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Research on Comprehensive Compensation Strategy for Long-distance Cable Traction Power System

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Abstract

The construction of electrified railway faces power quality problems dominated by reactive power and negative sequence due to the complex terrain and weak power grid structure in highland areas. To solve the problems, this paper discusses the technical scheme of Long-distance Cable traction power supply system (LCTPS) and its control strategy. Firstly, a Long-distance cable power supply model is constructed and a reactive power compensation scheme applicable to this system is designed. Then, a reactive power negative sequence compensation scheme is designed based on the theory of co-phase power supply. Furthermore, a comprehensive compensation control strategy was established based on IEEE standards. Finally, a simulation model is established to analyze the correctness of the compensation scheme and verify the effectiveness of the compensation strategy.

Reactive Power Compensation Scheme

The LCTPS consists of a central traction station, several ordinary single-phase traction stations, and a cable traction network. It can eliminate the neutral sections, which can effectively avoid the transient effects of over-phase trains and "slope stop" accidents. To consider the cost constraints, this paper adopts the compensation method of shunt reactor coarse adjustment and Static Var Generator (SVG) fine adjustment.

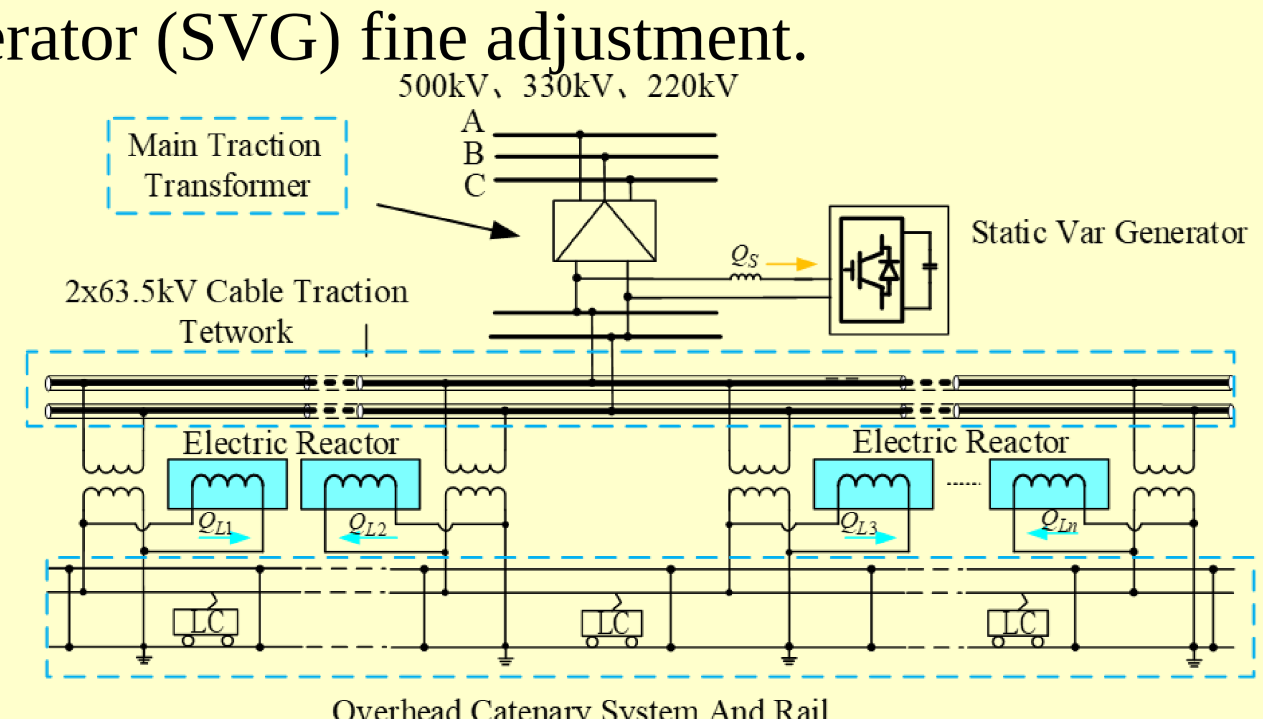

Fig.1 Reactive power compensation device of LCTPS

Negative Sequence Compensation Scheme

The core device of the reactive-type negative sequence compensation scheme is the SVG, which generates a compensation current at the primary side in the opposite direction of the load negative sequence current by controlling the reactive power magnitude of the SVG at each port, thus realizing the compensation of the negative sequence current.

