Adding directional elements to relay protection



Overview

Costello, Schweitzer Engineering Laboratories, Inc. Abstract—Phase and ground directional elements are relied on for fa. t and secure protection throughout the power system.

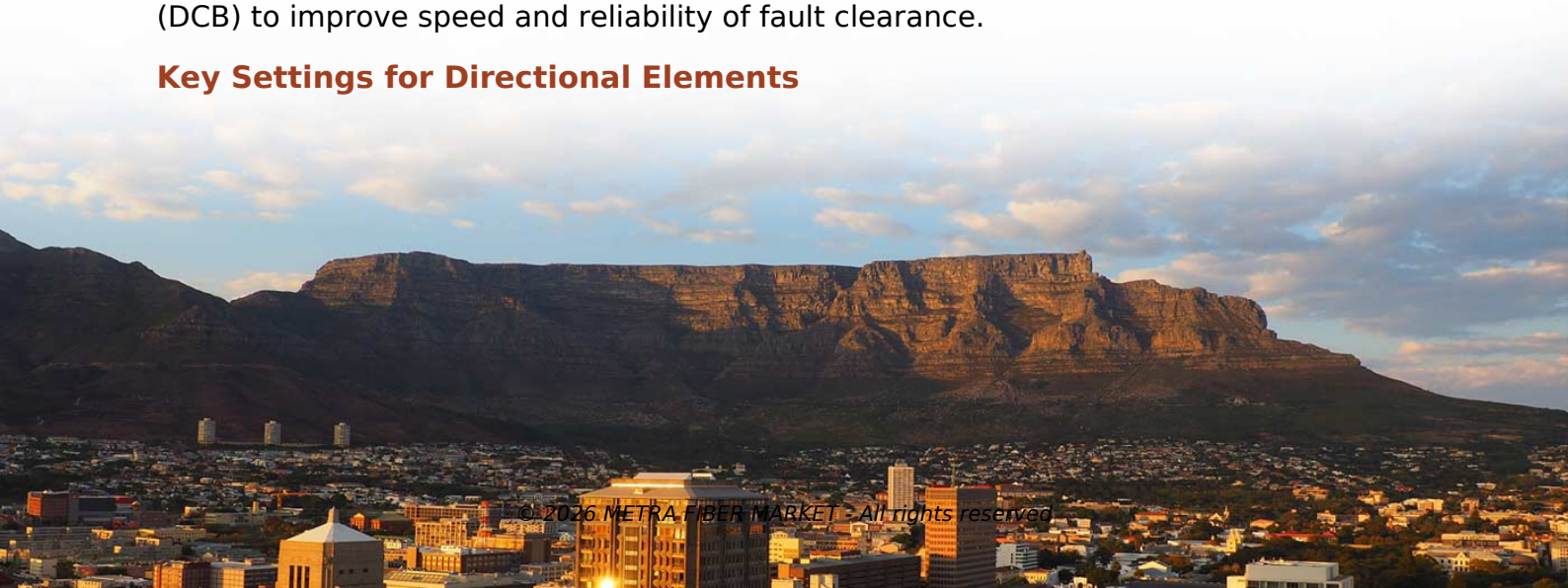
Key Takeaways

Directional elements in relay protection are set by defining forward/reverse operating sectors, pickup currents, and phase angles to ensure secure and selective fault detection.

Purpose of Directional Elements

Directional elements are used to determine the direction of fault currents in a network, which is critical for selectivity and security in overcurrent and distance protection schemes. They are essential in looped or networked systems, where non-directional relays could misoperate due to bidirectional fault currents. Directional elements are commonly paired with overcurrent or distance relays in schemes like Permissive Overreaching Transfer Trip (POTT) and Directional Comparison Blocking (DCB) to improve speed and reliability of fault clearance.

Key Settings for Directional Elements



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Operating Sector (Forward/Reverse)Define the forward and reverse sectors in degrees relative to the polarizing voltage or current. This ensures the relay operates only for faults in the intended direction and blocks for reverse faults. Typical Relay Characteristic Angle (RCA) settings: Solidly grounded networks: +60° to +75° (lagging/inductive)Isolated networks: -90° (leading/capacitive)Compensated networks: 0° (unity/resistive), The sector can be extended or retracted using minimum/maximum forward and reverse angle settings to accommodate capacitive or resistive fault currents.

Pickup Current

Set the pickup value based on system studies and fault current calculations. For overcurrent directional relays, this is typically a percentage above the maximum load current to avoid nuisance tripping. Example: 120% of line primary current for phase overcurrent, 125 A for earth fault protection with a time delay of 0.

8 seconds.

