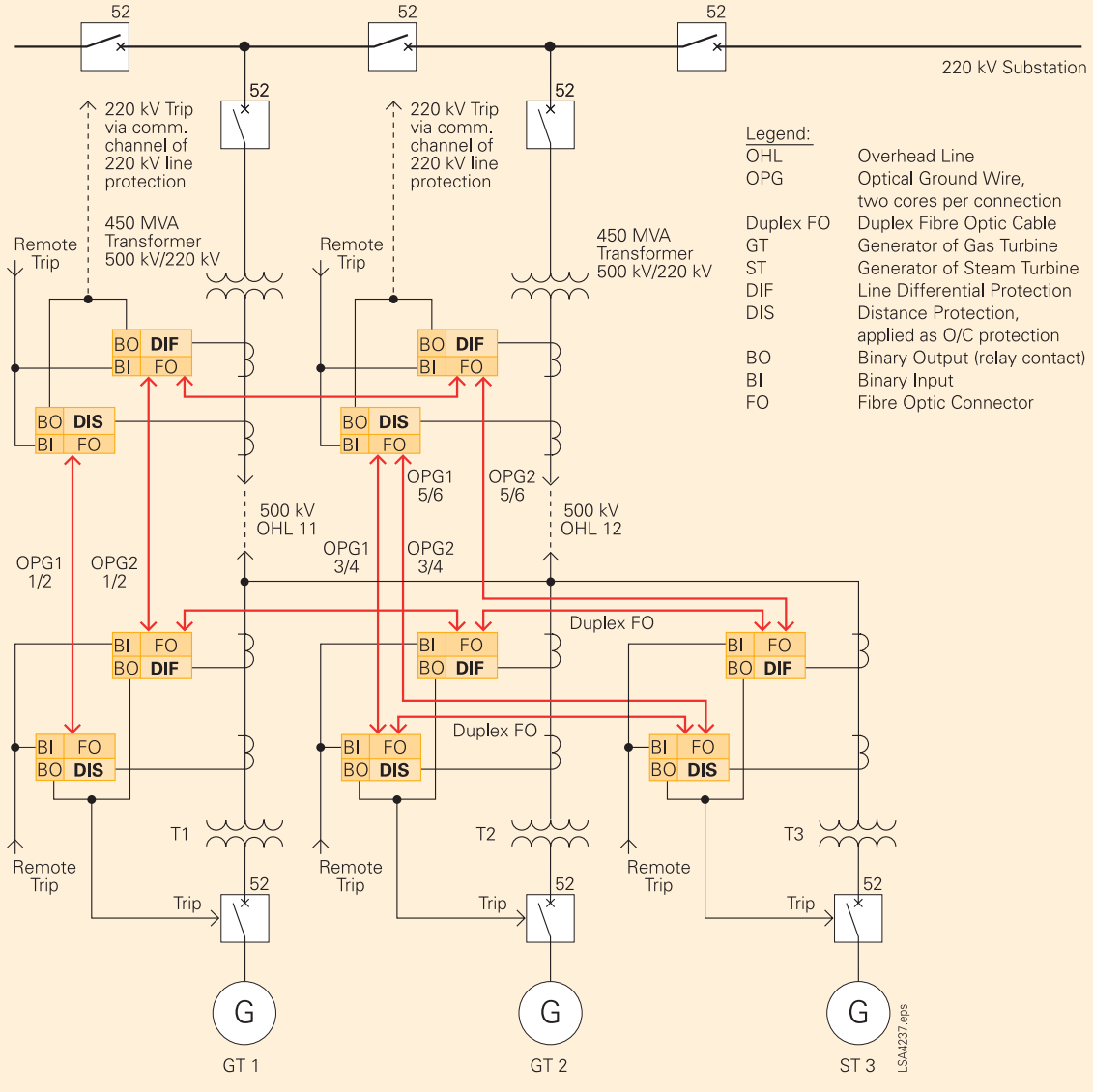

Fig. 5 Protection concept for the power station test phase

Conclusion

Thanks to the diversity of SIPROTEC relays and our engineers' expertise, we were able to significantly reduce the commissioning time for the finished power station, despite the fact that the infrastructure was not yet fully expanded. Vietnam's energy network was reinforced, providing a stronger basis for their booming economy.

Plus

The SIPROTEC relays have meanwhile been converted to the parameter set for operating phase 2. The power station was successfully tested and the parallel connection of the two transmission lines was dismantled. The protection commands from the SIPROTEC relays will now be transmitted to the 220 kV station until the 500 kV system has been completed.