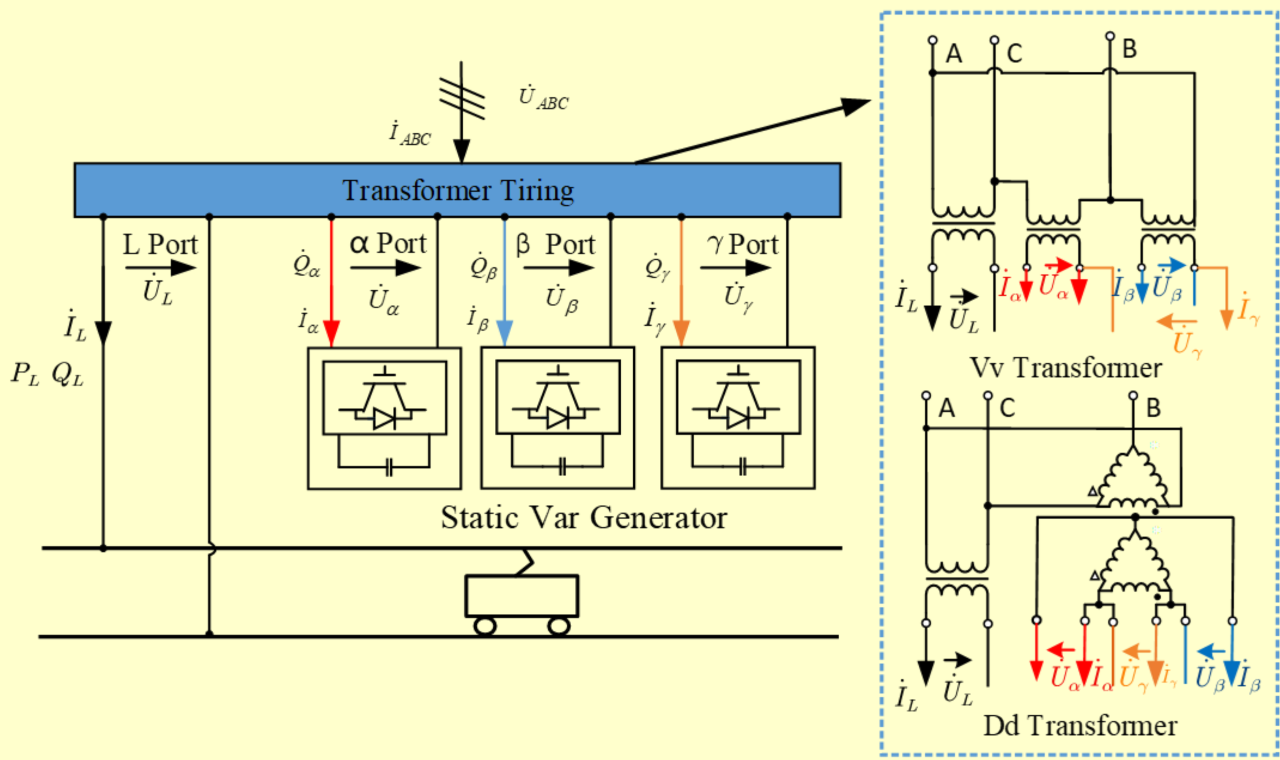

Fig. 2 Reactive negative sequence compensation device of LCTPS

Simulink Result

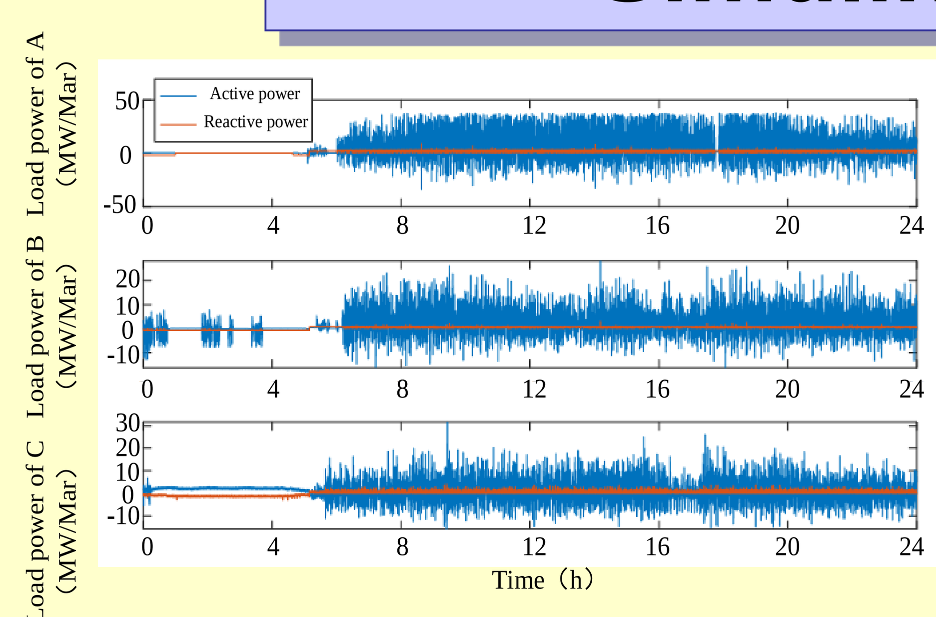

Fig. 3 Load fluctuation curves

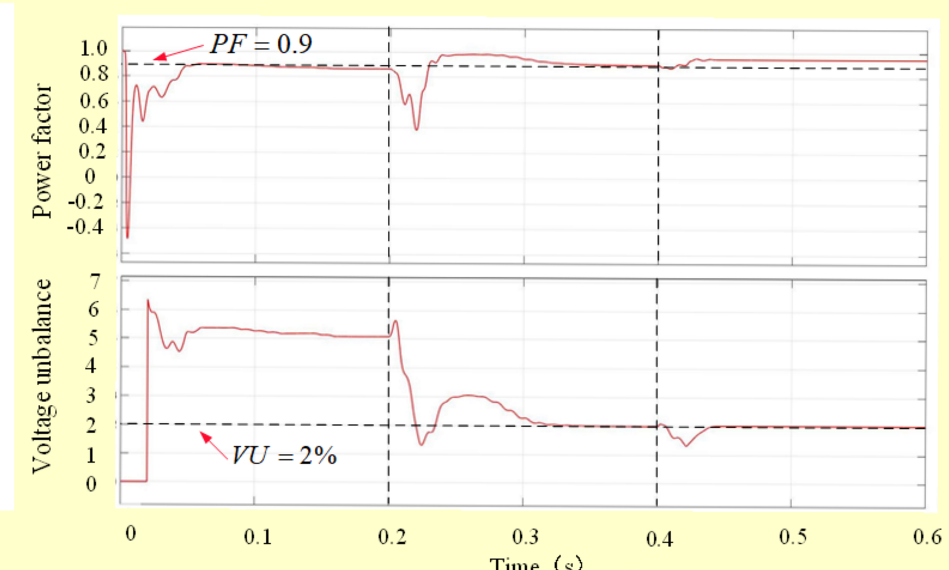

Fig. 4 Power quality of active-type

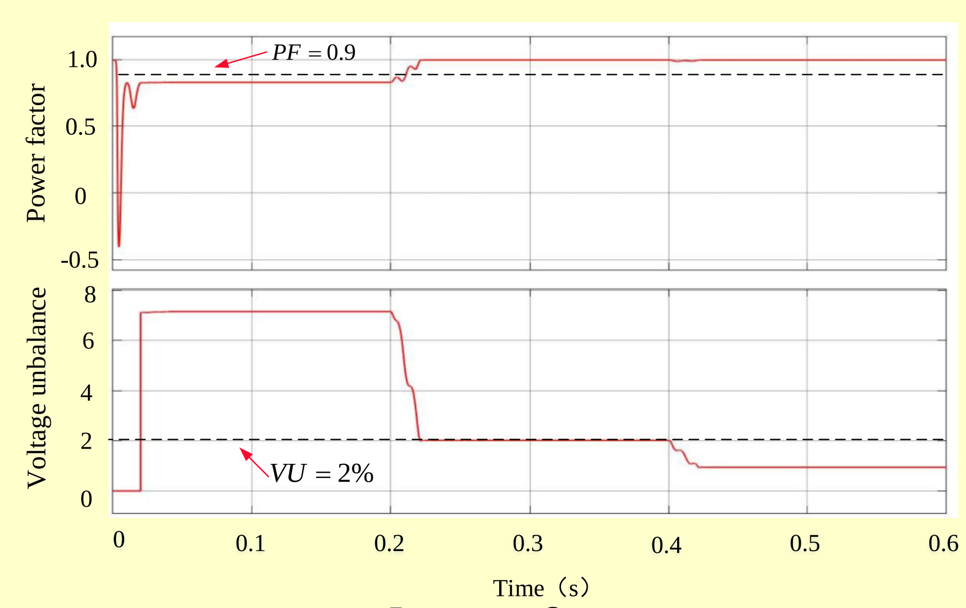

Fig. 5 Power quality of reactive-type

Table 1 Comparison of active-type and reactive-type

	Active-type		Reactive-type	
	Power factor	Voltage unbalance	Power factor	Voltage unbalance
Capacity	98.0MVA		67.8MVA	
0-0.2	0.86	5.10%	0.83	7.20%
0.2-0.4	0.90	2.00%	1.00	2.00%
0.4-0.6	0.95	0.98%	1.00	0.95%

Summary

This paper focuses on the comprehensive compensation scheme for LCTPS, analyzes the Long-distance Cable traction power supply model and designs a reactive power management scheme for LCTPS, designs a three-port reactive power type negative sequence compensation scheme based on the theory of interconnected power supply. The conclusions are as follows: cable power supply has more advantages than traditional power supply, but reactive power and negative sequence problems are still serious. In this paper, a comprehensive compensation scheme is designed for LCTPS with power factor and voltage unbalance as the compensation targets. The simulation results show that the scheme has good compensation effect and can save 30.8% of installed capacity. The technical solution of LCTPS provides important technical guidance for realizing long-distance traction power supply in the western region.