Time Grading

Time delays are coordinated with upstream and downstream relays to maintain selectivity. Ensure a minimum grading margin after accounting for relay and breaker tolerances. Zone 2 and Zone 3 distance elements are set considering adjacent line fault clearance times and breaker operating times.

Coordination

In ring or networked configurations, only the closest relay to the fault should assert forward. Reverse elements supervise or block to prevent unnecessary remote trips. Directional elements also supervise distance elements to prevent forward elements from tripping for reverse faults due to residual currents or phase effects.

Practical Testing and Validation

Use secondary injection testing with a multifunctional test set to verify forward and reverse operation, pickup, drop-off, and time grading. Check CT/PT polarities and reference voltages before testing to ensure accurate angle measurements. Document settings including CT/VT ratios, operating sectors, and coordination tables for repeatable and auditable testing.

Summary

Setting directional elements involves: Defining forward/reverse operating sectors with appropriate angles. Selecting pickup currents based on system studies. Coordinating time delays with other relays.

Validating through secondary injection testing. Adjusting for network type (grounded, isolated, compensated) and fault characteristics to ensure secure and selective protection.

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Article Content

Fundamentals and Improvements for Directional Relays

Costello, Schweitzer Engineering Laboratories, Inc. Abstract—Phase and ground directional elements are relied on for fa. t and secure protection throughout the power system. Although directional relays

The essentials of directional protection and selectivity in modern ...

And because of this, the usage of directional protection is important in order to avoid disconnection of unnecessary circuits. As normal overcurrent relays cannot provide this function, a

Directional Elements In Power System Protection

In these applications, modern directional elements provide an output signal to control the operation of the sensing elements or a restraining torque in the case of electromechanical relays....

Use of Directional Elements at the Utility-Industrial Interface

Reverse power elements and directionally supervised overcurrent elements are often employed at the utility-industrial interface by industrial and utility engineers. Im-proper selection and setting of such

Directional Element Design for Protecting Circuits with Capacitive ...

Abstract— This paper, based on real world event data, introduces a state of the art directional element that has been proven to prevent many of the commonly reported mis-operations caused by

Directional protection and directional

This White Paper describes the sense, the potentials and the use of directional protection and directional zone selectivity functions, hereafter called “D” and “SdZ D” respectively.

Practical handbook for relay protection engineers | EEP

Also principles of various protective relays and schemes including special protection schemes like differential, restricted, directional and distance relays are explained with sketches.

Directional Over Current & Non Directional Over Current Protection ...

Therefore, it is necessary to make the relay respond for a particular defined direction, so that proper discrimination is possible. This can be achieved by introduction of directional control elements.

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Directional Relays | Features of Directional Relays

Directional Relays: Selective protection cannot be achieved with time graded overcurrent protection systems in ring or loop systems as well as in radial circuits with two end power supply. A directional

Directionality Concepts for Overcurrent Relay Applications

This paper will provide a brief discussion on past polarization methods on EM relays but will highlight newer, more reliable, directional functionality available in microprocessor relays.

Use of Directional Elements at the Utility-Industrial Interface

This paper reviews applicable standards and references, and describes the reasons for installing various protective elements at the utility-industrial interface. The paper also reviews the operating

Directional Element Design and Evaluation

Directional elements are fundamental to protection-scheme security and selectivity, performing such critical tasks as supervising distance elements and controlling overcurrent elements.

Directional Control in Protective Relays | How to Set Directional ...

Directional Control in Protective Relays | How to Set Directional Elements in SEL Protective Relays Romero Engineering Company 18K subscribers 246

Types of Electrical Protection Relays or Protective Relays

Operating Principles: Protective relays operate by detecting abnormal signals, with specific pickup and reset levels to start or stop their action. Application in Power Systems: Primary

Impedance-Based Directional Elements Why Have a Threshold Setting?

Impedance-Based Directional Elements – Why Have a Threshold Setting? Ryan McDaniel and Michael Thompson, Schweitzer Engineering Laboratories, Inc. Abstract—Determining the direction of a fault

Impedance-Based Directional Elements

75th Annual Conference for Protective Relay Engineers, March 2022 Originally presented at the 48th Annual Western Protective Relay Conference, October 2021 1 Impedance-Based

Directional Elements in L-PRO 4000

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This directional control for overcurrent elements is coming from bus and transformer protection practice (used in our B-PRO and T-PRO relays). An important consideration for setting this Directional

DIRECTIONAL PROTECTION

The IEEE device number used to signify a directional element is 67-directional overcurrent, generally based on the phase relationship of V (voltage) and I (current), with no distance to fault capability.

Related Video Reference

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This document is for preliminary research. Verify specifications against current standards, product documentation and project requirements.

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