Ultra-high voltage direct current transmission relay protection



Overview

This book gives insights into protective relaying of UHV AC transmission systems and sheds light on the conundrum of protective relaying for the EHV systems.

Key Takeaways

Relay protection in UHVDC systems ensures rapid fault detection, isolation, and system stability for long-distance high-voltage DC transmission.

Overview of UHVD

C Relay ProtectionUHVDC transmission systems operate at extremely high voltages, often exceeding 800 kV, and are used to transmit large amounts of power over long distances with minimal losses. Relay protection in these systems is critical because DC faults can propagate quickly, potentially damaging converters, transformers, and transmission lines.

Unlike A

C systems, DC systems lack natural current zero crossings, making fault interruption more challenging.

Key Protection Components

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Converter Station Protection

Converter differential protection monitors the current entering and leaving the converter valves to detect internal faults. Valve protection relays detect overcurrent, overvoltage, and thermal overloads in thyristor or IGBT valves.

D

C bus protection isolates faults on the DC link to prevent damage to the converter and connected AC systems. Line ProtectionDC line current differential relays compare currents at both ends of the line to detect faults. Distance protection is less common in DC but can be implemented using voltage and current measurements to locate faults.

Pole-to-ground fault detection is essential in symmetric monopole configurations, minimizing earth return currents and environmental impact.

Auxiliary Protection

Overvoltage and surge protection safeguards against lightning and switching transients. Communication-assisted protection ensures rapid coordination between converter stations, often using fiber-optic links for high-speed signaling.

Protection Strategies

Fast Fault Clearance: DC faults must be cleared within milliseconds to prevent converter damage. Redundancy: Multiple relays and protection channels are used to ensure reliability. Coordination with AC Grid: UHVDC links are integrated with AC networks, requiring protection schemes that prevent cascading failures and maintain grid stability.

Adaptive Protection: Modern UHVDC systems use digital relays capable of adjusting settings based on operating conditions, load flow, and converter control modes.

Advanced Considerations

Symmetric Monopole Configuration: Reduces earth return currents and simplifies fault detection, as each pole operates at equal but opposite voltages relative to ground. Integration with FACTS and Storage: Relay protection must account for dynamic interactions with flexible AC transmission systems and energy storage devices.

High-

Speed Communication: Essential for differential and pilot protection schemes, enabling near-instantaneous fault detection and isolation.

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Conclusion

Relay protection in UHVDC systems is a sophisticated combination of converter, line, and auxiliary protection schemes designed to ensure rapid fault detection, minimize equipment damage, and maintain grid stability.

Modern UHVD

C systems leverage digital relays, high-speed communication, and adaptive algorithms to handle the unique challenges of DC transmission, particularly in symmetric monopole configurations and long-distance renewable integration.

Article Content

Fault Detection Method for Uhv Dc Transmission System Relay

First, transient fault characteristics of the UHV DC system are analyzed using fast Fourier transform (FFT), and key fault features are extracted via modal transformation and wavelet transform as input

A Novel High-Resolution Main Protection for Long-Distance LCC

Abstract Most long-distance transmission lines of 1000 km or above in China adopt ultra-high-voltage direct current (UHVDC) transmission, and their configured main and backup protections

Protection Technologies of Ultra-High-Voltage AC Transmission

This book gives insights into protective relaying of UHV AC transmission systems and sheds light on the conundrum of protective relaying for the EHV systems.

Ultra-fast current differential protection with high-sensitivity for ...

• An ultra-fast current differential protection for HVDC transmission line is proposed.
• The performance of the proposed protection method is verified.

High-speed main protection for multiterminal LCC-MMC-UHVDC

Case studies demonstrate that the proposed protection offers sufficient selectivity and a resistive tolerance of 600 ohms and boasts a speed of 0.2 ms, satisfying the requirements of 800 kV

Traveling Wave Differential Protection Technology and Its Application ...

This paper proposes a practical time-domain TWDP scheme specifically designed for high-voltage direct-current (HVDC) lines and provides both theoretical analysis and field validation.

Transmission Line Protection Theory

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The D90Plus Line Protection System and the D60 Line Distance Relay handles the challenge of dual-breaker line terminals by supporting two three-phase current inputs to support breaker failure,

Power-line communication

Power-line carrier communication (PLCC) is mainly used for telecommunication, tele-protection and tele-monitoring between electrical substations through power lines at high voltages, such as 110 kV, 220

Protection Technologies of Ultra-High-Voltage AC Transmission Systems ...

Description Protection Technologies of Ultra-High-Voltage AC Transmission Systems considers the latest research on UHV, UHV transmission line electromagnetic field, transmission line parameters,

Research on over-voltage characteristics of ultra high-voltage direct ...

Abstract Load dumping overvoltage has a significant effect on insulation coordination of direct current (DC) transmission system. Based on the PSCAD/EMTDC electromagnetic transient

Generation mechanism and influencing factors of transie

The transient overvoltage caused by faults in ultra-high-voltage direct current (UHVDC) transmission lines and alternating current (AC) systems can adversely affect system safety and stability. This

Modeling and Fault Characteristics Analysis of Ultra High Voltage ...

Therefore, conducting in depth analysis of the control and fault characteristics of high voltage direct current transmission systems holds significant theoretical and practical significance.

Development and prospect of UHV transmission technology

Since the first ultra-high voltage (UHV) project was completed and put into operation in China in 2009, UHV transmission technology has been tested, validated, widely promoted and

HVDC Transmission: Technology Review, Market Trends and Future

Close coordination between investing bodies in High-Voltage transmission infrastructure and end users should be maintained when building new large-scale HVDC links, to avoid possible

Improving the Performance of Power Transmission via Ultra High Voltage ...

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It is the key to improve the efficiency of transmission in the grid network. And the feasibility of applying Ultra High Voltage Direct Current (UHVDC) transmission to improve efficiency reliably is adequately

Fault Detection Method for Uhv Dc Transmission System Relay Protection ...

To address the challenges in traditional ultra-high voltage direct current (UHV DC) protection, including low accuracy in detecting high-resistance faults, long detection time, and inadequate fault pole

Master-slave control strategy of the cascaded

1 INTRODUCTION The ultra-high voltage direct current (UHVDC) system is widely applied in long-distance transmission lines because of its

A comprehensive review of DC fault protection methods in HVDC ...

High voltage direct current (HVDC) transmission is an economical option for transmitting a large amount of power over long distances. Initially, HVDC was developed using thyristor-based

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